Project Millennium Application

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

Volume 1
Project Description

April, 1998

Project Millennium
Taking Suncor into the 21st Century

SUNCOR
ENERGY

OIL SANDS

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April 21, 1998

HAND DELIVERED

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Dear Sirs:

Re: Applications for the Suncor Millennium Project

Suncor Energy Inc. (Suncor) applies to the Alberta Energy & Utilities Board (AEUB) pursuant to Section 14 of the *Oil Sands Conservation Act* (OSCA) to amend Approval No. 8101, as follows:

- to modify the existing scheme for the recovery of oil sands including modifications in access, ore transport, extraction, tailings handling, upgrading, utilities and support infrastructure to sustain an increase in production to a minimum level of 12 185 000 m^3 of oil products in each calendar year by 2002;

- to operate an expanded Steepbank Mine based on a thirty-year mine plan; and

- to revise the integrated reclamation plan for the mine on Lease 86/17 and the expanded Steepbank Mine.

Suncor also submits the Project Millennium Environmental Impact Assessment (EIA) Report (Report) to the Alberta Director of Environmental Assessment (Director) for his review, pursuant to Section 48 of the *Alberta Environmental Protection and Enhancement Act* (AEPEA) and for a decision, in due course, by the Director that the Report is complete pursuant to Section 51 AEPEA.

Suncor also seeks approval from Alberta Environmental Protection to modify the existing Fort McMurray oil sands processing plant and to modify reclamation of the associated oil sands mines as proposed in the application enclosed. Accordingly, Suncor applies pursuant to Sections 64 and 67 of AEPEA for an amendment to the existing approval No. 94-01-00, as amended.

Suncor also seeks approval from Alberta Environmental Protection pursuant to section 11 of the *Water Resources Act* (WRA) to amend the Licence to Divert and Use Water Nos. 27549 and 27551 to increase the allocation for water diversion in the course of mine development and operation to 17 790 000 cubic metres (14,500 acre-ft) annually, and to amend Interim Licence No. 10400 to increase the consumptive use for industrial processing to 21 170 000 cubic metres (17,200 acre-ft) annually.

This joint application has been developed to combine all information required under the OSCA, AEPEA and WRA as well as information for associated applications under the *Hydro and Electric Energy Act, Pipeline Act,* and the *Electric Utilities Act* into one document to facilitate and expedite the regulatory review of Project Millennium. Section A5, Volume 1 contains a checklist of the information and requirements for the amendments to the approvals under OSCA, AEPEA, WRA and the approved Terms of Reference for the EIA.

Other applications under provincial statutes will be submitted separately to the agencies having jurisdiction. These incidental applications include approvals for surface dispositions under the *Public Lands Act* and rulings under the *Alberta Historical Resources Act.*

All communications on these applications should be directed to:

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PROJECT MILLENNIUM

APPLICATION

Suncor Energy Inc.,

Oil Sands

April 1998

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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 heterocycle
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

A INTRODUCTION

Suncor Energy Inc. is applying for regulatory approval to proceed with the construction, operation and reclamation of the proposed Project Millennium located at its current operations near Fort McMurray in the Regional Municipality of Wood Buffalo in northeastern Alberta. On 31 July 1997, Suncor released a disclosure document for the proposed project. Since then, a comprehensive public and regulatory consultation and communication program as well as an Environmental Impact Assessment have been underway in parallel with engineering studies.

This document comprises the application for approval of Project Millennium and serves to meet requirements under the Alberta Oil Sands Conservation Act and the Alberta Environmental Protection and Enhancement Act. It also includes the Environmental Impact Assessment.

A1 CORPORATE OVERVIEW

In 1992, Suncor Energy Inc. (Suncor) unveiled a strategic plan to improve its long-term profitability and to make its production costs competitive with those of Canada's top producers of conventional crude oil. The series of initiatives announced by Suncor at the time was intended to make its oil sands business economically viable and environmentally responsible, as well as to ensure that oil sands operations would be sustained well into the twenty-first century.

The strategy included:

- a change in mining technology
- expansion of plant design capacity
- acquisition of additional oil sand leases
- enhancement of revenues through product mix
- improvements in environmental performance

By 1997, this strategy had achieved operating costs averaging $14.75/bbl, providing confidence in the long-term viability of sustained oil sands production. Production capacity increased—from 60 000 bbl/d in 1992 to 85 000 bbl/d by the end of 1997—through capital and operating improvements in the mine and fixed plant. Concurrent with these production increases, Suncor has achieved dramatic reductions in air emissions and improvements in energy efficiency and has implemented a dry landscape reclamation technology.

Steepbank Mine and Fixed Plant Expansion will increase production capacity to 105 000 bbl/d by late 1998, and in 2001 the Production Enhancement Phase (at an estimated cost of $190 million) will further increase capacity to 130 000 bbl/d. These increases will be realized by changing plant processes and optimizing the capacity of certain plant units.

The proposed Project Millennium will increase the annual operating capability of Suncor's oil sands facility to a minimum of 210 000 bbl/d by 2002. Sufficient reserves have been acquired to sustain that rate for over thirty years. The projects estimated $2 billion cost includes an expansion to Steepbank Mine, additional bitumen extraction capacity and a second upgrading train.

Through a comprehensive consultation program, Suncor provided residents of the region and other stakeholders with continuing opportunities to ensure the best project decisions were made and that economic benefits are balanced with environmental responsibilities. This commitment to address the needs of all community interests resulted in an overall project design which will:

- reduce emissions for each unit of production
- reduce energy intensity
- decrease water use over the long term
- continue with an integrated reclamation plan which will eliminate the long-term storage of liquid fine tailings and return the land to pre-development capability

In addition to maintaining Suncor's current workforce of 1 600 full-time employees and 380 contractors, Project Millennium will result in the creation of about 800 direct jobs and 1 200 indirect jobs. The on-site construction work force will be about 2 500 to 3 000 peaking in the year 2 000.

Average annual operating expenditures for Project Millennium are estimated at $285 million (incremental). Suncor's target to acquire goods and services from locally-owned businesses will generate substantial economic benefits for both the Regional Municipality of Wood Buffalo and the Province of Alberta.

A project of this magnitude will not be without social impact. Suncor is striving to ensure any adverse impacts will be minimal and short-lived. A heightened level of collaboration among developers, government institutions and the local communities is acting to mitigate social and environmental impacts from the cumulative effects of a number of announced oil sands projects. This collaboration manifests itself in many ways including: community planning; joint cumulative effects assessment; cooperative effects monitoring; regional infrastructure planning and coordination; and facilitation of advance funding for infrastructure. The project will increase the Municipality's assessment base (and thus its fiscal capacity) in the order of 30 to 35 percent.

A1.1 Suncor Energy Inc.

Suncor Energy Inc. is a growing Canadian integrated oil and gas company with international interests and assets of $3.5 billion. The company employs 2 350 people domestically in three operating divisions.

Oil Sands (based near Fort McMurray, Alberta) mines and extracts oil sands and markets high-quality crude oil products. Exploration and Production (based in Calgary, Alberta) explores for and produces natural gas and conventional crude oil. Sunoco (based in Toronto) refines and markets transportation fuels, petrochemicals and heating oils with a retail network in Ontario.

Internationally, construction has begun at the joint-venture Stuart Shale Oil demonstration plant in Queensland, Australia. Initial production of 4 500 bbl/d from the $225 million demonstration plant is targeted for the end of 1999.

Suncor is a publicly-traded company with shares traded on the Toronto, Montreal and New York Stock Exchanges.

Suncor believes that its future success depends on its ability to become a "sustainable energy company". This means caring about maintaining a healthy environment, economy and society. By demonstrating responsible action and leadership in these areas, Suncor will continue to earn its licence to operate and grow.

A1.2 Suncor Energy Inc., Oil Sands

Suncor pioneered commercial development of the Athabasca oil sands in 1962 as Great Canadian Oil Sands Ltd. and in 1967 began operation of the world's first commercially-successful oil sands mining and upgrading facility. Suncor's mine ranks as one of the five largest in Canada.

The Oil Sands operation is located within the Athabasca oil sands deposit, from which a viscous, tar-like substance called bitumen is extracted. The mine's ore body lies beneath an overburden of muskeg, sand, clay and silt. Large shovels excavate the bitumen-laden sand and heavy haulers carry it from the pit, dumping the ore into sizers to break up the lumps. From there, mine ore enters the Extraction plant, where bitumen is separated from sand. In the Upgrading plant, bitumen is heated, cracked and separated into three petroleum distillates: naphtha, kerosene and gas-oil. These components can be hydrotreated and custom-blended into a variety of products ranging from light, sweet crude oil to sour distillate to diesel fuel. Energy for the operation is provided by the Energy Services plant, which generates electricity, steam and process water for the entire site. Suncor Oil Sands products are marketed domestically and in the United States through a pipeline network.

Throughout its history, Suncor has implemented innovative and practical technologies to develop the potential of the vast Athabasca oil sands deposit. Despite engineering challenges, fluctuating oil markets and turbulent economic events, the company has remained committed to the oil sands industry, considering it an abundant and increasingly important source for Canada's energy future.

Suncor's commitment begins with the people of the Regional Municipality of Wood Buffalo. Since the early 1960s, the company and its employees have supported the local community in the development of a mature community infrastructure. Suncor's partnership with the community continues through support of regional initiatives such as local health, civic, educational, cultural and environmental activities.

A1.3 Economic Viability

The oil sands are a national resource and may soon become the main source for Canada's long-term fuel supply as conventional supplies are declining. Oil sands products are in demand both domestically and in the United States, and Suncor is in a position to increase its oil sands production further. For the company's long-term economic viability, Suncor must ensure its oil sands operation can compete with North America's leading low-cost producers of conventional crude. Suncor's efforts make this resource a valuable and key part of Canada's economic success and energy self-sufficiency. Key accomplishments of the 1992 strategy include the following:

- Production costs in 1997 ($14.75/bbl) were nearly $5.00/bbl lower than in 1992 as a result of technology improvements and increased production.
- Production rose from 60 000 bbl/d in 1993 to 85 000 bbl/d by the end of 1997 through increased capacity of various units within the mine and fixed plant, accompanied by improvements in environmental performance.
- A daily average production goal of 105 000 bbl/d and further environmental improvements through the Fixed Plant Expansion and Steepbank Mine projects are on track for full production by late 1998.

- A commitment to install the Production Enhancement Phase (PEP), which will further increase production to 130 000 bbl/d in 2001.
- Additional oil sands leases were acquired to sustain oil production well into the twenty-first century.
- Market development has secured long-term demand for Suncor's products, both domestically and in the United States.
- Improved environmental performance.

The economic viability of Suncor's oil sands operation has been demonstrated. Project Millennium is expected to further enhance economic viability through:

- increasing company revenues through higher sales volumes and increased prices as a result of meeting customer needs
- reducing unit operating costs through technology enhancements, operating efficiencies and economies of scale
- implementing environmental and technological enhancements that improve Suncor's ability to meet stakeholder expectations into the future
- integration with other potential Suncor initiatives including other Suncor, Athabasca and Cold Lake Leases and pipeline arrangements

After full production is reached, Project Millennium operating costs (including sustaining capital), are expected to average $10/bbl to $11/bbl. The lower operating costs further improve the competitiveness of oil sands production in the marketplace, reduce the vulnerability of the operation to world oil price volatility and secure the company's future.

A1.4 Environmental Protection

Suncor has developed the "We Care" environmental policy which is incorporated into all aspects of its activities. Environmental management involves continuous improvement through planning and disciplined implementation at all levels to eliminate, minimize or mitigate the impacts associated with its operations.

Since 1992, Suncor has accomplished the following environmental improvements:

- Completion of a $15 million upgrade to the sulphur plant (in 1994), increasing sulphur recovery from 96% to 98%.

- Odour abatement enhancement (in 1995) with the installation of a vent collection and treatment system on the diluted bitumen storage tankage, the secondary Extraction plant and the Naphtha Recovery Unit (NRU) at a cost of $15 million.

- Further reductions of sulphur dioxide emissions with the 1996 startup of a $190 million Flue Gas Desulphurization unit to treat Energy Services plant stack emissions. In tandem with improvements in the sulphur plant this project reduced overall plant-wide sulphur dioxide emissions by approximately 75% from 1995 levels. Suncor received an Emerald Award (in the large business category) from the Alberta Foundation for Environmental Excellence in 1997 in recognition of this dramatic improvement.

- Technology and energy utilization improvements have reduced the emission of greenhouse gases from the operation per unit of production. While oil production increased by 37% from 1990 to 1997, greenhouse gas emissions increased only 5 percent.

- The application of new technology to consolidate tailings (produced by the extraction process) commenced in late 1995. This technology has been commercially demonstrated by Suncor and will produce tailings which can be reclaimed to a dry state.

At Suncor, environmental management systems include planning and program implementation to mitigate the impacts associated with operations. Suncor has developed a comprehensive environmental compliance and assurance process which is integrated throughout all areas of the business. Life cycle analysis and eco-efficiency determinations are being incorporated into project design and decision-making at all levels.

Additional precautions are being taken during the planning and construction phases to ensure the minimization of any environmental impact resulting from Suncor's activities. For Project Millennium, the Environmental Impact Assessment (EIA) terms of reference were established through public investment process, and consultation with stakeholders is as a continuing process.

Suncor's commitment with Project Millennium is to continuously maintain and build upon the stakeholder relationships and environmental improvements that were achieved as part of the Steepbank Mine and Fixed Plant Expansion projects.

A2 PROJECT OVERVIEW

A2.1 Project Millennium Scope

Suncor's oil sands activities, 35 km north of Fort McMurray (Figures A2-1 and A2-2), straddle the Athabasca River. The present operations are situated on the west side of the river and include Lease 86/17 Mine (which commenced operation in 1967) and a Base plant comprising Extraction, Upgrading and Energy Services. A new development linked by a bridge (commissioned in 1997) over the Athabasca River is situated on the east side of the river. This development, which includes Steepbank Mine, Steepbank ore preparation plant and a service complex, will commence operation in late 1998.

Steepbank Mine, together with Fixed Plant Expansion Project (to be commissioned in mid-1998) will boost Suncor Oil Sands production capacity to 105 000 bbl/cd from the current 85 000 bbl/cd by year-end. The Production Enhancement Phase will raise production in increments to the 130 000 bbl/cd level in 2001.

Project Millennium will further increase the production capacity of upgraded crude oil products to a minimum of 210 000 bbl/cd by 2002, through the expansion of Steepbank Mine and additional plant capacity.

At a cost of $2 billion, the scope of Project Millennium includes all activities required to plan, construct and operate a major facility expansion. These activities include:

- an expansion of Steepbank Mine
- Millennium Extraction plant (a second primary separation plant) located on the east side of the Athabasca River to produce raw bitumen
- raw bitumen pipeline to the existing Base Extraction plant
- modifications to the Base Extraction plant to clean the raw bitumen and produce a diluted bitumen product
- a second upgrader train to produce a slate of upgraded crude oil products
- modifications and additions to Energy Services steam and power generation, as well as other infrastructure to facilitate the increased production level

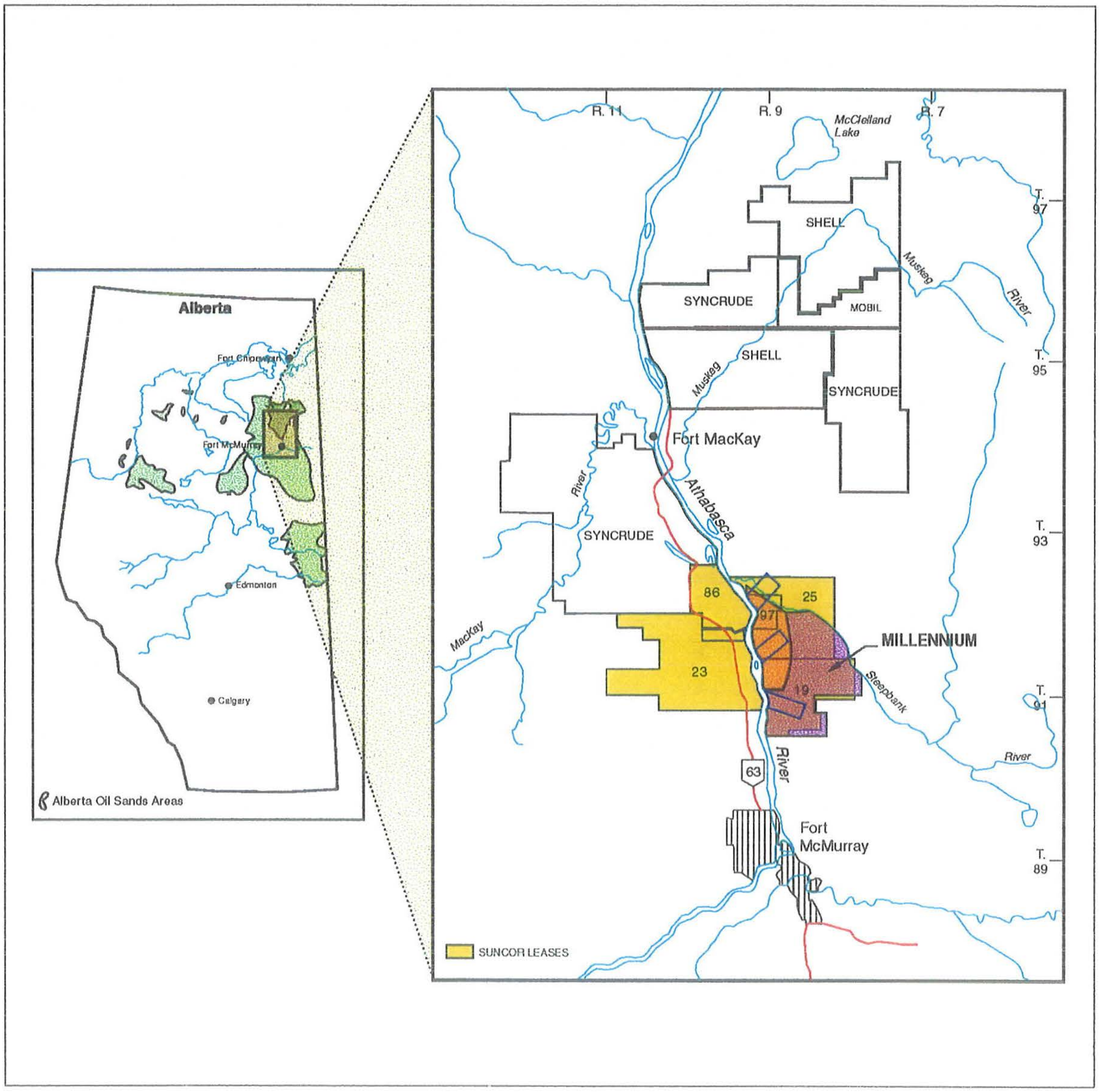


Figure A2-1 Location Map

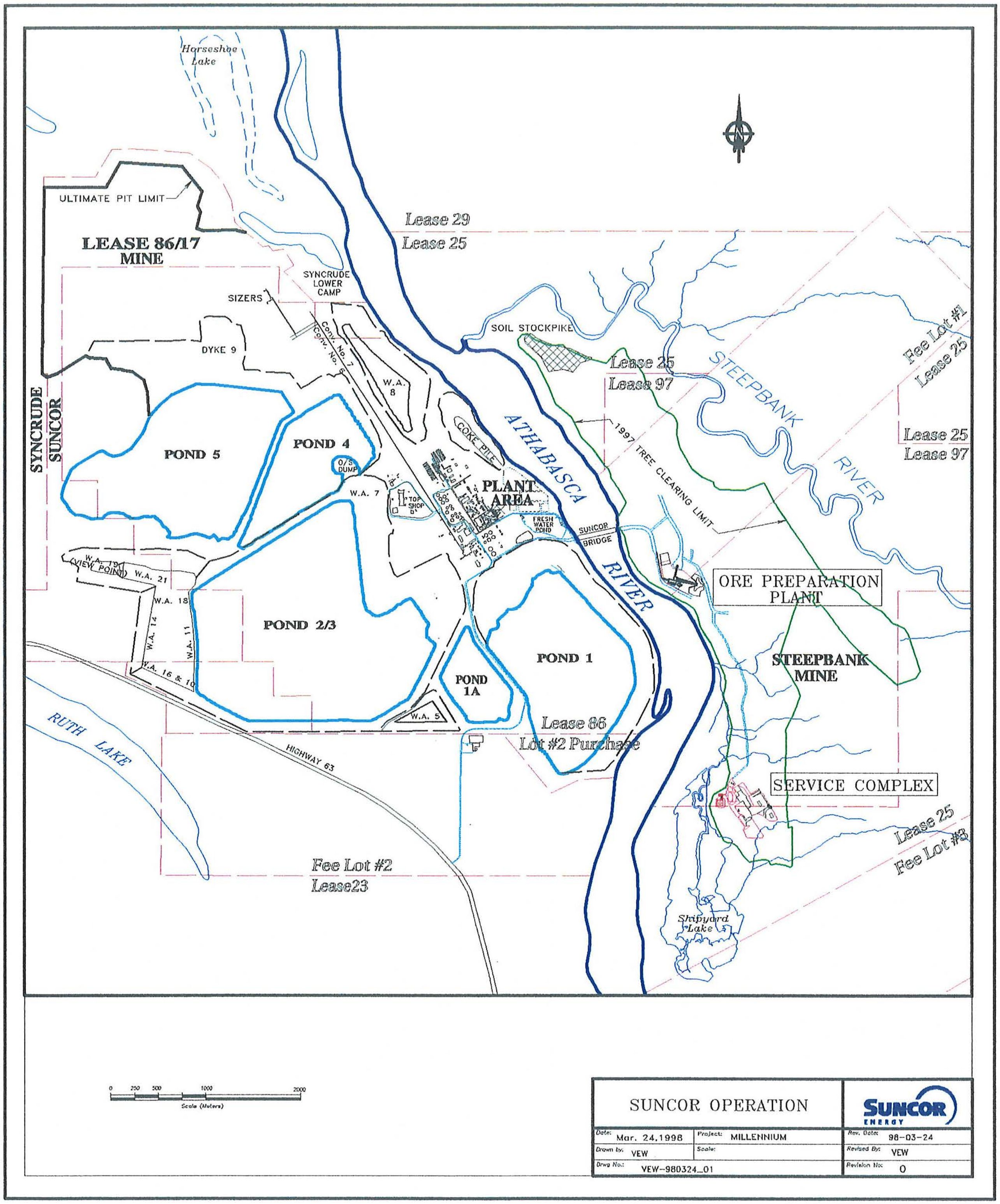


Figure A2-2 Map of Suncor Operation

- management, control and mitigation of environmental impacts during construction and operation of mine and plant facilities

- an integrated management plan for all tailings produced by both Extraction plants and an integrated reclamation plan for current and future tailings ponds and other disturbed areas

In approximately 2012, additional primary extraction capacity will be installed in the area of the expanded Steepbank Mine. Over its thirty-year life the project will produce and upgrade 2.8 billion barrels of bitumen for market.

A2.2 Rationale for Project Millennium

A favourable business climate and a significant net societal benefit for oil sands development combined with Suncor's experience and positive track record provide the impetus for Project Millennium. Specifically, Suncor can proceed with Project Millennium with confidence because:

- There exists a market window of opportunity for oil sands products with an integrated transportation system. Suncor has the experience and ability to take advantage of these markets.

- Suncor has demonstrated the economic viability of oil sands operations, even in an environment of low commodity prices.

- Suncor has exhibited continuous improvement in its operation through collaborative research, application of technology, management and operating practices.

- The business climate is favourable, with a generic fiscal tax and royalty regime, as well as a responsible regulatory environment that is fair, predictable and timely.

- Suncor believes the environmental and social impacts of the proposed development can be mitigated to a level acceptable to its communities.

- The net economic benefit accruing from the project is very significant to the Region, Alberta and Canada.

Detailed planning and a continuing comprehensive consultation program for Project Millennium will ensure that development can proceed as a logical, orderly extension to Suncor's existing operations. Recent application of new technologies will improve energy efficiencies. The application of Consolidated Tailings will facilitate reclamation to a dry landscape. And the commissioning of the Flue Gas Desulphurization unit in 1996 has reduced plant-wide SO_2 emissions by over 75 percent. Project Millennium will present further opportunities for gains in energy and environmental performance. These include:

- Significant reduction of discharge water to the Athabasca River from the Upgrader cooling and wastewater systems.
- Improvement in unit energy consumption site-wide by 18% over 1997
- Minimal increase in SO_2 emissions, although production more than doubles from today's level.

Project Millennium will create 800 permanent direct positions and in the order of 1 200 indirect jobs. The on-site construction workforce will peak at 2 500 to 3 000 workers. The new permanent positions, combined with normal workforce attrition, will provide significant new opportunity for local employment. Suncor will be working in collaboration with educational institutions and neighbouring communities to ensure that there are sufficient numbers of potential employees with acceptable skills and qualifications.

The $2 billion investment in Project Millennium will create sizable benefits to Alberta and Canada. These include the following:

- Development expenditures will create $1.2 billion in household income within Alberta.
- Operating expenditures will generate $140 million in household income annually in Alberta.
- Taxes and royalties to federal and provincial governments over the project life will exceed $4.2 billion.

A heightened level of collaboration among developers, government institutions and local communities is serving to mitigate social and environmental impacts from the cumulative effects of a number of projects including those of Suncor, Syncrude Canada Ltd., Shell Canada Ltd., and Mobil Oil Canada. This collaboration manifests itself in many ways including: community planning; joint cumulative effects assessment; cooperative effects monitoring; regional infrastructure planning and coordination; and facilitation of advance funding for infrastructure.

A2.3 Overview of Project Millennium Operations

Project Millennium's configuration and integration with present operations is depicted on Figure A2-3.

When Project Millennium comes on-stream, Lease 86/17 Mine will have been depleted and all ore will be supplied by an expanded Steepbank Mine.

Approximately half of the ore will be produced from the initial mining pit (Pit 1), then converted to a slurry at the Steepbank Ore Preparation plant and hydrotransported to the Base Extraction plant for primary and secondary extraction.

The other half of the ore will be produced from a second mining pit (Pit 2). That ore will be delivered to the Millennium Extraction plant (located on the east side of the Athabasca River near Pit 2) for primary extraction. Raw bitumen produced by this plant will be pipelined to the Base Extraction (secondary) plant for further cleanup. The bitumen will then be upgraded in the Upgrader into a slate of crude oil products.

As previously indicated, Steepbank Mine will commence operations in 1998 in Pit 1. Ore will be mined using truck and shovel methods, then delivered to truck dumps and ore sizers and on to the Steepbank Ore Preparation plant. Facilities there include rotary drum breakers, at which point warm water is added to form a slurry. This slurry is pumped to agitation/surge tanks and then hyrotransported across the bridge to the Base Extraction plant for primary extraction.

There, the ore is introduced into separation cells, where the majority of oil is recovered from the top of the cell as bitumen froth. Other circuits, including the processing of separation cell tailings, recover additional bitumen. Bitumen froth is heated, deaerated and sent to secondary extraction, where it is diluted with naphtha, then cleaned of fine minerals and residual water. The diluted bitumen product is transferred to intermediate storage, which acts as a buffer between the bitumen production and upgrading processes.

Tailings (coarse sand, fine minerals, water and some hydrocarbon) from the primary extraction separation cells are piped to the tailings pump house for conversion to Consolidated Tailings and then disposal in ponds in mined areas. Included in Consolidated Tailings will be mature fine tailings recovered from existing ponds. Ultimately an existing inventory of fine tailings will be converted to Consolidated Tailings that will be reclaimed into a dry landscape.

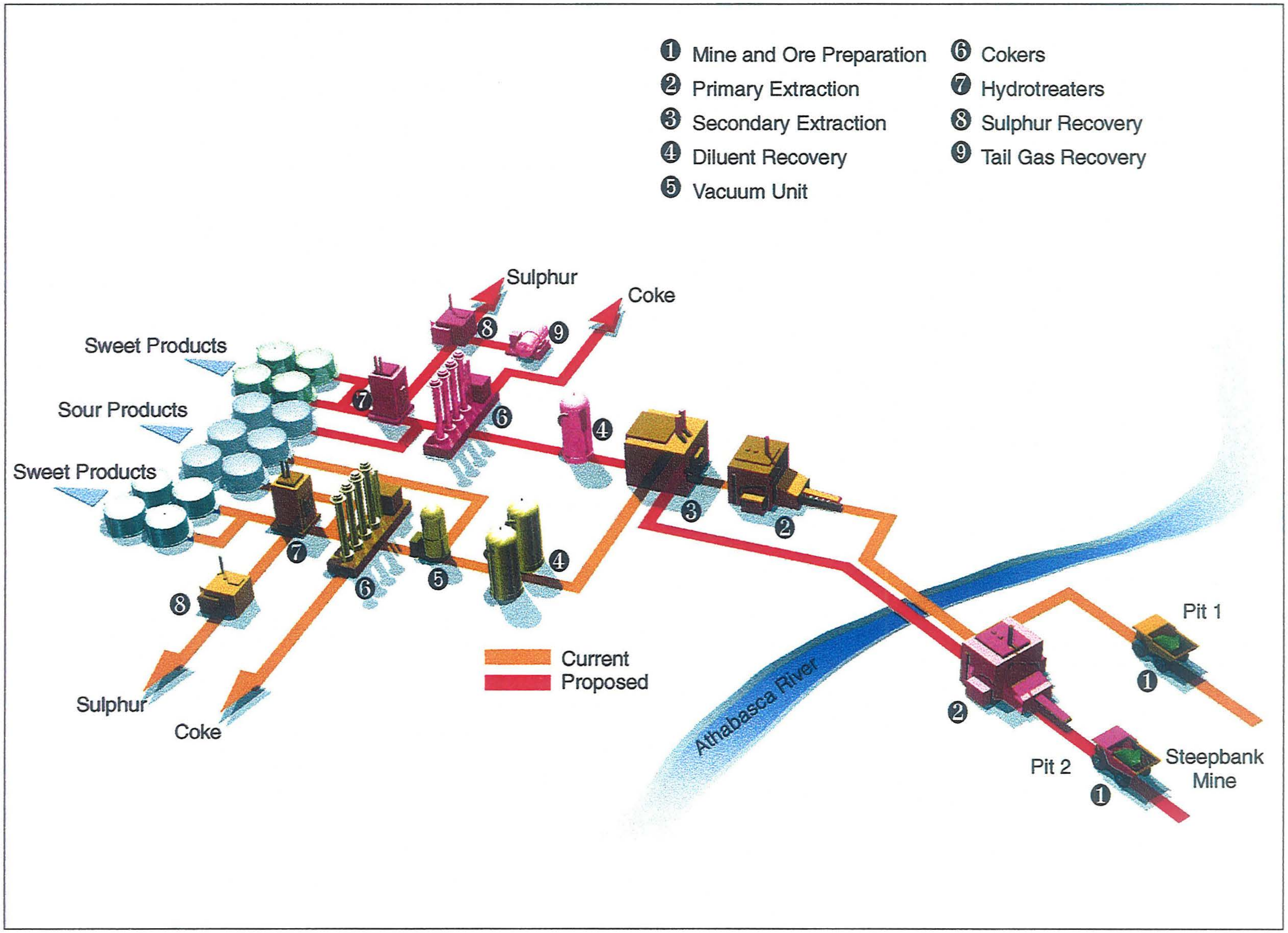


Figure A2-3 Project Millennium

Water releases rapidly from the Consolidated Tailings and is recycled for use in the Extraction plant. Consolidated Tailings will be placed in available space on Lease 86/17 and subsequently in the mined areas of Steepbank Mine.

Tailings from secondary extraction include fine clays and minerals, water and residual diluent. Much of the diluent is recovered in a naphtha recovery unit, resulting in an overall diluent recovery of 99.3 percent minimum.

Preparation for the start of mining in Pit 2 of Steepbank Mine will begin in 2000 with clearing and salvage of commercial trees, drainage, removal and salvage of surface soils, and prestripping of overburden.

Mining will begin in 2002 using existing truck and shovel methods. Ore will be prepared at the Millennium Ore Preparation plant using Steepbank technology and then piped to the Millennium Extraction plant. This plant will use similar warm-water separation-cell technology as previously described. Bitumen froth will be heated and deareated with steam from gas-fired package boilers constructed for that purpose near the Millennium Extraction plant. The resulting "raw bitumen" will be pipelined across the Suncor Bridge to the Base Extraction plant for secondary extraction. In approximately 2012, additional primary extraction capacity will be installed in the east bank mining area. The combined bitumen production operation will produce at a level of 260 000 bbl/cd of bitumen, which will be upgraded into a variety of crude oil products to meet customers needs.

A second upgrader train will be added, using essentially the existing process, but with the latest technology enhancements. The major upgrading steps include:

- recovering diluent
- processing bitumen, using delayed coking to produce sour intermediate products and fuel gas by rejecting carbon as petroleum coke
- manufacturing hydrogen from steam and natural gas for use in hydrotreating
- hyrotreating coker products to remove sulphur
- removing sulphur from byproduct gases

The typical product slate for Project Millennium will be in about the following proportions:

- Light Sweet Crude 100 000 bbl/cd
- Light Sour Crude 80 000 bbl/cd
- Diesel 30 000 bbl/cd

These products are transported through an extensive pipeline network to reach markets in Eastern Canada, Central United States, the West Coast and offshore. Some of the diesel production is used by Suncor's mine fleet and for local transportation.

Other products are petroleum coke (a portion of which is used to generate steam and electricity) and sulphur.

The Millennium upgrading train, while using present technology will introduce several enhancements including:

- Improved utilization of extraction recycle water for process cooling purposes, thereby transferring heat energy to the extraction process.
- A reconfigured cooling and wastewater system, which will reduce withdrawals of water from the Athabasca River and significantly reduce discharge of treated water to the Athabasca River.
- An improved sulphur recovery facility which will recover 99.5% of sulphur from Millennium Upgrader acid gases.
- No new continuous-flaring sources.
- Low NO_x burners which will be used throughout the new train.

Energy Services provides the steam and electricity for Bitumen Production and Upgrading. Three coke-fired boilers (supplemented by smaller gas-fired boilers) supply the steam demand. Two in-plant steam turbo-generators currently supply the majority of the operation's electrical demand; the remainder is imported from the Alberta power grid.

Utilization of warm-water extraction technology and heat integration with the Upgrader serve to reduce the steam demand per unit of bitumen production such that additional steam generation is also reduced. However, additional electricity is required and will be supplied with on-site gas turbine generators.

Project Millennium will force the relocation of certain support infrastructure. Development of the Fee Lot 2 area (held by Suncor, in the vicinity of its Security Gate) is contemplated. Currently included in preliminary plans are:

- an administration and warehouse complex
- a relocated camp (approximately 3 000 persons)
- a natural gas liquids plant and storage facility (owned and operated by others)
- provision for a Suncor tank farm
- a tank farm and pipeline terminal for the proposed Athabasca Pipeline Project (owned by others)
- tanker truck loading and unloading facilities

Surface reclamation occurs as areas become available. Reclamation objectives are to re-establish forest vegetation common to the area with a capability equivalent to pre-disturbance conditions. The final landscape will be capable of developing into a self-sustaining cover of forest vegetation that could provide a range of uses.

Suncor's Steepbank Mine plan recognizes the environmental sensitivity in disturbing areas surrounding the Steepbank and Athabasca Rivers. On the south side of the Steepbank River, an undisturbed 100-m setback is maintained from the crest of the escarpment. Along the Athabasca River, the mine plan removes ore out to the edge of the escarpment with the constraint that the intersection point with the escarpment will be well above the 1-in-100-year flood level. As this escarpment has a relatively gentle slope, the result is an undisturbed setback which exceeds 300 m (however, there is a pinch point along the Pit 1 mining area, where the undisturbed area is reduced to 120 m over a 100-m stretch). By 2005, the Pit 1 escarpment will be rebuilt, with a dyke constructed from suitable overburden materials to an elevation approximately equivalent to the top of the present escarpment. The area will then be reclaimed. Similarly, the Pit 2 escarpment will be rebuilt by 2008.

Steepbank Mine's expansion requires an external starter tailings pond to contain additional tailings that are generated before mined-out space becomes available. This pond will be situated above the escarpment and will be enclosed by an overburden and sand structure.

The reclamation plan will be integrated with Lease 86/17. Figures A2-4 and A2-5 show a rendering of the reclamation progress for the combined area at mid-operation and in the far-future.

An end pit lake will result in the final mining area. Criteria for this lake will include that it be geotechnically secure, can be filled with water within a reasonable timeframe and is capable of supporting a healthy aquatic ecosystem.

After the end of the mine life (in about 2035) all mining, ore preparation and other facilities will be removed.

A2.4 Objective- and Criteria-Based Process

In April 1997, AEUB and AEP introduced a document "A Proposal for the Introduction of: Regulatory Objectives and Operating Criteria-Based Approval Process for Integrated Oil Sands Developments" (AEUB and AEP 1997), regarding the use of regulatory objectives and operating criteria in

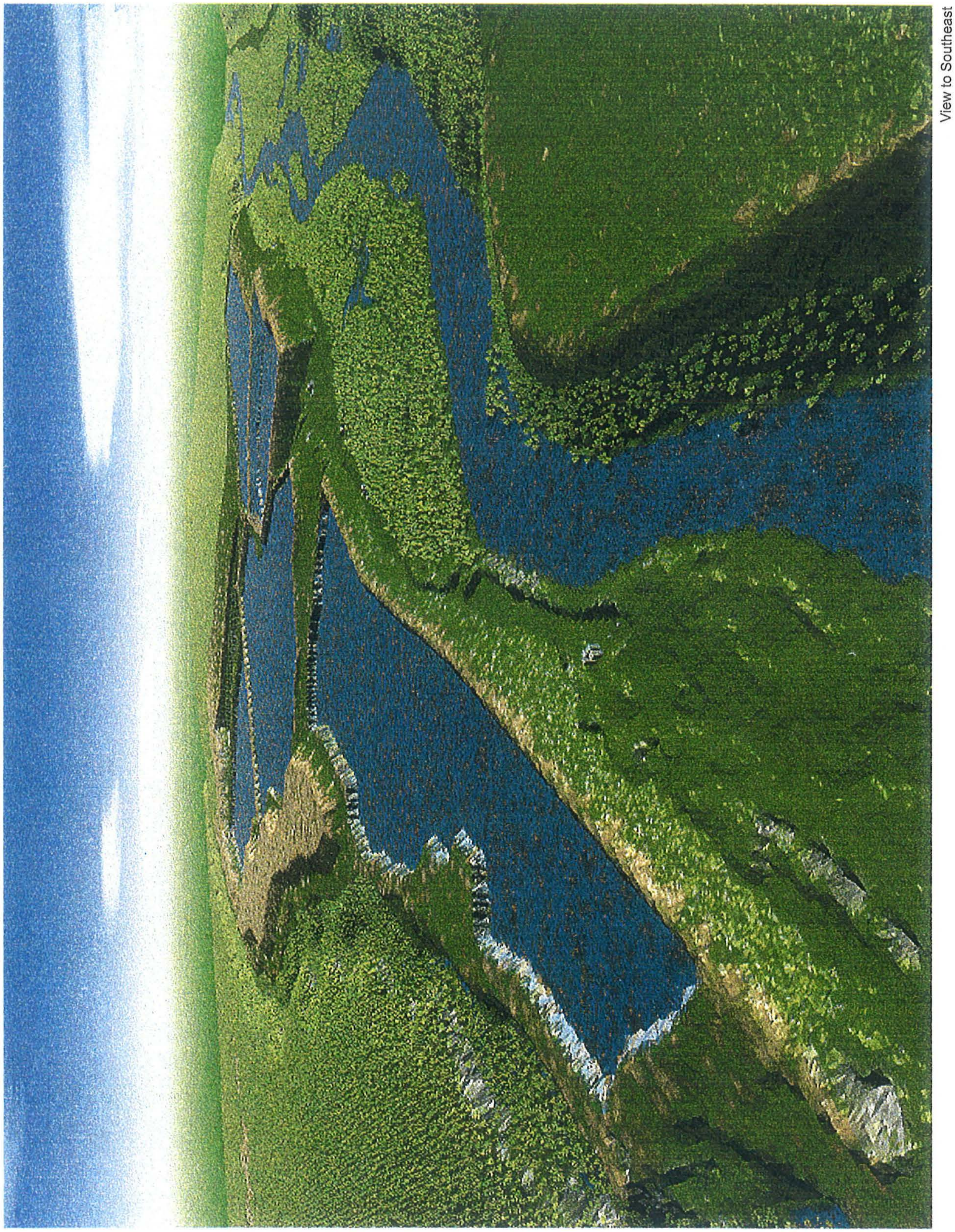


Figure A2-4 Suncor Operations Mid-Life

View to Southeast

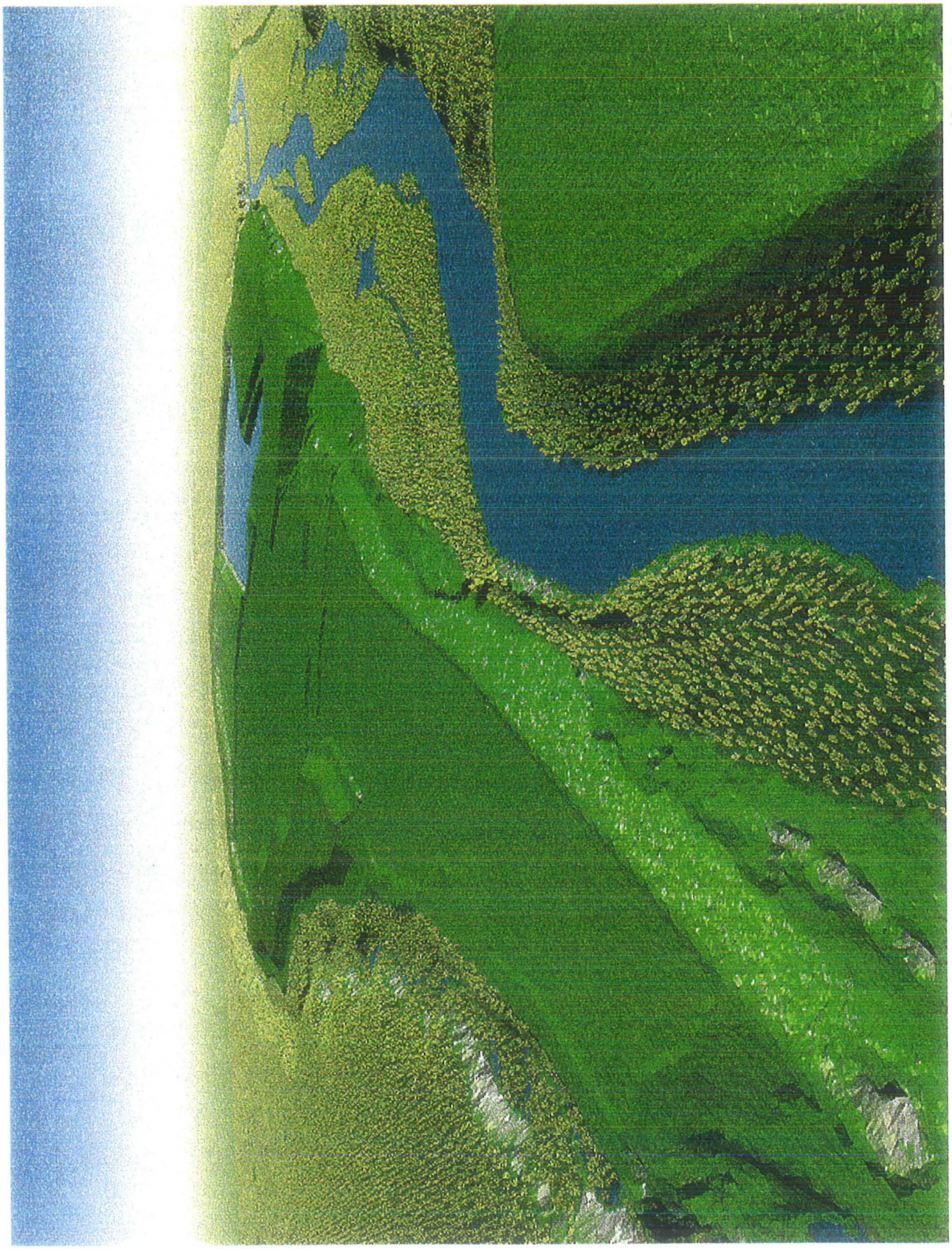


Figure A2-5 Suncor Operations Far-Future

future approval processes. The document reviews and defines the concept of approvals based on regulatory objectives and operating criteria, highlights the benefits of such an approach, and summarizes the process used to define appropriate criteria. The document also describes the joint AEUB and AEP regulatory objectives and an operating criteria proposal.

Benefits of a regulatory objectives and criteria-based approval process stated to be:

- to make the regulation of integrated oil sands projects more efficient and effective with respect to the management of important public interest issues
- to provide regulators, project operators and the public with clearly-defined and documented expectations regarding the operating performance of projects
- to provide a clear focus for defining reporting requirements and conducting other surveillance activities
- to establish a definitive basis on which to measure regulatory compliance and determine appropriate actions
- to establish objectives and criteria which would provide a common and independent basis on which the industry's performance can be reported to, and judged by, public stakeholders

The proposal supports the shift in regulatory priority from the approving function to those of standard setting and enforcement. Suncor is generally in favor of the approach. Table A2-1 sets forth a list of issues, project objectives and operating criteria (that parallels the AEUB/AEP proposal) for Project Millennium. Additionally, the table highlights technology and operating improvements incorporated into the project to achieve the operating criteria.

Where the terms "minimize" or "maximize" are used in the table, Suncor's intent is to use technology that is best to accomplish the objective, considering cost, performance and commercial viability factors.

Table A2-1: Project Millennium Operating Criteria, Technology and Operating Improvements

Issue and Sub-Issue	Regulatory Objectives	Operating Criteria	Technology and Operating Improvements
Energy Resource Management			
Oil Sands Mined	• Maximize Oil Sands Recovery • Minimize ore sterilization	• 7% cut off grade • 3 m mining thickness cut-off	• truck and shovel operation
Bitumen Recovery	• Maximize bitumen Extraction efficiency	• 92.5% overall bitumen recovery	• inclined plate separators • tertiary recovery • lower operating temperature
Dilluent Recovery	• Maximize diluent recovery (minimize absolute losses to tailings)	• 99.3% of diluent recovery	• new recovery tower • lower D/B ratio to use less diluent • make up diluent reformulated to have narrower boiling range (reduced light and heavy ends and benzene)
Sulphur Recovery	• Maximize overall sulphur recovery • Maximize sulphur plant recovery	• 98.1% overall recovery of all sulphur in acid gases produced	• new sulphur plant will raise overall recovery capability • tail gas treating unit will process all gases from the new sulphur plants and a portion of the gases from the base plant
Upgraded Product yield	• Maximize the yield of oil sands products	• 81.2% gross liquid yield	• enhanced delayed coking technology selected on basis of yield, operability and cost.
Byproduct Recovery	• Minimize discard of coke, sulphur or other byproducts	• byproducts stored in a manner that enables recovery at a later date and meets environmental location conditions	• coke will be used as fuel or sold as first priority • all sulphur produced will be sold to market
Plant Integration	• optimize site-wide plant integration	• facilities designed to optimize overall conservation - energy, water, land • facilities designed to maintain partial production during planned maintenance turnarounds	• technical integration across entire facility • segregation of certain units to provide maximum flexibility for turnaround avoidance

Issue and Sub-Issue	Regulatory Objectives	Operating Criteria	Technology and Operating Improvements
Energy Efficiency	• Maximize use of produced gas • Minimize use of external energy • maximize co-generation power	• design for optimum heat recovery and minimum heat rejection to atmosphere or cooling water	• waste heat recovery loop capturing heat from upgrading to use in the bitumen extraction process • closed cycle gas turbine generators with heat recovery steam generation
Flaring	• Minimize amount of flared gas	• flare less than 0.5% of the energy value of bitumen feeding the upgrader	• flare gas recovery project to increase capture of flare gases in base plant • no new continuous flaring sources
Environmental Protection			
Substance Release and Contaminant Emissions	• minimize air emissions • controlled release of industrial waste water • ensure safe drinking water is available	• Sulphur Dioxide emissions at 79 t/cd (365 day rolling average) • potable water quality maintained to meet the Guidelines for Canadian Drinking Water Quality	• use commercially proven pollution prevention and control technologies • dedicated potable water supply
Water Use and Management	• minimize the volume of fresh water used • protect the sustainable supply of surface and groundwater	• as licenced	• reconfiguration of coolling and wastewater system will maximize water recycling
Tailings	• ensure tailings are stored in a manner that protects environment • minimize the volume of fluids in the final reclaimed landscape	• water release (operational and reclamation) must meet acceptable standards • all tailings impoundment structures will meet appropriate Dam Safety Guidelines	• commercial use of Consolidated Tailings • all fluid tailings will be removed from external tailings pond
Land Conservation and Reclamation	• minimize total land disturbance • maximize progressive reclamation	• land will be reclaimed to equivalent capability from pre-disturbance conditions	• soil amendment materials stockpiled for future use • use of Consolidated Tailings to return the land to a dry landscape
Waste Management	• ensure proper identification, storage, minimization and disposal of waste generated in the operation	• all hazardous waste to be disposed of in approved facilities	

Issue and Sub-Issue	Regulatory Objectives	Operating Criteria	Technology and Operating Improvements
Public Interest			
Socio-Economic	• ensure orderly, efficient and economic development of Alberta's oil sand resource • optimize the use of Alberta goods and services • maximize the use of local resources for employment and business opportunities • prevent and/or mitigate the impact on cultural resources of the area	• project must have acceptable economic return balanced with environmental impact	• 65% of goods and services expected to be supplied in Alberta • creation of business Alliance with 8 major Alberta companies • target for 12% of all Suncor employees to be aboriginal

A3 PUBLIC CONSULTATION PROGRAM

A3.1 Suncor's Policy and Objectives

Suncor is committed to sharing information and encouraging open dialogue with individuals and groups that have an interest in, or are affected by, its operations. These communities of individuals and groups include:

- neighbouring and regional residents
- special-interest groups representing the broader public interest in Suncor's development
- government regulators
- company shareholders
- employees
- business associates

The aboriginal communities in the region, as represented by First Nations and Metis governments, are essential in the consultation process because of the land-based nature of oil sands development.

Suncor defines public consultation as:

> *The communication of the company's strategic intent and the facilitation of dialogue with interested communities or individuals so their needs and concerns can be reflected in how Suncor manages, plans and develops its business.*

This means Suncor involves regional communities on an ongoing basis in discussions relating to both its day-to-day operations and long-term plans. The company consults with these communities before detailed plans for projects requiring regulatory approval are finalized.

Suncor wants those affected by its activities to be able to agree that their input has been fairly considered in arriving at the best business decision.

A3.2 Description of Program

Since 1994, a comprehensive approach to consultation has been developed to reflect the needs of the region's residents. Developments include the following: the role of Suncor's Vice-President of Human Resources and Community Affairs has expanded to include community affairs; an internal stakeholder relations committee has been established; and a menu approach to consultation has been developed, to ensure all information is available to interested parties on all aspects of Suncor's oil sands development.

Community groups sought an effective, efficient process to receive information necessary for informed decision-making and to have their input incorporated into the company's evolving development plans. To manage the process, Suncor established the following prerequisites and principles of consultation:

Prerequisites:

- belief that consultation adds value
- commitment from senior management
- willingness to be influenced and to make changes

Principles:

- integrity of regulatory process is preserved
- process is open and transparent
- information is shared early, freely and in draft form
- participation of stakeholders is effective
- sensitivity to all needs of participants is maintained

By developing a number of avenues for involvement, each interested community selected its areas and levels of interest. Four types of consultation evolved:

- information-sharing
- continual consultation
- project consultation
- regional consultation

This approach was applied to the Steepbank Mine and Fixed Plant Expansion Project, and is continuing for Project Millennium.

A3.2.1 Information-Sharing

To better inform the general public, Suncor has held community forums, issued a "Report to the Community" (a newsletter on Suncor's future plans delivered semi-annually to 15 000 households in the region) and developed a Web site on the Internet (www.suncor.com). Suncor has issued a public disclosure document outlining plans for the development of Project Millennium. The disclosure document, together with Environmental Impact Assessment Terms of Reference are available on Suncor's web site. Media releases and advertising have informed the communities of Suncor's plans and how those interested may become involved. For additional information, names and telephone numbers of contact people have been provided. Copies of Suncor's materials are also available at the Fort McMurray Public Library and the Oil Sands Discovery Centre.

A3.2.2 Continual Consultation

The stakeholder relations committee, chaired by Suncor's Vice-President of Human Resources and Community Affairs, is responsible on an ongoing basis for consultation efforts about Suncor's existing operations. The mandate of the committee includes: communicating to stakeholders about environmental performance; socio-economic matters; and health and safety concerns.

A number of communities have sought further involvement in Suncor's day-to-day business and strategic development. Meetings with representatives from these communities have been held to exchange information and to provide input for Suncor's activities.

Stakeholders' needs have been assessed in consultation with them and an ongoing consultation plan has been developed. Memoranda of Understanding (MOU), which outline specific consultation plans, have been developed with Fort McKay, Fort Chipewyan and the Oil Sands Environmental Coalition (OSEC). These plans are reviewed each year to ensure they remain current.

A3.2.3 Project-Specific Consultation

Both the Steepbank Mine and Fixed Plant Expansion projects provided a learning opportunity about the consultative process. Project-specific relationships have been developed one-on-one with those communities indicating a desire to participate in the future development of Project Millennium.

To help accomplish this, Suncor developed a framework which integrates community input into the project design and the Environmental Impact Assessment (EIA) process. Project consultation progresses through a series of phases (from pre-feasibility to application filing) as follows:

- disclosure and project concept
- EIA terms of reference development
- project feasibility updates and EIA issues and methods review
- EIA results and documentation

The EIA builds on previous projects (Suncor's and others), thus avoiding over-consultation and stakeholder confusion. For example, consultation on EIA key indicator resources was limited to verifying those identified in the Steepbank Mine process as well as in other projects.

A3.2.4 Regional Consultation

With the 1997 announcements of development plans by Suncor and other oil sands developers, it became apparent that stakeholders in the Regional Municipality of Wood Buffalo (RMWB) could soon be overwhelmed with information and issues about which to respond. Cumulative effects assessment was identified as the greatest concern to the majority of stakeholders. Accordingly, three major initiatives have begun:

1. The Regional Infrastructure Working Group (RIWG) was formed to review infrastructure issues and to develop a population model as a planning tool for local agencies. This work will effectively minimize duplication and simplify the consultation process for communities. RIWG consists of at least one representative from each of the oil sands developers in this region and the planning director from the Regional Municipality of Wood Buffalo. Suncor has a representative on this committee and participates in several subcommittees dealing with infrastructure topics. RIWG's work is detailed in the EIA.

2. During the development of the EIA, oil sands developers met to discuss a regional development scenario for 2010 that would form the basis of the cumulative effects assessment (CEA) of all the projects proposed for the region. This group (Cumulative Effects Assessment Working Group) focused on environmental effects and the development of a framework to enable each company to complete an assessment. Their work is covered in the EIA.

3. In October 1997, the need for overall regional coordination of development issues was addressed by the formation of the Athabasca Oil Sands Development Facilitation Committee. This committee consists of a senior executive from each of five of the oil sands developers, the two MLAs and representation from the RMWB. A coordinator has been hired by this group to work on regional development issues and to liaise with governments and the RIWG. Suncor's Vice-President of Human Resources and Community Affairs participates in this initiative.

Suncor is an active participant in all three committees and has found them to be very effective in arranging and implementing action plans to address development issues within the RMWB. Regional planning and coordination is charted on Figure A3-1.

In both project-specific and regional consultation, Suncor has continued the practice of sharing information freely and in draft form, thus allowing interested parties the maximum opportunity to provide ideas and input for

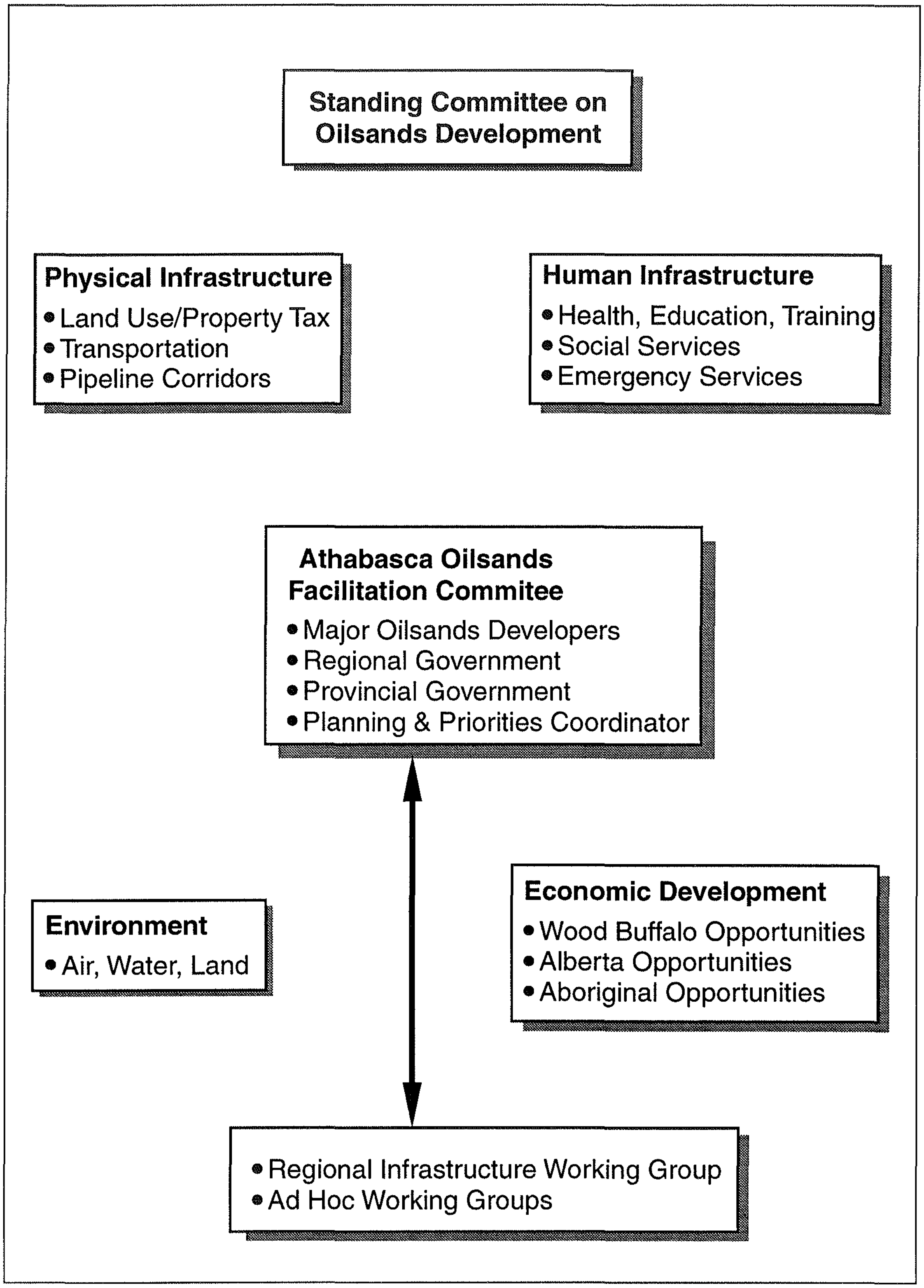


Figure A3-1 Regional Planning and Coordination Model

consideration by the company. The resulting improvements can then be incorporated into the project. Communities appreciate this approach and have agreed to review draft information for this purpose, taking into account that it may change as the project progresses.

Through this process the parties have worked toward identifying opportunities and resolving concerns before filing this application. The objective is to develop projects which reflect the combined efforts of Suncor and its neighbours as well as maximizing the benefits for all concerned. When this project application is filed, no issue should be unresolved because of a lack of understanding of the project and all the parties' needs. Suncor views consultation as a part of maintaining long-term relationships.

Table A3-1 lists public consultation events to mid-April 1998 and names the individuals or groups involved in each event. This list includes stakeholder activities associated with Suncor's Project Millennium, regional consultation meetings as well as other closely-related activities. Numerous other meetings have been held (particularly with regulators) as part of doing business.

A3.3 Outcomes of Consultation

A3.3.1 Interested Groups and Communities

Suncor's prime interested groups and communities are:

- residents and leaders of the Regional Municipality of Wood Buffalo (RMWB)
- the First Nations of the Athabasca Tribal Council
- Zone 1 Metis Locals within RMWB
- consolidated Metis Locals
- local and provincial environmental groups, represented by the Oil Sands Environmental Coalition (OSEC) which includes:
  - the Pembina Institute for Appropriate Development
  - the Fort McMurray Environmental Association
  - the Toxic Watch Society
  - the Environmental Resource Centre
- regulatory agencies
- employees and shareholders

A3.3.2 Agreements with Interested Communities

Agreements have been developed between Suncor and several prime interested communities to better manage the public consultation process. For example, Suncor has:

Table A3-1 Public Consultation for Project Millennium

Event Date	Community	Activities
19 August 1997	Fort McKay Environmental Services	EIA interface
29 August 1997	Fort McKay First Nation	Introduce Project Millennium, request consultation plan
3 September 1997	Athabasca Chipewyan First Nation	Memo of Understanding (MOU) development
3 September 1997	Fort McMurray Chamber of Commerce	Relationship and communication, request consultation plan
4 September 1997	Athabasca Chipewyan First Nation (ACFN)	MOU development
5 September 1997	Mayor, RMWB	Update of Suncor plans
8 September 1997	Communications, Energy and Paperworkers Union (CEP) executive	Introduce Project Millennium
9 September 1997	ACFN	Introduce Project Millennium and request consultation plan
11 September 1997	ACFN	MOU development
12 September 1997	Miskisew Cree First Nation	Introduce Project Millennium and request consultation plan
12 September 1997	ACFN	MOU development
15 September 1997	ACFN	MOU development
16 September 1997	Regional Infrastructure Working Group (RIWG)	RIWG - Socio-Economic Impact Assessment (SEIA) model review
16 September 1997	ACFN	MOU development
18 September 1997	ACFN	MOU development
26 September 1997	Shell, Syncrude, Mobil, OSEC, Fort McKay	CEA workshop
30 September 1997	Fort McKay	Consultation plan
5 October 1997	ACFN	MOU development
6 October 1997	OSEC	Introduce Project Millennium to OSEC
7 October 1997	RIWG	Community baseline data review
8 October 1997	ACFN	MOU development
9 October 1997	ACFN	MOU development
10 October 1997	RMWB, Member of the Legislative Assembly (MLA), Syncrude, Shell, Mobil	Regional infrastructure to support oil sands development, initiated by Syncrude
10 October 1997	Miskisew Cree, ACFN	MOU action

Event Date	Community	Activities
14 October 1997	Provincial Task Force, Community	School Task Force
16 October 1997	Fort McMurray Community	Project Millennium Open House
17 October 1997	ACFN	Terms of Reference (TOR) consultation
21 October 1997	Industry, public	CEA Working Group
28 October 1997	OSEC	EIA TOR review
30 October 1997	RMWB regional manager, department heads	Strategy consultation
30 October 1997	ACFN	TOR review
31 October 1997	Standing Committee on Oil Sands Development (RMWB)	RIWG presentation of Urban Population Impact Model
06 November 1997	Regional Economic Development Authority (RMWB)	Discussion of need for economic development during period of growth
13 November 1997	School Boards, Keyano, Regional Health Authority (RHA), RMWB	RIWG presentations, training on urban population impact model for community
18 November 1997	RMWB, Department of Energy	RIWG meeting
19 November 1997	Fort McMurray First Nation (Gregoire Lake Reserve)	Open House for Project Millennium
20 November 1997	Chipewyan Prairie Dene First Nation (Janvier)	Open House for Project Millennium
26 November 1997	Fort McKay and Companies	Industry Exchange (Trade Show)
26 November 1997	Fort McKay	Consultation proposal
26 November 1997	ACFN	Conference call to discuss EIA TOR
26 November 1997	Fort McKay	Consultation planning
27 November 1997	ACFN	Fish monitoring flight
3 December 1997	ACFN	EIA TOR conference call
3 December 1997	RMWB	Project Millennium presentation
9 December 1997	RIWG	Update and planning for subcommittee meetings
10 December 1997	RIWG	Regional Communities meeting, sub-committee of RIWG: kick-off meeting for collection of socio-economic data on a regional basis
10 December 1997	CEA working group	CEA approach and aboriginals' role

Event Date	Community	Activities
10 December 1997	RIWG	RIWG Transportation subcommittee
10 December 1997	RIWG, Keyano	Jobs and Education subcommittee
17 December 1997	Keyano College Business Department	Presentation of Suncor's Strategic Direction
06 January 1998	RIWG, Regional Council	Presentation of RIWG, coordinator's role and facilitation committee
07 January 1998	RIWG	Regional communities meeting, sub-committee meeting to plan for baseline and cumulative socio-economic effects in outlying communities
12 January 1998	RIWG	Regional Communities full-group meeting
13 January 1998	ACFN	MOU development
19 January 1998	Fort McKay	Consultation
22 January 1998	RMWB	Meeting with Regional Manager and Planning Director to review Project Millennium consultation plan
05 February 1998	RIWG Small Communities Subcommittee	Planning meeting for full-group meeting - February 17
05 February 1998	Al-Pac, Northlands and AEP Forestry	Project Millennium preliminary consultation
09 February 1998	OSEC and Fort McKay	Project Millennium detailed consultation kick-off
10 February 1998	ACFN	MOU development
12 February 1998	Anzac Community	Project Millennium Open House
17 February 1998	RIWG, Small Communities Subcommittees	Full-group meeting to discuss next steps for verifying community baseline and collecting impact assessment
19 February 1998	Fort McMurray Community	Project Millennium Open House to update and present preliminary EIA and SEIA results
20 February 1998	RIWG	Full-group meeting to report progress on transportation, jobs and education, small communities
27 February 1998	ACFN	MOU development
5 March 1998	Anzac, Gregoire Lake	Regional Communities/RWIG presentation on data survey to Executive committee at a public meeting
9 March 1998	RMWB Department Heads	Presentation on Project Millennium
12 & 13 March 1988	CEA workshop	Environmental thresholds

- signed a MOU with the Fort McKay community which is regularly reviewed and its action plan updated as needed.

- signed an MOU with the community of Fort Chipewyan which demonstrates the parties' commitment to developing a long-term relationship for facilitating ongoing consultation, mutual respect, business development, and social and cultural support. This memorandum is regularly reviewed and action plans are updated as necessary.

- entered into a consultation agreement with OSEC which defines the roles and responsibilities of each party in project-specific consultation relating to Project Millennium. Objectives of this agreement are to:

  - increase the level of understanding and accord between parties
  - improve the project
  - ensure an effective, efficient regulatory review of the project

- entered into an agreement (as have Syncrude, Shell and Mobil) in December 1997 with representatives of Fort McKay First Nation and Metis Local to provide funds for a staff position. This director, employed by Fort McKay Industrial Relations Corporation, works closely with developers to review applications, assess environmental impacts and ensure Fort McKay's needs are identified.

- engaged the Athabasca Chipewyan First Nation (ACFN) to facilitate their input.

- worked with other oil sands developers, OSEC and local aboriginal groups to participate in the development of a cumulative effects assessments framework.

- worked with other developers and the communities to develop and execute a regional process to validate outlying community baseline data, provide consolidated project data and receive impact assessments from a number of communities in the region through the RIWG.

- Suncor jointly funded the coordinator position for the associated projects related to regional development.

Suncor expects that these initiatives will form the foundation for long-term, open and mutually-beneficial relationships between the company and the community.

Suncor does not intend that the consultation process for this project will create undue expenses for participants. However, duplication of efforts will not be funded. All agreements with interested parties for participation in the consultation process will be public. Suncor believes it is in everyone's best interest for the company to:

- provide the necessary financial resources in the pre-filing consultative stage to facilitate effective consultation
- benefit from the ideas of others and identify opportunities for improvement
- clearly define (and if possible) resolve concerns before filing a project application

A3.3.3 Issues Management

Early in the consultation process for Steepbank Mine and the Fixed Plant Expansion, Suncor developed an issues management database to record questions, opportunities and concerns raised about its development plans. This system has been extended for Project Millennium

The issues database forms the foundation for the EIA. The work is focused to address the concerns raised.

A3.3.4 Impact of Consultation on Project

Consultation has an impact on Project Millennium in the following general areas:

- relationship building and understanding both parties' needs
- enhancement of the EIA program
- enhancement of application documents
- contribution to regulatory process efficiency
- project design
- impact mitigation

The project description (as presented in this application) and the supporting EIA reflect the results of consultation to the time of filing. Consultation will continue, which could result in further project refinement.

A number of project improvements were made as a result of stakeholders' influence. These include:

- reduction of SO_2 emissions, by treating some of the Base plant acid gases through Millennium Upgrader Tail Gas Treatment Unit
- reduction of wastewater discharge through system reconfiguration
- use of co-generation, to reduce emissions and conserve energy
- use of existing Naphtha Recovery Unit during planned maintenance on new tower, to maintain diluent recovery
- improvements in diluent quality, to reduce VOC emissions
- broader understanding of desired end land use
- target to increase Aboriginal hiring (to 12%)
- facilitation and development of regional cooperative initiatives

A3.4 Other Related Consultation Initiatives

Suncor's Aboriginal Affairs Department is responsible for maintaining regular communication with aboriginal communities in the region to facilitate joint pursuit of:

- socio-economic opportunities
- environmental initiatives
- education and training initiatives
- community cultural activities

Suncor's Aboriginal Business Development Committee (ABDC) identifies business opportunities and works with aboriginal communities to maximize the associated benefits for the communities. The volume of contracts with aboriginal suppliers reached $16 million in 1997 (up more than 50% over the previous year) and is targeted to increase to $25 million. Aboriginal employment has increased from about 2% of the Suncor workforce to 4% currently. The target for aboriginal hiring is to reach 12% of the Suncor workforce by 2002.

Suncor is an active participant in the Fort McMurray Regional Air Quality Coordinating Committee (RAQCC), which deals with air quality issues in the region.

Suncor is a founding participant in the Regional Aquatics Monitoring Program (RAMP), dealing with water quality and fish habitat.

Suncor is a participant in the Regional End Land Use Committee, a group that reviews and recommends alternatives for end land use at the closure of various mining properties.

Suncor is taking part in the Alberta Oil Sands Community Exposure and Health Effects Assessment Program, which is managed by a community committee.

A3.5 Ongoing Plans

Suncor will continue to:

- distribute its "*Report to the Community*" newsletter
- maintain its Web site on the Internet
- hold community forums
- meet with interested parties on both a project-specific and a continual-consultation basis
- participate in committees as long as needs exist
- meet with the local MLA, MP and Region Council
- host community events to clarify business opportunities for the people of the region, including aboriginal businesses
- maintain proactive relationships with local media to convey understanding and information on Suncor activities

Events planned following the filing of this application are listed in Table A3-2. Suncor will continue to take a forward-looking approach to sharing information with, and seeking input from, all interested parties. Consultation will continue through all phases of Project Millennium to ensure the best ideas are identified, explored and incorporated into the project.

Suncor will continue to focus its efforts on regional coordination. These efforts will help to enhance benefits and minimize impacts of prolonged growth in the region.

This integrated approach to regulatory approvals in Alberta has been a success for stakeholders, regulators and industry. Suncor will continue to facilitate a process which both preserves the integrity of the regulatory approval regime and engages all interested parties in an effective, efficient regulatory review.

Table A3-2 Continuing Public Consultation - Planned Activities

Target Date	Community	Activities
April 1998	Region	Report to the Community
April 1998	Fort McKay	Survey Completion on Project Millennium
April 1998	Standing Committee on Oil Sands Development (RMWB)	Presentation on Project Millennium
May 1998	Administrative Committee (RMWB)	Presentation on Project Millennium
May 1998	OSEC	Application Review
May 1998	CEA Working Group	Continue discussion on cummulative effects approaches
June 1998	Regional Council	Presentation on Project Millennium
October 1998	Region	Report to the Community

A4 SUMMARY OF ENVIRONMENTAL IMPACT ASSESSMENT

A4.1 Introduction

Project Millennium's Environmental Impact Assessment (EIA), which includes the Socio-Economic Impact Assessment (SEIA), has been prepared to assess the impacts associated with Project Millennium, including the expansion of Steepbank Mine (development, operation and reclamation), as well as the net impacts associated with increasing plant production of upgraded oil products to the 210 000 bbl/cd level.

The EIA predicted impacts that could result from the proposed project, identified mitigations to avoid or reduce those impacts and evaluated the residual effects. This EIA follows and extends the EIA prepared for the "Steepbank Mine Project Application" (Suncor 1996b). It was prepared over a period of sixteen months, and focuses on issues raised by communities, stakeholder groups and regulatory bodies, as reflected in the EIA terms of reference (Volume 1, Section A5, Table A5-5). The EIA describes the assumptions used, is quantitative wherever possible and explains the effects of Project Millennium from a regional perspective. In preparing the regional impact analysis, cumulative effects of other oil sands developments and forest harvesting were considered.

This section summarizes the Environmental Impact Analysis (EIA) and mitigation plans which are presented in greater detail in Volume 2 of the application.

The focus of the EIA is on addressing key concerns identified by the public and regulators (particularly concerns incremental to those addressed during the Steepbank Mine EIA). It also focuses on the cumulative effects of regional development. Additionally, the EIA considered the "Fort McMurray Athabasca Oil Sands Subregional Integrated Resource Plan" (AEP 1996a). Key concerns addressed include:

- cumulative effects of oil sands development on local and regional air quality
- protection of water quality and aquatic ecosystem health in the Athabasca and Steepbank Rivers and Shipyard Lake wetlands
- impacts of surface disturbance on the terrestrial ecosystem (terrain and vegetation), especially within the Athabasca and Steepbank River valleys
- cumulative effects of oil sands development on wildlife
- health protection of local and regional residents
- effects on traditional and historical resources
- economic and employment opportunities
- cumulative impacts on infrastructure and community services in the Regional Municipality of Wood Buffalo, particularly transportation, housing, health care and education

A4.2 Summary Conclusions

The EIA supports Suncor's application to AEUB and AEP for the proposed Project Millennium and meets obligations under AEPEA to provide information relating to the potential environmental effects of the project. Suncor is committed to implementing measures that will ensure that the proposed project will not create significant adverse impacts. Notable conclusions are:

- While cumulative air emissions will increase as a result of Project Millennium and other projects, when taken together the modelled emissions generally remain under Alberta Environmental Protection guidelines for ground-level concentrations. Acid deposition is predicted to increase, but further work is required to understand the relationship between loading and environmental sensitivity. A comprehensive, cooperatively-planned and integrated air monitoring system will continue to monitor regional air quality. As well, a program for effects monitoring is in place.

- Athabasca River water quality will not be impacted by the Project nor combined developments. Any potential impact would be reduced with a substantial reduction of plant wastewater and cooling water discharged to the river. The Shipyard Lake wetland ecosystem's will be protected. There will be no net loss of fish habitat in the east bank mining area.

- A closure plan which integrates Lease 86/17 and the east bank mining areas was assessed to have a high likelihood of meeting objectives. Consolidated Tailings technology is proving to be a key factor in reclamation performance. At the closure of the mine, the end pit will be reclaimed to a lake. Further research and development is required to establish design criteria.

- Based on available information, the cumulative health impacts of Project Millennium together with regional projects, will be of acceptable risk. Work is progressing in the area of naphthenic acids and particulates to add further knowledge to the health risk assessment database. Also, Suncor is participating in cooperative health studies and environmental effects monitoring in the region.

- There will be moderate impacts on the local community during Project construction and as the Project comes on-stream, heightened by the significant cumulative oil sands development in the region. This is to be expected for resource development of the proposed scale. These cumulative effects are being addressed through a high level of cooperation among the Regional Municipality of Wood Buffalo (RMWB), the Province of Alberta, community stakeholders and the developers.

- The project will provide very significant economic benefits to the region, Alberta and Canada. Suncor is committed to ensuring that the aboriginal community shares in the benefits through employment and business opportunities.

A4.3 EIA Process

A4.3.1 Scope

The EIA has been completed in accordance with the Final Terms of Reference for Project Millennium. The Terms of Reference which were issued by AEP following input from federal and provincial regulators, stakeholder groups, regional communities, and Suncor, required the EIA to:

- identify the environmental resources affected by Project Millennium
- predict positive and negative impacts and the extent to which negative impacts could be mitigated
- quantify and assess impact significance where possible
- identify information sources
- explain the selection of key components to be examined in the EIA and the influence of the consultative process in the selection
- describe the following for each environmental parameter:
  - existing baseline conditions
  - the nature and significance of effects and impacts of the proposed project
  - how biodiversity is addressed (where appropriate)
  - plans to eliminate, minimize or mitigate negative effects and impacts
  - residual impacts and their significance
  - a plan to monitor effects and impacts and to demonstrate acceptable environmental performance
  - a plan to address those adverse impacts that require cooperative resolution by government, industry and the community

Also, the EIA has been required to address the cumulative effects that are likely to result from the project in combination with other existing and planned projects or foreseeable activities in the region.

A4.3.2 Local and Regional Considerations

Two study areas (Figure A4-1) have been defined to provide local focus and a regional perspective for the EIA. The Local Study Area (LSA) centred around Suncor's plant and the mine development area. The Regional Study Area (RSA) extended south of Fort McMurray and north to the Birch Mountains area. Both the RSA and the LSA were variable dependent on the environmental component being assessed.

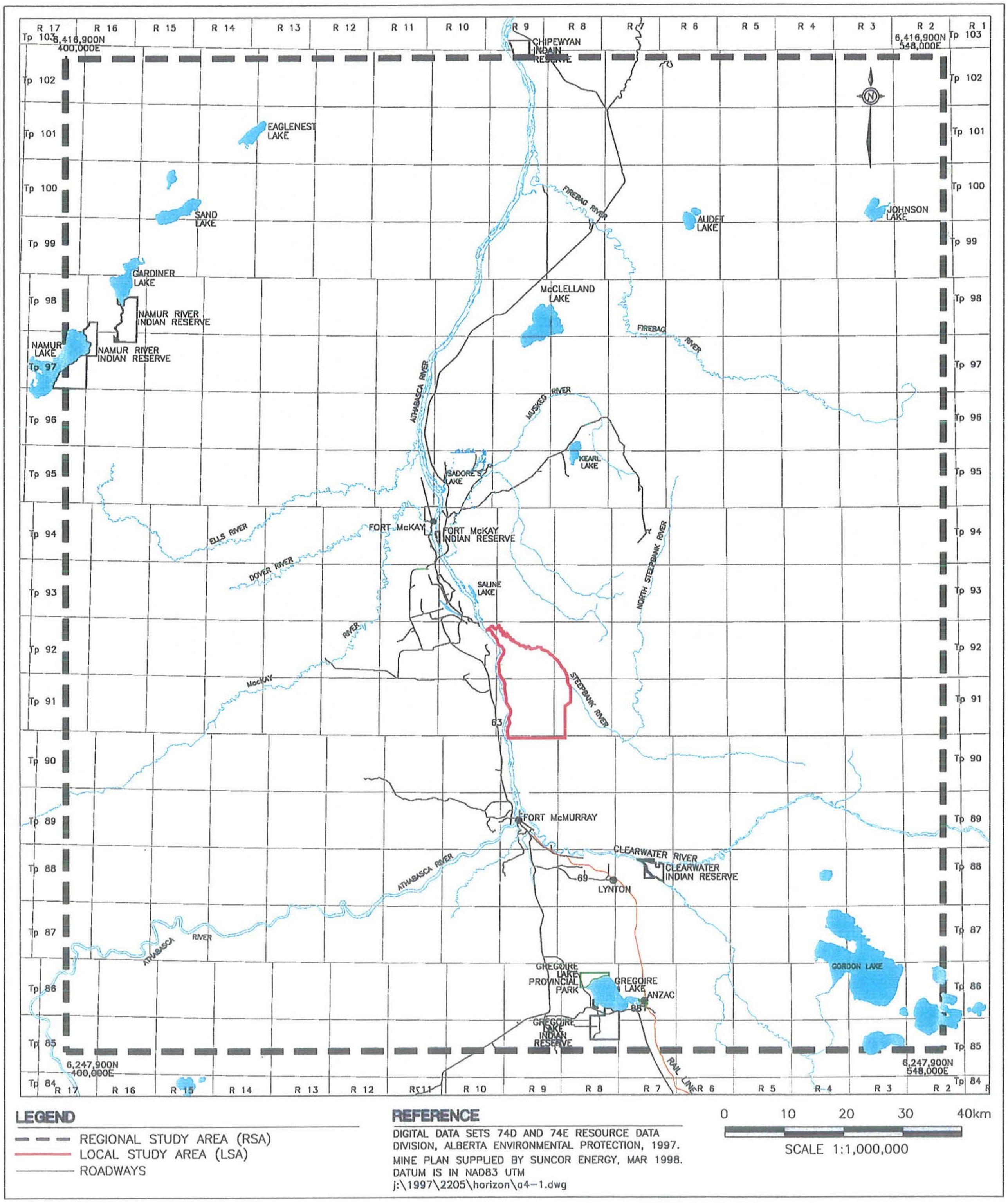


Figure A4-1 Regional and Local Study Areas

A4.3.3 Impact Assessment

Table A4-1 illustrates the two EIA assessment levels that were conducted.

Table A4-1 Project Millennium Impact Assessment Levels

	Baseline	Impact Assessment	Cumulative Effects Assessment
	EXISTING + APPROVED DEVELOPMENTS	EXISTING + APPROVED DEVELOPMENTS + SUNCOR PROJECT MILLENNIUM	EXISTING + APPROVED DEVELOPMENTS + SUNCOR PROJECT MILLENNIUM + PLANNED DEVELOPMENTS
EXISTING	**Suncor Lease 86/17**	Suncor Lease 86/17	Suncor Lease 86/17
	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 ½	Syncrude Mildred Lake Debottlenecking Phase 1/2	Syncrude Mildred Lake Debottlenecking Phase ½
	Syncrude Aurora Mine	Syncrude Aurora Mine	Syncrude Aurora Mine
	Forestry	Forestry	Forestry
PLANNED		**Suncor Project Millennium - Mine Expansion and Upgrader**	Suncor Project Millennium - Mine Expansion and Upgrader
			Shell 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

Baseline conditions were defined to include existing oil sands and forestry plus approved developments. The incremental impact of Project Millennium alone on the baseline conditions was assessed. Cumulative effects assessment also included known planned projects together with Project Millennium.

A4.4 Air Quality Impacts

Stakeholder concerns about air emissions from the proposed Project Millennium have focused on:

- sulphur dioxide (SO_2), which can acidify surrounding soils and water bodies
- oxides of nitrogen (NO_x), which contribute to ground-level ozone and acidification
- hydrocarbon emissions, including volatile organic compounds (VOCs) which could cause odours, health impacts and contribute to ground-level ozone
- sulphur compounds, which could cause odours
- greenhouse gas (GHG) emissions, which have a possible impact on global environment
- particulate emissions, which could affect human health

Project Millennium will dramatically reduce Suncor's emissions on a unit of production basis from current levels. However, due to the magnitude of the production increase, absolute emissions will increase.

Emissions of SO_2 have been effectively reduced with the commissioning of the Flue Gas Desulphurization (FGD) plant in 1997. Through Project Millennium design opportunities and improvements within the Base plant, Suncor is targetting to meet ambient air quality guidelines when the Project comes onstream.

Regionally and combined with other projects, an increase in acid deposition is predicted because of overall increase in SO_2 and NO_x emissions. Suncor is working through the Clean Air Strategic Alliance (CASA) and Regional Air Quality Coordinating Committee (RAQCC) framework to further understanding of the relation of acid loading and environmental sensitivity.

Major contributors of NO_x emissions are the Mine fleet and Energy Services. The maximum ambient NO_2 concentrations will be less than hourly guidelines. The daily and yearly guidelines are exceeded in the mine pit areas due to the equipment emissions. There is a potential for increased acidification in the region when these emissions combined with SO_2 are added to other baseline developments. Strategies to minimize NO_x emissions include: use of low-NO_x burners for new plant equipment; a site-wide NO_x management plan; and use of mine fleet vehicles with improved emission control technology.

There is the potential for ground-level ozone concentrations to exceed provincial guidelines for limited periods at some locations during the summer because of a predicted increase in regional NO_x. Suncor is participating in a regional ground-level ozone modelling program with other oil sands developers. This program (expected to be completed by October 1998) will employ a new modelling framework that replaces the current model, which is recognized as having been inaccurate. Suncor has worked with AEP and other developers to achieve consensus on the modelling framework.

Suncor recently identified a significant increase in emissions from its Tar Island tailings pond (Pond 1). These emissions include methane as well as volatile organic compounds (VOC) associated with the naphtha diluent used in the secondary extraction process. Assessment of sources indicates that these emissions are restricted to Pond 1. The emissions are related to unrecovered bitumen and diluent lost to tailings ponds. Project Millennium will improve the diluent character and thus reduce VOC unit emissions. Suncor is committed to investigate these emissions thoroughly in order to develop an action plan by the first quarter of 1999. Suncor will further quantify and characterize existing emissions, assess environmental and human health impacts, determine cause of emissions, and evaluate control options.

Suncor is a member of the Canada Climate Change Voluntary Challenge and Registry Program, and will manage greenhouse gas emissions corporate-wide following a seven-point plan. The Suncor plan includes progressive greenhouse gas management; developing alternative sources of energy; research; pursuing offsets; public policy advocacy; education; and reporting progress.

Particulate emissions from Suncor's operations will continue to be low. These emissions have been were substantially reduced with commissioning of the FGD.

An enhanced air quality monitoring network has been recently installed in the oil sands region. Called the Wood Buffalo Zone Air Monitoring Program, the initiative combines expertise and leadership of government, health and community organizations, industry as well as other stakeholders. Data collected by the monitoring network will help guide government and industry decisions to protect human health, vegetation and wildlife and to examine soil and water acidification, as well as to minimize odours in the region over the long term.

A4.5 Athabasca River Water Quality and Aquatic Ecosystem Impacts

Potential effects on Athabasca River quality, fisheries and fish habitat or aquatic health that could result from Project Millennium activities include:

- reduced river flows caused by river-water withdrawal or diversion of natural groundwater or surface water flows from mined leases

- sedimentation caused by minesite and river valley erosion

- water quality changes resulting from release of operational waters (pre-mine drainage, treated sewage and wastewaters) and reclamation waters (reclamation landform seepage and runoff) to the Athabasca and Steepbank Rivers. (This includes an end pit lake left after mine closure)

- impacts resulting from drainage changes to Leggett, Wood and McLean Creeks as well as Unnamed Creek, which drains to the Shipyard Lake wetlands

Mitigating measures that Suncor will employ to protect aquatic habitat and water quality include:

- collecting all process-affected waters for reuse as process water
- routing drainage water and runoff from cleared areas into sedimentation ponds before discharge to receiving streams
- constructing a seepage collection system around mine and tailings pond areas
- maintaining water flows to Shipyard Lake wetlands during mine operations as well as long-term redevelopment of surface drainages to wetlands
- maintaining vegetation buffers along Athabasca and Steepbank Rivers, to control mine erosion
- implementing a reclamation plan that includes wetlands systems for natural treatment of runoff and seepage water
- achieving rapid revegetation of land disturbances for erosion control
- modifying the Upgrader cooling and wastewater treatment systems, to substantially reduce discharge of cooling and wastewater to the Athabasca River
- releasing operational CT water only when proven acceptable. (Includes waters associated with the end pit lake.) This is the subject of continuing research and monitoring.

In 1997, Suncor (in partnership with other parties) initiated a long-term Regional Aquatics Monitoring Program (RAMP). The objectives of the program include the following:

- monitoring to allow assessment of regional trends and cumulative effects
- providing data against which assessment predictions for water quality and aquatic resources will be verified

It has been concluded that water releases and aquatic habitat changes associated with Project Millennium will not impair Athabasca River water quality, reduce fish abundance or affect aquatic ecosystem health if the above mitigation measures are taken. Downstream users will not be affected. Changes to surface runoff and groundwater flows to the Athabasca and Steepbank Rivers and to Shipyard Lake wetlands are minimal and will have a negligible impact on fish habitat. Suncor will develop a mine and operating plan which will result in no net loss of fish habitat associated with Shipyard Lake wetlands, Leggett, Wood and McLean Creeks.

No tainting of fish is predicted. Suncor will conduct a fish health and tainting study on CT release waters with a taste panel of regional residents.

A4.6 Terrestrial Resource Impacts

The terrestrial environment (i.e., landforms, soil and vegetation) on the east side of the Athabasca River will be affected by the following east bank mining area activities:

- mining of the Athabasca River escarpment and uplands in the Pit 2 ore body
- placement of both the Millennium Extraction and Ore Preparation plants, and a connecting corridor in the Athabasca River Valley
- construction of an external tailings pond above the escarpment
- altering surface drainages

Most of these issues are similar to those considered in the Steepbank Mine application. Project Millennium accelerates opening of the Pit 2 area by about seven years and mines the entire Pit 1 and Pit 2 resource in a space of about thirty years - rather than fifty or more years. Suncor will continue with mitigating measures identified in the Steepbank EIA including:

- no disturbance of the Steepbank River Valley

- maintaining a 100-m no-disturbance setback from the Steepbank River escarpment crest

- contouring (including introducing surface irregularities) dyke and overburden storage overburden area slopes where possible
- restoring vegetation on constructed landforms to a diversity and community type compatible with regional vegetation communities
- managing flows into Shipyard Lake wetlands during mine operations to protect water quality, and maintaining flows to this area in the long term
- adopting a dry landscape reclamation strategy through implementation of CT technology
- creating new wetlands as part of the uplands reclamation

Three Steepbank Mine application commitments are modified by Project Millennium:

- Movement of all infrastructure from the Athabasca River Valley except the mine access road and bridge will be delayed by about three years, to from 2033 to 2030.
- The Athabasca River escarpment in the Pit 1 mining area will be replaced with an overburden dyke (as previously indicated) but four years earlier, by 2005. The escarpment in the Pit 2 area will be rebuilt by 2008, also with an overburden dyke.
- Project Millennium will require an external tailings pond. That pond will be constructed in a geotechnically-secure manner, with gentle slopes of overburden and sand, and will have a minimum 300-m no-disturbance buffer to the Athabasca River.

Despite mitigation, there will be some landform alteration. After reclamation, the mined area of the Athabasca River escarpment will be somewhat more linear and there will be topographic features created where overburden has been placed.

Revegetation of disturbed areas will restore the potential to achieve regional diversity and vegetation community types but it will take some time for vegetation communities to mature.

Vegetation buffers and setbacks from the Athabasca River will minimize the visual impact of the mine during operations. With removal of facilities from the river valley in 2033, the most notable long-term visual impact will be provided by the bridge and existing plant (on the west side of the river) plus landform alterations mentioned above.

Overall integrated reclamation of the east bank mining area and Lease 86/17 with CT technology will allow the natural diversity of pre-development habitats to be restored. However, in the Local Study Area, there will likely be more mixedwood forests and fewer wetlands. There is flexibility to adjust the mix of habitat types to meet preferences of end land users and to maintain sustainable ecosystems.

The overall size of the Shipyard Lake wetlands will be relatively unchanged and its supply of water will continue to be maintained in both the short and long term.

An end pit lake will be created in the uplands area. Objectives for this lake include: geotechnical security, relatively rapid filling (ten years or less) and a healthy aquatic ecosystem. Suncor will develop detailed design criteria during the life of the Millennium project, prior to closure.

This project's impact on the terrestrial environment is considered to be moderate to high during the operation period and low following final reclamation. The Integrated Resource Plan (IRP) guidelines for Athabasca River Valley development will be satisfied. None of the terrestrial impacts are regionally significant.

A4.7 Wildlife Habitats and Population Impacts

The upland boreal forest ecosystem in the vicinity of the east bank mining areas provides moderately-productive habitat for moose, terrestrial furbearers and breeding birds. Habitats in the Athabasca River Valley are substantially more productive for most wildlife species and provide high quality over-wintering habitat for moose.

Potential impacts on wildlife populations due to east bank mining area activities include:

- direct loss of habitat, especially high-value habitat in the Athabasca River Valley
- fragmentation of habitats by some restriction of wildlife movement along the Athabasca River Valley
- direct mortality during clearing and overburden removal
- effects to health from exposure to chemicals in the air and water, as well as vegetation on CT deposits

Major wildlife impact mitigations that will be implemented by Suncor in the course of the mining development include:

- phasing the clearing and reclamation, to limit the area of habitat disturbance at any one time
- accelerating the reclamation process through enhanced revegetation techniques
- reclaiming CT landforms to a mixture of wetlands and stands of deciduous and mixedwood forests
- maintaining vegetation buffers along the Athabasca and Steepbank Rivers and minimizing disturbance where possible

During the operational phase of the east bank mining areas, there will be a moderate to high local impact on wildlife populations caused by habitat loss due to the project. In the longer term, reclamation of the east bank mining areas with a relatively high proportion of deciduous and mixedwood forest will restore overall habitat potential for most of the area's wildlife species.

Projections of contaminant accumulation in plants and animals, and its associated toxicity due to use of CT indicate a low potential for impact on wildlife populations.

A4.8 Human Health Impacts

Suncor considers the most important factor associated with its growth initiatives to be that the health of the local communities, future users of reclaimed landscapes and Suncor employees is not negatively affected.

Potential impacts on human health from Project Millennium come from:

- chemicals in water releases
- chemicals in air emissions
- consumption of local plants and animals exposed to project air emissions and water releases during the operational phase
- chemicals in soils, plants and water from the reclaimed landscape

To protect human health, Suncor will:

- strive to reduce air emissions, especially those parameters that have potential consequences to human health
- manage water discharges to ensure potential downstream water uses are protected
- design and develop reclaimed landscapes that are safe for future land users

Based on available information, Project Millennium will not result in unacceptable chemical exposures for people who live or work in the project area. This conclusion is based on a conservative analysis of predicted exposures that might arise from:

- contacting or ingesting surface waters
- ingesting local plants and animals
- inhaling airborne chemicals

A recent assessment was initiated to address stack particulates and associated polycyclic aromatic hydrocarbons and metals in response to stakeholder concerns. This information will be available upon completion of assessment. Work is also progressing in the area of naphthenic acids and toxicity. This information will add further knowledge to the overall health risk assessment database. Suncor will continue to participate in the Fort McMurray regional health study and the aquatics and air effects monitoring programs in the region.

A4.9 Socio-Economic Impact Analysis

Project Millennium will provide a number of significant economic benefits to the Wood Buffalo Region, to the Province of Alberta and to Canada. These include:

- creation of 800 direct jobs and about 1 200 indirect jobs
- direct on-site construction employment peaking at 2 500 to 3 000 workers
- capital expenditures of $2 billion to be spent:
  - 17% within the Region
  - 48% in the rest of Alberta
  - 15% in the rest of Canada
- average annual project operating expenditures that will generate $140 million in household income each year in Alberta
- Project Life income taxes and royalties to Alberta and Federal governments will exceed $4.2 billion
- municipal assessment base (and thus its fiscal capacity) will increase by about 30% to 35%

The incremental impact of Project Millennium would be to increase the population of the region, primarily in the urban service area of Fort McMurray, by about 1 100. While such an increase would cause some stress on the existing community infrastructure, the impact would be readily manageable. However, the cumulative effect of the proposed developments in the region (should they all proceed) is to increase the population in Fort McMurray from the current estimate of 38 700 to 49 500 by 2006.

As well, the cumulative effect of all announced projects will have a noticeable impact on the community infrastructure. Paramount among community concerns are:

- transportation safety, primarily north of Fort McMurray on Highway 63, but also south to Edmonton
- provision of adequate health care and attraction of sufficient physicians
- provision of sufficient housing
- provision of adequate education and training infrastructure
- aboriginal employment
- provision of sufficient social services
- provision of appropriate emergency services
- municipal financial needs prior to project startups
- equitable sharing of economic benefits

To enhance local socio-economic benefits and to minimize negative impacts, Suncor will:

- work actively with local government, stakeholder groups and other developers to mitigate adverse community impacts
- work in partnership with the communities and with education institutions to develop a diversified pool of successful employment candidates from the region
- work with municipal and provincial authorities and other developers in the region to find ways of funding necessary infrastructure so growth will proceed on planned timelines
- continue to work with the aboriginal communities to ensure their participation in the economic benefits of development through employment and business opportunities
- give preference to local suppliers and contractors when purchasing goods and services
- provide camp accommodation for the construction workforce and temporary accommodation for the permanent workforce

A heightened level of cooperation existing among the Municipality, the Province of Alberta, community stakeholders and the developers will help to understand and mitigate the cumulative effects of proposed development. Suncor is an active participant on a number of committees and is confident that the requisite infrastructure can be developed in a timely and orderly fashion. The transition period will produce stress in the community, as may be expected for a development of this magnitude. However, over the long term, Project Millennium will confer significant benefits to the region.

A4.10 Historical Resources

Extensive on-site investigations, of the area to be affected by mining, located four sites where recent cultural materials were subsequently identified. The potential for significant undiscovered sites within the area is low and further mitigation requirements prior to mining are not considered necessary. One outcrop of the Devonian Waterways Formation containing fossil remains was also identified in the LSA, but this was outside the development area. As this will not be affected, no mitigation is required.

A4.11 Traditional Land Use and Resource Use

Assessment of Project Millennium's effects on traditional land and resource use included considering changes in:

- surface and subsurface minerals
- environmentally-significant areas
- forestry
- use of local plants for food or spiritual and medicinal purposes
- hunting
- trapping
- fishing
- non-consumptive recreational use

Suncor will mitigate the impacts of the east bank mining areas on existing land uses by:

- protecting surrounding resources from the effects of air emissions and water discharges through continuous improvement processes and effective reclamation of disturbed areas
- in consultation with aboriginal groups, designing a closure plan that accommodates traditional land uses

Hunting and trapping potential will be disrupted during construction and operations as a result of access restrictions and habitat disruption. Timber and gravel resources will be salvaged and not wasted.

A5 APPLICATION GUIDE AND DESCRIPTION

A5.1 Application Scope and Purpose

This application, supported by the EIA, describes the proposed Project Millennium. The application is an integrated application to AEUB and AEP.

Suncor is seeking an amendment to Approval No. 8101 from AEUB for the following:

- Approval of the scheme (as described in this application) for the expansion of mining activities, construction of new facilities, modification of existing facilities and the integrated reclamation plan to support a production increase to a minimum of 210 000 bbl/cd

Suncor is seeking an amendment to its approval No. 94-01-00 (as amended) from AEP for the following:

- expansion of mining activities, construction of new facilities and modifications of existing facilities (as described in this application) to support a production increase to a minimum of 210 000 bbl/cd including:
    - an expansion of Steepbank Mine
    - modifications to the Steepbank Mine service complex
    - modifications to the Steepbank Mine drainage plan
    - construction of an external tailings pond
    - construction of an ore preparation plant at Pit 2
    - construction of the Millennium Extraction plant
    - installation of associated pipelines crossing Suncor Bridge to the Base plant
    - modifications to the Base Extraction plant
    - construction of the Millennium Upgrader
    - modifications to Energy Services facilities including co-generation facilities
    - addition of associated air emissions points
    - modifications to the freshwater, wastewater and cooling ponds
    - associated potential development on Fee Lot 2 (including tank farm, administration building, warehouse and camp)

- modifications to the approved integrated Conservation and Reclamation plan for the current approval period (to June 24, 2006).
- modifications to the integrated closure plan to accommodate the expansion in mining activities
- operation of the modified existing and proposed new facilities

Suncor will apply at a later date for approval (as required) for the construction (in about 2012) and operation of additional extraction capacity in the east bank mining area.

Suncor is seeking amendments to File No. 27549/27551 and Licence No. 10400 from AEP for the following:

- An increase in the allocation for water diversion in the course of mine development and operation. This water will be diverted to prevent runoff exposed to oil sand, by Suncor's mining operation, from entering the environment.
- An increase in the allocation for the consumptive use of water from the Athabasca River to build an operating inventory for the Millennium Extraction Plant.

A5.2 References to Applicable Legislation

A5.2.1 This Application

This application seeks approval from the Alberta Energy and Utilities Board (AEUB) and Alberta Environmental Protection (AEP) in accordance with the following legislation:

- Review and acceptance of the Project Millennium Environmental Impact Assessment Report by the Director of Environmental Assessment Division, AEP under the *Alberta Environmental Protection and Enhancement Act* (AEPEA).
- Amendment of Approval No. 8101 under the Alberta *Oil Sands Conservation Act* (OSCA).
- Amendment of the existing Approval No. 94-01-00 (as amended) under AEPEA.
- Amendment of the existing File No. 27549/27551 and Licence No. 10400 under the *Water Resources Act.*

A5.2.2 Other Associated Project Applications

Suncor will file applications for other aspects of Project Millennium under other statutes. The following is a list of identified federal and provincial application and approval requirements applicable to this project:

<u>Federal</u>:

- *Fisheries Act,* for disturbance to Wood Creek, McLean Creek and Shipyard Lake fish habitat.

<u>Provincial</u>:

- Alberta *Hydro and Electric Energy Act,* for exemption under the act to construct and operate turbogenerators.
- Alberta *Electric Utilities Act*, for exemption under the act for power rates and tariffs for power generated by Suncor in its operations.
- Alberta *Pipeline Act*, for the construction and operation of hot water, raw bitumen, natural gas, gypsum and water pipelines.
- *Municipal Government Act, Part 17*, for a development permit from the Regional Municipality of Wood Buffalo for the construction and operation of Project Millennium and related infrastructure
- *Public Lands Act,* for surface rights
- *Historical Resources Act,* for clearance to construct the facilities

A5.2.3 Other Applications

Suncor is proceeding with those amendments to its AEPEA approval as required for the Production Enhancement Phase (Appendix I)

A5.3 The Applicant

The name of this applicant is Suncor Energy Inc.

The address of the applicant is:

Suncor Energy Inc., Oil Sands
P.O. Box 4001
Fort McMurray, Alberta
T9H 3E3

Correspondence about this application should be directed to the above address to the attention of:

Mark Shaw, Director, Sustainable Development
Phone: 403 743 6892
Fax: 403 791 8344
E-Mail mshaw@suncor.com

A5.4 Guide to the Application

The applications for approval to AEUB and AEPEA have been integrated to:

- reduce the amount of duplication, particularly in the area of project descriptions
- facilitate an efficient review of the application by regulators and the public

This application is presented in two volumes:

- Volume 1 contains the requisite information as specified by:
  - AEPEA "Regulatory Requirements for Application"
  - AEUB "Application Guidelines"
  - Information Requirements under the *Water Resources Act*
  - EIA Terms of Reference (in part)

- Volume 2 contains the remaining information as specified by the EIA Terms of Reference

The following series of tables identifies locations of the required information within this application, cross-referenced to the information guidelines.

Table A5-1 AEPEA Regulatory Requirements for Application, Cross-Referenced with Suncor Volume 1, Project Description and Volume 2, EIA

AEPEA Regulation Clause	Regulation Information Required (Abbreviated)	Volume 1 Project Description	Volume 2 EIA
3(1) a	Name and address of Applicant	A5	
3(1) b	Location, capacity and size of the activity to which the Application relates	A5	
3(1) c	Nature of the activity and the change to the activity (amendment, addition or deletion as the case may be)	A5	
3(1) d	Where the Applicant requires an approval from the Energy Resources Conservation Board, the date of the written decision in respect to the Application	A5	
3(1) e	An indication of whether an environmental impact assessment report has been required	A5	
3(1) f	Copies of existing approvals that were issued to the Applicant in respect of the activity under this Act or a predecessor of this Act	B1.3	
3(1) g	Proposed or actual dates for construction commencement, construction completion and commencement of operations	C6	
3(1) h	List of substances, their sources; the amount of each substance that will be released into the environment as a result of the activity, the change to the activity or amendment, addition, deletion, as the case may be; the method by which the substances will be released; and the steps taken to reduce the amount of the substances released	F3	B3 C2.2 C3.2
3(1) i	Summary of the environmental monitoring information gathered during the previous approval period	Suncor 1996b Suncor 1995a	
3(1) j	Summary of the performance of substance release control systems used for the activity during the previous approval period	F Suncor 1996b Suncor 1995a	
3(1) k	Justification for the release of substances into the environment as a result of the activity, the change to the activity or the amendment, addition or deletion, as the case may be	F3	

AEPEA Regulation Clause	**Regulation Information Required (Abbreviated)**	**Volume 1 Project Description**	**Volume 2 EIA**
3(1) l	Measures that will be implemented to minimize the amount of waste produced, including a list of the wastes that will or may be produced, their quantities and the method of their final disposition	F2	
3(1) m	Any impact, including surface disturbance, that may or will result from the activity, the change to the activity or the amendment, addition, or deletion, as the case may be	F E	EIA
3(1) n	Confirmation that any emergency response plans required to be filed with the local authority of the Municipality or with Alberta Public Safety Services have been so filed	Emergency Response Information in Section B6, Suncor 1996a	
3(1) o	Confirmation that there are contingency plans in place to deal with any unforeseen sudden or gradual releases of substances to the environment	B6.1, Suncor 1996a	
3(1) p	Conservation and reclamation plan for the activity	E	
3(1) q	Description of the public consultation undertaken or proposed by the Applicant	A3	
3(1) r	Information required under any other regulation under the Act to be submitted as part of or in support of the Application	A5	
3(1) s	Any other information required by the Director, including information addressed in a standard or guideline pertaining to the activity that is published or adopted by the Department	A5	

Table A5-2 AEUB Guidelines (September 1991) Respecting an Application, Cross-Referenced with Suncor Volume 1, Project Description and Volume 2, EIA

AEUB Guideline	Guideline Information Required (Abbreviated)	Volume 1 Project Description	Volume 2 EIA
1.5.1	Identification of act and section under which Application is made	A5	
1.5.2	Name and address of the Applicant	A5	
1.5.3	Statement of need and timing for the project	A2, C1	
1.5.4	Overall description of the proposed scheme, including location, size, scope, schedule, pre-construction, startup, duration and reasons for proposed schedule	A2, C1	
1.5.5	Description of the regional setting of the development; reference to existing and proposed land use	E1, E2	A2 F3
1.5.6 (a) 1.5.6 (b)	Lease map Location of landowners and their dwellings in relation to proposed site	B1 A2	
1.5.7	Topographic map	C2.3	
1.5.8	Aerial Photo	B1, C2.3	
1.5.9	General description of storage and transportation facilities of the final hydrocarbon product	B3, C3	
1.5.10	Proposed rate of production of the hydrocarbon product over the term for which approval is requested	A5	
1.5.11	Description of the subject oil sands owned by or leased to the Applicant	B1	
1.5.12	Description of status of negotiations held or to be held with the freehold, leasehold and mineral surface rights owners	C2.4.1	
1.5.13	Description of proposed energy sources with a comparison to possible alternative sources, rates of resource utilization; and description of sources and supply	C4	
1.5.14	Description or results of public information programs planned or initiated for the project	A3	
1.5.15	Term of the approval sought, including expected start and completion dates of the scheme	A5	

AEUB Guideline	Guideline Information Required (Abbreviated)	Volume 1 Project Description	Volume 2 EIA
1.5.16	Name of person responsible to Application, to whom correspondence should be addressed	A5	
2.1.1 (a) to (k)	Geological description	C2.2	
2.1.2 (a) to (g)	Evaluation of the reserves within the project area, the mine site, tailings sites and surface facilities	C2.2	
2.1.3 (a) to (c)	Description of the project layout and mining equipment selected	C2.4	
2.1.4 (a) to (d)	Description of the mine development plans	C2.4	
2.1.5 (a) to (e)	Description of the design, stability analysis, construction method and schedule of pit slopes and discard, including tailings	C2.4	
2.4.1 (a) to (d)	Separate description of the bitumen extraction, upgrading, utilities, refining and sulphur recovery facilities	C2.5	
2.4.2	Overall material and energy balances, including information about hydrocarbon and sulphur recoveries, water use and energy efficiency	D	
2.4.3	Quality of products, byproducts and discard generated and a general description of their disposition	C1.4	
2.4.4	Manner in which surface drainage within the areas of the processing plant, product storage and discharge would be treated and disposed	F3.2.3 Suncor 1995a Suncor 1996a	
2.4.5	Comparison of the proposed process, with alternative processes considered on the basis of overall recovery, energy efficiency, cost, commercial availability and environmental considerations; and reasons for selecting the proposed process	C2.5, C3, C4	
2.4.7	Sample set of production accounting reports for the processing facility, with each entry explained using flows from identified measurement points and calculated flows	D1.6	
2.5.1	Description of any facilities to be provided for generation of electricity to be used by the project	C4	
2.5.2	Identification of the source, quality and quantity of fuels, electricity or steam to be obtained from beyond project site	C4	

AEUB Guideline	Guideline Information Required (Abbreviated)	Volume 1 Project Description	Volume 2 EIA
2.5.3	Where energy resources from outside the project boundaries are to be supplied: a detailed appraisal of the options available to eliminate the need for such resources, with consideration for overall recovery, energy balances, costs, technical limitations and environmental implications	C4	
2.6.1	Description of air and water pollution control and monitoring facilities as well as a liquid spill contingency plan	F Suncor 1996a	
2.6.2(a)	Description of the water management program including: (a) proposed water source and expected withdrawal; (b) source water quality control; (c) wastewater program; and (d) water balance for the proposed scheme	C3, C4, D, F3.2.4	
2.6.3	Manner in which the surface drainage within the project area would be collected, treated and discarded	C2.4.3, F3.2	
2.6.4 (a) to (d)	Description of the emission control system	F Suncor 1995a	
3.1.1 (a) to (g)	Commercial viability information	A1, C1	
3.1.2 (a),(c) and (d)	Description of project capital and operating costs	C1.6	
3.2.1	Summary of quantifiable public benefits and costs incurred during both construction and operation and how they pertain to Alberta and Canada	A4.11	
3.2.2	Summary of non-quantifiable public benefits and costs incurred each year during construction and operation of the project and how they pertain to Alberta and Canada	A4.11	
3.3.1	Appraisal of the economic impact of the project on the region and on provincial and national levels	A4.11	
3.3.2	Discussion of any initiatives undertaken to accommodate regional economic priorities	A4.11, A3.4, C6	
3.3.3 (a) to (d)	Assessment of direct and indirect employment opportunities	A4.11	

Table A5-3 Water Resources Act Information Requirements

Dam Safety Guideline Clause	Information Required	Volume 1 Project Description	Volume 2 EIA
1	Key plan showing principal topographic features of the drainage area (watershed) and downstream channel at an appropriate scale	C2.4.3	
2	General plan of tailings ponds and adjacent areas at an appropriate contour interval showing location of all appurtenant structures and reference bench marks	C2.4.1	
3	General plan of tailings pond at an appropriate scale showing borrow areas, extent of reservoir, water surface and reservoir capacity curves	C2.4.1	
4	Centerline profile of dykes	C2.4.1	
5	Typical cross-sections(s) of dykes at maximum section	C2.4.1	
6	Gradation curves of granular filter materials and the base material being protected	C2.4.2	
7	Calculations showing analysis of embankment stability including the effect of rapid drawdown of the reservoir	Not Applicable	
8	Details of the hydrologic studies carried out to establish the size of the spillways(s)	Not Applicable	
9	Detailed plan of spillway	Not Applicable	
10	Detailed plans(s) of outlet works showing locations and dimensions of all valves or sluice gates, intakes, trash racks, outlet towers, gate houses and appurtenant structures	Not Applicable	
11	Discharge rating curve for the outlet works	Not Applicable	
12	Subsurface exploration results	C2.2	
13	Miscellaneous plans of construction features not covered above such as pilings, fish ladders, flash boards, timber details, radial gates or mechanical operating devices, fuse plug spillways, etc	Not Applicable	
14	Construction specifications	C2.4.2	
15	Proposed construction schedule	C2.4.2	
16	Spillway and outlet model studies	Not Applicable	
17	Plans for handling river diversion during construction	Not Applicable	
18	Flood inundation maps, flood action plans, and emergency preparedness plans	N/A	
19	Instrumentation drawings, reports and reading schedules	C2.4.2	
20	Schedule of first filling of reservoir, operating methodology	C2.4.1	
21	Design reports	C2.4.2	
22	Additional information required at discretion of the Dam Safety Branch	C2.4.2	

Water Diversion Guideline Clause	Information Required	Volume 1 Project Description	Volume 2 EIA
1	The application form (WR1) must be completed and signed by the owner or an authorized official of the company	Separate application to be filed	
2	Plans should be on a material suitable for microfilming, and should have title block which includes: 1. company name 2. drawing number 3. the stamp or seal of a registered professional engineer	Separate application to be filed	
3	A key plan showing the overall project and its location in Alberta	A2	
	A general location plan tied to quarter-section lines, including the configuration of the river, meander, location of intake, pumphouse and other associated works (including control structures, spillway, dam location)	C2.4	
	Detailed design drawings of the intake and pumphouse (if it is a permanent pumpsite) or diversion works, including the location, elevations and extent of the diversion works	Provided in final design	
	If a sewage treatment plant or lagoon is used, provide plans of the plant and/or lagoon including outfall and discharge channel	Provided in final design	
	Conceptual plans may be accepted for initial processing on the understanding that construction plans will be forwarded for review (one set of plans will be required for processing)	Provided in final design	
4	Quantitative analysis of the effect the proposed diversion of water may have on: 1. the source of supply and current water users 2. neighbouring lands and works 3. aquatic habitat 4. the environment in general		C2 C3 C4
5	Other reports may include: 1. project description 2. construction specifications 3. proposed construction schedule 4. operational strategy(ies)	C2.4	
6	Written permission must be obtained from the appropriate provincial or municipal authority if the project affects road or road allowance	Not Applicable	
7	The appropriate pump specifications are required for the intake pump(s) only, including the rate capacity and expected operating capacity of the pump(s)	Not Applicable	

Water Diversion Guideline Clause	Information Required	Volume 1 Project Description	Volume 2 EIA
8	The Crown (under Section 4 of the *Public Lands Act*) claims ownership of the bed and shore of all waterbodies, therefore, a Licence of Occupation (LOC)/easement may be required	Will be obtained when appropriate	
9	If permanent works are to be constructed in a watercourse, approval may be required under the *Navigable Waters Protection Act*	Not Applicable	

Table A5-4 EIA Terms of Reference, Cross-Referenced to Suncor Application

TOR Section	Environmental Assessment Topic or Issue (Abridged)	Volume 1 Project Description	Volume 2 EIA
	Purpose		
1.1	Purpose of document	A4	A1, A2
	Scope of EIA Report		
1.2	EIA report prepared in accordance with Terms of Reference and information requirements under AEPEA, *Alberta Energy and Utilities Board Act* and *Canadian Environmental Assessment Act* and Regulations	A4	A1
	EIA to address all impacts, mitigation options and residual effects relevant to project including, as appropriate, Lease 86/17 and Steepbank Mine	A4	A2
	EIA will form part of application to AEUB	A5	
	Public Participation		
1.3	Public consultation	A3	
	The Proponent and Project History		
2.1	Name of legal entity operating Project	A5	
	Suncor history, existing plant, proposed development	B Suncor 1996a	
	The Project Area		
2.2	Project area	C4	A2
	Legal description of the Steepbank Mine extension, lease boundaries, perimeter of current approval and area proposed to be disturbed in relation to existing features	B1	D1
	Show additional extraction and upgrading facilities to be constructed	B1	
	Project Components and Development Schedule		
2.3	Describe and locate major project components	A2, C	
	Key factors controlling schedule of proposed stages of development	C6	
	Description and schedule of land clearing	E5	
	Placement information and schedule for out-of-pit storage	C2.4, E5	

TOR Section	Environmental Assessment Topic or Issue (Abridged)	Volume 1 Project Description	Volume 2 EIA
	Project Need and Alternatives		
2.4	Need for the Project and alternatives	A2.2, C1	
	Decision basis for major project features	C2, C3, C4, E	
	Potential use of alternative technologies to reduce environmental impacts	C2, C3, C4, E	
	Contingency plans if selected major components prove unfeasible	C2, C3, C4, E	
	Regulatory Approval		
2.5	Applicable approvals and legislation; policies and initiatives and their implications	A5	
	Major Project components applied for within duration of AEPEA and WRA approvals	A5, C, F	
	Process Description		
3.1	Oil sands preparation, extraction and upgrading processes; material and energy balances; flow diagrams	B, C, D	
	Technology used, alternative technologies considered and their effects on water requirements, waste generation, chemical use, tailings, air emissions and bitumen recovery	C	
	Hydrocarbon and sulphur balances, energy efficiency of technologies chosen	D	
	Mining Description		
3.2	Mining methods, alternative mining methods considered and their environmental implications	C2.4, E	
	Effect of minimum ore grade selected on tailings volume, fine tailings volume, water requirements and long-term reclamation	B2.3, C2.2, C2.5, E	
	Utilities and Transportation		
3.3	Description and location of Project utilities	B4, C4	
	Amount and source of energy for mine and plant facilities	C4, D	
	Options for supply of thermal energy and electric power with their environmental implications	C4	
	Road access to and within Project area; need to upgrade or construct new roads; access management	B5, C5	

TOR Section	Environmental Assessment Topic or Issue (Abridged)	Volume 1 Project Description	Volume 2 EIA
	Analysis of impact on Highway 63 during construction and operation; mitigation options; cooperative infrastructure development	A4	F2
	Methodology determining projected traffic volume, mitigation options		F2
	Cooperative infrastructure development with other oil sands and industry operators	A3	
	Sources of road construction and restoration materials; volumes required; local availability	C2.4.1	
	River and stream crossings by utility lines, roads and pipelines; design features to prevent spills, contingencies for spill response; environmental risks associated with spills	C2.6	C2.2
Air Emissions Management			
3.4	Emissions profile (normal and upset conditions)	F3	B2
	Emission control technologies in context of available technologies	C2.5, C3, C4	B2
	Incremental greenhouse gas emission in context with total provincial and national emissions; management plan	F3	B3
Water and Wastewater Management			
3.5	Water management plan for Project including: site runoff and containment, groundwater protection, muskeg and mine pit dewatering, and discharge of aqueous contaminants beyond lease boundaries	C2.4.3	C2, C3
	Permanent and temporary alterations to natural watercourses and their effects	C2.4.3	C2, C3, C4
	New water intake structures and design to address fish entrainment issues and navigational concerns	Not Applicable	
	Wastewater management plan: expected volumes and quality of wastewater; treatment technology proposed in context of available technologies	C3	
	Effluent and reclamation discharges: volumes; quality; location; duration; load estimates for significant contaminants	C2.4.3	C2, C3
	Alternatives to reduce freshwater consumption	C2.5, C3, C4	
	Findings of the Northern River Basin Study (NRBS) in relation to the Project		C3, C4
	Total water balance during approval under WRA	C2.4.4	

TOR Section	Environmental Assessment Topic or Issue (Abridged)	Volume 1 Project Description	Volume 2 EIA
	Discharges to surrounding watershed and Athabasca River from reclaimed sites, including tailings ponds; management strategy for handling releases	C2.4.3	C2, C3
	Potable water and sewage treatment systems to be installed	F6, F3.2.5	
	Hydrocarbon, Chemical and Waste Management		
3.6	Hydrocarbon storage: location; nature; amount; containment and environment protection	B3, C3	
	Chemical product consumption: listing and identification versus specified lists of toxic substances	F2	
	Chemical storage and management	F2	
	Waste stream generation: characterization, volumes and management	F2	
	Tailings, overburden, other mining wastes, coke, sulphur and gypsum: management plans; evaluations to minimize fine tailings considering mining methods and minimum ore grade selected	F2, B2.3	
	On-site waste versus off-site waste disposal strategy; location of on-site waste disposal locations	F2	
	Incorporation of pollution prevention and waste minimization principles into project design	F2	
	Environmental Management Systems		
3.7	Existing environmental management systems and their incorporation into the Project	B6.1	A1
	Monitoring air and water emissions and waste: independent and collaborative programs; new initiatives required as a result of the Project	F3	B, C
	Contingency plans that consider environmental effects of serious malfunctions and emergency response system	B6.2.2 Suncor 1996a	C2
	Contingency plans to respond to unpredicted negative impacts during and after Project development	B6.2.2 Suncor 1996a	
	Assessment Requirements		
4.1	Environmental resources and resource uses: prediction of impacts; mitigation of negative impacts; impact significance; biodiversity considerations		D, F3, G

TOR Section	Environmental Assessment Topic or Issue (Abridged)	Volume 1 Project Description	Volume 2 EIA
4.1	Sources of information: summary of previous assessments; information limitations		A1
	Key ecosystem components: selection rationale; consultative process		A2, C, D
	For each environmental parameter: description of existing conditions; nature and significance of environmental effects and impacts; plans to minimize, mitigate or eliminate negative effects and impacts; residual impacts and significance; plan to identify possible effects and impacts; plan to address adverse impacts when joint resolution is required		B, C, D F
Cumulative Environmental Effects			
4.1.1	Likely cumulative environmental effects of the Project: assessment; study area and time boundaries; rationale to define boundaries for each environmental component		B5, C5, D6, F1.4, F2.4, F3.8, F4.4
	Likely cumulative environmental effects of the Project in combination with existing and proposed projects and forseeable activities: assessment		B5, C5, D6, F1.4, F2.4, F3.8, F4.4
	Previous data: appropriateness; limitations		A1
	Cumulative assessment methods: cooperative initiatives; assumptions; confidence in data and analysis		A2
EIA Study Area			
4.2	Description of Local and Regional Study Areas		A2
	Consultation process; rationale and assumptions used in establishing Study Area boundaries	A3	A2
Cooperative Opportunities			
4.3	Cooperative ventures initiated and developed to minimize environmental impact		B, C, D
Climate, Air Quality and Noise			
4.4	Baseline climatic and air quality conditions		B2
	Effect of Project components on air quality, locally and regionally		B3
	Ground-level concentrations of air quality parameters. Changes to particulate or acid deposition patterns. Selection and limitations of models used.		B2, B3

TOR Section	Environmental Assessment Topic or Issue (Abridged)	Volume 1 Project Description	Volume 2 EIA
	Potential for decreased air quality: implications, interactive effects		B3
	Air quality impact mitigation		B3, B5
	Ambient air quality monitoring		B2
	Project components with potential for increased noise levels, implications and mitigation		B3
	Aquatics		
Fisheries and Fish habitat			
4.5.1	Existing fish resource: description; use		C4.1
	Fish habitat: description and map; critical habitat areas; seasonal habitat use; information base; information deficiencies; proposed studies; key indicator species and selection		C4.1
	Fish and fish habitat: potential impacts of Project		C4.2
	Design, construction and operational factors incorporated into Project to protect fish resources		C4.2
	Fish and fish habitat: residual impact and significance; plans to offset any loss in productivity of fish habitats; "No Net Loss" plan; cooperative mitigation strategies		C4.2
	Potential for increased fishing pressures in Study Area and implications		F3
	Monitoring programs to assess impacts and effectiveness of mitigation strategies		C4.2
Water Quality			
4.5.2	Water quality before and after project development and operation		C3.1, C3.2
	Natural seasonal variations in water quality		C3.1
	Components of Project which influence surface and groundwater quality		C2, C3
	Comparison of predicted and existing water quality; implications of any predicted non-compliance with quality guidelines; impacts on sediments.		C3.2
	Water courses sensitive to acidic deposition and potential project impacts		C3.2
	Relevant issues identified by NRBS program		C3.1, C3.2

TOR Section	Environmental Assessment Topic or Issue (Abridged)	Volume 1 Project Description	Volume 2 EIA
	Post-reclamation water quality; impact of CT water discharges on land, soil, vegetation and receiving watercourses		C3.2
	Impact of CT waters on Shipyard Lake; management of water quality of Shipyard Lake and feed streams		C3.2
	Aquatic quality monitoring programs		C3.1, C3.2
Surface Water Hydrology and Hydrogeology			
4.5.3	Pre- and post-Project surface hydrology		C2.1, C2.2
	Pre- and post-disturbance watercourse configuration	C2.4.3	C2.1, C2.2
	Effects on surface water quantity caused by the Project		C2.2
	Temporary and permanent alterations, diversions, withdrawals and disturbances: resultant impacts under a variety of operating conditions (including emergency conditions) on hydrology		C2.2
	Permanent alterations, diversions, withdrawals and disturbances: use of, to enhance fish habitat and recreational potential		C2.2, C4.2
	Potential flooding and its effects		C2.2
	Project activities affecting stream bed and shores, and mitigation measures	C2.4.3	C2.2, C4.2
	Surface water runoff monitoring program		C2.2
	Groundwater regime	C2.4.3	C2.1
	Project effects on groundwater and options to manage and protect groundwater systems		C2.2
	Interrelationship of groundwater to surface water; potential impacts to streams, Shipyard Lake and the Athabasca River		C2.1, C2.2
	Potential effects of alterations to groundwater regime on terrestrial and riparian vegetation and surface water		C2.2, D3.2
	Implications of development on surface and groundwater flows to associated wetlands		C2.2, D3.2
	Impacts of withdrawing water from the Athabasca River or other water sources on water users, including wildlife and fisheries; impact on downstream watercourses		C3.2, C4.2

TOR Section	Environmental Assessment Topic or Issue (Abridged)	Volume 1 Project Description	Volume 2 EIA
Terrestrial			
Land Use			
4.6.1	Athabasca Oil Sands Integrated Resource Plan (IRP): consistency with guidelines and objectives; mitigation and research requirements to satisfy guidelines		F3.6
	Proposed setbacks from Athabasca and Steepbank Rivers, compliance with IRP	C2.4	F3.6
	Unique sites and special features in the study area: Project impact; Special Places candidate sites (if present)		F3.5
	Existing land uses: Project impact; mitigation strategies		F3
	Recreation and public access: Project impact and implications		F3
	Replacement of existing land use by reclamation	E	D, E
Geology, Terrain and Soils			
4.6.2	Map of bedrock, surficial geology and topography of Study Area	C2.2, C2.4	
	Aggregate resources: management plan	C2.4.1	
	Sequential maps and assessment of anticipated changes to topography, elevation and drainage patterns	C2.4.1, E5.1	
	Map of soil types and distribution in Project area	E3	D2.1
	Map and assessment of pre- and post-disturbance land capability	E3	D2.1, D2.2
	Availability and suitability of soils for reclamation	E2.5	D2.1, D2.2
	Criteria to be used in salvaging soils for reclamation	E2.5	
	Areas where soils will be stockpiled and salvaged; estimate of volume salvaged and required for reclamation	C2.4	
	Soil-related constraints affecting reclamation; constraints on revegetation; soil erosion; soil contamination		D2.2
	Regional soil sensitivity to acid deposition: studies and planned work		D2.2
	Ecological Land Classification (ELC) for Project area	E1.4, E2.5	D4.1

TOR Section	Environmental Assessment Topic or Issue (Abridged)	Volume 1 Project Description	Volume 2 EIA
	Impact on each ELC unit from disturbance based on key soil characteristics		D4.2
	Vegetation and Forest Resources		
4.6.3	Map and description of vegetation communities affected by the project using Alberta Vegetation Inventory Standards Manual Version 2.2	E2.5	D3.2
	Description of plant communities for each ecosite phase: species important to wildlife; indicator species; rare species	E2.5	D3.1, D5.1
	ELC map of pre- and post-disturbed landscapes and assessment of land uses		D4.1, D4.2 F3
	Rare, vulnerable or endangered species: opportunities to mitigate impacts to species, if present		D3.2, D5.2
	Commercial and non-commercial forest: classification; comparison pre- with post-disturbance; impact on present and future needs	E2.5, E3.4	D3.2, F3.6
	Vegetation disturbance: amount; temporary and permanent changes; significance of the effects; implications for other environmental resources		D3.1, D3.2
	Strategy to minimize impact of the project on vegetation		D3.2
	Plan for mitigating the adverse effects of site clearing	E	D3.2
	Inventory of peatlands and wetlands	E2.5	D3.1
	Predicted effect of Project on peatlands and wetlands; plans to minimize the impact		D3.2
	Wildlife		
4.7	Use and potential use of Study Area by wildlife		D5.1
	Rare, threatened and endangered species and their habitat needs		D5.1
	Potential adverse impacts on wildlife during each phase of Project		D5.2
	Significant local habitat for indicator wildlife species		D5.1
	Potential to return area to pre-disturbed wildlife habitat conditions		D5.2
	Mitigation plan and schedule for wildlife habitats		D5.2

TOR Section	Environmental Assessment Topic or Issue (Abridged)	Volume 1 Project Description	Volume 2 EIA
	Monitoring programs to assess wildlife impacts and effectiveness of mitigation strategies		D5.1, D5.2
	Current bird deterrent system: expansion to incorporate the Project; system limitations, effectiveness and potential improvements; impact on adjacent reclaimed land		D5.1, D5.2
Reclamation and Mine Closure			
5	Mine closure plan; reclamation concepts and objectives; proposed end use objectives and other factors necessary to implement the plan	E	E
	Reclamation timeframe and release of lands back to the Crown	E	E
	Incorporation of final landform into mine planning and development	E	E
	Return of land to pre-disturbed equivalent capability, with regard for end-use preferences	E	E
	Incorporation of IRP identified values into reclamation plan	E	E
	Promotion of biodiversity	E	D, E
	Aquatic components of post-reclamation landscape: issues, hydrological analysis, comparison to pre-disturbance	E	C, E
	Wetlands; how the reclamation plan incorporates diversity, size and extent into the final design	E	D, E
	ELC map for post-reclamation landscape considering potential land uses		D
	Species for permanent revegetation; selection rationale		D3.2, E
	Parameters used to monitor and evaluate reclaimed ecosystems: key milestone dates, measurement of progress to achieve targets		C, D, E
	Plans to demonstrate reclamation success to stakeholders	E	E
	Reclamation constraints	E	E
	Need for further reclamation research and development programs	E	E
Public Health and Safety Issues			
6	Implications for public health or regional health service delivery		F2.5, F3

TOR Section	Environmental Assessment Topic or Issue (Abridged)	Volume 1 Project Description	Volume 2 EIA
	Potential to increase human exposure to contaminants		F3.3
	Workforce and public safety: emergency response and mitigation plans	B6.2, Suncor 1996a	F2.5
	Potential health and safety impacts due to higher traffic volume and increased risk of accidental spills		F1.3
	Documentation of health and safety concerns from stakeholders during consultation	A3	
Historical Resources / Traditional Land Use			
7	Historic Resources Impact Assessment (HRIA) and consultation		F4.2
	Overview and summary of previous heritage resource studies		F4.2
	Results of consultation with aboriginal stakeholders; aboriginal land uses; project impact and mitigation strategies	A3	F4.2, F4.3 F4.4
	Stakeholder concerns with respect to historical significance or current traditional land use		F4.2, F4.3
Socio-Economic Assessment			
8	Socio-economic impacts of the Project on the communities of the region and on Alberta	A4.11	F2.4, F2.5
	Suncor policies regarding use of regional and Alberta goods and services	A4.11, C6	
	Summary of industrial benefits; description of engineering and contracting plan	A4.11, C6	
	Workforce requirements for construction and operation; local employment and business opportunities	A4.11, C6	F2.4
	Plan to work with aboriginal and other local residents and businesses with regard to employment and business opportunities	A3.4	F2.2, F2.4
	Impact on local services and infrastructure; cumulative effects; options to mitigate impacts	A4.11	F2.5
	Cooperative strategies to mitigate socio-economic concerns and continuing consultation plans	A3	F2.5
Public Consultation			
9	Public consultation program	A3	
	Consultation process and influence on the project	A3	
	Communication program and continued public consultation	A3	

B CURRENT OPERATIONS

B1 OVERVIEW

B1.1 Background

When Suncor's Oil Sands operation commenced activities in 1967 as Great Canadian Oil Sands, it was the first integrated oil sands production venture in the world. Over the years, the operation underwent a series of operational and capital improvements as well as expansions in production capacity. By early 1996 plant capacity had grown to 79 500 bbl/cd. Early in that year Suncor applied to increase production to 107 000 bbl/cd (gross) or 105 000 bbl/cd (net after internal fuel consumption). Two separate applications were filed and subsequently received regulatory approval: Fixed Plant Expansion Project (Suncor 1996a) and Steepbank Mine Project (Suncor 1996b). These two projects will be completed in 1998.

In July 1997, Suncor announced plans to increase daily production from its oil sands facility to 210 000 bbl/cd level by 2002. This production level will be achieved in stages and is a combination of projects currently approved (Steepbank and Fixed Plant Expansion), initiatives to enhance existing equipment (Production Enhancement Phase or PEP) and plans to twin the existing facilities and expand Steepbank Mine (Project Millennium). Production capacity by the end of 1997 was 85 000 bbl/cd.

The Production Enhancement Phase (PEP), to raise production to 130 000 bbl/cd, begins in 1998 and is targeted for mid-2001 completion. PEP comprises a number of small, independent projects designed to improve reliability, reduce or eliminate small production restrictions and increase capacity in some cases.

Project Millennium, the subject of this application, will increase production through development of additional bitumen production capacity and construction of a second upgrading train. This section describes operations through to the completion of PEP, the base upon which Project Millennium will build.

B1.2 Location and Lease Holdings

The Suncor Oil Sands operation is located on the Athabasca Oil Sands deposit (35 km north of Fort McMurray), straddling the Athabasca River. Suncor holds the following Oil Sands Leases in Township 92, Ranges 7 to 10, west of the 4th Meridian (Figure B1-1) under the *Mines and Minerals Act*:

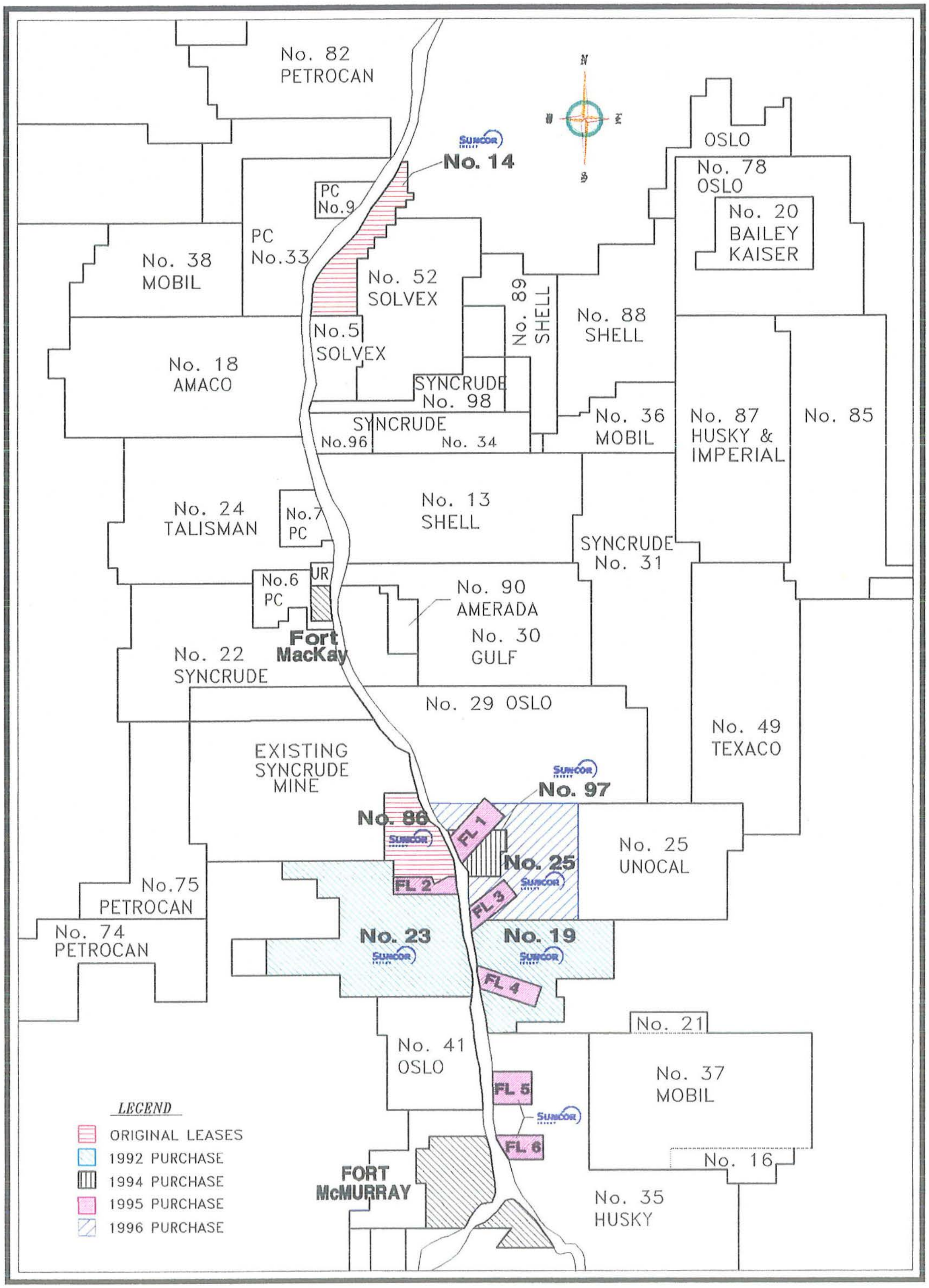


Figure B1-1 Lease Map

- No. 7387060 T04 (Lease 86)
- No. 7279120 092 (Lease 17)
- No. 7280060 T23 (Lease 23)
- No. 7276030 T11 (Lease 97)
- No. 7279080 T19 (Lease 19)
- No. 7280100 T25 (Lease 25)

Lease 86 and Lease 17 are collectively referred to as Lease 86/17 in this document. In addition, Suncor also holds Fee Lots 1 through 6, Quarriable Minerals Lease No. 1993010001 on Lease 86/17 and Mineral Exploration Permit No. 9390110001 on Lease 86/17 (for metallic and industrial minerals).

Suncor began its mining operations on the west side of the Athabasca River on Lease 86/17 in 1967 and bitumen reserves there are nearing depletion. The soon-to-be opened Steepbank Mine is located on the east side of the river (on Leases 97, 19, 25 and Fee Lots 1 and 3) and is accessed by a bridge over the Athabasca River. Figure B1-2 shows an aerial photo of Suncor operations.

Additionally, Suncor holds the following surface rights under the *Public Lands Act*, to accommodate facilities and operations:

- Mineral Surface Leases: Nos. 901468, 920406 and 941307
- Miscellaneous Land Leases: Nos. 890107 and 950032
- Licences of Occupation: Nos. 1839, 2003, 3489, 770976, and 950761

Suncor also holds fee simple title to its plantsite on the west side of the river.

B1.3 Operating Approvals

Following is a list of current operating approvals for the Suncor Energy Inc., Oil Sands operation:

- Alberta Energy and Utilities Board (AEUB) Approval No. 8101
- Alberta Environmental Protection (AEP) Approval No. 94-01-00 (as amended)
- (AEP) *Water Resources Act* Licence to Divert and Use Water No. 10400
- (AEP) *Water Resources Act* Licence to Divert and Use Water File Nos. 27549 and 27551
- (AEUB) *Hydro and Electric Energy Act* Permits and Licences Nos. SU 97-10 to SU-97-12 inclusive
- Alberta Energy and Utilities Board *Pipeline Act* permit No. 19971124.

Figure B1-2 Aerial Photgraph

These approvals allowed Suncor to proceed with the Fixed Plant Expansion and Steepbank Mine. Approval documents are available for examination from Suncor Energy Inc., Oil Sands.

Suncor advised the Alberta Energy and Utilities Board (AEUB) and Alberta Environmental Protection (AEP) by letter in December 1997 that it intends to proceed with the Production Enhancement Phase and that it will seek the necessary amendment to its approval under the *Alberta Environmental Protection and Enhancement Act* (AEPEA) prior to construction. These letters are provided in Volume 1, Appendix 1 of this application.

B2 BITUMEN PRODUCTION

This section describes current bitumen production operations: those of Steepbank Mine and the Fixed Plant Expansion and Production Enhancement Phase (PEP).

B2.1 Mining of Oil Sands

Site preparation for oil sands mining involves several steps: clearing vegetation; draining muskeg and overburden aquifers; removing and storing muskeg and overburden; and depressurizing the basal aquifer located in parts of the mine area.

Trees are cleared in accordance with requirements of Alberta Lands and Forest Service. Tree and bush clearing (including logging of salvageable timber, piling and burning) is carried out during winter months when the muskeg is frozen. Clearing occurs in advance of the mine operation.

Muskeg and overburden aquifers are drained by a network of ditches in advance of muskeg and overburden removal. From these aquifers, drained water is channelled via drainage ditches to settling basins, which are designed for settling out solids as well as removing minor amounts of oil and grease. Water from the basins and control weirs is discharged to the Athabasca River, with the flow controlled to reduce erosion of natural embankments. Systems to control discharge of water from the existing Lease 86/17 Mine and Steepbank Mine are detailed in Suncor's "Application for Renewal of Environmental Operating Approval" (Suncor 1995) and its "Steepbank Mine Project Application" (Suncor 1996b) respectively.

Muskeg is removed for use in reclamation with trucks and either hydraulic shovels or front-end loaders which strip frozen muskeg in winter. Muskeg suitable for use as soil-building amendment is either stored in designated areas or applied directly to reclamation sites.

Since 1993/94 Suncor has used a truck and shovel process to remove overburden and mine the oil sand deposit. The removed overburden is either used to construct tailings pond dykes or hauled to waste areas. In 1997, the mine fleet included twenty-eight 218-t trucks; eight 77-t trucks; three 23-m^3 hydraulic shovels; three 44-m^3 cable shovels; and miscellaneous dozers, graders, loaders and backhoes.

A limestone quarry is located on the existing Lease 86/17 mine oil sands pit. Limestone from this quarry is used for road building and for the Flue Gas Desulphurization Unit (FGD) in the Energy Services plant.

On Lease 86/17, mined oil sand is crushed through sizers and then carried 4 km by conveyors to a surge bin in the Extraction plant. Suncor expects to complete mining on Lease 86/17 by 2001.

Steepbank Mine will commence operation in 1998. There, ore mined with truck and shovel methods will be delivered to sizers and then by conveyors to a slurry preparation plant. Slurry will be pumped to the existing Extraction plant through two hydrotransport lines. The slurry preparation stage is discussed further in Volume 1, Section B2.2.3.

Rejects from the slurry preparation plant are conveyed to a rejects bin, then trucked to in-pit disposal.

Modifications to Steepbank Mine required to achieve the PEP production target include:

- four 218-t trucks
- one shovel
- one additional hydrotransport line

B2.2 Bitumen Extraction

B2.2.1 Scope

This section describes the essential steps in bitumen extraction and reviews Extraction plant configurations (including tailings management and diluent recovery) as they will exist at the end of the Steepbank Mine and Fixed Plant Expansion projects and at the end of PEP. Discussion of the technology evolution and the decisions that led to these configurations can be found in the "Steepbank Mine Project Application" (Suncor 1996b).

B2.2.2 Bitumen Extraction Stages

Bitumen extraction involves the following main stages:

- conditioning delivery of ore to the plant
- primary extraction:
  - primary separation
  - middlings recovery
  - tailings oil recovery
- froth heating and deaeration
- froth treatment (producing diluted bitumen)
- diluted bitumen to intermediate tankage
- Consolidated Tailings plant and Pump House
- diluent recovery from froth treatment tailings
- emission control

Over the years technology in each of the component stages has evolved to facilitate: process streamlining; improvements in recovery, process reliability, and measurement; reduction of energy consumption; and lessening of environmental impact. Suncor's extraction process has been in rapid transition and will be significantly changed with the commissioning of Steepbank Mine in late 1998. PEP modifications will primarily add production rate capacity.

A simplified process flow diagram for Extraction operations is shown on Figure B2-1. Modifications for PEP include:

- installation of froth recycle on Line 6 deaerator
- tie-in of remaining separation cell to slurry pipeline distributor to handle ore from Steepbank Mine
- adding IPS unit for increased capacity
- converting the scroll mechanism and feed arrangement in remaining nine Bird centrifuges, for increased capacity
- adding a new, larger-diameter (approximately 5 m) Naphtha Recovery Unit to maintain diluent recovery criteria
- one additional pump train (total of four)
- upgrading pumps on existing lines
- one additional tailings line (total of seven)
- installation of one additional siphon from Pond 2 to Pond 1A (total of two), for increased capacity
- replacing barge pumps and twinning existing line for increased capacity

B2.2.3 Ore Preparation

Lease 86/17

Until 2001 (when the current mine is depleted) ore from Lease 86/17 will continue to be crushed in sizers and then delivered by conveyors to a surge bin located at the front end of the Extraction plant. Apron feeders and feed conveyors transfer ore to conditioning drums, to which steam and hot water are added.

Conditioned slurry is passed through a vibrating screen to remove rocks and clay lumps larger than 1 cm in diameter. These oversize reject materials are trucked to an oversize dump. Screened slurry is further diluted with hot process water and is pumped into a separation cell.

Steepbank Mine

At Steepbank Mine, slurry preparation and hydrotransport processes will transfer sufficient heat and mechanical energy to the oil sand to cause

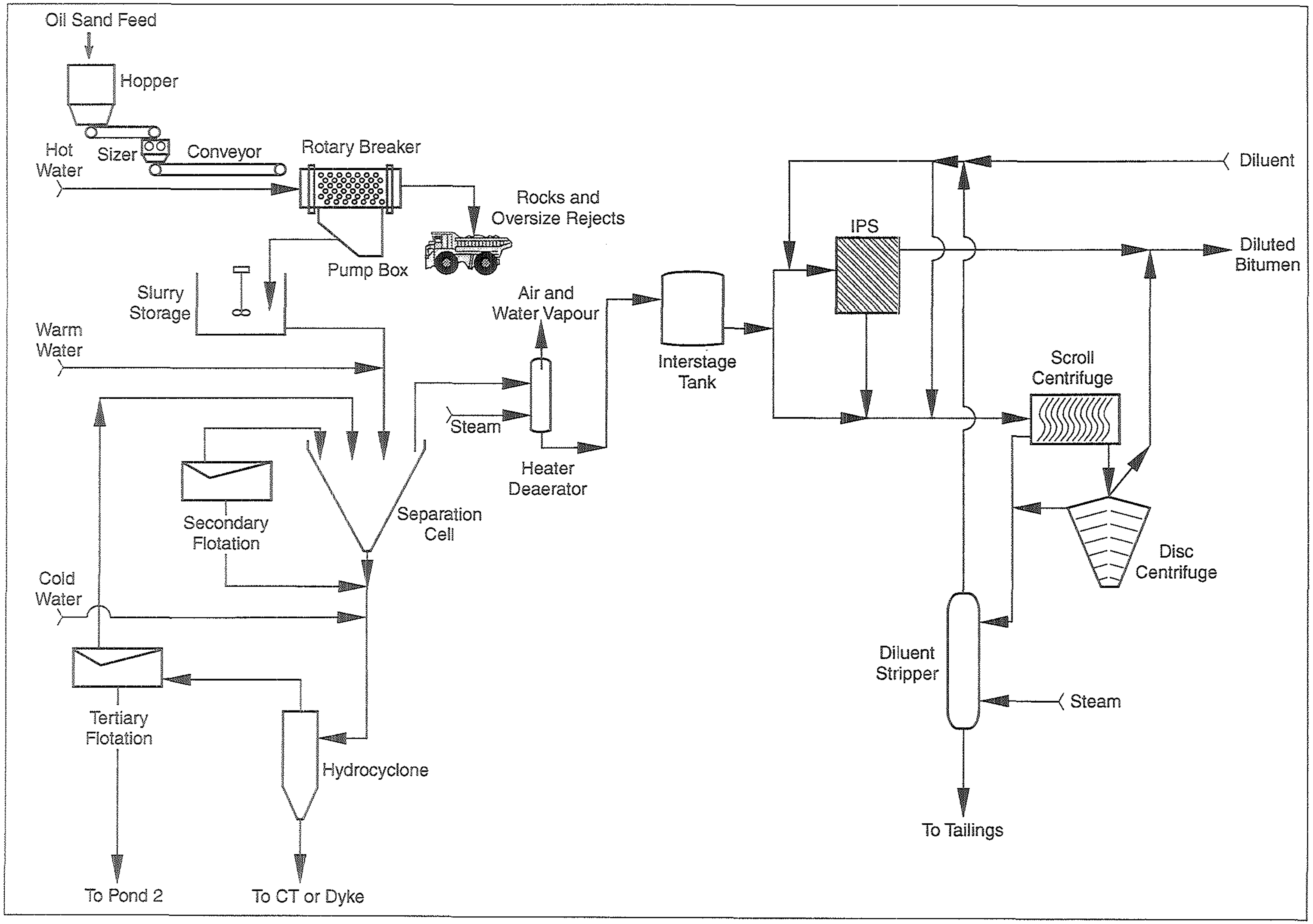


Figure B2-1 PEP Extraction Process

release of bitumen from the oil sands matrix and ready the slurry for bitumen recovery.

Ore will be crushed to less than 400 mm in diameter by two sizers, then delivered by conveyor to one of two trains (normally only one is in operation). Each train comprises two rotary drum breakers in parallel mounted on a pump box. Each rotary drum breaker is a rotating perforated drum in which mined material is broken down by tumbling action to particles less than 50 mm in diameter. These particles will pass through holes in the drum and will be collected in the pump box.

Rejects from the rotary drum breakers will be conveyed to a rejects bin, from which they will be trucked to in-pit disposal.

Hot process water (90°C) will be sprayed into the breakers to generate a slurry product with a specific gravity (sp. gr.) of about 1.6. Slurry from the operating breaker pump box would then be delivered to three wet storage surge tanks in parallel, two of which are normally in operation. This storage provides a surge volume which dampens irregularities in ore delivery and enables the downstream hydrotransport operations to operate at steady-state rates. Each storage tank is equipped with an agitator to keep solids and bitumen in suspension.

Steepbank ore will be pumped (using hydrotransport) from the Steepbank Ore Preparation plant to the existing Extraction plant, then through a distributor directly to a separation cell. At the conclusion of PEP, there will be three hydrotransport lines feeding ore to six separation cells.

B2.2.4 Primary Extraction

The primary mechanism of bitumen recovery is the separation cell, of which there are five in the existing plant with a sixth cell under construction. Due to the surface area and residence time in these cells, a layer of bitumen froth separates from the feed slurry and the bulk of the sand in the slurry settles to the bottom of the vessel. Most bitumen recovery occurs in the separation cell and the product (bitumen froth) is sent to a heater/deaerator. A relatively dense sand slurry is removed from the base of the vessel and sent to tailings.

A third stream (the middlings) is recovered from the side of the separation cell and sent to a bank of secondary flotation cells. This stream comprises a dilute suspension of sand, fines and residual bitumen. The bulk of residual bitumen is recovered in the flotation cells and delivered to a froth cleaner (which acts as a sump), from which the froth is recycled to the separation cell feed.

Combined tailings from the separation cells and secondary flotation cells are pumped to banks of hydrocyclones in the Final Tailings Pump House. Hydrocyclone overflow is processed in a set of tertiary flotation cells, with tertiary froth recycled to the separation cell feed streams and tertiary tailings pumped directly to a tailings pond. Tertiary froth recovery has just commenced in the existing Extraction plant.

A sixth primary extraction train is currently under construction (to accommodate increased production levels), and will have a process flow similar to current operations. The biggest change is the deep cone geometry of the separation cell. This sixth cell will have better hydraulic isolation of its middlings contents from the underflow steam, which will aid in maintaining steady-state conditions in the separation cell and thus will enhance recovery.

B2.2.5 Froth Treatment

After heating and deaerating, bitumen froth is transferred to an insulated froth interstage tank (commissioned in June 1997). The froth (which requires further cleaning) is typically at a temperature of 95°C and is composed of: bitumen, 60 wt%; water, 30 wt%; and mineral, 10 wt%. Diluted bitumen, the product of the extraction process, is then transferred to diluted bitumen storage.

The froth treatment process uses centrifuge and inclined-plate technology in parallel (Figure B2-1).

Inclined Plate Separation

About one third of froth feed from the interstage tank is mixed with hot diluent and directed to the inclined plate separator (IPS). A compact version of a gravity separator. Diluted bitumen enters a feed box, from which feed is distributed to numerous inclined plates for separation into product and underflow streams.

The IPS divides the diluted froth feed into two streams as follows:

- diluted bitumen, which is pumped to diluted bitumen storage
- an underflow stream, which will be mixed with the remaining portion of froth feed (two-thirds or less) and directed to the centrifuge plant

Suncor is placing one IPS unit into operation and another is planned for mid-1998. Increase PEP production levels may require the installation of an additional IPS unit.

Centrifuge Froth Treatment

Centrifuges have been the mainstay technology for froth cleanup since the inception of oil sands operations. About two-thirds of froth feed from the interstage tank is mixed with hot diluent and sent for two-stage centrifuge treatment, with demulsifier added as required. In the first stage, scroll centrifuges remove the bulk of the mineral from the froth. In the second stage, mineral and water contents are reduced to 0.5 wt% and 4 wt% respectively by disc centrifuges. Product from the disc centrifuges (diluted bitumen) is pumped to storage. Waste streams from the centrifuges are combined and sent to a diluent stripping tower.

PEP will include enhancements to the first-stage centrifuges to achieve the required capacity.

B2.2.6 Consolidated Tailings

As described in the "Steepbank Mine Project Application" (Suncor 1996b), Suncor has adopted CT technology as a means to accomplish dry landscape reclamation of its tailings ponds. The first commercial-scale CT operation commenced in October 1995 and is currently proceeding on a full scale.

Extraction process tailings are sent to hydrocyclones, which produce a 70% mineral concentration underflow stream. This stream, which contains 90% of the sand-size particles in the ore, is mixed in the Final Tailings Pump House with mature fine tailings (recovered from Pond 1 and Pond 2/3) and gypsum (a byproduct of the Flue Gas Desulphurization plant). The resulting CT mixture, readily pumpable with existing tailings pumping systems, is currently deposited in Pond 5 where it consolidates into a stable deposit.

Hydrocyclone overflow is pumped to Pond 2/3 for storage after the tertiary recovery process.

Tailings sand will not be used exclusively for CT. About 15% is required for dyke construction on Lease 86/17 in the period 1999 to 2008.

PEP modifications include: one additional tailings line (total of seven); one additional bitumen-recovery-from-tailings pump train (total of four); and one additional bitumen-recovery-from-tailings line (total of three).

B2.2.7 Naphtha Recovery Unit

Froth treatment tailings are routed to a naphtha recovery unit, where diluent is separated for recycling by the use of counter-current contact with live steam. Lean tailings are then pumped to storage in a tailings pond.

PEP proposes to replace the existing tower with a larger-diameter (approximately 5m) unit to maintain diluent recovery criteria (>99.3% of diluent used in the extraction process). The existing tower will be utilized when the new tower is down for planned maintenance.

B2.3 Consolidated Tailings Technology

The CT process results in recombination of coarse and fine tailings into a stable deposit with a reclaimable surface (Figure B2-2). Successful implementation of CT technology will eliminate future fine tailings accumulation and will consume the current fine tailings inventory. At the same time, the surface area required for water clarification will be reduced to about 30% of that used today.

B2.3.1 CT Process Description

As shown on Figure B2-3, mature fine tailings from existing tailings ponds are combined with thickened (cycloned) fresh sand tailings produced by the Extraction plant. The mixture is chemically stabilized (to prevent segregation of fine and coarse mineral solids) through the use of gypsum, which is a byproduct of Suncor's Flue Gas Desulphurization (FGD) plant.

Figure B2-4 shows how the CT process is integrated into the plant operation. Oil sand ore entering the Extraction plant is mixed primarily with recycle water from the tailings ponds, augmented with water drawn from the Athabasca River. The process tailings are sent to hydrocyclones which produce a 70% mineral concentration underflow stream. This stream (which contains in excess of 90% of the sand-size particles in the ore) is mixed in the Final Tailings Pump House with mature fine tailings (recovered from Pond 1 and Pond 2/3) and gypsum. Addition of sufficient gypsum changes the structure of the suspension by causing the clay particles to become strongly attractive. These clay particles form a structure which supports the relatively inert silt and sand-size particles and which prevents segregation of the coarse and fine particles. This resulting CT mixture is readily pumpable (using existing tailings pumping systems) for deposit in Pond 5. Once deposited in the pond, the mixture dewaters relatively rapidly, leaving a stable deposit. Fines not captured in the deposit form a gypsum-treated fine tailings deposit refered to as Consolidated Tailings Mature Fine Tailings (CTMFT), which has greatly improved settling characteristics relative to typical Clark process tailings. The target is to capture 90% of the fines during initial deposition. Segregated fines will be recaptured either during subsequent deposition of fresh CT or when mechanically remixed with fresh CT.

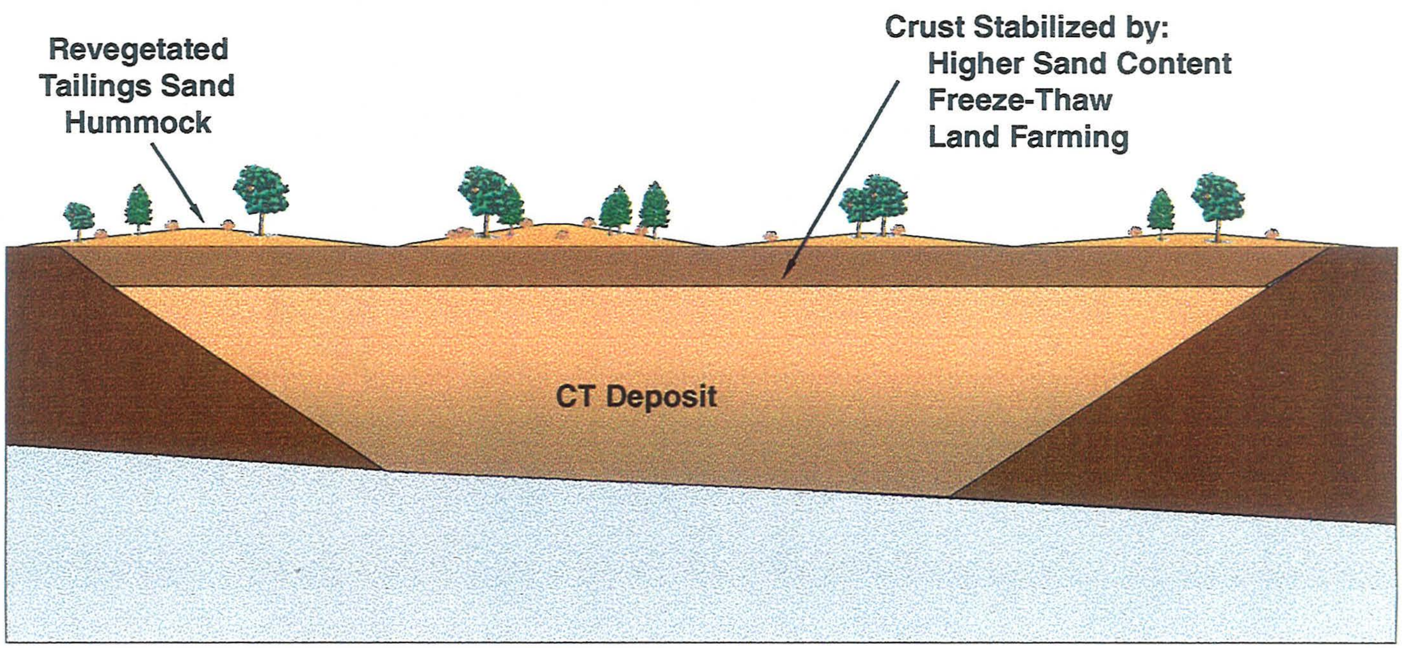


Figure B2-2 CT Deposit Reclamation

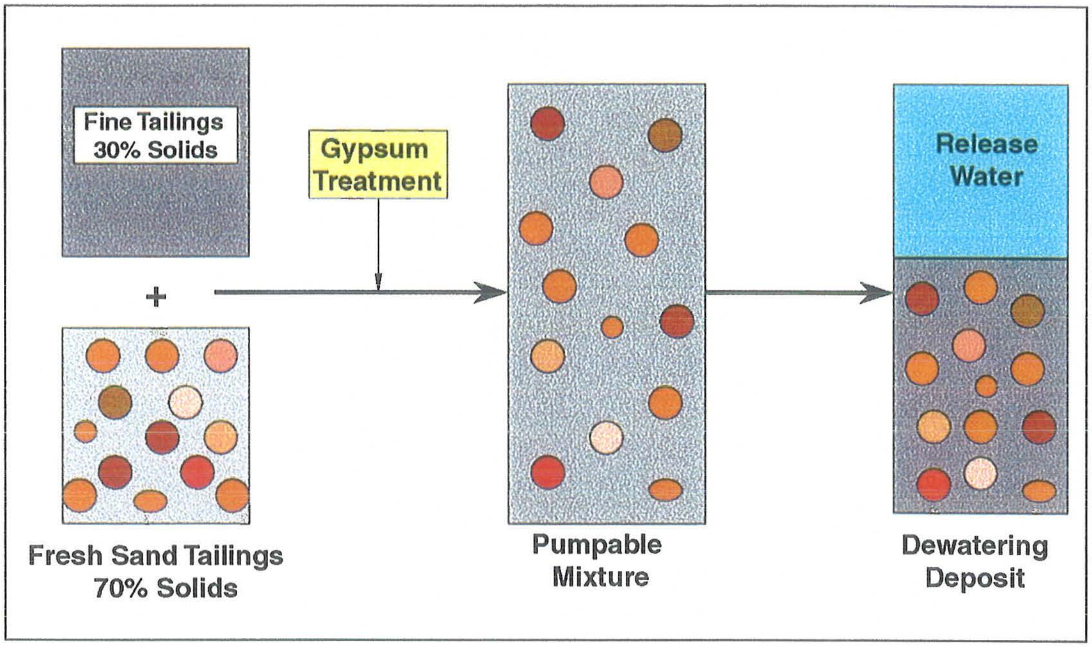


Figure B2-3 Consolidated Tailings

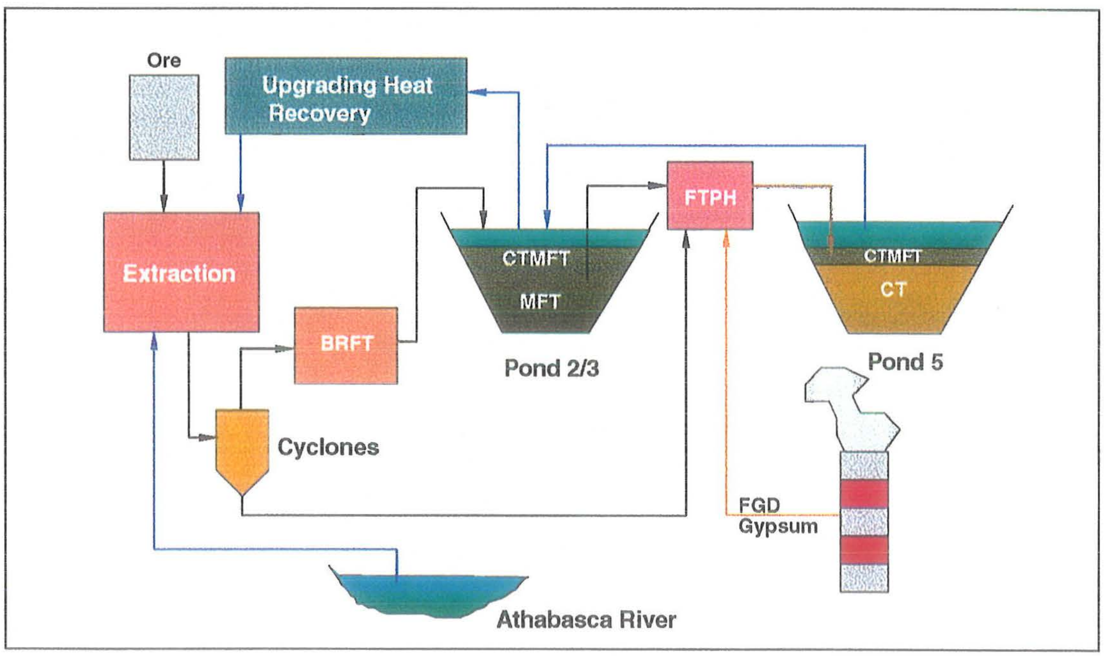


Figure B2-4 Consolidated Tailings Process

The CT deposit releases essentially mineral-free water to the surface of the pond. However, this release water also contains significant concentrations of chemicals (calcium, magnesium and sulphate) from the gypsum which were not adsorbed by the clay particles. Calcium and magnesium concentrations could adversely affect the extraction recovery process. This is resolved by mixing release water from Pond 5 with the clay-rich cyclone overflow stream prior to entry into Pond 2/3. This step serves to remove these chemicals from the recycle water and to accelerate sedimentation of fine clays in Pond 2/3, so the pond serves as a thickener to produce MFT for the CT process. Recycle water reclaimed from Pond 2/3 is also essentially mineral-free, which enables reduced fouling of the heat exchangers in the Upgrading heat recovery system.

Primary variables which must be controlled in the design of the CT mixture are: concentration of gypsum; concentration of water; and the ratio of the sand to fine particle sizes (SFR). These are discussed below.

B2.3.2 Selection of Treatment Chemistry

While a range of organic and inorganic chemical species can be used as treatments to produce CT, unacceptably high costs are associated with these treatments due to the very large volumes of fine tailings which require processing. For instance, a treatment that costs as little as $\$1/m^3$ results in incremental operating costs of hundreds of millions of dollars at an oil sands scale of operations.

Suncor has selected a soluble calcium-based treatment for its CT process. This alternative has been chosen because of the proven effectiveness of the treatment and the availability of gypsum (calcium/magnesium sulphate) as a low-cost byproduct of the FGD process.

A minimum treatment level is required to alter the structure of the clay minerals in suspension such that a consistent CT product is produced. During the initial phases of the CT operation, a treatment of 0.9 kg/m^3 of gypsum of CT has been used. However, operating data has demonstrated that the clay mineral content is variable both in the MFT and the cyclone underflow streams. Since the amount of gypsum required is determined primarily by the amount of clay minerals (or their exposed surface area) in the mixture, actual treatment amounts of gypsum also vary. An important indicator that adequate treatment has been applied is the residual concentration of calcium and magnesium in the CT mixture pore fluid. It has been found that a 3 millimolar concentration of calcium plus magnesium produces the necessary alteration in clay particle structure.

It is expected that the quantity of gypsum required for treatment can be reduced in the future without affecting residual pore fluid concentration. CT release water (containing elevated levels of calcium and magnesium) will be returned to the extraction recycle water inventory. This water will be reacted with the clays in the cyclone overflow stream prior to entering Pond 2/3. When these pre-treated clays are recovered for use in CT, the required dose of additional gypsum to produce CT should be reduced.

B2.3.3 Selection of CT Water Content

Non-segregating CT behaviour occurs over a range of initial solids concentrations, chemical treatment species and quantities as well as coarse-mineral to fine-mineral ratios. Typical behaviour is illustrated on Figure B2-5, which summarizes extensive laboratory and field pilot testing conducted over several years (AGRA 1996a). To be successful, the CT process must operate within the non-segregating region since re-incorporation of fines and sand into a single homogeneous deposit is the fundamental goal of the process. Operational issues that further constrain selection of CT composition are described below.

The above analysis does not use the total presence of clay mineral, only the component that responds to gypsum treatment. It is the combination of the water and clay contents which determines the segregation nature of the CT mixture. Experimental data has shown that there is little effect on the sand to fines (SFR) ratio within the range of interest to Suncor (5>SFR>3).

Figure B2-6 shows that a plot of water and clay content in the full sample leads to a family of lines at a constant clay mineral to water ratio (CMWR). Based on laboratory and pilot plant data, Suncor has chosen to use the following criterion: CMWR>0.1. Future experience in the commercial environment may lead to modification of this value.

B2.3.4 Selection of the Sand to Fines Ratio

This selection process is driven by balancing two objectives. One objective is to produce a deposit which consolidates quickly, gains strength and allows surface reclamation to proceed. This is best accomplished at a SFR exceeding 6:1. Another objective, to reduce the existing inventory of fine tailings, would suggest a lower SFR than 6:1. The current plan is to reduce the existing inventory of fine tailings by 2020 to 25 Mm^3 (the ongoing volume required for the CT process). This plan requires a SFR of about 3.5:1.

B2.3.5 Method of Deposition into CT Deposits

There is a trade-off between method of deposition and CT mixture composition. CT mixtures with elevated water content or reduced clay content are particularly sensitive to deposition. Under these conditions, deposition needs to provide a low-energy environment that offers quiescent

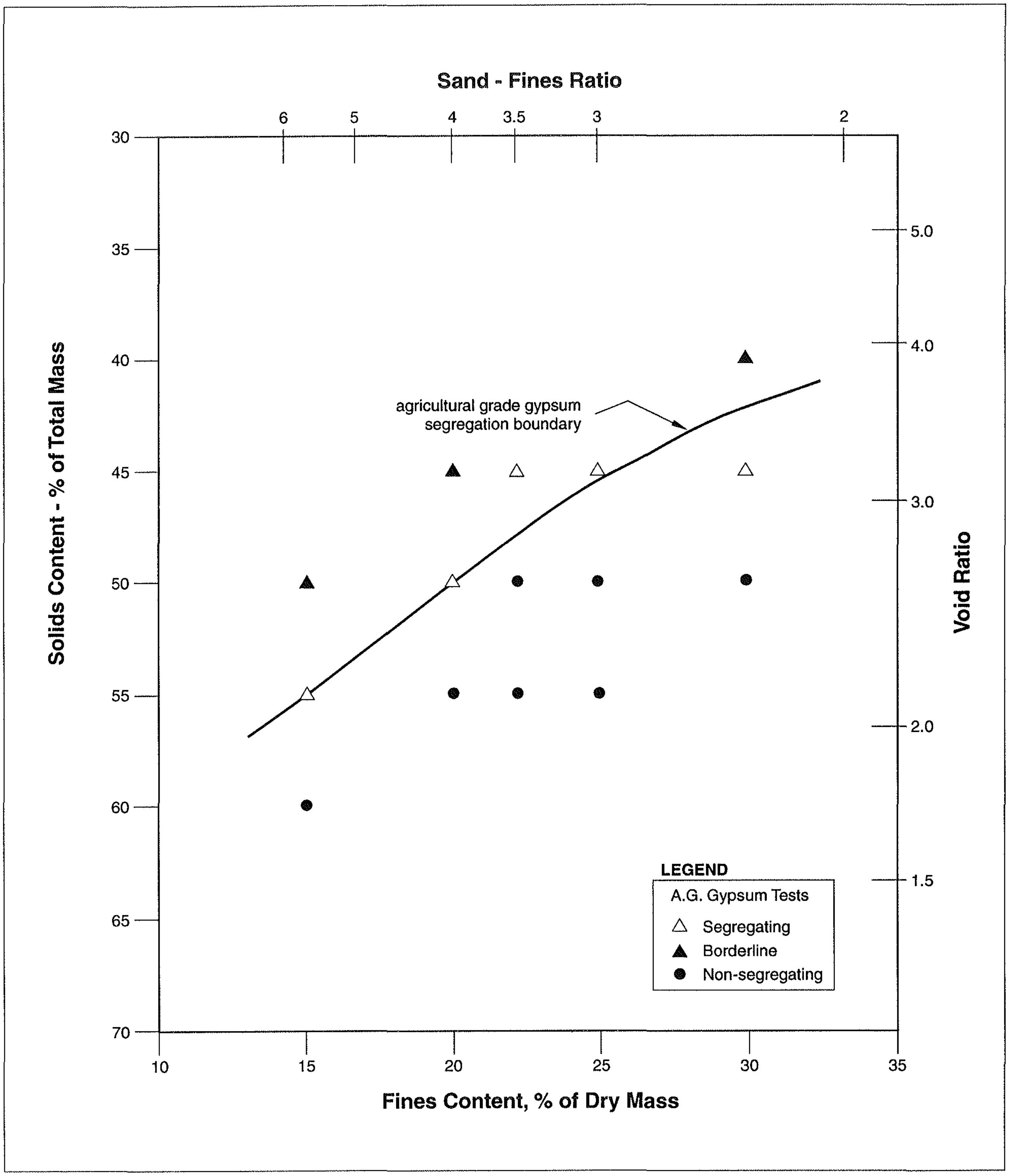


Figure B2-5 Consolidated Tailings Segregation Boundary

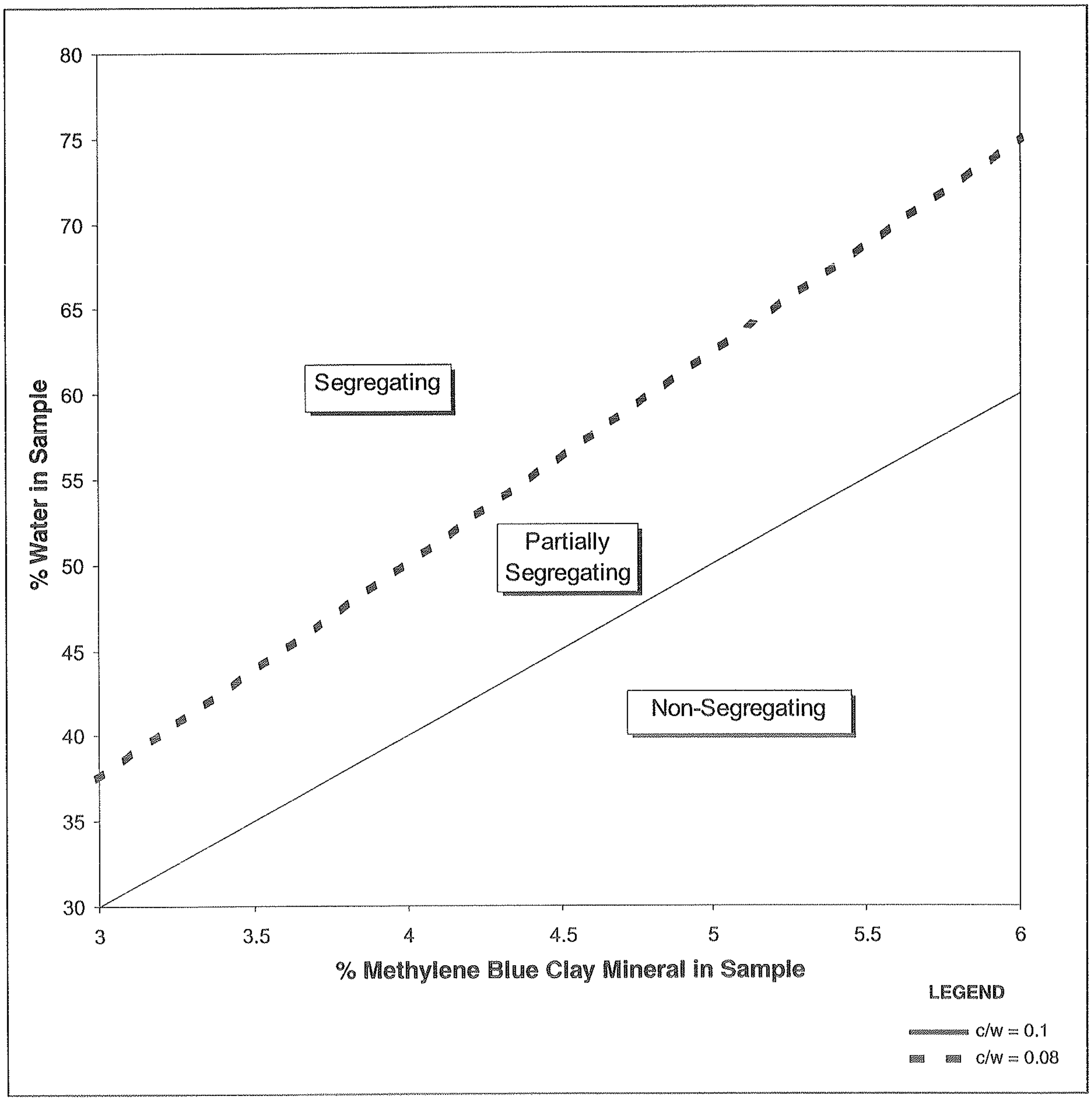


Figure B2-6 Segregation Behaviour for Quiescent Deposition

conditions for initial settling into relatively thin layers. In order to extend the range of CT mixtures which produce relatively non-segregating behaviour, Suncor is experimenting with a "tremie" deposition system shown on Figure B2-7. This system deposits fresh CT in such a manner that dilution with surface water is minimized.

B2.3.6 CT Implementation and Operating Experience

Overview

CT operation on a commercial scale commenced in October 1995, on a single process line as part of the Consolidated Tailings Commercial Trial-Phase 1. This phase operated through April 1996 and produced about 5 Mm^3 of CT in Pond 5 with a fines capture rate estimated to be around 60%. Although this capture rate was lower than anticipated, it did represent a significant improvement in fines capture during startup of a new tailings pond. The release water was essentially mineral-free, with a reduced toxicity relative to typical tailings pond waters.

Phase 2 of the Consolidated Tailings Commercial Trial started up on a single train in October 1996, followed by a second train in January 1997. During this phase, most of the major components required for full commercial operation were installed and commissioned. These systems operated until March 1997, when the MFT line from Pond 2/3 failed during spring ice breakup. CT operations were curtailed until September 1997 as the result of planned plantwide maintenance outage in May and dedication of most of the tailings sand to the construction of Dyke 8 in the summer months. CT operations resumed during the fall of 1997, using new, twin 24" pipelines. A tremie deposition system was installed on one of the lines on a test basis, while a shore-based deposition system was used for the alternate line.

Water Chemistry

Figure B2-8 shows the concentration of calcium and magnesium in Pond 5 release water. The data suggests that dosage levels above the minimum required values of 3 millimolar have been achieved. This supports plant measurements which only infrequently identify low gypsum treatment as an operating problem. Periods when the trend is between 2 millimolar to 3 millimolar are summer periods of reduced CT deposition. During these periods, precipitation of calcium related to absorption of CO_2 from the atmosphere occurs.

Water from Pond 5 has been transferred back to Pond 2/3 since April 1997. The low chemistry measurements in Pond 2/3 reflect the stripping of calcium and magnesium by clays in Pond 2/3 recycle water and cyclone overflow. The recycle water clarified to essentially mineral-free during the fall of 1997. Recycle water chemistry levels are still within historical precedent relative to calcium and magnesium. An impact on extraction recovery is not anticipated.

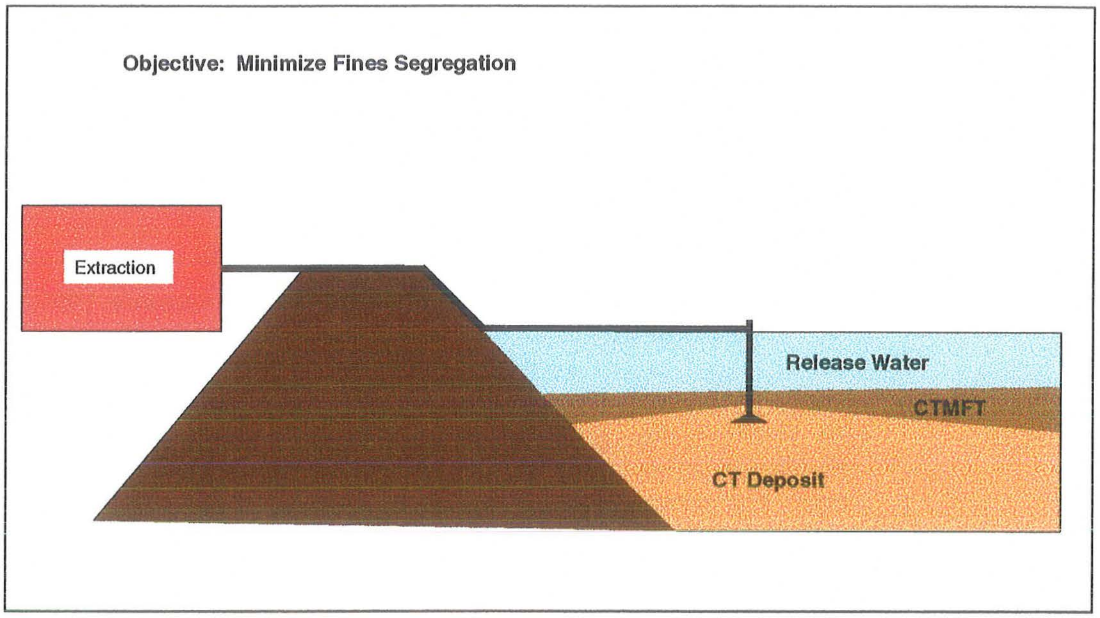


Figure B2-7 Tremie Deposition

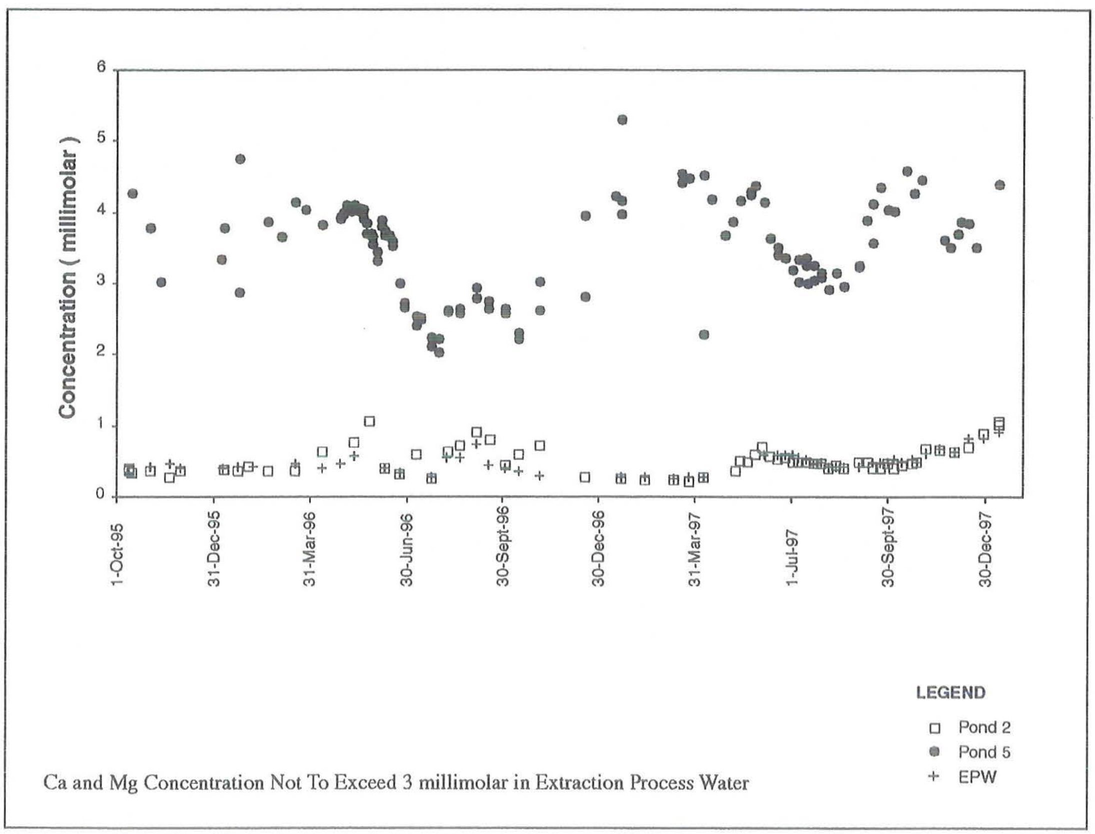


Figure: B2-8 Ca and Mg Concentration

CT Deposit Characteristics

Figure B2-9 shows the predicted volumes of (CTMFT) and CT in Pond 5. Included in the figure are actual volumes obtained from in situ measurements.

Figure B2-10 shows profiles through the deposit in Pond 5. These profiles suggest that a deposit with the characteristics of CT is becoming established. A mineral balance around Pond 5 shows that the overall clay capture since the beginning of CT operations is in the order of 65% to 70%.

Figures B2-9 and B2-10 show that some CTMFT has accumulated during the commissioning and early operation of the CT system, and that limited accumulation is likely to continue. As shown in Figure B2-9, this material will be removed and incorporated in future CT deposits. It will not have a significant detrimental impact on final reclamation of the deposit. Based on experience, it can be concluded that CT technology is viable and will be a major asset to achieve reclamation objectives.

B2.4 Tailings and Water Management

B2.4.1 Tailings Management

Tailings ponds are developed in the mined pits to contain extraction tailings, process waters from the Upgrading plant and drainage water from the mine pit. There are currently four active tailings Ponds: Nos. 1, 2/3, 4 and 5 (Figure B1-2). A fifth pond (Pond 1A) is used to increase the fines settling time of process recycle water.

Lease 86/17 Dykes

Prior to the development of CT, the extraction process created tailings with a swell factor of 30% (ratio of tailings volume to ore volume). As there is insufficient overburden material to construct the dykes needed to contain these tailings volumes, tailings sand must be used for dyke construction. Lease 86/17 tailings pond dykes are constructed from tailings sand and overburden waste materials. Sand is slurried to the ponds from the Final Tailings Pump House and is positioned on the dyke by means of temporary sand retaining walls. As water flows into the pond, sand settles on the top of the dyke, where it is packed using tracked vehicles during the summer. During the winter, sand is beached on the edge of the pond, producing no increase in dyke height.

Fine tailings (which settle to the bottom of tailings ponds) have a low hydraulic conductivity of 10^{-6} cm/s which is further reduced to 10^{-8} cm/s when the fine tailings consolidate. At the contact point between the tailings dyke and the fine tailings deposit, tailings consolidate quickly as water seeps into the dyke. This creates a very-low-permeability layer which significantly reduces the loss of process water from the tailings pond basin.

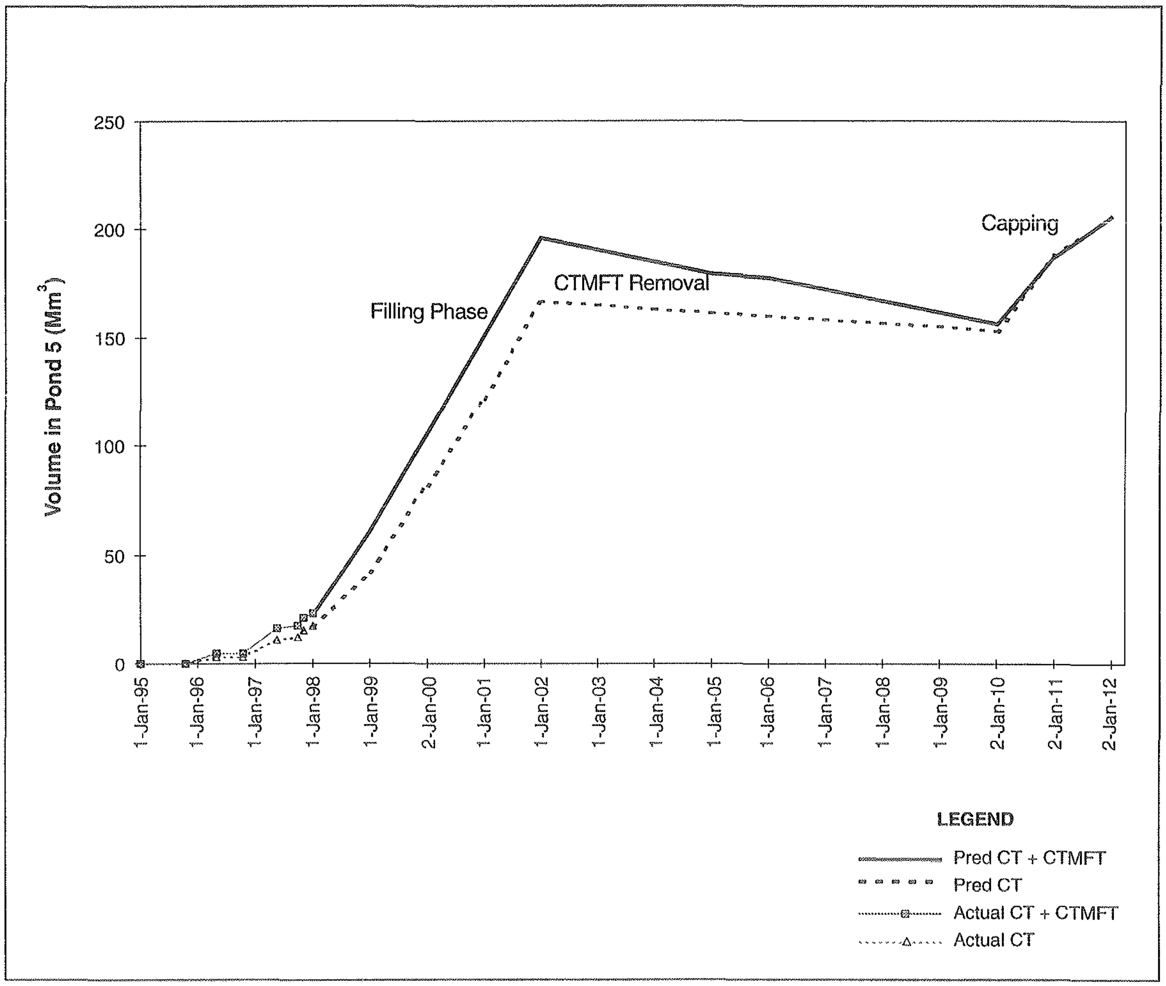


Figure B2-9 Pond 5 Infilling - Predicted vs Actual

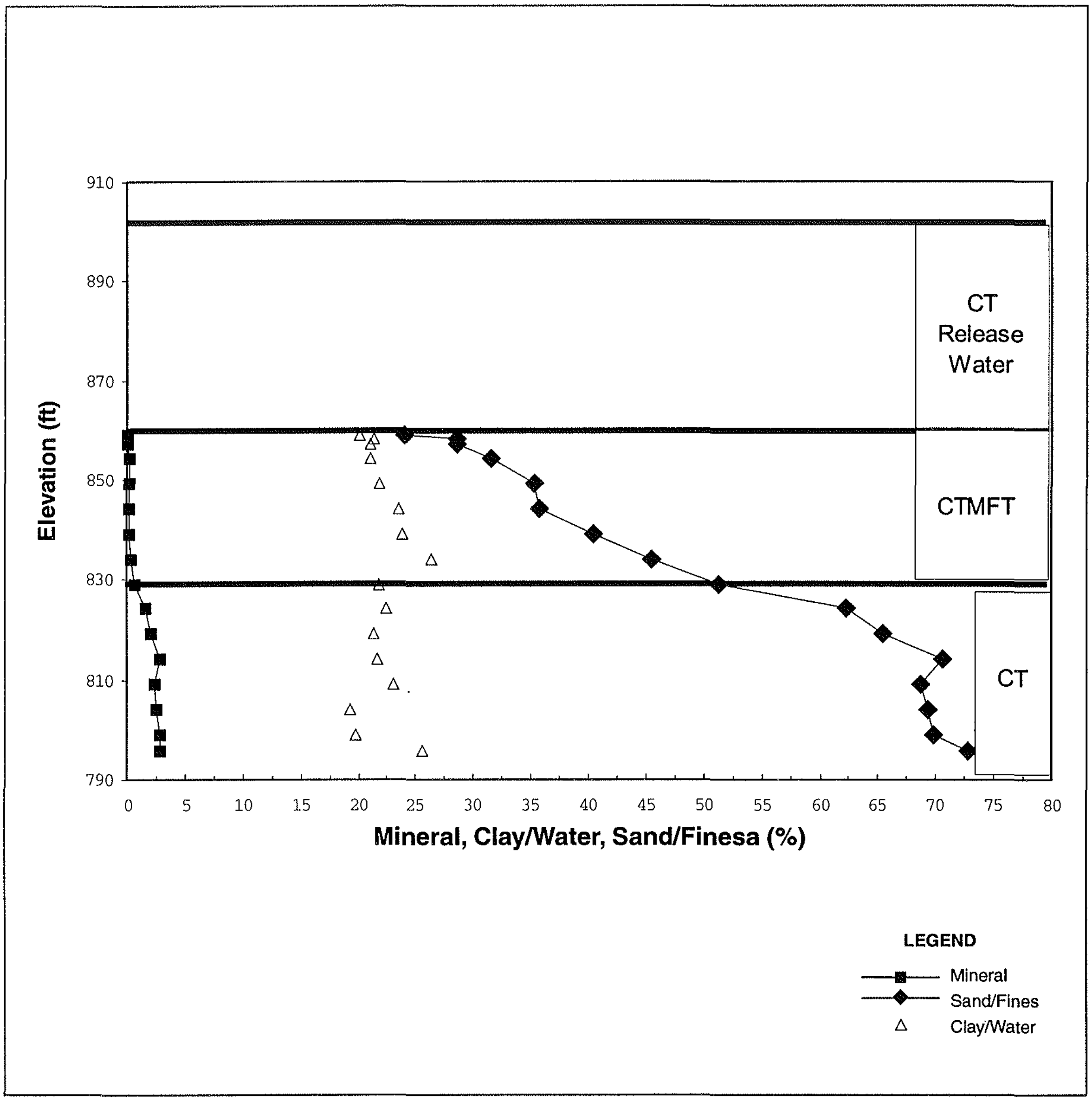


Figure B2-10 Pond 5 - Deposition Profile

Steepbank Mine Dykes

With the introduction of CT technology, the tailings swell factor has been reduced to near zero, thus eliminating the need to use sand for dykes. Steepbank Mine dykes (to contain Consolidated Tailings and water) will be constructed entirely of overburden materials, accomplished by excavating overburden, hauling it to the site and compacting it according to design specifications.

Stable, efficient performance of tailings pond dykes is ensured by the following means:

- monitoring piezometers, slope indicator installations and drainage discharges
- performing regular inspections to examine the state of dyke stability, surface seepage and erosion
- conducting analyses to ensure the dykes have an adequate factor of safety
- implementing surface erosion protection measures on completed portions of the downstream side of dykes

B2.4.2 Water Management

Freshwater for use in Suncor's oil sands plant is drawn from the Athabasca River. Suncor is licensed to withdraw 59.8 Mm^3 annually (equivalent to 163 000 m^3/cd) from the river at a maximum instantaneous rate of 3.8 m^3/s (Licence No. 10400). The water balance for Suncor's operation at the end of PEP is described in Volume 1, Section D.

Water Survey of Canada records from the Fort McMurray gauging station No. 07DA001 for the thirty-five-year period (1958 to 1992) indicate:

- the average annual low-flow condition of the Athabasca River is 11.8 Mm^3/d
- the lowest rate ever recorded during this period occurred in 1988, when river flow fell to 7.6 Mm^3/d

Suncor's 1997 average water intake requirements comprise a diversion of river-water of approximately 1.1% to 1.7%, expressed as a percentage of the above two low-discharge conditions. Actual consumption during these low-discharge conditions is 0.22% and 0.34% respectively, because 80% of water diverted from the Athabasca River is returned to the river.

Volume 1, Section C3.4 of the "Steepbank Mine Project Application" (Suncor 1996b) describes water-control systems and plans associated with Lease 87/17 and Steepbank Mine. Overburden and muskeg drainage water is surface runoff that discharges to the river via separate licenced mine drainage points. Mine-affected waters are directed to the tailings ponds. The drainage plan for Steepbank Mine will be affected by Project Millennium and is discussed in Volume 1, Section C2.4.3.

B2.5 Reclamation

Suncor's current reclamation practices are detailed in the "Steepbank Mine Project Application" (Suncor 1996b). Reclamation of disturbed areas is begun as soon as is practical following mining operations. On Lease 86/17, most of the overburden storage area and dyke slopes have undergone reclamation and are now healthy ecosystems inhabited by a number of wildlife species. Recent development of CT technology will allow reclamation of the tailing ponds to a solid landscape. Steepbank Mine will begin mining operations in late 1998 and is currently in the site preparation and mine development stage of the reclamation cycle.

B3 UPGRADING

This section describes the current Upgrading operations, those of Fixed Plant Expansion and PEP.

B3.1 Existing Upgrading Facilities

In March 1996, Suncor applied to the AEUB for approval to construct and operate the Fixed Plant. Construction of these facilities is complete and commissioning of the Vacuum Unit and the second Diluent Recovery Unit is underway. The new units are expected to reach stable, reliable operation by the end of 1998.

B3.1.1 Location and Products

The upgrading area is located at the Suncor's Base plantsite. Layout of the existing facilities is shown on Figure B3-1.

Upgrading facilities process diluted bitumen to produce:
- diluent naphtha
- upgraded crude products
- diesel fuel
- cracked and virgin intermediate products

The process also produces three byproducts:
- coke
- sulphur
- fuel gas

Table B3-1 lists the existing major upgrading facilities.

Table B3-1 Existing Major Upgrading Facilities

	Upgrading Units
	Diluent Recovery Unit 1 Delayed Coking Unit 1 Gas Recovery Unit 1
	Hydrogen Plant 1
	Naphtha Hydrotreater Kero Hydrotreater Gas-Oil Hydrotreater
	Sulphur Recovery Units 1 and 2 (SRU-1 and SRU-2, including SUPERCLAUS ™) Amine Unit 1
	Sour Water System
	Product Storage Tankage
	Vacuum Unit 1 Diluent Recovery Unit 2

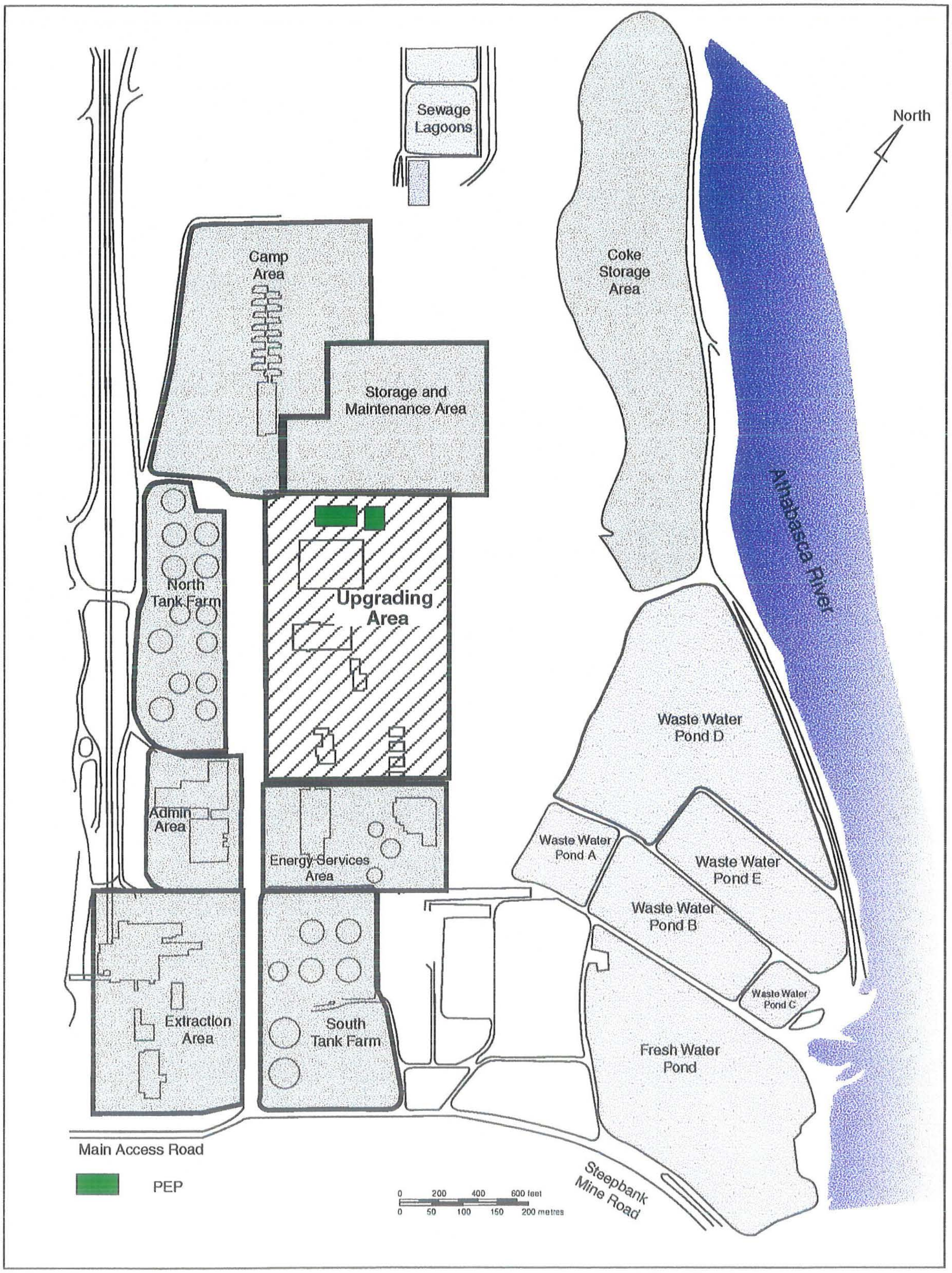


Figure B3-1 Suncor Plant Site - Existing Upgrading Facilities

B3.1.2 Bitumen Upgrading

Bitumen produced by the extraction process is a highly-viscous, tarry, black material with an American Petroleum Institute (API) gravity of 8 to 9 degrees. It contains about 5% sulphur as well as small amounts of metals such as nickel, cadmium, vanadium and iron. Upgrading steps include:

- diluent recovery
- vacuum recovery of selected light products
- processing bitumen using delayed coking
- manufacturing hydrogen
- hydro-desulphurizing coker and virgin products
- sweetening byproduct gases for use as fuel
- recovering sulphur from upgrading acid gases
- treating wastewater

Figure B3-2 illustrates the process flow.

Material and energy balances for the current operation are provided in Volume 1, Section D.

Crude oil products are shipped from the Suncor plant to the Edmonton area through a pipeline owned and operated by Suncor.

Diluent Recovery

The first stage in the upgrading process is the recovery of the naphtha diluent (used in the extraction process) in Diluent Recovery Units 1 and 2. The Diluent Recovery Units use a three-stage flash followed by a fractionation column to recover diluent naphtha for recycling and a kerosene side draw.

Vacuum Recovery of Selected Light Products

When commissioned, the Vacuum Recovery Unit will remove about 40% of the virgin oil from the bitumen feed, producing vacuum gas-oil of higher quality (and therefore higher value) than coker gas-oil.

Delayed Coking

Coker heater feed flows from the Vacuum Recovery Unit to the Delayed Coking Unit 1. This unit uses conventional delayed coking technology to upgrade bitumen feed to intermediate products, coke and fuel gas. The unit, along with common auxiliary facilities, is made up of four parallel sets of coker heaters and coke drum pairs. Coke byproduct is used as fuel for the Energy Services boilers, and the balance is stockpiled or sold.

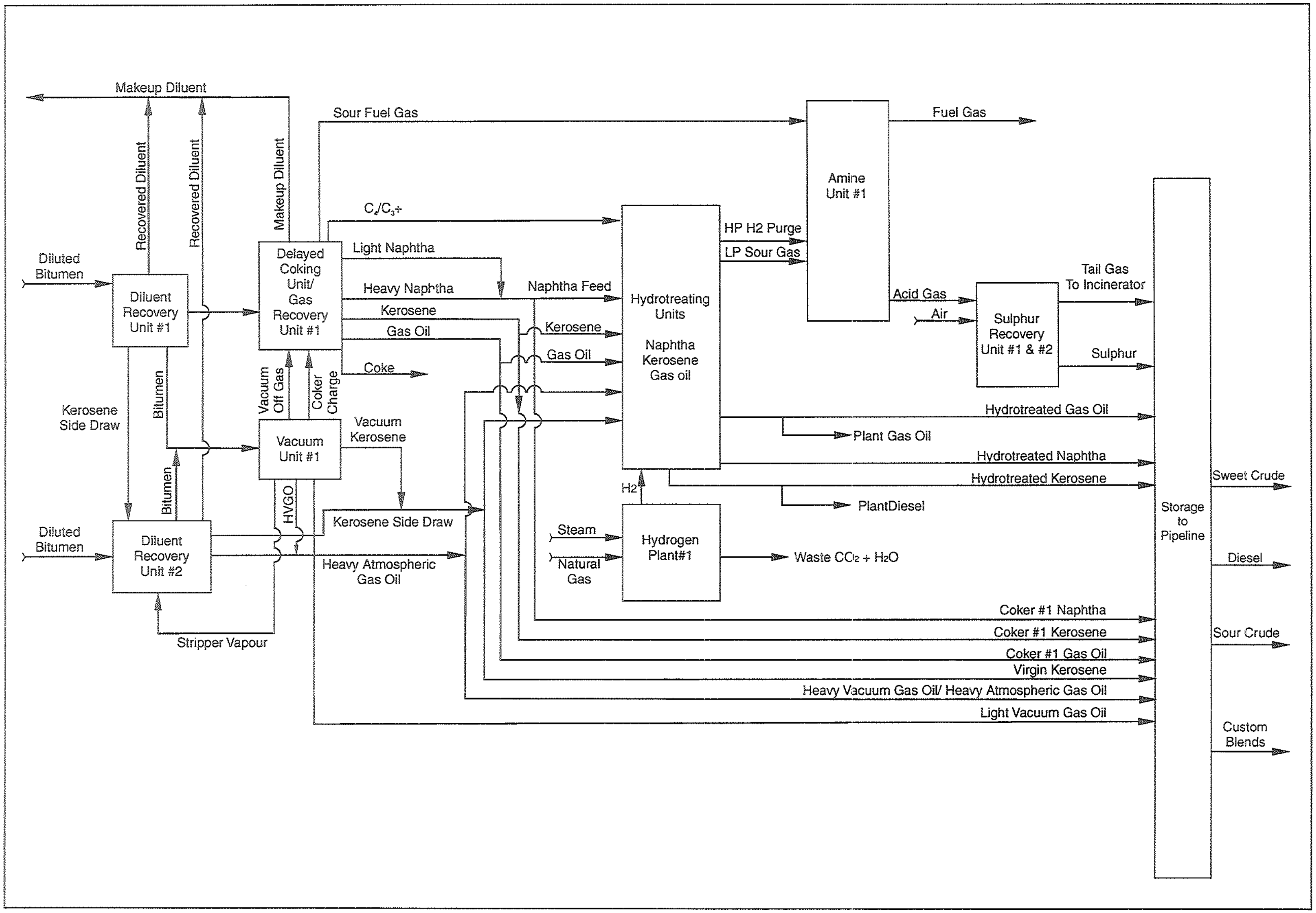


Figure B3-2 Existing Upgrading Block Flow Diagram

Coker vapours are fed to the Coker Fractionator, where they are separated into three main fractions:

- naphtha
- kerosene
- gas-oil

Overhead vapours are fed to the Gas Recovery Unit 1, which recovers naphtha from coker gas and produces a makeup diluent stream for recycling to the Extraction froth treatment facilities. These three intermediate fractions, the Diluent Recovery Unit kerosene side draw, and the vacuum gas-oil are either sent to product storage for sale, or fed to one of three separate hydrotreaters for processing.

Hydrotreating

Depending on market and individual customer demands, a portion of coker and virgin products is upgraded (to reduce nitrogen and sulphur content) in three separate hydrotreater units (naphtha, kerosene and gas-oil). The process involves exposing the intermediate hydrocarbon product to hydrogen at high pressure in the presence of catalyst. Hydrotreated products can be custom-blended and shipped as crude oil products, or sold as individual components (naphtha or diesel). Plant fuel requirements (diesel for mining equipment and igniters in boilers, and gas-oil for burners in boilers) are also met by hydrotreated products.

Hydrogen Production

Hydrogen required for the upgrading process is manufactured on-site by conventional steam/methane reforming, using imported natural gas. Manufactured hydrogen is purified using a circulating potassium carbonate solution.

Sulphur Management

Sour gas recovered in the Gas Recovery Unit 1 and in the hydrotreating process is treated in amine contactors using diethanolamine (DEA) to remove hydrogen sulphide (H_2S). An amine regenerator recovers the H_2S and feeds it to the sulphur plant. Sour water recovered through the upgrading process is treated in a sour water stripper. Sour gas produced in the stripper is also fed to the sulphur plant.

Currently, about 480 t of liquid sulphur are produced each day and transported off-site by trucks to customers. Sulphur production is estimated to increase to about 542 t/cd by the end of 1998.

Sulphur plant operation depends on several process variables, the major ones being:

- the ratio between air and acid gas (H_2S)
- converter and condenser temperatures
- catalyst activity

The sulphur plant uses two independent claus sulphur recovery trains that process acid gas in parallel and a common Superclaus™ unit (a $15 million upgrade in 1994). Sulphur is recovered from the acid gas by converting H_2S to liquid elemental sulphur. Each train has a reaction furnace and three stages, consisting of a:

- heater
- catalytic reactor or converter
- condenser

These two trains combine and feed a common fourth stage, the SUPERCLAUS ™ unit, which treats the tail gas. Effluent gas from the SUPERCLAUS ™ unit is fed into the incinerator, which oxidizes any unreacted sulphur species to SO_2 before the effluent stream is emitted to the atmosphere via the incinerator stack. Stack emissions are controlled by closely monitoring both process variables and emissions and then making the necessary operational adjustments.

The SUPERCLAUS ™ unit has:

- increased sulphur recovery in the Upgrader, from 96% to 98%
- lowered the sulphur plant's SO_2 emission rates, from an average of 39 t/cd to an average of 18.6 t/cd in 1997.

Wastewater Treatment

Waste effluent from the Upgrader and Energy Services plants is treated (using API separators) to remove separable hydrocarbon, then routed through a series of ponds for natural treatment and the settling of solids. Water quality is evaluated at several control points before discharge from the site to the Athabasca River. If necessary, contaminated water can be diverted from the discharge stream at several control points for additional treatment or alternate disposal. The discharge stream meets regulated water quality guidelines as per the AEPA approval.

B3.2 Production Enhancement Phase

B3.2.1 Continuous Improvement Initiatives

The Production Enhancement Phase (PEP) consists of a series of continuous improvement initiatives to be implemented between 1998 and the planned maintenance turnaround in 2001.

Design of many of these continuous improvement modifications will not be finalized until completion of the performance testing runs of the Diluent Recovery Unit 2, the Vacuum Unit 1 as well as other modifications made during the Fixed Plant Expansion Project.

Operating targets and product specifications for PEP include:

- 130 000 bbl/cd production level
- 46% sweet crude oil products
- 12% diesel and kerosene products
- 42% sour crude oil products
- environmental emissions within current approval limits

Projects included in PEP are listed in Table B3-2.

Diluent Recovery Unit 1

Additional heater and diluent pumping modifications are required to process increased diluted bitumen.

Diluent Recovery Unit 2

The Diluent Recovery Unit exchangers will be converted for higher-steam duty. Additional use of pond effluent water as a cooling medium for process units is planned, to improve energy efficiency.

A waste heat exchanger is also being considered, to condense catacarb regenerator effluent. Installation of this unit would further reduce steam demand and increase condensate returned to the feedwater system in Energy Services. These modifications, together with the installation of cooling towers at the Energy Services freshwater pond, will also reduce the return water flow from the site to the Athabasca River.

Vacuum Unit

Modifications to the Vacuum Unit will allow higher processing flows through the unit. These include additional cooling, piping and pumps.

Table B3-2 Upgrading Production Enhancement Phase Projects (PEP)

Plant Area	Modifications
Diluent Recovery Unit 1	Additional heater and pumps
Diluent Recovery Unit 2	Exchanger conversion for higher-steam duty and addition to pond effluent water cooling loop
	Diluent pumping modifications including new charge pump, larger discharge header and existing pump modifications
Vacuum Unit 1	Modifications to piping, packing, trays and pumps during construction
	Additional cooling
Delayed Coking Unit 1	Additional steam-out system including parallel header, steam-out drum and cooler to accommodate shorter coke drum cycles
	Parallel wet gas compressor
	Additional pre-saturated lean oil cooler
	Coker top head removal system
Amine and Sulphur Plants	New supply of 90% pure oxygen (by others) for capacity
	Additional blower for sulphur unit
Hydrogen Plant and Hydrotreating	Additional small-capacity hydrogen compressor
	Modifications to hydrotreaters to improve reliability and sustainable production rates, including exchangers and piping metallurgy upgrades
Flaring	Flare gas recovery system including: compressor, suction scrubber, discharge knockout drum, after-cooler and sour water pumps, to reduce sulphur emissions due to continuous flaring

Delayed Coking Unit 1

A second steam-out system is required at production rates somewhere beyond 105 000 bbl/cd for controlled cool-down on the coke drum and its contents as it is taken offline at the end of the cycle. The drum and coke are cooled from about 430°C to ambient temperature by water injection at a controlled rate over a period of five hours. Heat is removed by water flashing to steam, which is condensed in the steam-out system. A common steam-out system serves all four sets of cokers, and will be in constant use when the drums are cycled every twenty hours.

Increased bitumen charge will result in increased coker off-gas production. As the current wet gas compressor is at or near capacity, a second parallel wet gas compressor will be required to support increased production.

Additional process coolers are required where equipment currently in operation is at or near capacity. Proper cooling is required to maintain product quality specifications. Coker top head removal system enhancements are required to facilitate shorter coker cycle times.

Amine and Sulphur Plants

As part of a previous project, Sulphur Recovery Unit 2 was modified to enable it to use oxygen enrichment. Sulphur Recovery Unit 1 will also be modified as part of PEP. Both units will combust oxygen-enriched air with acid gas to achieve higher capacity. An additional blower is required to overcome increased pressure drop in the system and to enable more reliable operation at higher rates.

Under review are the following options:

- possible use of additional SUPERCLAUS ™ catalyst within the SUPERCLAUS ™ converter. This would provide optimum conditions for the catalyst to promote the required conversion reactions required to handle increased gas flows.

- installation of a Comprimo-licensed deep-cooler. With this process, the tail gas exiting the SUPERCLAUS ™ converter is cooled to below the solidification point of sulphur in order to recover any vapour. This technology has not yet been technically- and industry-proven for retrofitting a plant of Suncor's size and complexity.

Hydrotreater and Hydrogen Plants

An additional hydrogen compressor (combined with equipment modifications in the hydrotreater units) will be added to support higher hydrotreated product rates. Tube metallurgy will be upgraded in the hydrogen reformer. As a result, tube wall thickness will be reduced, resulting in increased catalyst volume, and in turn, increased hydrogen production.

Flaring

In the current operation, the following three vessels are continuously routed to flare:

- the gas-oil fractionator overhead receiver
- the oil-water separator
- the steam-out drum

This flaring contributes 7.4 t/d of SO_2 to the atmosphere. By mid-1999, the installation of a flare gas recovery system will be complete. Flare gases will be recompressed to the suction of the existing wet gas compressor, which feeds Gas Recovery Unit 1. The vapours will be sent to the Depropanizer for hydrocarbon recovery and eventually to Amine Unit 1 for

H_2S removal. The project will capture up to 6.0 t/d of the SO_2 emissions from these sources and will recover about 33 000 scf/h of fuel gas.

Tank Farms

Products from Extraction and Upgrading are stored in the South and North Tank Farms, respectively. The South Tank Farm (nine tanks) provides storage and pumps for diluted bitumen, diluent and fuel storage tanks (fuel oil and diesel) used by Energy Services. The North Tank Farm (13 tanks) provides storage for virgin, coker and hydrotreated products. Pumping facilities for the pipeline and for internal blending and recycle of final and intermediate products are also located in the North Tank Farm.

Four slop oil tanks, located in the vicinity of the API separators, are used for handling slop oils and waters.

The tank farms are supplied with several mechanisms to protect the environment, including dykes to contain potential spills, fire foam injection facilities, inert gas blankets and dewatering facilities. Total operating capacity of all tanks is 263 000 m^3. Many of the tanks have facilities to enable storage of more than one type of product, depending on the operational requirements.

Tanks that hold naphtha are equipped with floating roofs to control the hydrocarbon emissions which result from high vapour pressure. The slop oil tanks are equipped with emission treatment devices to control odorous emissions. A vapour recovery unit captures vapours from all South Tank farm vents except two Energy Services fuel tanks.

B4 ENERGY SERVICES

This section describes:

- Suncor's existing Energy Services facilities
- a series of modifications and improvements to be made to these facilities in the Production Enhancement Phase (PEP), between 1998 and 2001

B4.1 Existing Energy Services Facilities

The purpose of Energy Services is to provide the industrial utilities (water, steam, electric power and compressed air) to satisfy energy and other service demands from the Mining, Extraction, Upgrading and Administration areas, as well as for its own needs.

B4.1.1 Location

Energy Services facilities are located in the centre of the Suncor plantsite, immediately adjacent to the Upgrading and the Extraction facilities. The facilities layout is shown on Figure B4-1.

B4.1.2 Major Facilities and Services

Major Energy Services facility components are as follows:

- Raw Water Supply
- Water Treatment
- Main and Auxiliary Steam Boilers
- Turbogenerators
- Electrostatic Precipitators (ESPs)
- Flue Gas Desulphurization (FGD)
- Electrical Distribution System
- Steam Distribution System
- Waste Heat Recovery System
- Fire-Water System
- Air System

Figure B4-2 provides a block flow diagram for the major Energy Services commodities: water, steam and electrical power. Raw water from the Athabasca River is used for process cooling, boiler feed-water makeup, emergency fire-water and potable water for plantsite use.

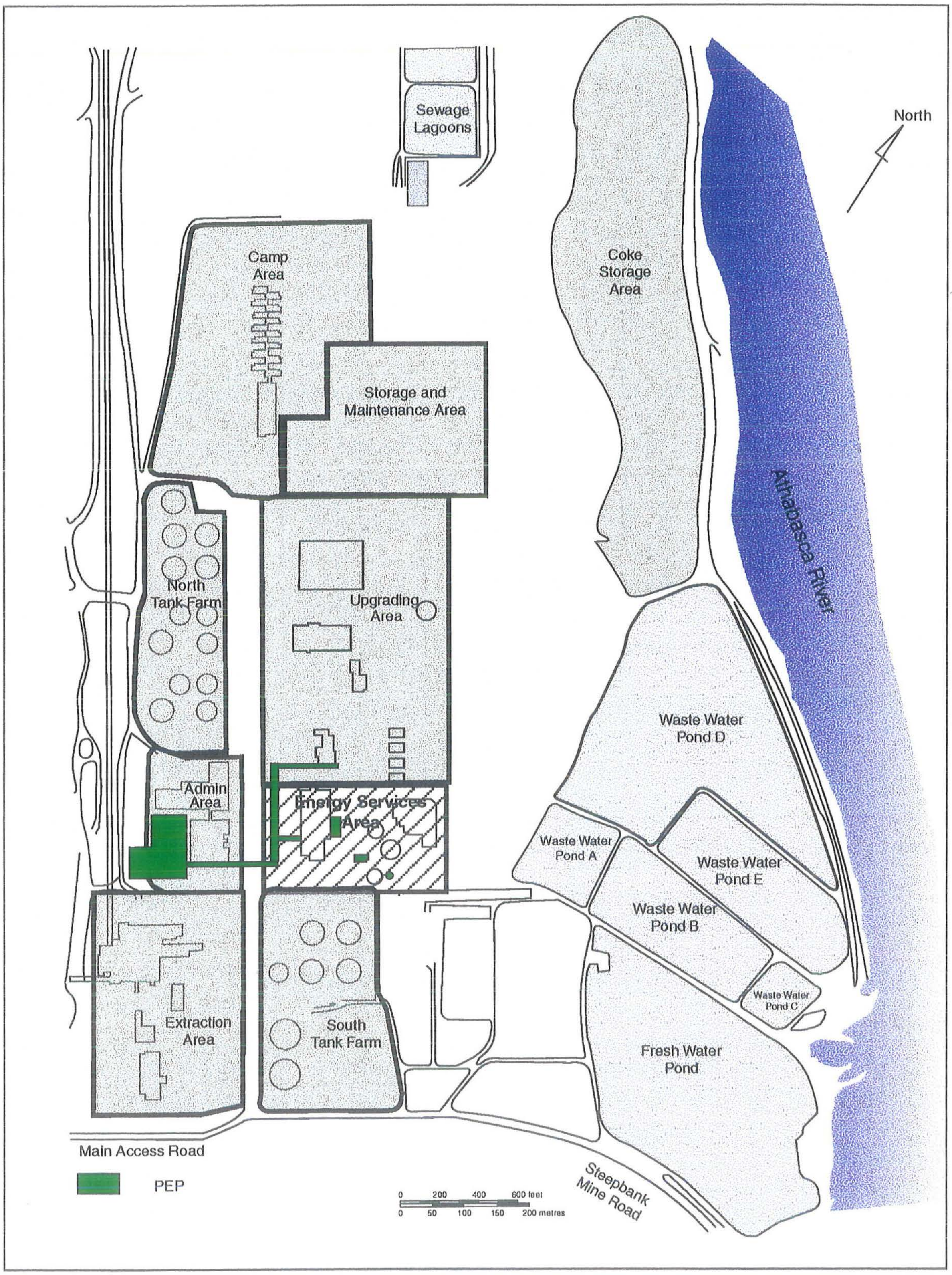


Figure B4-1 Suncor Plant Site - Existing Energy Services Facilities

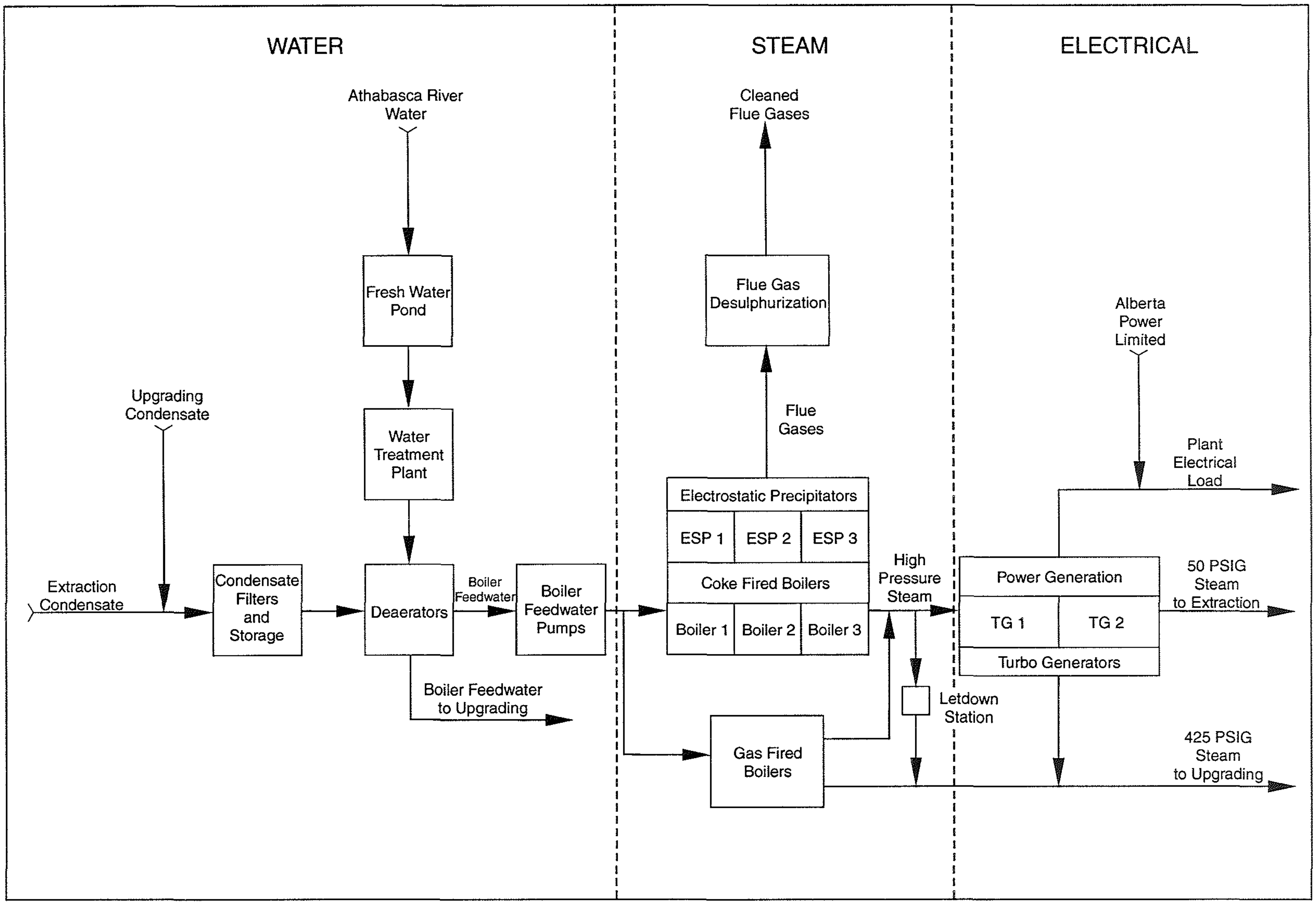


Figure B4-2 Existing Energy Services Block Flow Diagram

Coke- and natural gas-fired boilers produce steam for:

- process uses in the Extraction and Upgrading plants
- generation of electrical power via two steam turbogenerators

Main boiler flue gas in the electrostatic precipitators (ESPs) is conditioned by removing ash and sulphur dioxide (SO_2) in the Flue Gas Desulphurization Unit (FGD), then releasing the gas to the atmosphere.

Electrical demands in excess of on-site generation capacity are met by purchasing additional electrical power from Alberta's interconnected grid.

In addition, a number of air compressors and dryers produce compressed air for instrument control use.

Approximate current demand for Energy Services are:

- 30 000 m^3/d of treated boiler feed-water
- 30 million kg/d of high-, medium-, and low-pressure steam (based on current feed-water capacity). Installed boiler capability is 42 million kg/d
- 64 MW of internally generated electrical power
- 370 000 m^3/d of dry, compressed air at standard conditions

Water Systems

Suncor water systems are described on the basis of their function:

- fresh (raw)
- fire
- cooling
- utility
- treated
- potable
- boiler feed-water
- condensate

In the first four of these systems, settled river-water from the freshwater pond is used while the remaining systems treat the water before use. Figure B4-3 illustrates the existing water systems.

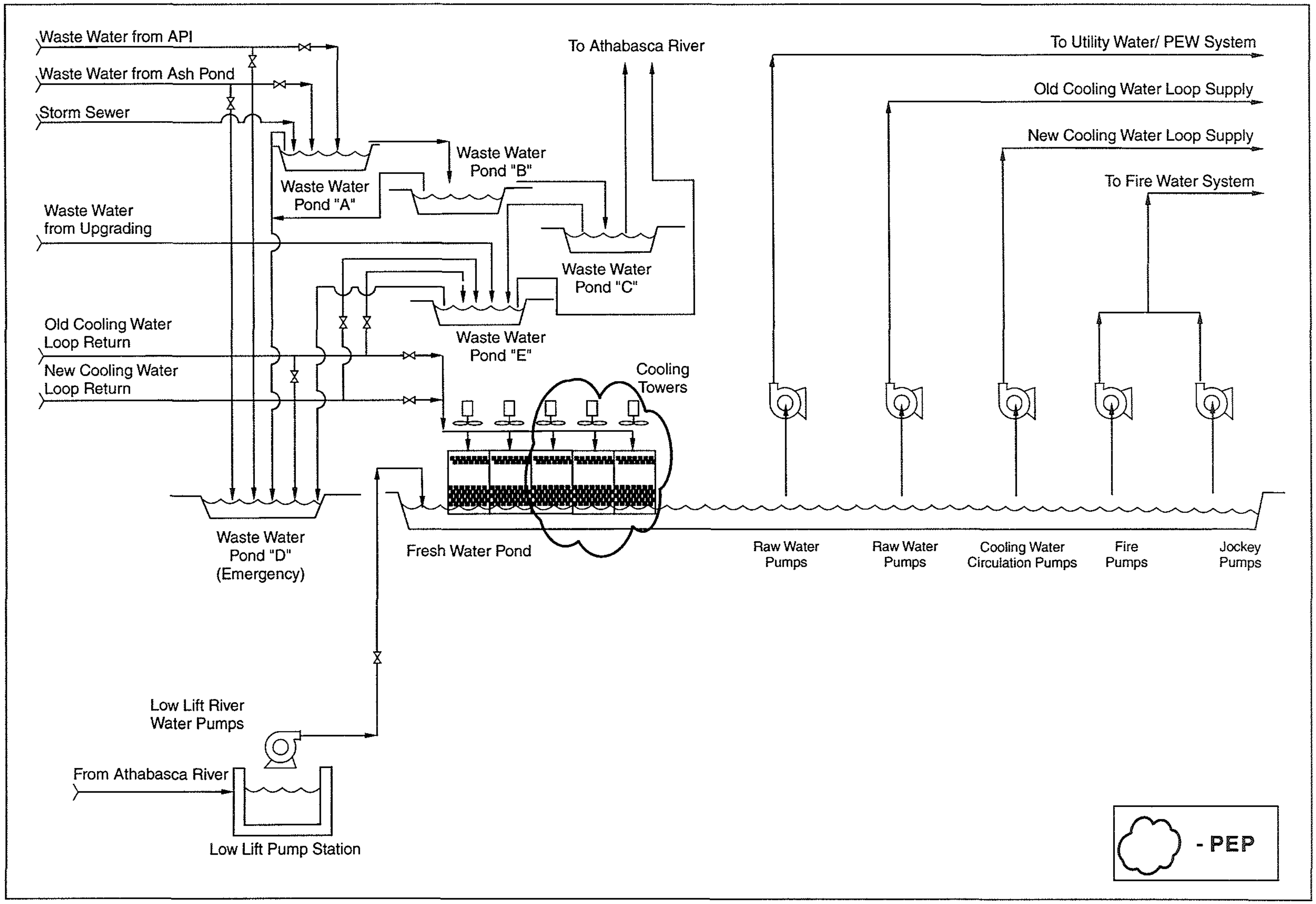


Figure B4-3 Water Distribution System Process Flow Diagram

The freshwater system consists of:

- a low-lift pumping station, located on the Athabasca River bank upstream of the returning plant effluent outfall
- the freshwater pond, which acts as a reservoir, settling basin and cooling pond

Depending on process requirements, about 75 000 m^3/d of raw water is diverted daily into the freshwater pond. Three pump houses take their feed from the freshwater pond:

- the fire-water pump house, for the emergency fire-water system
- the cooling water pump house, providing cooling water to Upgrading
- the river-water pump house (two pump sets), supplying cooling water to Upgrading's and Energy Services' raw water systems

Raw water from the freshwater pond is used as follows:

- after treatment, as makeup water (about 22 000 m^3/d) to the boiler feed-water system. In 1996, a reverse osmosis plant was commissioned to improve treated water quality, thus enhancing boiler reliability. The boiler feed-water system (which includes return condensate) supplies feed-water (about 30 000 m^3/d) to the coke- and gas-fired boilers, as well as waste heat boilers.

- as cooling water for Upgrading

- as utility water for equipment cooling, ash (from coke-fired boilers) transport, coke cutting and pump gland seal water

- after treatment, as potable water. Raw water (about 1 100 m^3/d) is clarified, filtered, chlorinated and distributed through the on-site potable water system

Fixed Plant Expansion water-system projects to be completed in 1998 include:

- modifications to the freshwater pond to improve water quality

- installation of a two-cell cooling tower to increase cooling and water recycling, thereby reducing the amount of effluent return to the Athabasca River

- installation of a separate potable water clarifier dedicated to drinking water service and chemistry

- increased pumping, deaerating and filtering capacity of boiler feed-water

Steam Systems

Energy Services produces both high- and low-pressure steam for distribution throughout the plantsite. High-pressure steam (2 900 kPa and 5 450 kPa) is produced by three 1965 coke-fired steam boilers and a 1981 gas-fired unit. Medium- and low-pressure (1 030 kPa and 70 kPa) steam is generated by four auxiliary gas-fired boilers. Total installed steam capacity is 42 million kg/d.

Originally, the three coke-fired boilers were of a forced-draft pressurized furnace type, exhausting through individual ESPs for particulate removal to a common 101-m dry stack. During construction of the FGD in 1995 and 1996, the coke-fired furnaces were individually stiffened and converted to balanced-draft operation by installing an induced draft fan on each unit. This provides the additional driving force required for flue gases to pass through the FGD (downstream of the ESP) to a 137-m wet stack.

In the FGD plant, coke combustion gases are spray-quenched, to reduce their temperature before entering a jet-bubbling reactor containing a solution of calcium carbonate produced from crushed limestone. About 95% of the sulphur dioxide (SO_2) is removed from the gases by reacting with calcium carbonate ($CaCO_3$) to form calcium sulphate ($CaSO_4$), or gypsum. Any gypsum not used in the Consolidated Tailings (CT) process is stored in Pond 4G, with decant water reused in the FGD process. Limestone crushing, conveying and slurry preparation systems comprise the remainder of the FGD plant facilities.

Waste Heat Recovery System

Suncor's Extraction facilities require large quantities of thermal energy for the bitumen recovery process. A significant portion of this total current Extraction heat requirement is supplied through existing waste heat recovered from the following:

- about 41% from exhaust steam from turbine drives and sulphur plant condensers in the Upgrader
- approximately 3% from the Naphtha Recovery Unit (NRU) overhead condensers
- about 13% from a cooling water loop

The remainder (about 43%) of the Extraction heat requirement is supplied by condensing supplemental low-pressure (345 kPa) steam supplied by Energy Services.

Several changes currently taking place during the Fixed Plant Expansion Project will help to reduce steam demand including the following:

- waste heat generated by new Upgrading units (representing about 19% of the Extraction heat requirement) will be transferred directly into Extraction process water by means of a pond water/waste-heat recovery loop.

- in Extraction, an interstage tank (between primary and secondary extraction) has been installed, reducing Extraction production rate variations and dampening variations in steam demand.

- hot water to be used for ore hydrotransport from Steepbank Mine will be stored in a holding tank, providing storage for waste heat recovered from the Upgrader and dampening variations in steam demand.

Figure B4-4 shows the current waste heat recovery system.

Electrical Supply System

Approximately 78% (64 MW) of the electrical power currently needed to operate Suncor facilities (average 82 MW) is produced by two on-site steam turbogenerators. The remaining electrical power required is purchased from Alberta Power Limited, through their Ruth Lake (240 kV) and Steepbank (72 kV) transformer substations.

The on-site primary electrical distribution system consists of:

- two incoming Alberta Power Limited power lines connected to a 72 kV ring bus at the Steepbank River substation

- two 72 kV lines connecting the Steepbank River substation with the 72 kV - 13.8 kV transformer at the Athabasca Crossing substation

- five 72 kV lines connected to six 72 kV - 13.8 kV cross-tie transformers and buses feeding:
  - mine loads via the Horseshoe Lake substation
  - Extraction and service building loads
  - Energy Services and Upgrading loads

- two 13.8 kV primary buses connecting two turbogenerators to the plantsite 13.8 kV distribution system

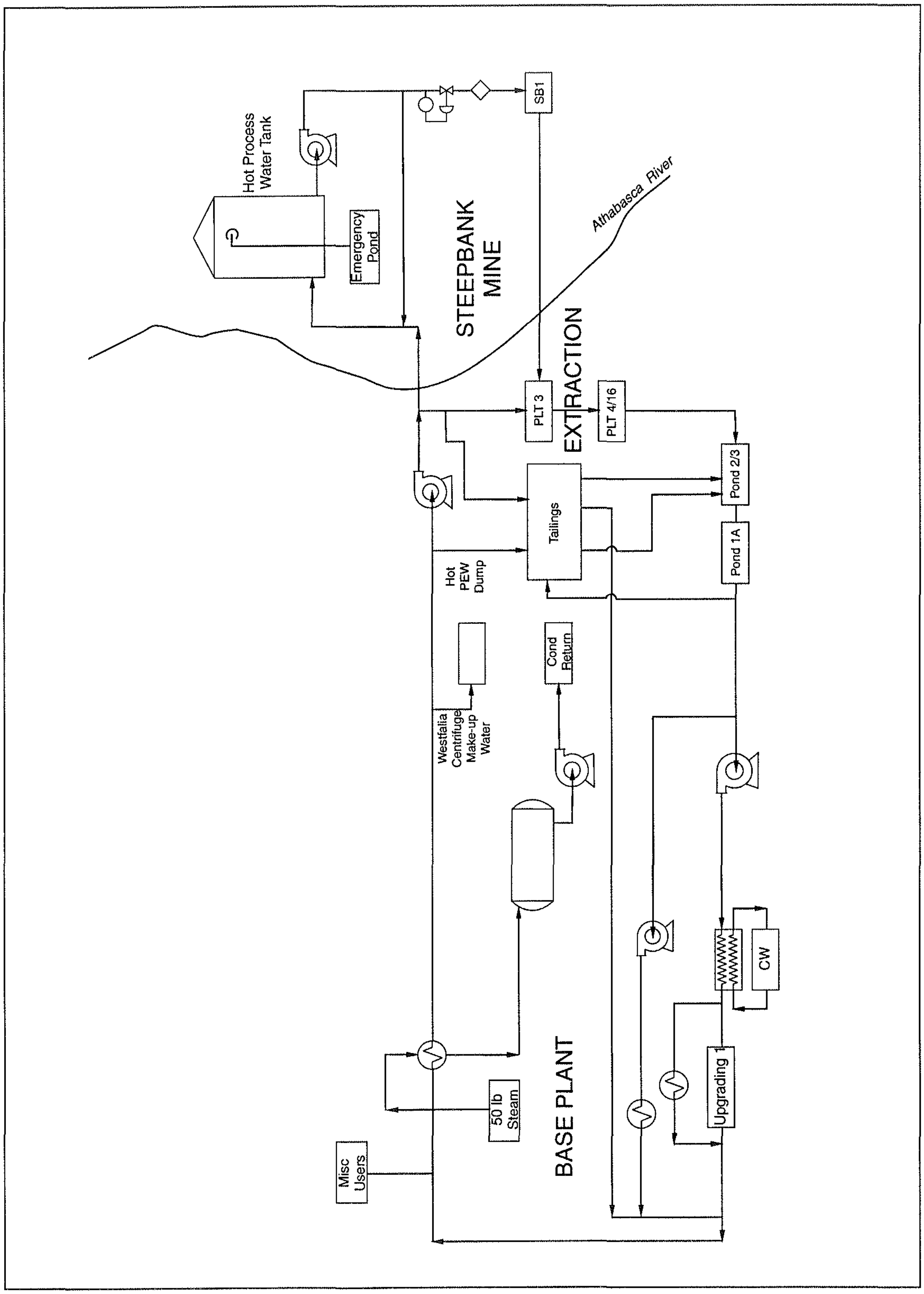


Figure B4-4 Existing Waste Heat Recovery Process Flow Diagram

Compressed Air Systems

Dry, oil-free compressed air is produced in Energy Services and distributed throughout the plant to operate control valves and a small number of air drives. A supplemental nitrogen supply tank and vapourizer together with a number of automatic solenoid-operated load-shed valves provide emergency backup service.

The distribution system consists of three main headers within Energy Services. All are equipped with emergency load-shed solenoid valves.

Continuous Improvement Modifications

Several steam system modifications are being implemented during the Fixed Plant Expansion Project including:

- upgrading coke-fired Boiler No. 3 in 1998, to increase capacity, improve efficiency and reliability as well as to reduce NO_x emissions. Similar modifications were completed to Boiler No. 2 in 1997.
- upgrading coke-fired Boiler No. 1 in 1999, with the same objectives
- installing an additional steam pressure reducing station, to increase system reliability and minimize production restrictions during turbogenerator outages

A number of other projects designed to improve reliability, enhance efficiency, improve environmental performance, and reduce operating and maintenance costs are also underway.

B4.2 Production Enhancement Phase (PEP)

Changes to Energy Services facilities have been planned so that the necessary steam, power, water, and instrument air is provided to support PEP production levels. These changes are summarized in Table B4-1; their locations are shown on Figure B4-1.

B4.2.1 Water Systems

The continuous improvement initiatives to be implemented for the water system between 1998 and the planned maintenance turnaround in 2001 include the following:

- installation of three additional cooling tower cells, to increase water cooling capability by 315 GJ/h. This will increase the use of recycled water, thereby reducing the volume of water discharged to the Athabasca River by approximately 25% from current levels

Table B4-1 Energy Services Production Enchancement Phase (PEP)

Plant Area	Modifications
Water System	Additional condensate filter (total 5) One new condensate tank and associated equipment One new condensate receiver and associated equipment Three additional cooling tower cells (total 5) Medium-pressure boiler feed-water pumps to replace low-pressure pumps
Steam System	New 5 450 kPa steam header to Upgrading
	New condensate return line from Extraction to Energy Services
	Waste heat recovery boiler and associated equipment on new gas-fired turbine
Electrical System	New gas-fired turbine generator (85 MW) and associated equipment
	Upgrade existing turbogenerators, increasing capacity by 13 MW each

- installation of a fifth condensate filter to enhance hydraulic throughput and condensate quality

- installation of a new condensate surge tank. This will improve Energy Services reliability through reduction of boiler and water treatment plant interdependence

- installation of a new condensate receiver. This will offload the hydraulically-limited existing condensate receiver and increase internal condensate recovery and energy efficiency

- replacement of the existing low-pressure waste heat boiler feed-water pumps with new steam- and electrically-driven medium-pressure pumps, to increase reliability and efficiency

- modifications to the main boiler feed-water pump piping. This will increase reliability of the boiler feed-water system by dedicating the main boiler feed-water pumps to the existing high-pressure boilers, the new high-pressure boiler and the gas turbine generator cogeneration unit

B4.2.2 Electrical and Steam Systems

Increased energy demands for PEP include the following types and amounts:

- electrical power, from the current 82 MW to 122 MW (average)
- additional steam demand, from the current 30 million kg/d to 38 million kg/d

These additional plant demands, along with the need to reduce interdependence between steam and electrical power generation systems, are best met by the installation of a gas turbine generator (GTG) integrated with a heat-recovery steam generator (HRSG). This unit will cogenerate electricity and steam, improving the energy efficiency of the operation.

The GTG is a high-efficiency natural gas-fired turbine operating on the Brayton thermodynamic cycle which will combust approximately 1.1 Mm^3/d of natural gas at full-load conditions. It consists of a compressor, combustor and turbine attached to a power generator. General configuration of the cogeneration unit is illustrated on Figure B4-5.

To further increase energy efficiency, the HRSG is attached to the back end of the turbine, using the hot exhaust gas (with supplemental firing if required) to generate steam. This addition, known as closed-cycle operation (versus open-cycle, where the GTG would exhaust into a stack directly to atmosphere), increases power generation efficiency from about 35% to 50% and is the source of supplemental steam production for PEP.

For the GTG, a number of support auxiliaries will be required consisting of:

- a fuel gas knockout drum
- a startup air compressor
- an intake air filter system
- a lube and hydraulic oil skid
- a boiler water treatment chemical skid
- a 16-m-high open-cycle exhaust stack

The HRSG will produce up to 3.3 million kg/d of 5 450 kPa exhaust steam and up to 8.7 million kg/d steam via supplemental firing. Other modifications include:

- a boiler blowdown drum
- a 34-m-high closed-cycle exhaust stack
- an emissions monitor capable of measuring CO, NO_x, exhaust gas temperature and flow rate on a continuous basis
- sampling ports, for routine verification of boiler efficiency
- a local control module
- a pipe rack containing:
  - boiler feed-water supply piping
  - 5 450 kPa steam return piping

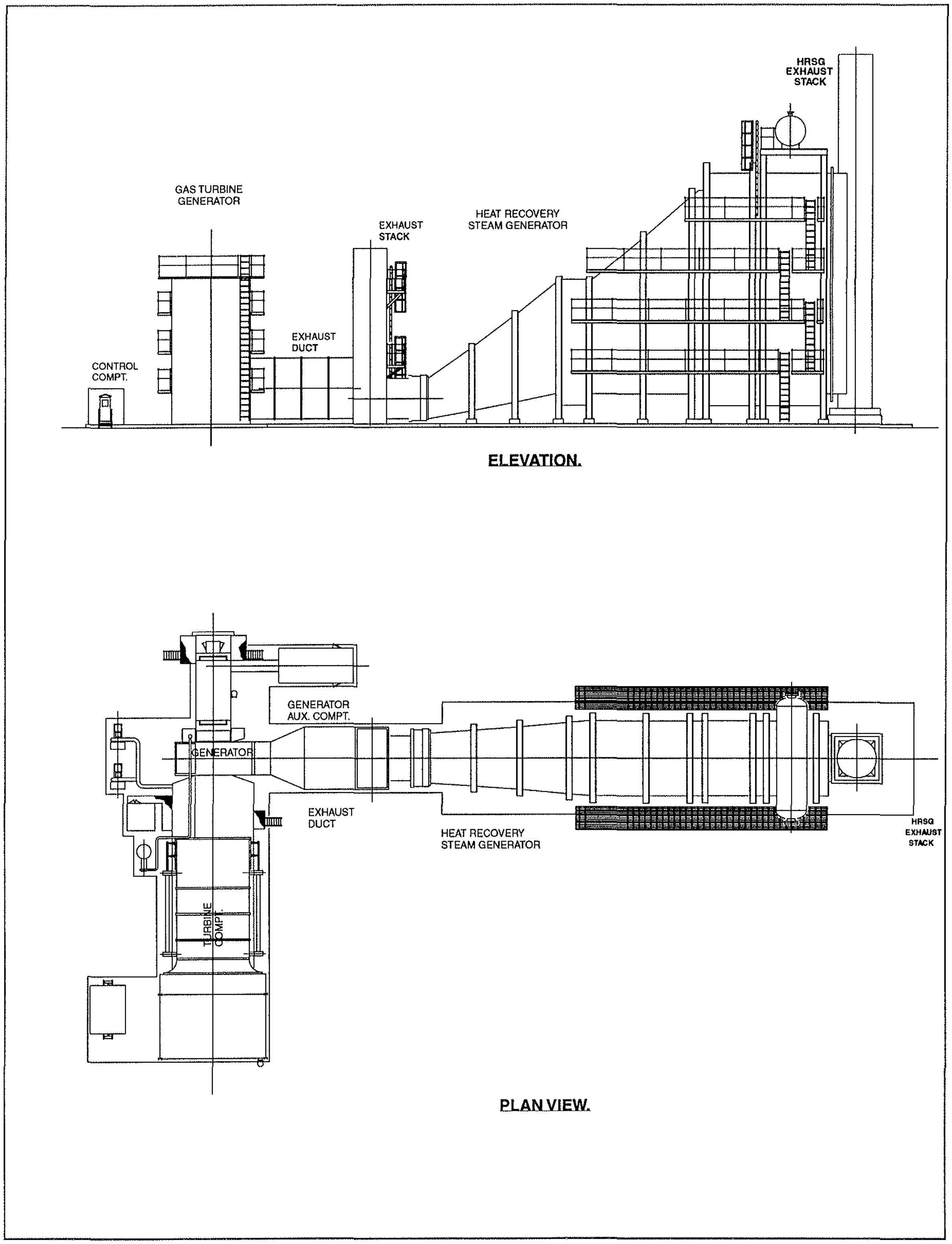


Figure B4-5 Gas Turbine Electricity and Heat Recovery Co-generation Unit

- instrument air piping
- power supply cables
- distributed control system instrument wiring

It is proposed to locate the GTG/HRSG cogeneration unit near the existing Cold Storage Warehouse and Administration building, as shown on Figure B4-1. The final design and unit location will meet all Suncor and regulatory noise and safety requirements.

B4.2.3 Compressed Air Systems

Several air system modifications will be initiated between 1998 and 2001 to increase spinning reserve capacity, enhance reliability and reduce maintenance costs. These include:

- upgrading two air receivers and associated system piping
- replacing a regenerative air drier with a molecular sieve type
- installing two additional 160 000 m^3/d turbine-driven air compressors, receivers and driers

B5 PLANT SUPPORT INFRASTRUCTURE

B5.1 Scope

Support infrastructure refers to the facilities required to support operations that have previously been described. This section discusses the infrastructure existing to support present operations and PEP.

Suncor's support infrastructure was initially installed in 1967 and has evolved over the years to accommodate a series of operational changes. The existing Base plantsite is congested in some areas as operations have expanded. Suncor has re-examined the support infrastructure and a new site master plan has been developed. The plan includes the demands of Project Millennium.

B5.2 Infrastructure

Figure B1-2 shows the general layout of Suncor's operations.

B5.2.1 Main Access Roadway

Access to Suncor plantsite is via a paved road from the junction with Highway 63 to the Security gate at the Lease 86/17 boundary, over the dyke separating Pond 1 and 1A and to the Base plantsite. From there a network of roads connects to the current Bitumen production operations office and maintenance shop (Bitumen Heights); to Upgrading and Extraction and the camp area; and to Steepbank Mine via the Suncor Bridge. There is no other developed access to Highway 63.

Improvement is planned for a second equipment access road which joins the main access road to the Steepbank Mine road by way of a route along the Athabasca River side of Pond 1.

The junction with Highway 63 was improved with the construction of an entrance lateral in 1997 in order to improve traffic safety.

B5.2.2 Support Facilities

The following is a list of major facilities and their purpose:

- Security Gate: Security personnel, visitor reception, weigh scales, parking lot
- Administration building: General administration office support, engineering and production support staff

- Lab/Health/Firehall: Laboratory analysis support for operations, fire response equipment and Health Centre
- Warehouse: Site parts for maintenance
- Training Centre: Safety training and other training for site
- Carpenter shop: Maintenance shop
- CMD Building: Upgrading Maintenance Shop
- Camp: 1400-person camp and food services
- Top Shop: Heavy-equipment maintenance for mine
- Warm-up Shop: Heavy-equipment storage shed
- Bitumen Production Administration: Support staff for mine operations
- Extraction Administration: Support staff for Extraction, permit centre and control room
- Upgrading Administration: Support staff for Upgrading
- Steepbank Office and Maintenance Complex: Support staff for Steepbank Mine operations and heavy-equipment maintenance

B5.2.3 Utilities

These include the following:

- Base plant potable water and sewage system
- Steepbank Mine potable water and sewage system
- Fire-water network
- Natural gas import pipeline and distribution pipelines
- Fibre optic communication network

B5.2.4 Product Pipelines

This includes:

- a product pumping station and pipeline connecting North Farm tankage to the Suncor Oil Sands pipeline and then to the Edmonton area
- the planned Athabasca Pipeline, connecting from Suncor tankage to the Hardisty area.

B6 ENVIRONMENT AND HEALTH

This section describes Suncor's environmental management, loss control, health and safety systems and practices.

B6.1 Environmental Management

B6.1.1 Policy and Management Systems

Suncor is committed to excellence in both implementation of standards of care for the environment (which comply with legislated requirements) and in responsiveness to the expectations of its communities, customers, shareholders, government and the public, sustaining a balance between a healthy environment and a healthy economy. In 1992, Suncor adopted its "We Care" environmental compliance and assurance policy which has been integrated into all aspects of its activities. This is a long-term commitment that calls for accountability at every level of the organization—the board of directors, executives, managers and employees.

The guiding principles of Suncor's "We Care" environment policy are as follows:

Leadership and Integrity: By their leadership and exemplary behaviour, management will demonstrate that environmental responsibility is critical to Suncor's success. Management is sensitive to the environmental impacts of Suncor's operations. Employees at all levels will be made aware of the potential impacts associated with their activities and will be provided with the tools, processes and training necessary to mitigate these impacts.

Accountability: Suncor management is accountable for setting goals and establishing standards and work procedures which contribute to fulfilling Suncor's commitment to the environment. All employees will understand their responsibilities and accept accountability for their actions.

Continuous Improvement: Suncor will adopt programs aimed at anticipating and reducing the emission of pollutants and the generation of wastes from its operations. Focus will be placed on controlling pollutants and wastes at the source. In setting its goals, Suncor will strive for improvements in environmental performance and will encourage innovation, recognize achievement and support research to this effect.

Self-Regulation: In setting environmental performance standards and goals, Suncor will strive to achieve levels of performance governed not only by legislated requirements but which also address the social, economic and environmental expectations of our communities, customers, shareholders, government and the public.

Integration: Suncor will integrate environmental considerations in business planning, facilities and product design, operating practices and training programs.

Conservation: Suncor will carefully manage natural resources and actively pursue opportunities to conserve energy. Suncor embraces the waste management principles of reduce, reuse and recycle.

Shared Responsibility: Suncor supports a partnership approach among government, industry and the public for the development of equitable, cost-effective and realistic solutions to environmental issues.

Preparedness: Suncor will be prepared in the event of an accidental release of contaminants to respond promptly in a manner that is protective of the health and safety of its employees and the public and mitigates the impact on the environment.

Suncor is committed to the "We Care" environmental policy. The company implements this policy by developing, maintaining and enhancing management systems to achieve progressive environmental performance and by ensuring that environmental issues and concerns are addressed in both continuing operations and in project planning. Life cycle analysis and eco-efficiency determinations are being incorporated into project design and decision-making at all levels. Components of the environmental management systems include:

- organizational effectiveness
- strategic planning
- community consultation
- employee awareness and training
- auditing
- monitoring and impact assessment
- emergency preparedness

In 1997, Suncor completed a "gap analysis," comparing its existing environmental management system to the requirements of ISO 14 000. Suncor is committed to enhance the existing environmental management system using the ISO 14 000 standards as a guide. Suncor is reviewing the costs and benefits of full ISO 14 000 certification.

Suncor's business units have developed operation-specific emergency response procedures for their activities and unit staff are part of the plant-wide emergency response team. Key components of Suncor's emergency response preparedness include the following:

- In-House Emergency Response Team: Comprising firefighting, rescue, first aid and health departments, the team is staffed, equipped and trained to provide in-house first-response capability.

- Mutual Aid Agreements: Agreements with the Regional Municipality of Wood Buffalo and Syncrude Canada Ltd. for reciprocal emergency response and compatible emergency response procedures.

- Oil Spill Preparedness: A member of an Oil Spill Co-operative, Suncor maintains an equipment trailer and a trained response team to handle oil spills.

B6.1.2 Environmental Activities and Initiatives

Suncor's environmental protection program requires planning and disciplined implementation at all levels to eliminate, minimize or mitigate (as appropriate) the impacts associated with operations. Substantial funding of plant-wide environmental initiatives in the period 1990 to 1997 is a demonstration of Suncor's commitment to a high standard of environmental performance.

In the years 1990 to 1997 Suncor invested about $347 million on projects to either reduce the impact of its operations on the environment or allow more effective evaluation of its impacts on the environment.

While all the initiatives are important in their own right, two developments are particularly significant:

- In 1996, Suncor commissioned the Flue Gas Desulphurization plant. This plant (built at a cost of $190 million) removes about 95% of the SO_2 emitted from coke-fired boilers and reduces SO_2 by 75% plant-wide.

- In October 1995, Suncor implemented a commercial-scale test of Consolidated Tailings and has since proceeded to its full implementation. This technology will enable reclamation of tailings ponds to productive, diverse landscapes.

Volume 1, Section F of this application discusses environmental effects expected from Project Millennium integrated with the current operation and identifies mitigation commitments in each of the five traditional categories: waste, substance release, conservation and reclamation, pesticides and potable water. Reclamation is discussed in detail in Volume 1, Section E.

B6.2 Health, Safety and Loss Control

B6.2.1 Policy and Management Systems

Suncor is committed to providing a safe and healthy work environment for employees, contractors and others who may be affected by its operations. Suncor respects the right of communities to be informed about the risk they may incur from Suncor products and operations, and their right not to be exposed to undue risk. Management is accountable for establishing progressive programs as well as setting standards and goals which support continuous improvement in health, safety and loss control performance. All employees are trained and responsible for following established safe work practices. Employees understand their responsibilities, act in accordance with this policy and accept responsibility for their actions.

The following are the guiding principles of Suncor's Health, Safety and Loss Control policy.

Leadership and Integrity: By their exemplary behavior, management will demonstrate Suncor Energy's commitment to achieving its vision of leadership in health and safety performance. Suncor will identify, assess and manage risks and hazards of its operations to employees, contractors and all others who may be affected by Suncor's operations. Management will foster awareness among employees and contractors of risks associated with their work and will provide appropriate training and tools to enable them to perform their tasks safely. Employees at risk will take part in setting the parameters under which these risks become acceptable.

Accountability: Suncor management will be accountable for establishing progressive programs and setting standards and goals which will foster continuous improvement in health, safety and loss control performance. All employees are responsible to follow established procedures and accept accountability for their actions.

Integration: Health, safety and loss control are important components of a sound business strategy. Health, safety and loss control programs will help sustain profits through improved employee health, productivity, reliability, quality and service. Health, safety and loss control goals will be integrated with other business objectives, and into performance assessment processes.

Prevention: Suncor will implement risk-based programs designed to anticipate, prevent and mitigate harm to health or safety.

Compliance: Legislative compliance is mandatory. Health, safety and loss control programs will be set to ensure that legislative compliance is maintained.

Continuous Improvement: Suncor will strive for progressive improvement in health and safety performance, consistent with its commitment to achieving its vision of leadership in these areas.

Shared Responsibility: Suncor supports a partnership approach among government, industry and the public for the development of equitable, cost-effective and realistic legislation.

Readiness: Suncor will be prepared in the event of an accident to respond promptly in a manner which is protective of the health and safety of its employees, contractors and the public.

Suncor's policy is implemented through a management system which includes the following elements:

- Planning
  - employee health and safety aspects
  - legal and other requirements
  - objectives, targets and action plans
  - employee health and safety management programs

- Implementation and Operation
  - structure and responsibility
  - training, awareness and competence
  - communications and reporting
  - management systems documentation - standards
  - operational control procedures and practices
  - emergency preparedness and response

- Measurement and Evaluation
  - monitoring and measurement
  - non-conformance, corrective and preventive action
  - records
  - audits

- Management Review and Stewardship
  - performance measure

- Continuous Improvement

B6.2.2 Health, Hygiene and Emergency Services

Suncor has a comprehensive health program that addresses the short- and long-term health care support required during day-to-day and expansion activities, including the following:

- Health and Hygiene programs focus on preventing workplace health issues and promoting healthy lifestyles, accomplished by educating employees and their families of the importance of healthy, balanced living.

- Employees, their families, and contractors are supported by an Employee Family Assistance Program.

- The Hygiene group focuses on reducing or eliminating health hazards through hazard review meetings, monitoring programs and recommended safe hygiene practices.

- The Occupational Health group focuses on the education of employees on healthy lifestyles, supports employees returning to work after an illness or injury, and conducts health assessments for legislated and hiring purposes.

- The Emergency Services department consists of highly-trained emergency response personnel who can respond to medical, fire, rescue, vehicle and other incidents. The department is equipped with two ambulances for on-site and highway response.

B6.2.3 Loss Control Program

Suncor's Loss Control Program is an integral part of its two guiding policies: the Environmental Policy and the Health, Safety and Loss Control Policy.

This loss control program has formalized these policy statements into activity standards (endorsed by senior management) for all personnel within the organization to follow. It is part of the management process which is designed to anticipate and control hazards involving people, materials and the environment.

Suncor's Loss Control Program extends to employees and the community. All business units participate monthly in the company's Joint Health and Safety Committee. This committee guides the overall Loss Control Program issues and performance.

Suncor's Loss Control personnel participate in an number of organizations for the purpose of exchanging up-to-date loss control concepts.

B6.2.4 Community Initiatives

Suncor is a participant in a number of community initiatives including:

- Mutual Aid response agreement with the Regional Municipality of Wood Buffalo and Syncrude
- Support to the Region with responses to incidents on Highway 63 and community emergencies, including flooding and forest fire
- Numerous cooperatives and partnerships, such as:
  - Wood Buffalo Safe and Healthy Communities
  - Tobacco Reduction Coalition
  - Regional Health Needs Assessment Steering Committee
  - Students Assisting Students Program
- Several programs that consider health effects associated with air quality:
  - Fort McMurray Community Exposure and Health Effects Assessment Program
  - Smoke-free Homes Campaign
  - Clean Air Strategic Alliance Focus Group on Human Health and Air Quality
  - Regional Air Quality Coordinating Committee (RAQCC)

C PROJECT MILLENNIUM DESCRIPTION

C1 PROJECT JUSTIFICATION

This section provides the market, economic, social and environmental rationale for Project Millennium in the context of Suncor's growth plans.

C1.1 Project Scope

Project Millennium will increase the production capacity of upgraded crude oil products at Suncor's oil sands plant to a minimum of 210 000 bbl/cd by 2002 through the expansion of Steepbank Mine and the addition of a second upgrading train.

The scope of Project Millennium (with a capital cost of $2 billion) includes all activities required to plan, construct and operate a major facility expansion which comprises the following:

- An expansion of Steepbank Mine to supply ore to support bitumen production capacity of 260 000 bbl/cd.
- Millennium Extraction plant (a primary separation plant) located on the east side of the Athabasca River to produce raw bitumen
- raw bitumen pipeline to the existing Base Extraction plant
- modifications to the Base Extraction plant to clean the raw bitumen and produce a diluted bitumen product
- a second upgrader train to produce a slate of upgraded crude oil products
- modifications and additions to Energy Services steam and power generation as well as other infrastructure to facilitate the increased production level

Included are integrated management plans for all tailings produced by both Extraction plants and an integrated reclamation plan for current and future tailings ponds. Management, control and mitigation of environmental impacts during construction and operation of both the mine and plant facilities as well as reclamation of the mine area is inherent in the project scope.

C1.2 Suncor's Oil Sands Growth Plan

In October 1992, Suncor announced a strategy to sustain its oil sands operation into the twenty-first century, including a change in mining technology; expansion of plant design capacity; an acquisition of additional oil sand leases; enhancement of revenues through product mix; and improvements in environmental performance.

By 1997, reliability had improved and production costs were reduced significantly, providing confidence in the long-term viability of sustained oil sands production. Production capacity increased (from 60 000 bbl/cd in 1993 to 85 000 bbl/cd by the end of 1997) through capital and operating improvements in the mine and fixed plant.

Steepbank Mine and the Fixed Plant Expansion will increase production capacity to the 105 000 bbl/cd level in 1998 and by 2001 the Production Enhancement Phase (PEP) will increase capacity further, to 130 000 bbl/cd. These projects will make optimum use of the current fixed plants. Project Millennium represents the next major step in Suncor's growth strategy.

Commensurate with these production increases, Suncor has achieved dramatic reductions in air emissions and improvements in energy efficiency as well as implementation of a dry landscape reclamation technology.

C1.3 Oil Sands Development Climate

In 1995, the Alberta Chamber of Resources National Task Force on Oil Sands Strategies published its findings. According to this report:

- There is an enduring market for oil sands bitumen and upgraded crude oil products.
- Markets for bitumen and upgraded crude are expanding in Canadian and United States refineries.
- The oil sands industry is viable in an environment of low commodity prices.
- Canada's oil sands industry is one of the country's most successful knowledge-based industries.
- Development of the oil sands-based industry is an integral part of Canada's energy future.

- A significant emphasis on research is continuing to yield solutions to improve the industry's environmental performance.

- Increased oil sands development will create both additional employment opportunities and new wealth for Canada unmatched by any other Canadian business.

Suncor's experience in recent years affirms the Task Force's conclusions. Moreover, the oil sands industry (in collaboration with government and others) has acted in significant ways to remove development barriers and enhance development levers. Accomplishments include the following:

- a generic fiscal tax and royalty regime
- a responsible regulatory environment that is fair, predictable and timely
- a philosophy of sustainable development and environmental responsibility
- a collaborative approach to science and technology development
- aggressive marketing
- flexible, integrated transportation
- creative, diverse and international access to capital
- informed and supportive stakeholders in industry, government and the community

A favourable business climate and societal net benefit for oil sands development combined with Suncor's experience and positive track record provide the impetus for Project Millennium.

C1.4 Market Factors

In recent years, Suncor has aggressively marketed upgraded crude oil from its operations with a view to tailoring its production to customer needs. Suncor's operation is capable of producing a variety of upgraded products: light, sweet (hydrotreated) crude oil blend; diesel; and light, sour crude.

Suncor's market assessment indicates that demand for upgraded crude from oil sands operations will continue to increase over the long term. The demand for light, sweet crude will increase as a result of the decline of conventional sweet crude reserves. Demand for light, sour crude will increase as a result of refinery sour processing capabilities. Quality diesel has a promising regional market and significant volumes of diluents are required to blend with bitumen for pipeline transportation.

Other factors which add to a positive market outlook for Suncor's oil sands production include the following:

- integration with Suncor's own Sarnia refinery
- establishment of marketing arrangements developed from Suncor's thirty-year oil sands operating history
- successful completion of a 30 000 bbl/cd contract for sales of light, sour crude oil to a United States refiner
- demonstration of ability to tailor products to customer needs across a variety of quality and product streams
- existence of potential downstream integration opportunities
- capability to undertake product quality investments if markets dictate

In this context, Suncor can proceed with confidence, knowing that Project Millennium markets will be available. Timeliness, however, is important because United States markets could be satisfied by other (offshore) suppliers, for example Venezuela oil sands.

Based on market outlook, the typical product slate for Project Millennium output will be in approximately these proportions:

- light, sweet crude 100 000 bbl/cd
- light, sour crude 80 000 bbl/cd
- diesel 30 000 bbl/cd

C1.5 Transportation to Market

Currently, Suncor has pipeline access to the IPL system (connecting Alberta to markets in Eastern Canada and the United States Upper Midwest) and the Trans Mountain system (connecting Alberta to the West Coast and offshore). The proposed Athabasca Pipeline will provide capacity from Fort McMurray to Hardisty and access (through the Express pipeline) to markets in the United States in Petroleum Administration District (PADD) IV (comprising Montana, Idaho, Wyoming, Utah and Colorado) and the Lower Midwest.

C1.6 Economic Factors

Since launching its oil sands growth strategy in 1992, Suncor has increased production and reduced operating costs. Cash costs per barrel (including sustaining capital) were reduced from $19.50/bbl in 1992 to the current $14/bbl to $15/bbl range. Viability of Suncor's oil sands operation has been demonstrated.

Project Millennium is expected to further reinforce Suncor's oil sands economic viability through the following means:

- significant increase in product revenues (from higher sales volumes and increased prices) as a result of meeting customer needs
- reduction in unit operating costs through technology enhancements, operating efficiencies and economies of scale
- implementation of environmental and technology enhancements that improve Suncor's continued ability to exceed stakeholder expectations

After full production is reached, Project Millennium's cash operating costs (including sustaining capital) are expected to average $10/bbl to $11/bbl. Lower operating costs further improve the competitive position of oil sands production in the marketplace and reduce the vulnerability of the operation to world oil price shocks.

C1.7 Social and Environmental Aspects

Development and operation of Project Millennium will provide a number of significant benefits to the Wood Buffalo Region, the Province of Alberta and Canada. These are discussed in Volume 1, Section A4 and the Socio-Economic Impact Assessment (SEIA) in Volume 2 of this application. Of specific importance to Fort McMurray and the Regional Municipality of Wood Buffalo (RMWB) is the creation of approximately 800 direct jobs and positive economic spin-offs from development and employment. There will be moderate impacts during project construction and operation, as expected for a project of this nature.

Suncor has made dramatic improvements to its environmental performance in recent years and is committed to continuing future improvements. Reclamation of areas disturbed by mining operations will restore Lease 86/17 Mine and east bank mining areas to productive and diverse landscapes. Environmental issues and mitigation measures are summarized in Volume 1, Section A4 and presented in detail in the EIA contained in Volume 2 of this application.

Suncor identifies social and environmental issues through its ongoing consultation process and is committed to implementing measures to ensure Project Millennium will not create significant adverse impacts.

C2 BITUMEN PRODUCTION

C2.1 Objectives and Criteria

C2.1.1 Introduction

The proposed Project Millennium will increase the annual design capacity of Suncor's oil sands facility through expansion of Steepbank Mine, modifications to existing plant facilities and construction of new plant components.

Reserves at Suncor's current Lease 86/17 Mine will be depleted in 2001. In 1996, Suncor applied for and received approval to develop Steepbank Mine which (in conjunction with modifications to fixed plant facilities). Steepbank Mine will commence production in late 1998 and will provide 50% of the extraction feed in 1999, then 100% of feed by 2002. The Production Expansion Phase (PEP) will further increase plant capacity through a series of small, independent projects and thus will require a commensurate acceleration of Steepbank Mine production.

C2.1.2 Production Plan and Objectives

Table C2.1-1 summarizes the bitumen production levels required to satisfy planned production levels for upgraded crude oil and other marketable products.

Table C2.1-1 Bitumen Production Levels

	Upgraded Crude Oil Level (bbl/cd)	Bitumen Production Level (bbl/cd)
Steepbank/Fixed Plant Projects	105 000	130 000
Production Enhancement Phase (PEP)	130 000	160 000
Project Millennium	210 000	260 000

Suncor's bitumen production objective is to provide a reliable and sufficient bitumen feed to the Upgrader at a cost that will allow the operation to be self-sustaining. At the same time, Suncor will continue to meet and exceed accepted standards of environmental protection, energy efficiency, resource conservation, and occupational health and safety in its operations.

C2.1.3 Bitumen Production

The following key principles were used to establish Suncor's bitumen production plan (encompassing mining, extraction, tailings and reclamation) for Project Millennium:

Environmental:

- disturbance footprint to be minimized
- Shipyard Lake preservation to continue
- maintenance of 100-m setback from Steepbank River escarpment crest
- length of time from initial disturbance to final reclamation to be progressively reduced
- in-pit storage of tailings to be maximized
- Consolidated Tailings technology to be used for dry landscape reclamation
- reclamation practices to continue as per approved Steepbank and Lease 86/17 Conservation and Reclamation plans
- diluent recovery (used in the bitumen extraction process) to be not less than 99.3%, with a stewardship target of 99.5%
- Pond 1 reclamation schedule to be maintained

Resource Conservation:

- Steepbank Mine expansion cut-off ore grade to be 7.0 wt% of bitumen within deposits that are a minimum of 3 m thick
- bitumen recovery from oil sands feed out of the mine to be not less than 92.5%

Energy Intensity:

- reduction in thermal demand per unit of production

Technology:

- technology must be proven reliable in oil sands environment
- new technology must be economical to apply
- technology must produce environmentally-acceptable results
- technology should benefit resource and energy conservation

Geotechnical:

- practices and standards to continue acceptable to regulatory agency and internal expert review panel

Specific issues, objectives, operating criteria, and technology and operating improvements are presented in Table C2.1-2.

Table C2.1-2: Bitumen Production Operating Criteria; Technology and Operating Improvements

Issue and Sub-Issue	Objectives	Operating Criteria	Technology and Operating Improvements
		Resource Conservation	
Oil Sands Mined	• Maximize Oil Sands Recovery • Minimize ore sterilization	• 7% cut off grade • 3 m mining thickness cut-off • pit limit using Net Cost Contour	• truck and shovel operation • in-pit storage of tailings and overburden wastes maximized
Bitumen Recovery	• Maximize bitumen Extraction efficiency	• 92.5% overall bitumen recovery	• tertiary recovery • lower operating temperature
Diluent Recovery	• Maximize diluent recovery (minimize absolute losses to tailings)	• 99.3% of diluent recovery	• new recovery tower, existing tower will remain as backup for planned maintenance outages • inclined plate separators will result in lower D/B ratio, using less diluent per barrel of bitumen • make up diluent reformulated to have narrower boiling range (reduced light and heavy ends and benzene)
Byproduct Recovery	• Minimize discard of coke	• coke stored in a manner that enables recovery at a later date and meets environmental location conditions	• coke will be used as fuel or sold as first priority
Plant Integration	• optimize site-wide plant integration	• facilities designed to maximize overall conservation - energy, water, land • facilities designed to maintain partial production during planned maintenance turnarounds	• waste heat recovery loop capturing heat from upgrading for the pond return water, used in the bitumen extraction process • disturbance footprint is minimized by utilizing in-pit storage for wastes • existing diluent recovery tower will be used during planned maintenance turnarounds to maintain diluent recovery at 99.3%
Energy Efficiency	• Minimize use of external energy	• Mine planned to minimize energy consumption for hauling • Separation circuit to operate at 55°C	• waste heat recovery loop capturing heat from upgrading to use in the bitumen extraction process

Issue and Sub-Issue	Objectives	Operating Criteria	Technology and Operating Improvements
Environmental Protection			
Substance Release/ Contaminant Emissions	• minimize air emissions • controlled release of industrial waste water	• control air and water emissions to lowest practical levels • potable water quality maintained to meet the Guidelines for Canadian Drinking Water Quality	• Vapours from froth cleanup and naphtha recovery facilities and diluted storage, if required, will be captured in the Vapour Recovery Unit
Water Use and Management	• minimize the volume of fresh water used • protect the sustainable supply of surface and groundwater	• water release (controlled or seepage) must meet acceptable standards • all tailings impoundment structures will meet appropriate Dam Safety Guidelines	• process effected water is collected in tailings pond and reused in the extraction plant • surface runoff that does not come in contact with oilsand is diverted to the Athabasca River
Tailings	• ensure tailings are stored in a manner that protects environment • minimize the volume of fluid tailings requiring impoundment	• water release (operational and reclamation) must meet acceptable standards • all tailings impoundment structures will meet appropriate Dam Safety Guidelines	• commercial use of Consolidated Tailings will significantly reduce tailings inventory • any fluid tailings not converted to CT will be removed from the external tailings ponds and incorporated into the end pit lake
Land Conservation and Reclamation	• minimize total land disturbance • maximize progressive reclamation	• Minimum setback of 100m from Steepbank River escarpment crest • Minimum setback from Athabasca River of 100m • land will be reclaimed to equivalent (or better) capability from pre-disturbance conditions	• setback from the Athabasca Rivers is greater than 300m adjacent to the external tailings pond; larger buffer is retained where possible • soil materials stockpiled for future use • use of Consolidated Tailings to return the land to a dry landscape

C2.2 Geology and Reserves

This section describes the geology of the east bank mining area with particular emphasis on the mine expansion area (Pit 2), which will be developed to satisfy Project Millennium ore requirements.

C2.2.1 Geology

Regional Setting

Situated in northeastern Alberta, the bituminous sands of the Lower Cretaceous McMurray Formation contain an estimated 900 billion barrels of bitumen. Approximately 10% of this resource is recoverable by surface mining methods. Economical surface-mining is restricted to areas adjacent to the valley of the Athabasca River and its tributaries, where erosion has reduced the overburden to 50 m or less. The areal extent of the oil sands and the region amenable to surface mining are illustrated on Figure C2.2-1. A schematic cross-section of the region's geology and stratigraphy is also shown on Figure C2.2-1.

Regional Geology

The basement rocks of the region are Devonian Period carbonates and evaporites that were deposited on Precambrian granites. An unconformity and a lengthy period of erosion occurred between the Devonian and the onset of Cretaceous deposition, allowing development of a rugged erosional surface on the Devonian limestones. This rugged topography of the Devonian surface controlled Cretaceous sedimentation within the region.

Paleogeographic lows on the Devonian surface directed drainage into a northwest-flowing river system. Fluvial sediments initially accumulated within a broad river valley until the Clearwater Sea encroached upon the region from the northwest, progressively raising water levels. The river system flooded, resulting first in deltaic marsh conditions that included large tidal estuaries. Finally, the region was dominated by open marine deposition (see Figure C2.2-2).

Each of these depositional environments was characterized by unique sedimentary conditions which distinguished the reservoirs and controlled the accumulation of oil, subsequently determining the grade and processing characteristics of the oil sand reserves.

An unconformity and erosional surface separates the Cretaceous McMurray Formation from Pleistocene deposits. Approximately ten thousand years ago, a Pleistocene glacier that had covered the region with thick ice for tens of thousands of years melted, leaving widespread unconsolidated sands, silts and clays of variable thickness. Thin organic and isolated clastic Holocene sediments comprise the most recent geological deposits.

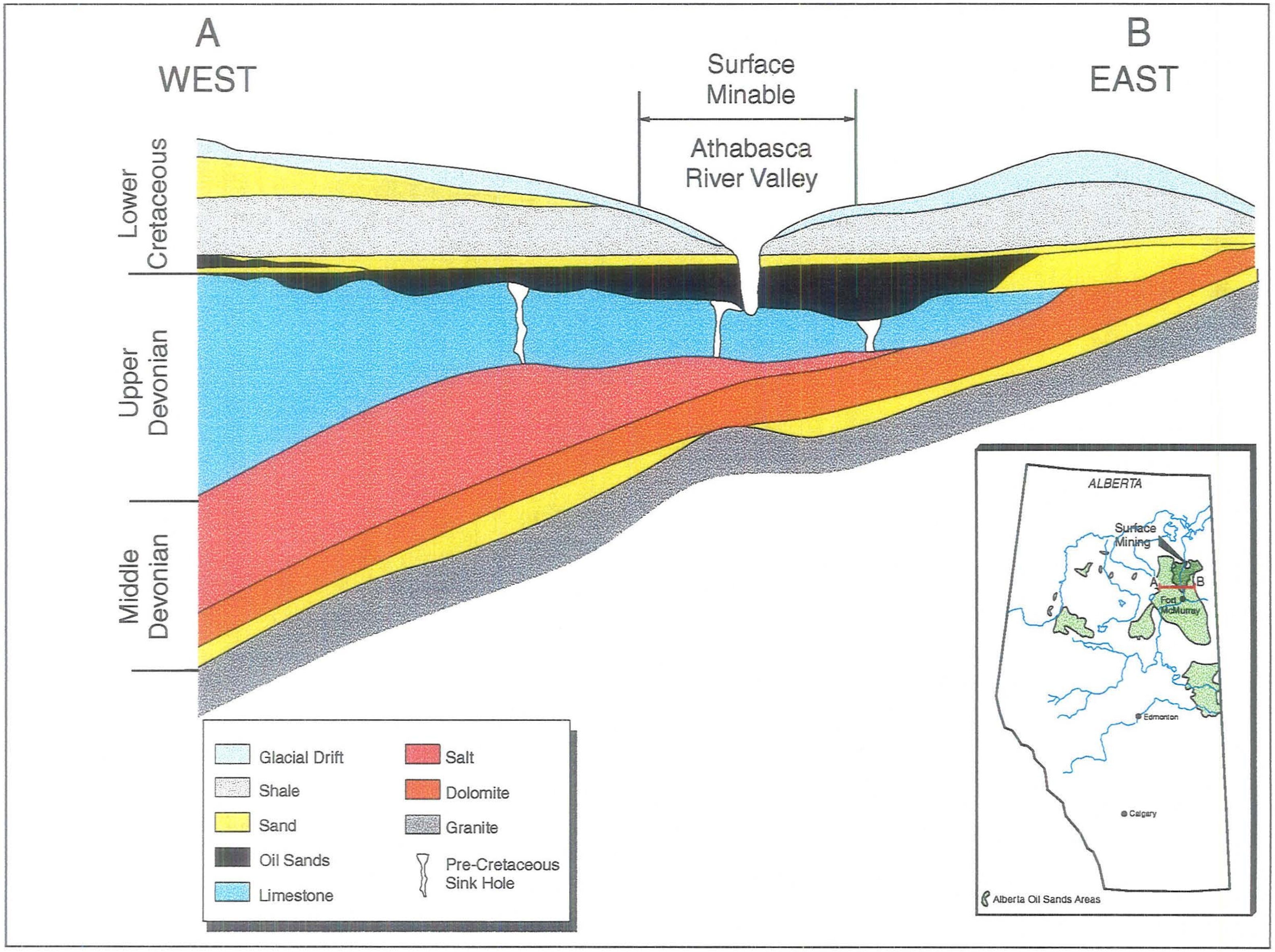


Figure C2.2.1 Oil Sands Area and Geological Cross-Section

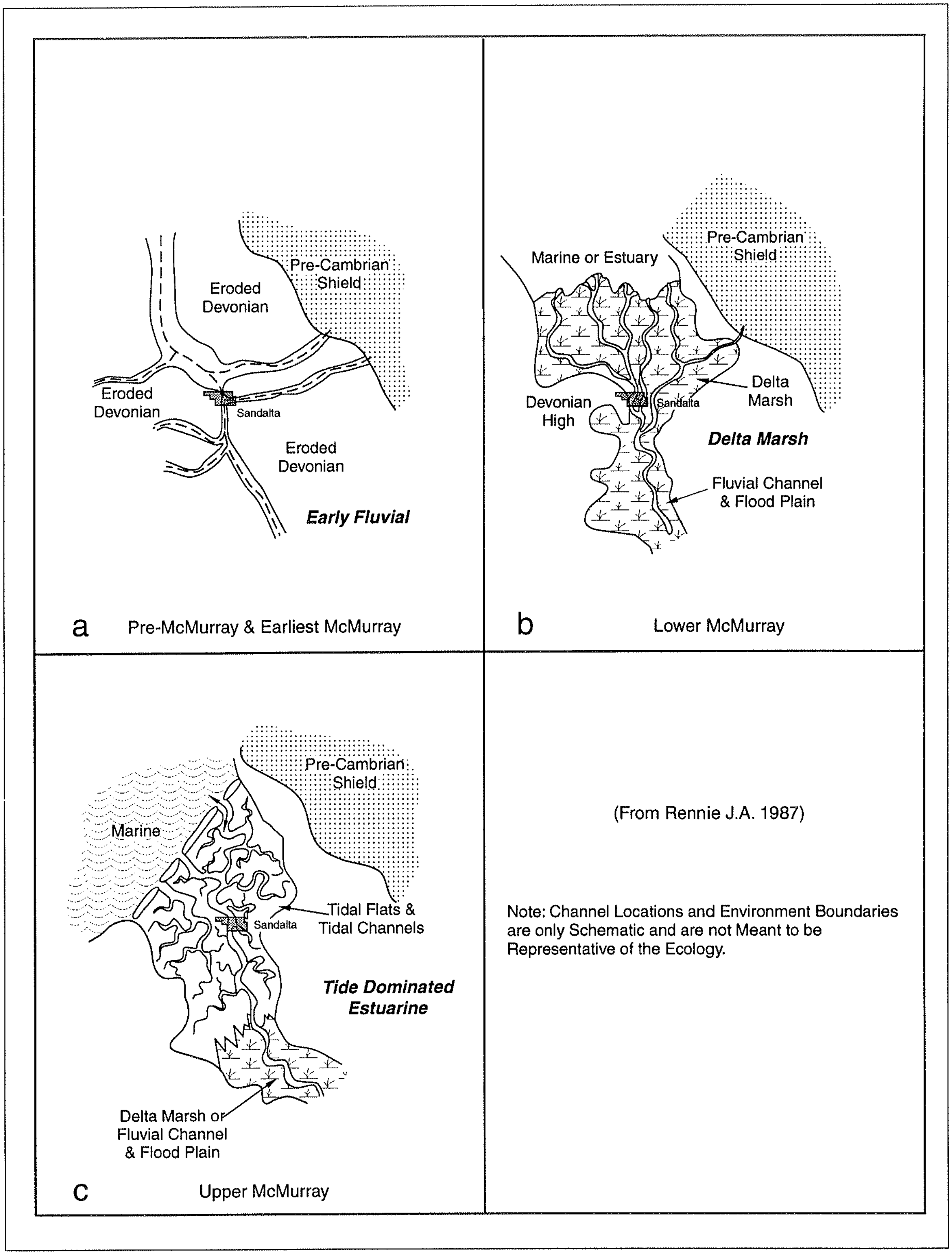


Figure C2.2-2 Depositional Environment of McMurray Formation

The McMurray Formation is of interest for bitumen recovery, by both in situ techniques and mining. It consists of a sequence of unconsolidated sands, silts and clays up to 80 m thick. Within the McMurray Formation are laterally-extensive, very-fine-grained to fine-grained sand sequences up to 50 m thick that were deposited in wide, accretionary fluvial and estuarine tidal channels. These sands form excellent bitumen reservoirs, with as much as 30% porosity and bitumen contents (expressed in weight percent) ranging from a few percent to over 16%, averaging 11% to 12%.

Geology of Steepbank Ore Body

Exploration drilling, geological modelling and a summary of the geology of the Steepbank ore body are discussed in the following sections. Suncor lease holdings have been illustrated previously (Figure B1-1).

Drilling and Logging

Drilling on Suncor's east bank leases was undertaken in the 1940s, 1970s, 1989, 1994, 1995, 1996 and 1997. Results from the 1998 drilling program will be available by summer 1998. (Selected 1998 geophysical log data were used to help locate the pit boundary in the Southwest area). Locations of all the drillholes, along with the 1998 layout, are shown on Figure C2.2-3.

Earlier drilling and analytical work (completed in the 1940s) was to standards much different than those required today. Work done in the 1970s, although better, is still not to current standards.

All drillholes from 1989 onward were cored from the top of the McMurray Formation into the Devonian. Each hole was logged by a geophysical service company specializing in slim-hole logging. A suite of geophysical logs was obtained that included: caliper, gamma, density, neutron, sonic, resistivity and spontaneous potential measurements. Dipmeter logs have been run on selected 1996 and 1997 drillholes.

Core Description, Sampling and Laboratory Analyses

Core from 1989 and subsequent programs was recovered in plastic sleeves and frozen to preserve moisture content. In the laboratory, core was bisected for sampling and description. Cores were correlated with geophysical logs from the drillhole to ensure a consistent and reliable depth reference.

A depositional facies model used for core descriptions was developed by Suncor for the Lease 86/17 area and modified for the east bank exploration area. Detailed observations were recorded from core about depositional facies, lithology, sedimentary structures, bedding dips, hardness and ore type as well as colour, burrowing, texture, sorting and geotechnical features.

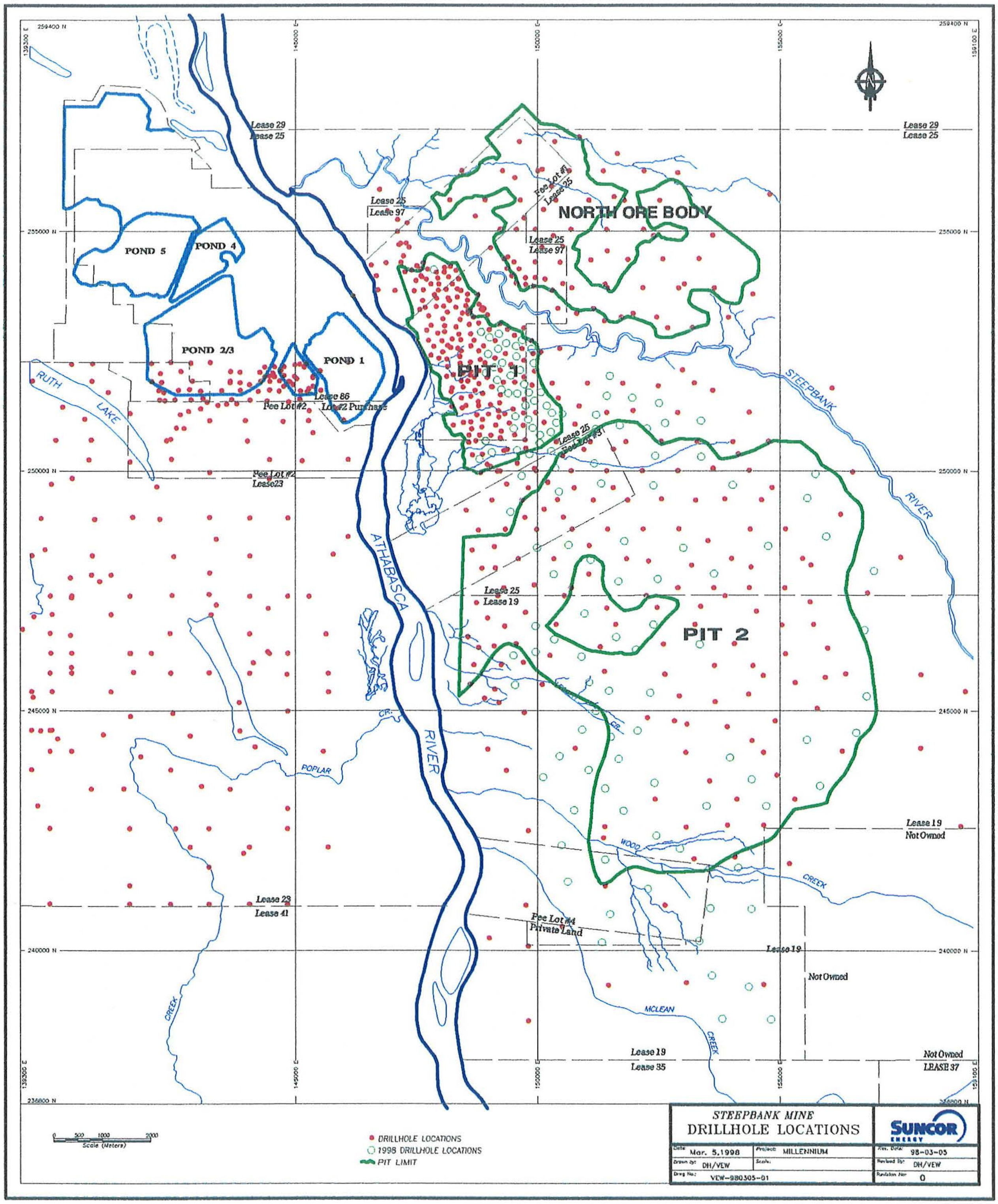


Figure C2.2-3 Drillhole Locations

Older core descriptions (from the 1940s through 1970s) are of much lower quality and usually lacking in geological detail, especially in terms of facies descriptions. These require considerable judgement and interpretation when used. Data from the 1940s are the least reliable and are only used when no other information is available. Should subsequent drilling adjacent to 1940s holes confirm the initial results, they will be retained in the database. Otherwise, older data will be discarded and replaced as more complete data sets are obtained.

All samples obtained from 1989 onward have been submitted for laboratory analyses that routinely included factors such as bitumen, mineral and water percentages (by weight) as well as particle size distributions. Check samples were submitted to verify laboratory precision and accuracy. Visual estimates were made of bitumen content while describing core as a quick method to identify possible lab errors. Reliable particle size and fines data are available only from the data acquisition programs of 1989 and later.

In the 1997 program, clay surface areas were measured by a methylene blue stain technique, and concentrations of iron, aluminium, and chloride ions (plus associated salts) were determined.

Since 1994, tests for evaluating ore characteristics (including porewater and bitumen chemistry) have been undertaken to help predict chemical and process reactions in Extraction and Upgrading. The data will be used to forecast ore processibility in the extraction process, to predict recoveries from ore from different depositional environments, and to develop ore-blending strategies. Also, the data will facilitate comparison of bitumen upgrading characteristics between the new leases and Lease 86/17. Overburden and interburden have been tested for sodium adsorption ratios to assist in planning material disposal.

Data Quality

Data from different drilling programs vary considerably in quality. For use in evaluating new leases and to assist with planning future drilling, data have been classified as good, fair or poor in quality based on the amount of information available from the core descriptions, logs and laboratory analyses of core samples.

Good-quality data sets are complete and reliable, and contain a full suite of logs, facies-based core descriptions, bitumen, mineral and water assays and particle size analyses. Fluid chemistry, ore processibility and bitumen chemistry data may also be available.

Fair-quality data sets are reliable but incomplete, consisting of well logs as well as bitumen, mineral and water assays.

Poor-quality data sets are either sparse or incomplete or both, requiring considerable interpretation and numerous assumptions. These data sets are only used when no others are available.

Geological, geophysical log and laboratory data available from drillholes are summarized in Table C.2.2-1.

Table C2.2-1 Geological Data Available

Years Drilled	Holes Drilled	Data Quality	Facies Description	Lab Data	Logs Runs
1940s	98	Poor/Fair	No	Bitumen only	No
1950s	1	Poor	No	None	Yes
1960s	2	Fair	No	BMW[1] partial sieves	Yes
1970s	28	Fair	No	BMW[1] full sieves	Yes
1989	33	Good	Yes	BMW[1] full sieves	Yes
1994	3	Good	Yes	BMW[1] full sieves	Yes
1995	36	Good	Yes	BMW[1] full sieves	Yes
1996	55	Good	Yes	BMW[1] full sieves	Yes
1997	122	Good	No	BMW[1] full sieves, metals, methylene blue and salts	Yes

[1] BMW - bitumen, minerals and water

Future Exploration

Continuing delineation drilling will add to the geological data base information from the Steepbank Mine expansion (Pit 2) area.

An additional 119 drillholes will be drilled during the winter of 1998 with more drilling planned for subsequent years. Drilling densities required for different stages of exploration and mine planning will depend on the complexity of the geological setting within the mine area, and the precision needed for mine planning and reserves calculations. As a general guideline: a drilling density of 2.5 to 3 drillholes/km^2 is required for a pre-feasibility study; a density of 7 to 10/km^2 is normally required for a feasibility study; and a density of 30 to 40/km^2 is needed to facilitate five-year mine planning. Currently defined Pit 2 drill density is 3.3 drillholes/km^2.

Currently Pit 1 drilling density is 30 holes/km^2 and will increase to 35.8 drillholes/km^2 when the 1998 drilling is completed. Pit 2 drill density is 2.4

drillholes/km^2 and will approach 3.3 drillholes/km^2 by the end of the 1998 drilling program.

Surface geophysical surveys have not been undertaken to date nor are any planned at this stage.

Overburden testing will resume in 1998 on selected drillholes, with approximately 25 shallow overburden test holes drilled to the top of the McMurray strata.

Geological Modelling

A computer-generated model was used to develop a three-dimensional picture of the ore body. Model output was compared to hand-drawn cross-sections to verify and refine the computer model.

Mine Modelling

Mine planning and mining geology have been modelled using software commercially available from Mincom Inc.. The software comprises a number of interrelated modules:

- Minescape: a core data module
- Geodas2: a geological database module
- Stratmodel: a module with geological modelling capability
- Minestar: a mine design module
- Reserves: a reserves calculation module

Geodas2 contains the geological horizons, bitumen, mineral and water analyses and particle size distribution data. One of its subroutines compares bitumen data from sampled intervals and calculates both ore and interburden zones. Interburden is determined as aggregated intervals greater than 3 m thick with a bitumen content less than cut-off grade.

The geological data are modelled Stratmodel, a three-dimensional stratigraphic model for layered deposits. Stratmodel develops a series of fundamental and derived surfaces that divide the geological sequence into layers between the topographic surface and the Devonian limestone surface.

Surface Modelling

Fundamental surfaces (determined from surface topography, core or log picks) include: surface topography; top and bottom of the Clearwater Formation; top and bottom of oil sand (also termed top and base of tar); top and bottom of ore; top and bottom of basal aquifers; drillhole collars; and the Devonian limestone surface. Fundamental surfaces are entered into Geodas2 as geological horizons.

Derived surfaces are determined using a gridded model with data from both fundamental surfaces and ore and interburden surfaces determined in Geodas2. Since Stratmodel surfaces are derived using a mathematical gridding algorithm they may vary slightly from some of the data points in the fundamental surfaces used to generate the grids. Stratigraphic surfaces generated by Stratmodel are reviewed and, if necessary, adjusted manually to more closely resemble the true surfaces.

Derived surfaces include: five ore and four interburden unit tops and bottoms; waste below top and base of oil sand; and various user-defined thickness maps termed isopachs (such as overburden, Clearwater, ore, interburden, and basal aquifer). Ore and interburden units, although possibly discontinuous, are always in the same sequence from top to bottom.

Overburden

Overburden is defined as materials (including lean oil sands) that lie over the ore. Composition of those overburden materials varies; it may contain muskeg, unconsolidated clays, silts and sands, as well as occasional thin, discontinuous, indurated beds. Materials commonly encountered are summarized and described in Table C2.2-2.

For engineering purposes, and to classify material for potential use, overburden materials have been described using the Modified Unified Soil Classification System. Typical uses for overburden materials in the mining operation have been summarized in Table C2.2-3. An overburden isopach map is presented on Figure C2.2-4.

Muskeg forms the top overburden layer and may be absent close to the river valleys or found in thicknesses over 7 m in the southeast area of Pit 2. Muskeg generally thickens towards the east and south, away from the valleys of the Athabasca and Steepbank Rivers. There is known to be sufficient muskeg for reclamation purposes, but a detailed determination of muskeg volume is yet to be established.

Underlying the muskeg are glacially-deposited sediments. These deposits consist of clayey to sandy glacial tills and glacio-fluvial coarse clastic sediments. The topographic crest of the Athabasca River valley separates sediments to the west from those lying to the east. Western-lying sediments are characterized by sands typically less than 5 m thick, while the eastward thickening sequence of tills with overlying sands and gravels reaches a thickness of over 20 m. Deep, glacially-derived channels have not been encountered in the east bank exploration areas.

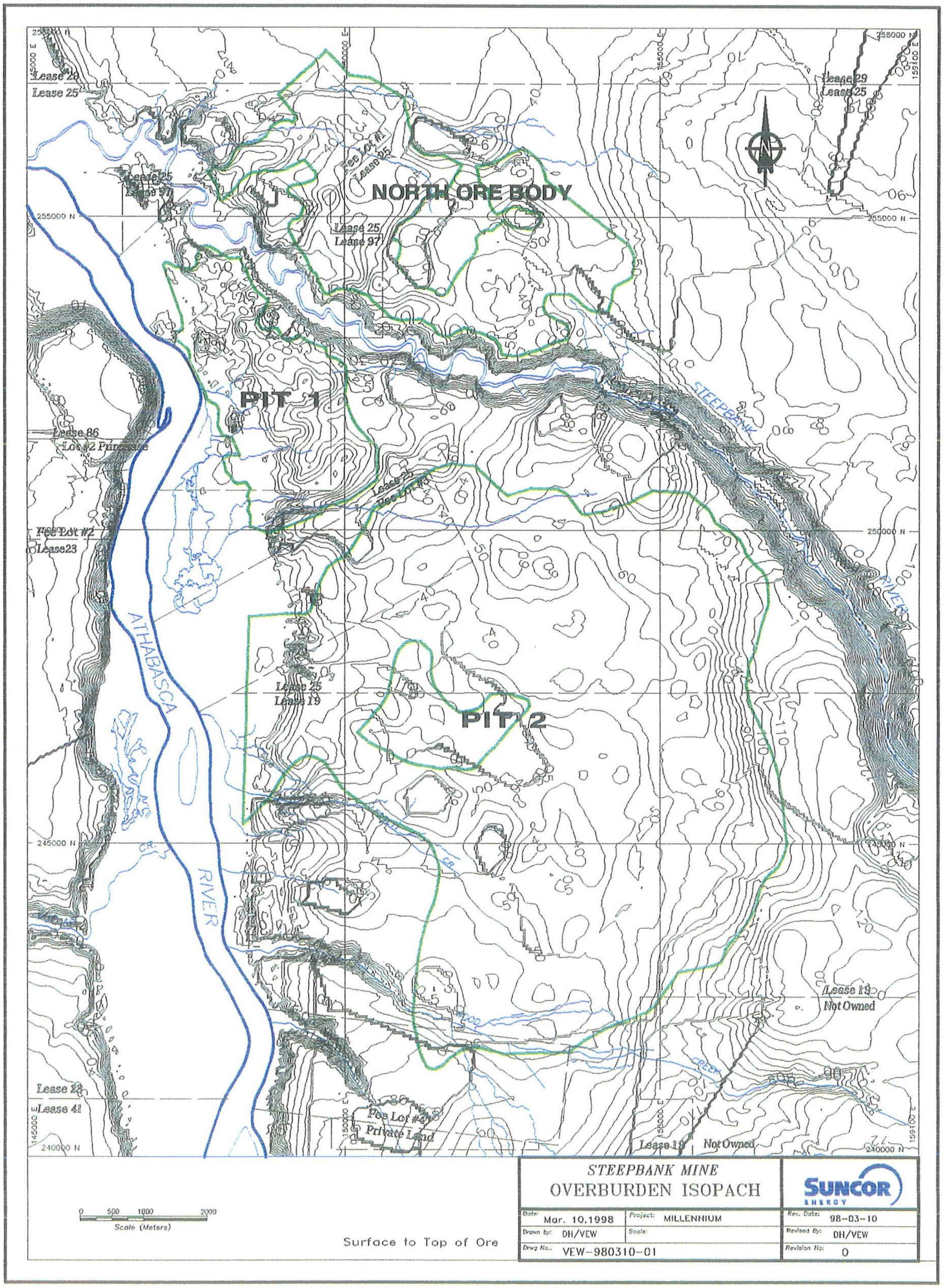


Figure C2.2-4 Overburden Isopach

Table C2.2-2 Summary of Overburden Classification

Age	Depositional Environment	Unit/Formation	Symbol	U.S.C.[1]
Holocene (Recent)	Colluvial	Colluvium	H_c	Variable
	Organic Deposits	Muskeg/Soil	H_o	PT/OL
	Lacustrine	Lakeshore/Lake Bottom	Hl	Variable (MH/CL/MI/OH/OLO)
	Fluvial	Alluvial	Hf	Variable
	Aeolian	Dune	Hac	SP/MC
Pleistocene	Glacio-Lacustrine	Channel/Lake Bottom/Lake Shore	Pl	CL/Ml
	Glacio-Fluvial	Outwash & Meltwater Channel Sand	Pfs	SM/SP/SW
		Outwash & Meltwater Channel Sand and Gravel	Psig	SP/SW
		Outwash & Meltwater Channel Gravel	Pigfs	GW/GP/GM
	Glacial	Sandy Till	Pgts	SC/SM
		Silty Till	Pgt	ML/CL
		Clayey Till	Pgtc	CI
		Clearwater Till	Pgc	CI/CH
		Clearwater Formation Bedrock Rafts	Pgkc	CH
		McMurray Formation Bedrock Rafts (Firebag Till)	PgKm	CL/SM
(Unconformity)				
Cretaceous	Shallow Marine	Clearwater Formation	KCd	CI/CH/CL/SM
			KCc	CH
			KCb	CI/CH/CL/SM
			KCa	CH
			KCw	CI/CL/SM
	Marine	McMurray Formation	Km	

[1] Modified Unified Soil Classification system

Of potential concern is the Clearwater Formation (which forms a part of the overburden) because it contains clays that can act as zones of geotechnical weakness as well as sands which can potentially serve as shallow natural gas reservoirs. For these reasons, this formation is identified from core descriptions and is mapped to provide information for engineering analysis. An isopach map of the Clearwater Formation is presented on Figure C2.2-5.

The upper part of the McMurray Formation may be included in the overburden if it meets at least one of these conditions:

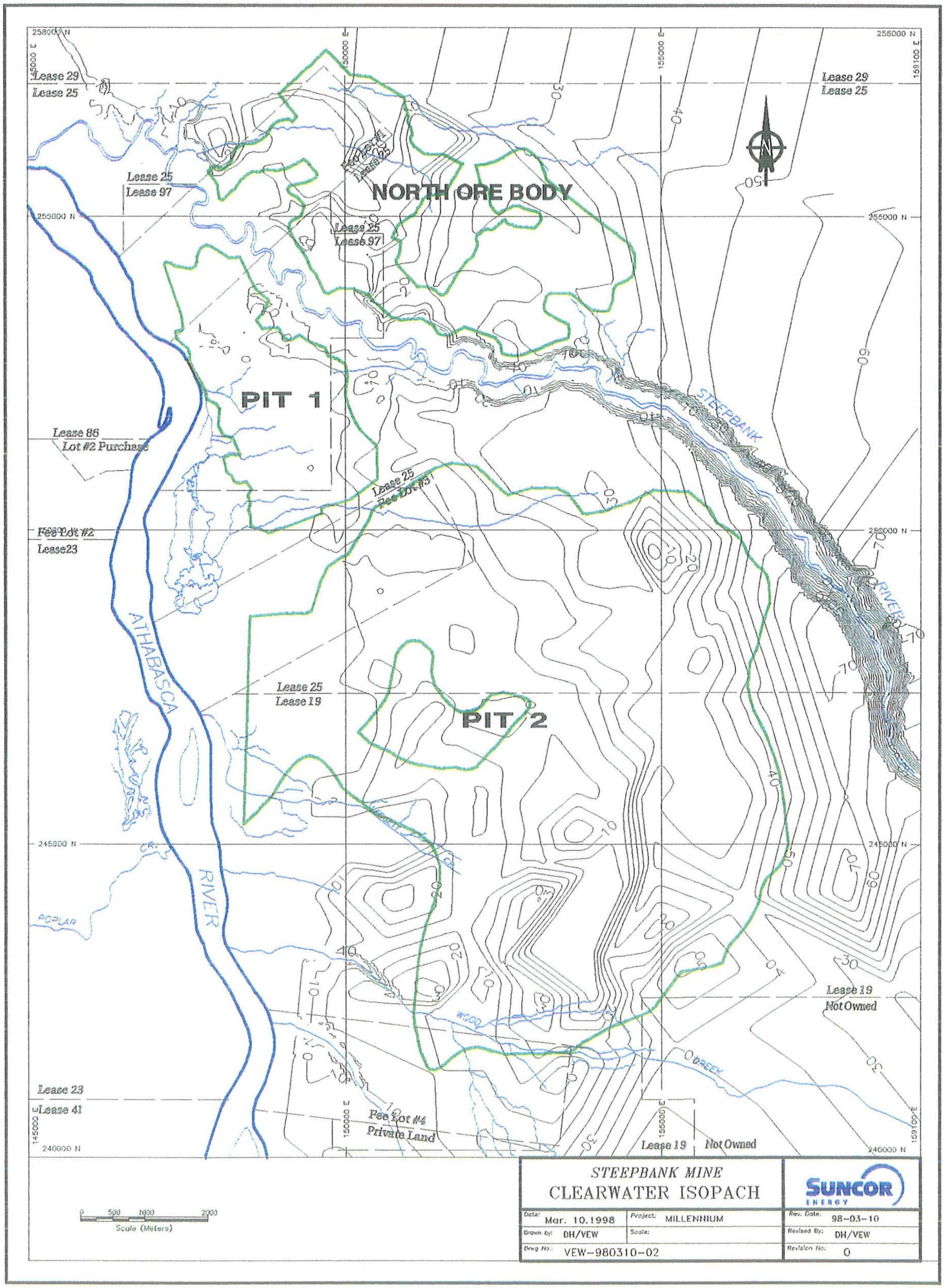


Figure C2.2-5 Clearwater Isopach

Table C2.2-3 Overburden Material Use by Class

Classification	Sub-Class	Dispatch Classification	Also Known As	Distinguishing Characteristics	Density	Uses
Muskeg		Muskeg	Peat	High organic content		Reclamation
Sand and Gravel		Sand and Gravel				
Pebble Silt Till (Glacial Till)	Sand	Boulder Clay	Silty Clay	Sandy texture clay with pebbles		Dyke construction
	Clay	Boulder Clay	"Good Clay", Boulder Clay	Plastic texture clay with pebbles/boulders		Road building, dyke construction
Second Sand		Sand and Gravel or Clearwater Silt	Waste Below Till, Wet Sand	Wet, sloppy, silty sand		None
Cretaceous Clearwater (KC)	Black Clay	Clearwater Silt	Black Clay, Waste Below Till	Rare on this lease		None
	Mixed Sand and Clay	Clearwater Silt	Waste Below Till	Silty sand-clay mixture, no bedding		None (downstream dyke construction if not wet?)
	Glauconitic Clay	Glauconitic Clay	Waste Below Till, Green Clay	Green-coloured clay		None (downstream dyke construction if not wet?)
Lean Oil Sand	Core Spec.	Lean Oil Sand	LOS, Lean Oil Sand, LTS	>20% fines, 3-6% bitumen		Dyke core Dyke construction
	Dyke Spec.	Lean Oil Sand	LOS, Lean Oil Sand, LTS			Dyke construction
	Waste	Lean Oil Sand	LOS, Lean Oil Sand, LTS	Wet or silty		None

- it is very high in fines content
- if oil-bearing, it is too thin or discontinuous to mine
- it is too lean to be designated as ore

Included as overburden are several coal occurrences identified during the 1997 drilling program. These usually lie in the upper part of the McMurray Formation, more rarely at the base. Upper beds are less than 5 m thick and are believed to be discontinuous. Lower beds are up to 8 m thick and are restricted to local Devonian topographic lows. Coal characteristics have not yet been determined by laboratory analysis.

Ore and Interburden Zone

Ore zones of interest for mining occur within a sequence of bituminous sands 40 m to 50 m thick that dominates much of the Pit 2 area. Thinner sequences of high-grade ore also occur close to the escarpment along the Athabasca River, where overburden is thin.

Within the ore zone, wide, accretionary, estuarine channel sand sequences have formed rich bitumen reservoirs. Basal fluvial channel sand sequences are of interest when they act as reservoirs but within the Pit 2 area they are often below the bitumen-water interface and form basal aquifers.

For practical mining, the floor or Base of Ore (Figure C2.2-6) may coincide with the Devonian but is often above it, with lean oil sand, clay or water sand present between the Base of Ore and the Devonian.

A Top of Ore surface (Figure C2.2-7) indicates the first occurrence of mineable oil sand. Lows on this surface usually outline thick sequences of lean Upper McMurray sediments. The Ore Zone is the interval between the Top and Base of Ore. In Pit 1, the Ore Zone averages about 40 m thick, while in Pit 2 it is about 55 m. Restricted areas near the centre of Pit 1 and one area in Pit 2 have been identified as those where the ore is locally thinner. Ore isopachs for Pit 1 and Pit 2 are shown on Figure C2.2-8.

Interburden zones are discontinuous and usually difficult to correlate stratigraphically between drillholes. This is not surprising considering that this is an accretionary sequence, where repetitive cycles of erosion and deposition occurred across the depositional basin and left discontinuous interburdens restricted in areal extent. Considerable additional work will be required to define interburden zones well enough so that reliable maps or sections for short-range mine planning can be created.

Three cross-sections generated by Stratmodel are presented to illustrate the mining geology of the area. Locations for the cross-sections are illustrated on Figure C2.2-9 and the cross-sections themselves are presented on Figures C2.2-10, C2.2-11 and C2.2-12.

Aquifers

Basal aquifers have been identified in fluvial sands filling Devonian topographic lows and within the Devonian. Minor thin, discontinuous perched aquifers (similar to those found on Lease 86/17) occur within the ore body. These do not pose any difficulty for mining operations.

The overburden aquifer in the muskeg (as well as glacio-fluvial sands and gravels) will be drained by a pattern of ditches prior to overburden stripping in a manner similar to that in the current mining operations.

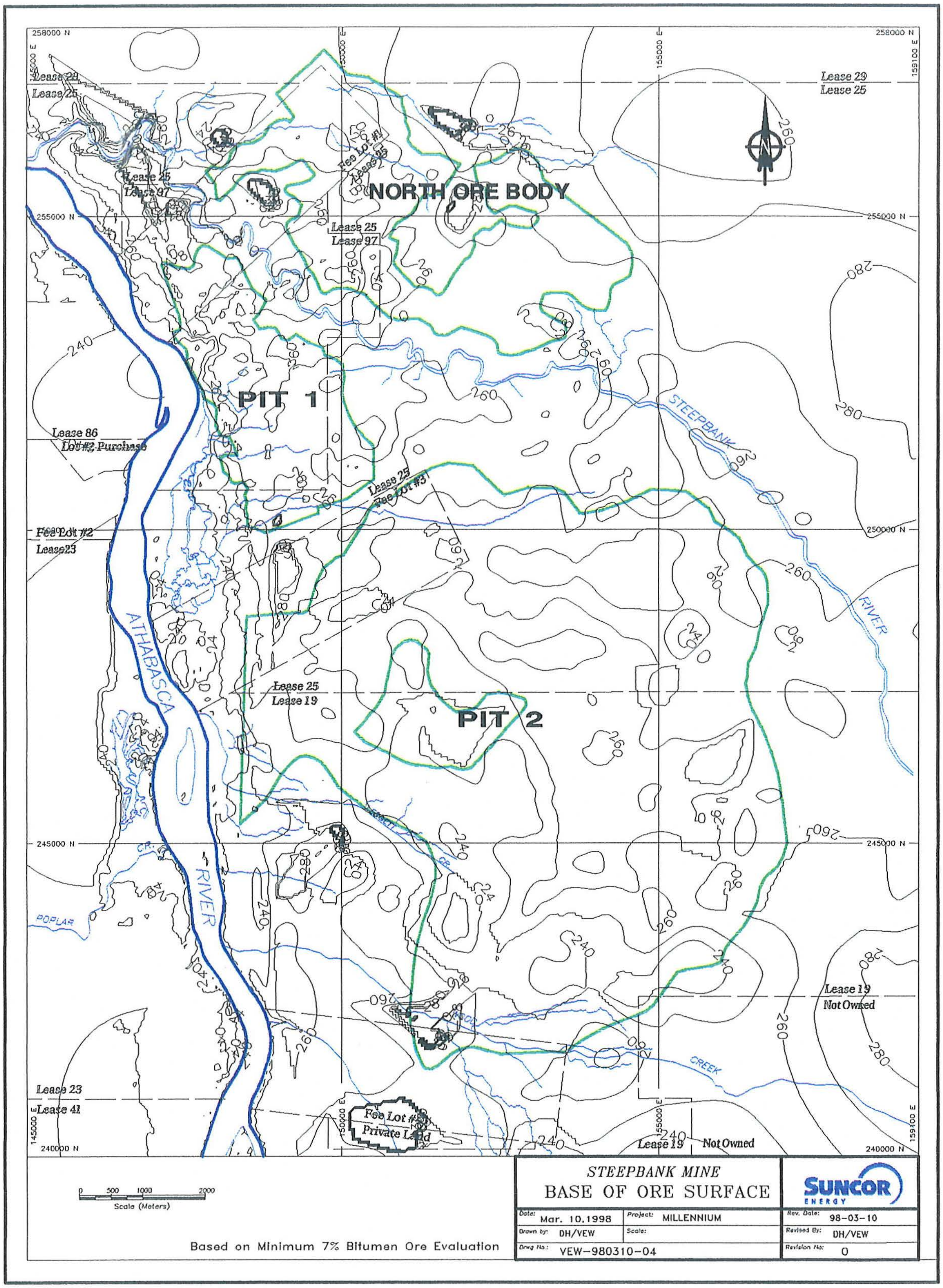


Figure C2.2-6 Base of Ore Surface

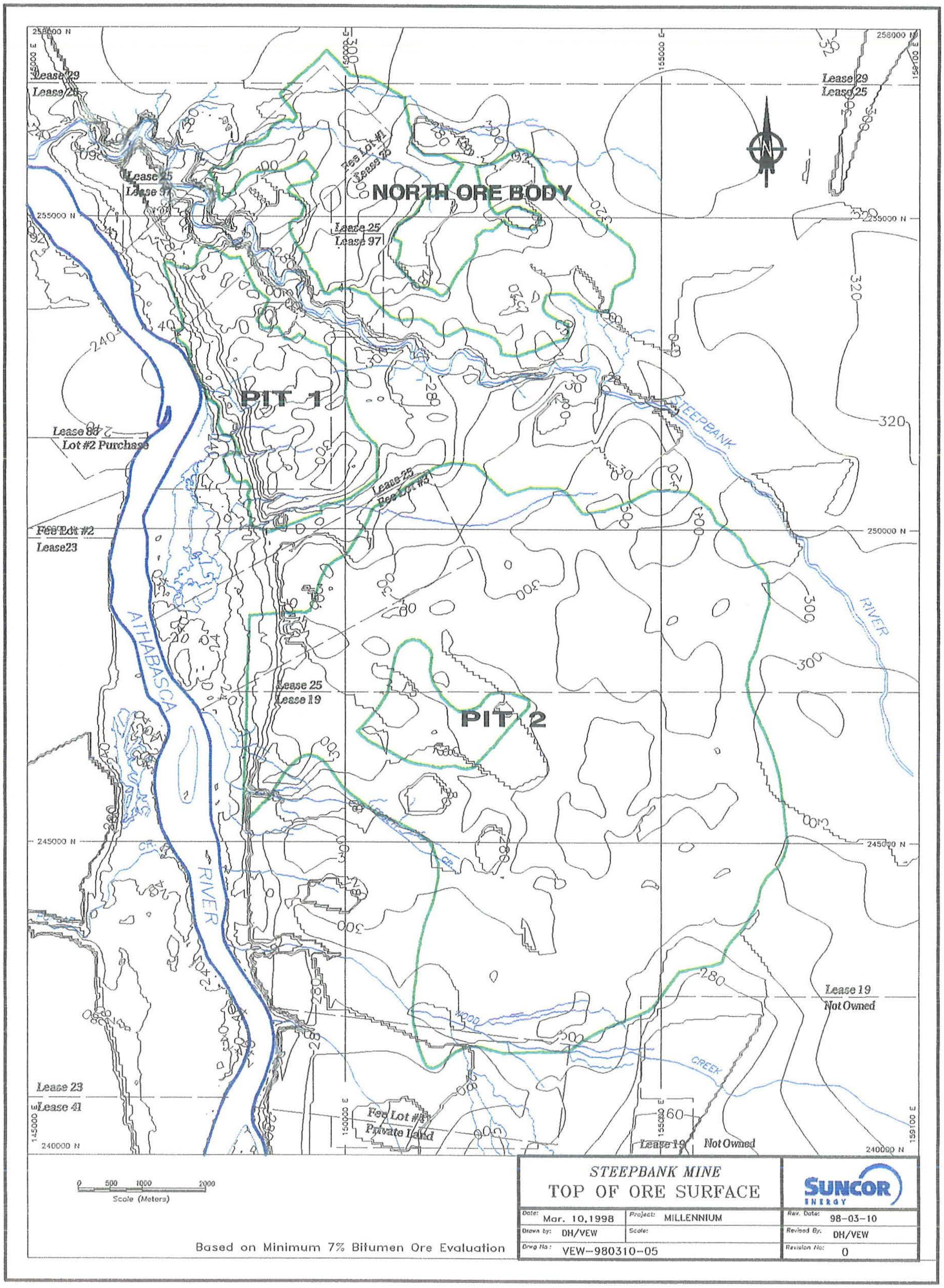


Figure C2.2-7 Top of Ore Surface

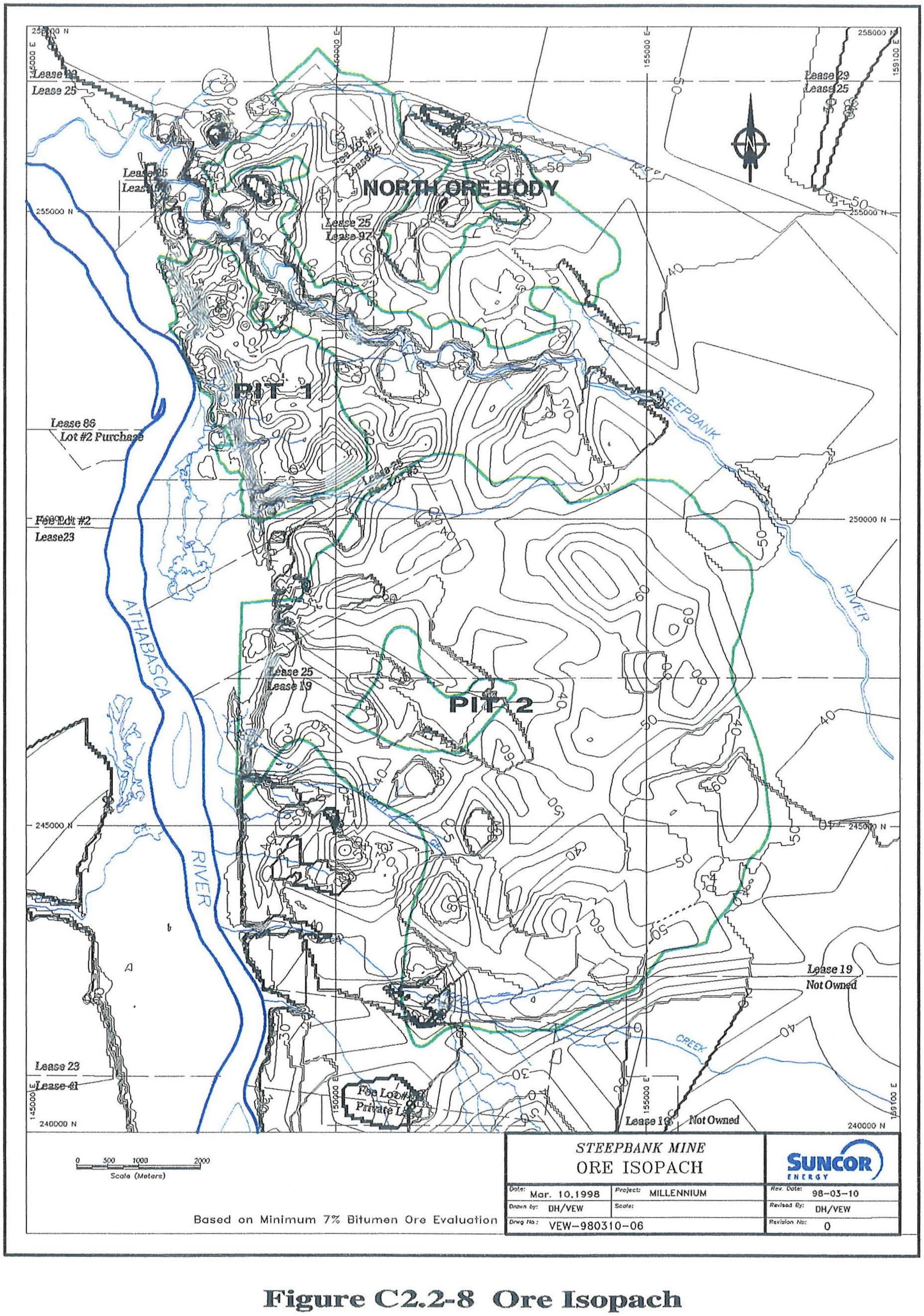


Figure C2.2-8 Ore Isopach

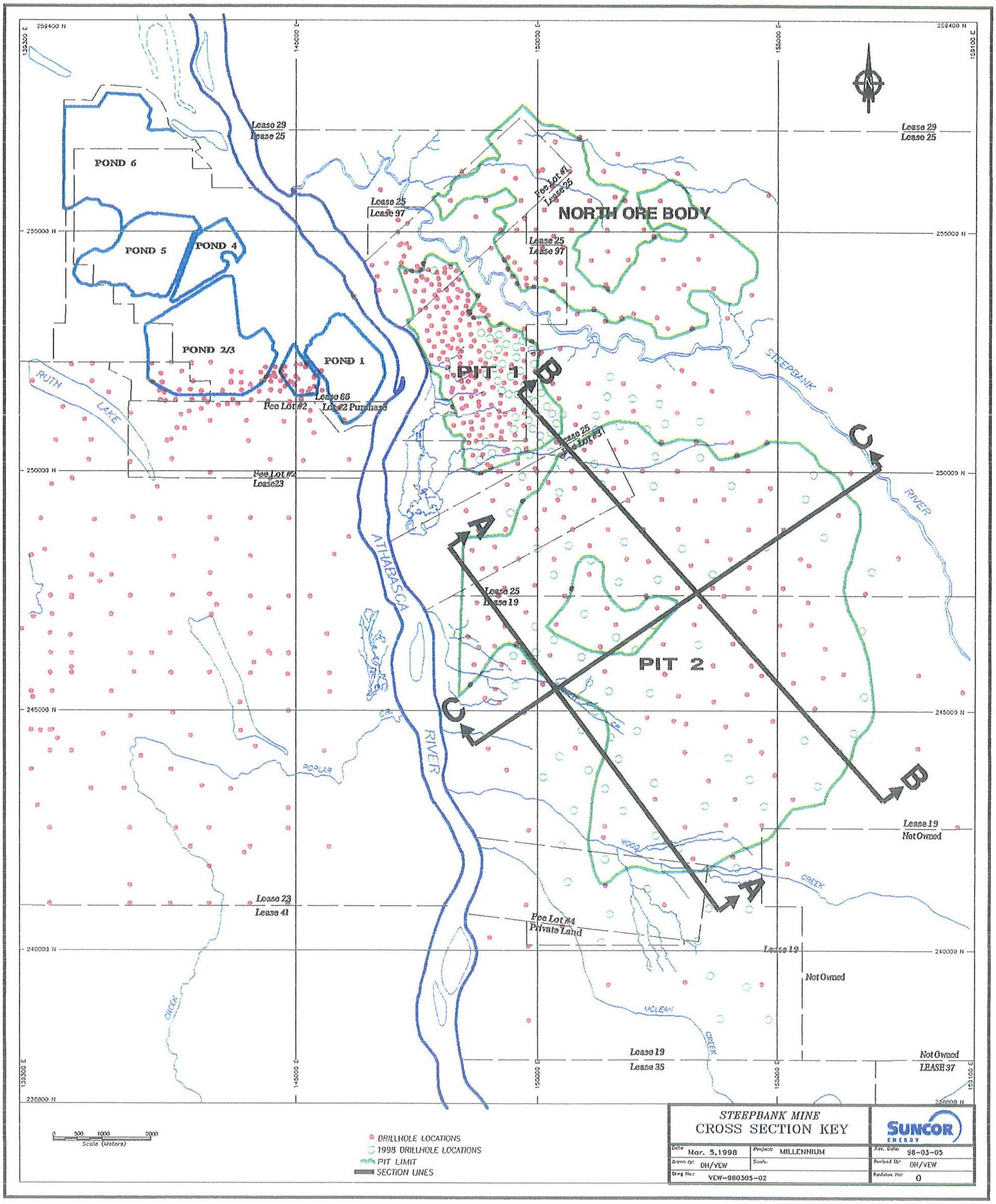


Figure C2.2-9 Cross-Section Key

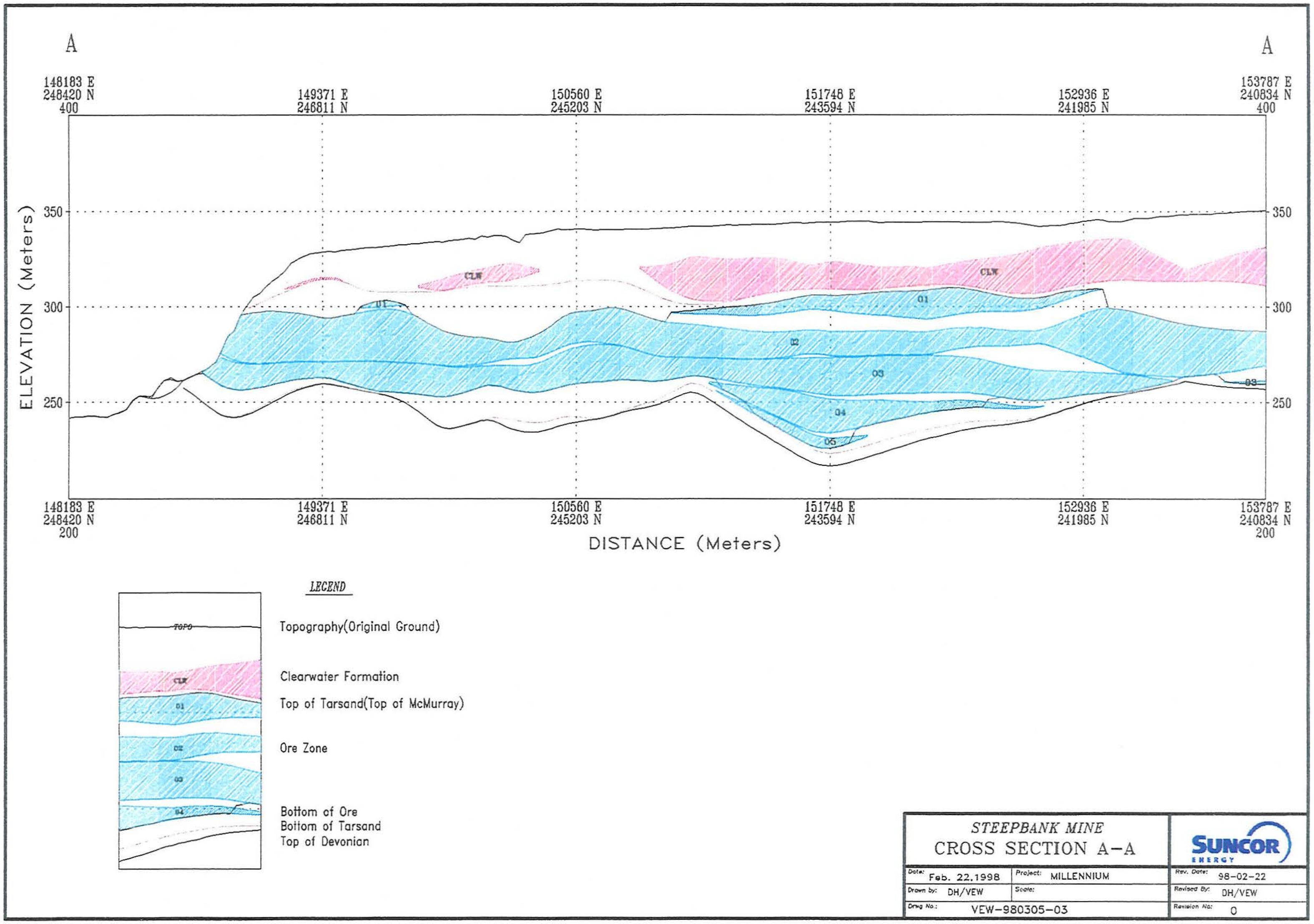


Figure C2.2-10 Cross-Section A

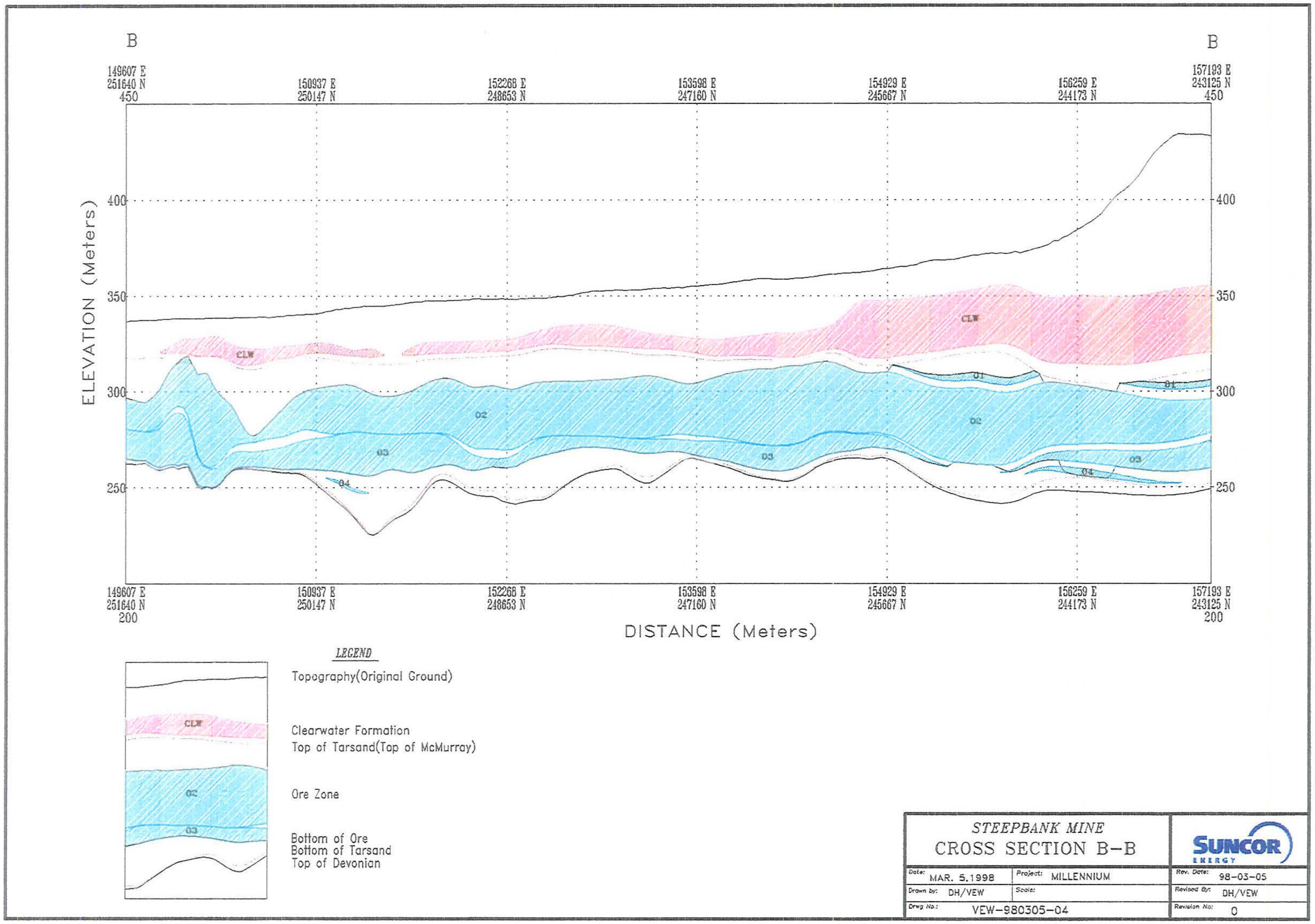


Figure C2.2-11 Cross-Section B

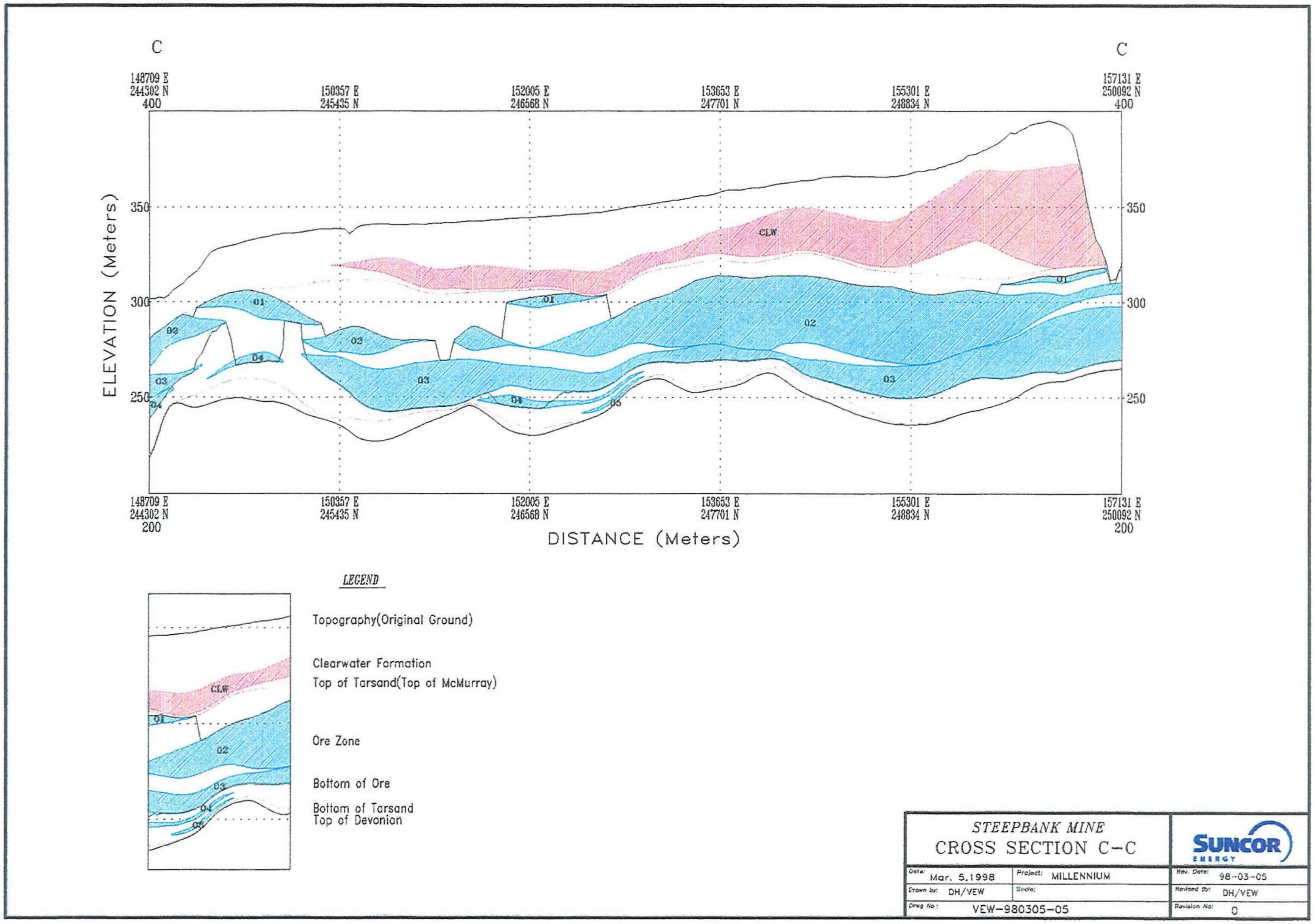


Figure C2.2-12 Cross-Section C

Devonian Surface

On Leases 97, 25 and 19 the Devonian surface is rugged, with topographic relief ranging from 20 m to 40 m. The Devonian surface is shown on Figure C2.2-13.

C2.2.2 Ore and Reserves

Ore Characteristics

The estimated ore grade for the entire Steepbank Mine is 11.7 wt% bitumen, 15.7 % fines and average (D50) particle size of 145 microns. Ore in Pit 1 grades 11.5 wt% bitumen, while Pit 2 grades 11.7 wt% bitumen.

Plant feed can be expected to fluctuate over short time periods (e.g., hourly, daily, weekly) depending on the location of the ore being mined. In Pit 2, for example, 20% of the ore is less than 11 wt% bitumen and 40% is over 12 wt% bitumen. Modelling shows that ore within the ore zones varies depending on the location: from lower grades in the upper part to higher grades in the centre to both high and low grades in the lower levels. Histograms of grade and tonnage distribution within Pit 1 and Pit 2 are shown on Figure C2.2-14 and by zone for Pit 2 on Figure C.2.2-15.

Fines data is a relatively recent addition to the east bank database and is insufficient to generate an accurate fines model. Additional data will be acquired as exploration proceeds. In general, highly elevated fines content in the ore can contribute to reduced bitumen recovery.

Pit Boundaries

Pit boundaries were determined by a method termed Net Cost and compared against two ratio methods, TV/BIP and TV/NRB:

- TV/BIP defined as the ratio of the total volume of all material to be moved (overburden, interburden and ore) to the total volume of bitumen in place. Comparisons were made to a TV/BIP ratio equal to 12.
- TV/NRB defined as total volume of all material to be moved in cubic metres to the net recoverable volume of bitumen in barrels. Comparisons were made to a TV/NRB equal to 2.2.
- Figures C2.2-16 to C2.2-18 illustrate the comparisons. Net cost is calculated by barrel of bitumen production.

For feasibility purposes, mining costs of $1.18/t overburden and $1.20/t oil sand, and extraction costs of $1.53/t oil sand processed were used. These costs are a composite of operating costs and sustaining capital costs. A net cost contour of $10/bbl was used to define the pit, and the TV/BIP and TV/NRB criteria were used for comparison.

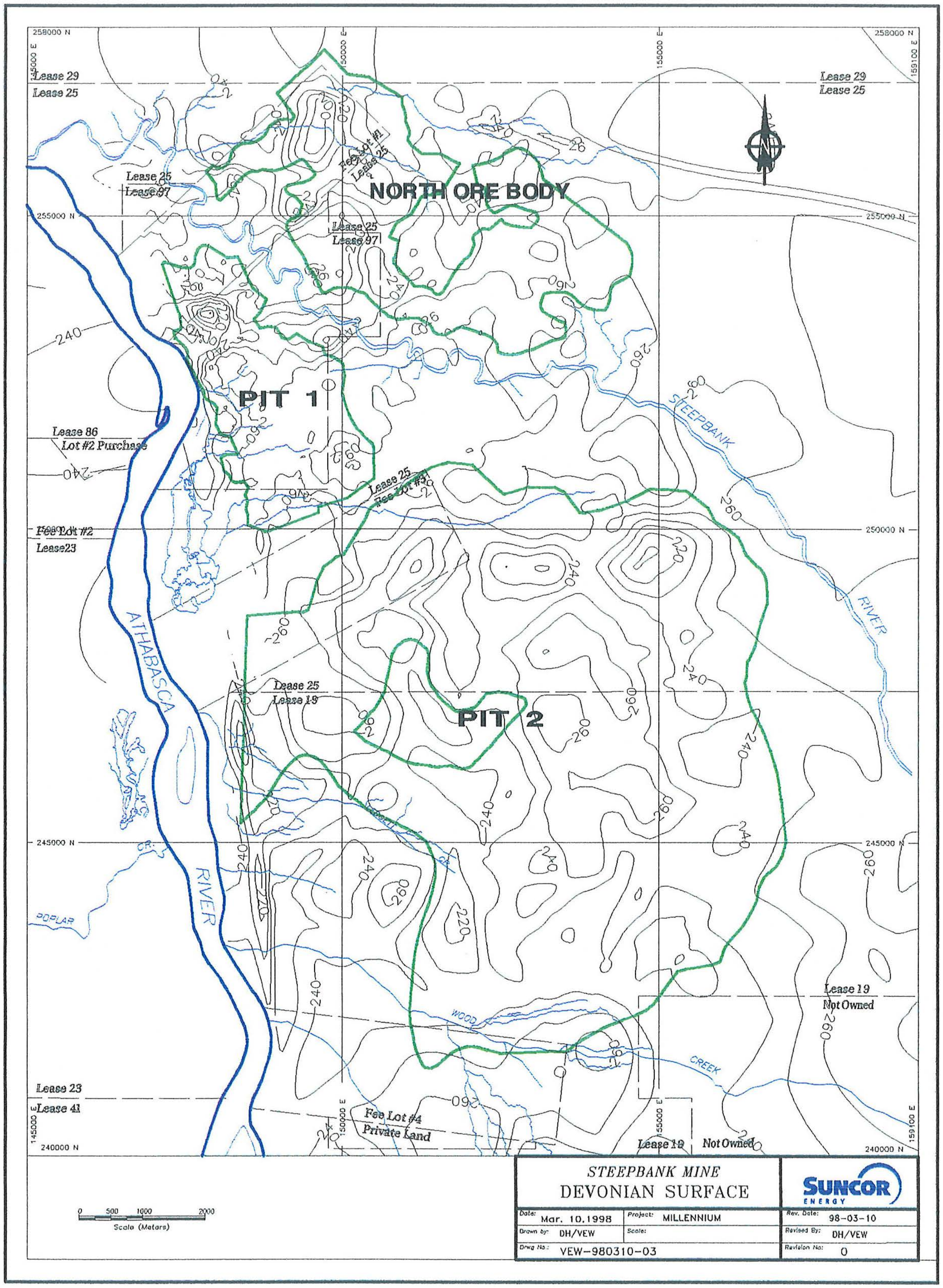
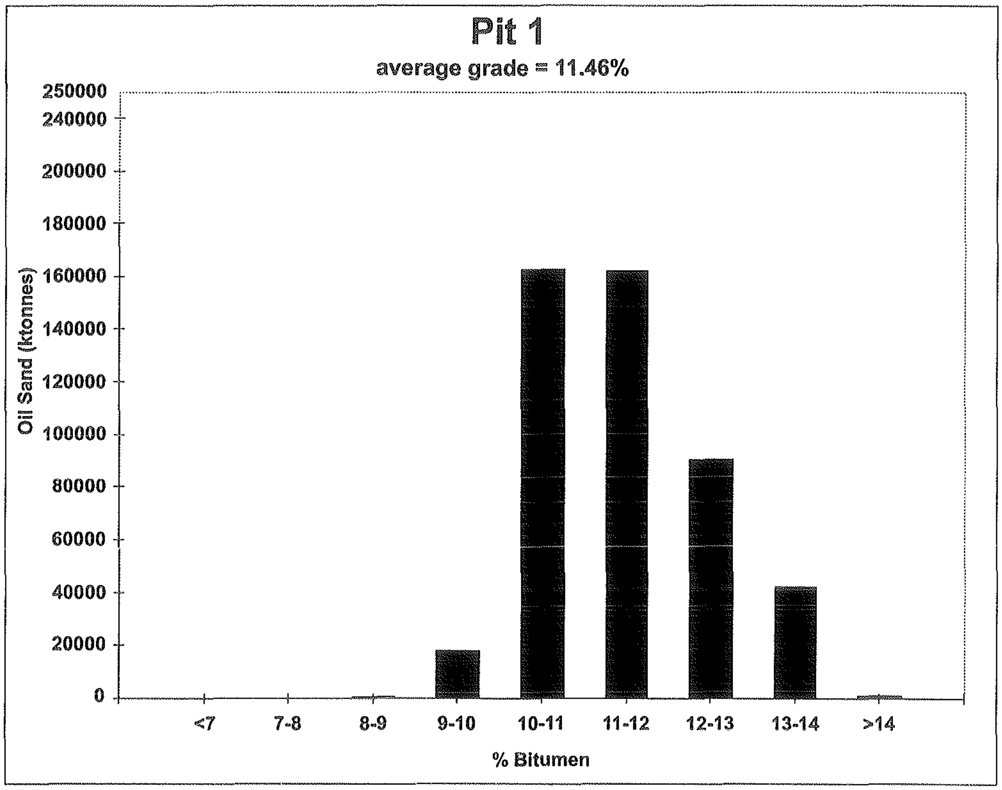


Figure C2.2-13 Devonian Surface



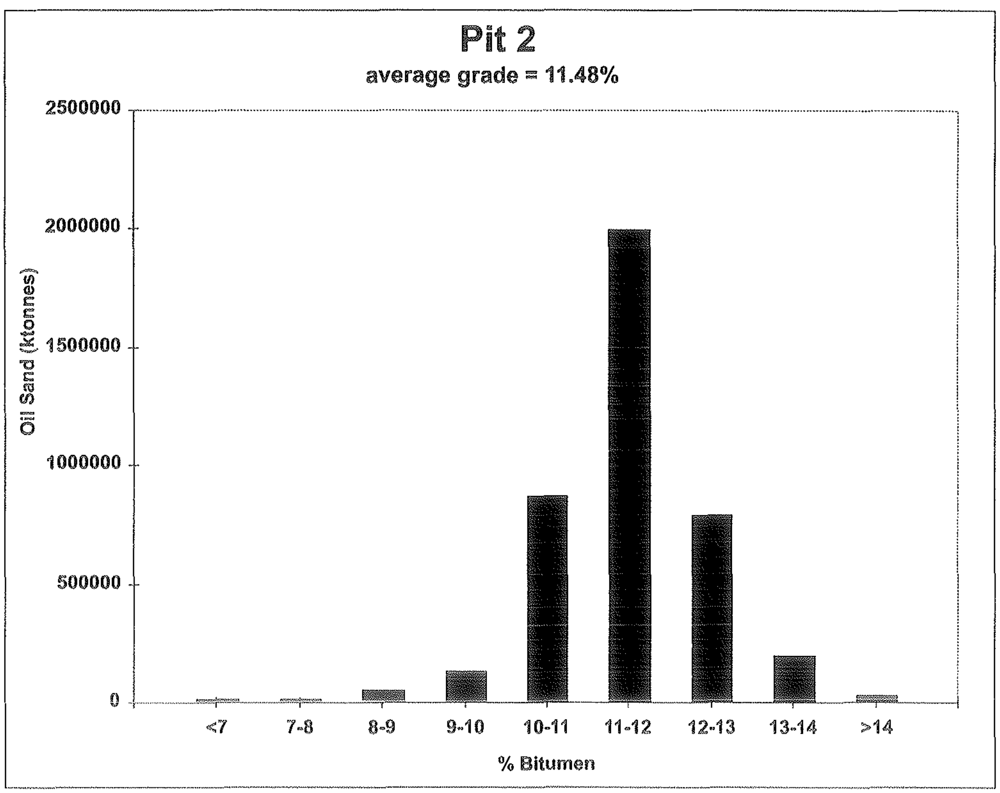


Figure C2.2-14 Grade and Tonnage Distribution - Steepbank Mine

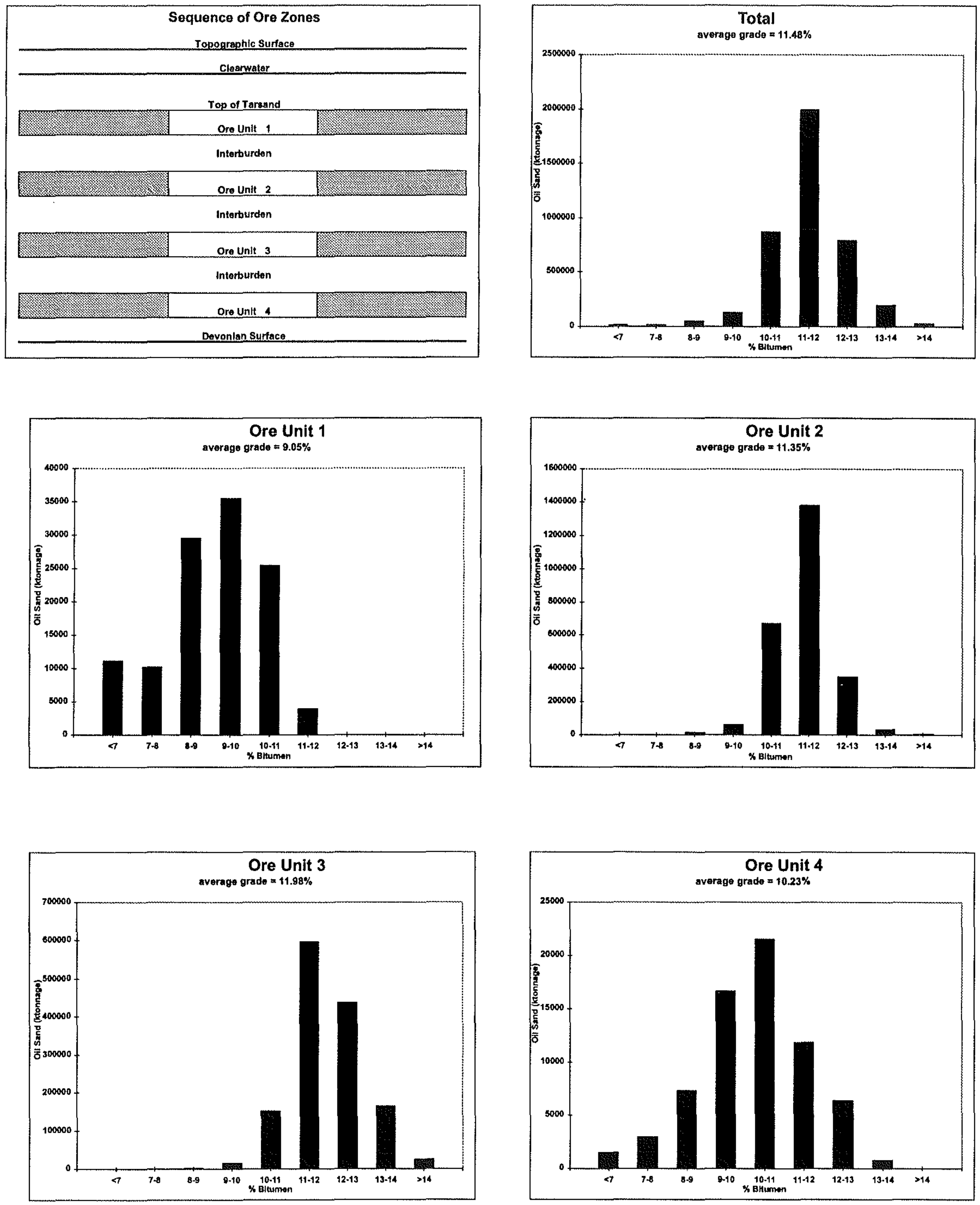


Figure C2.2-15 Grade and Tonnage Distribution - Pit 2

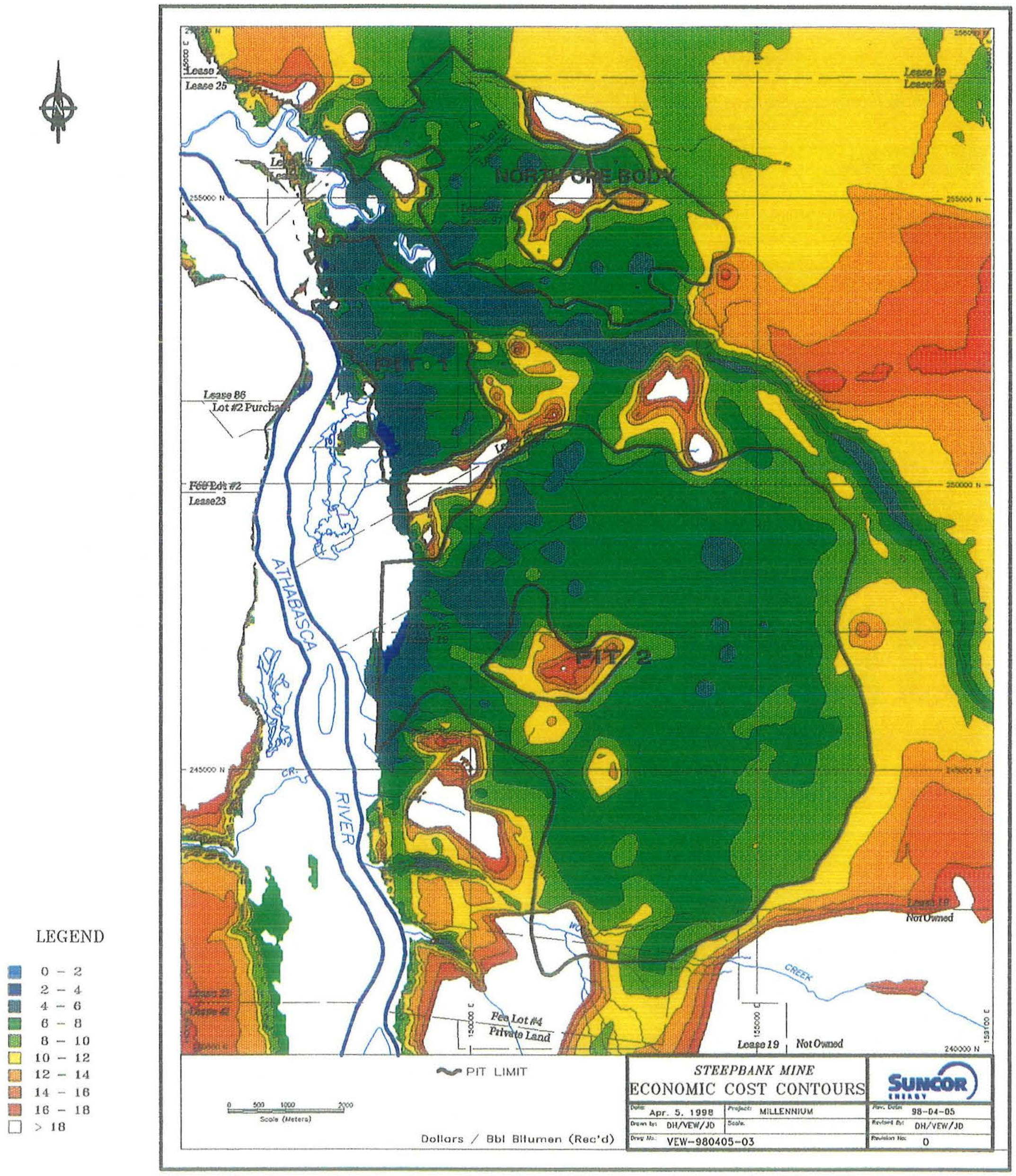


Figure C2.2-16 Net Cost Contours

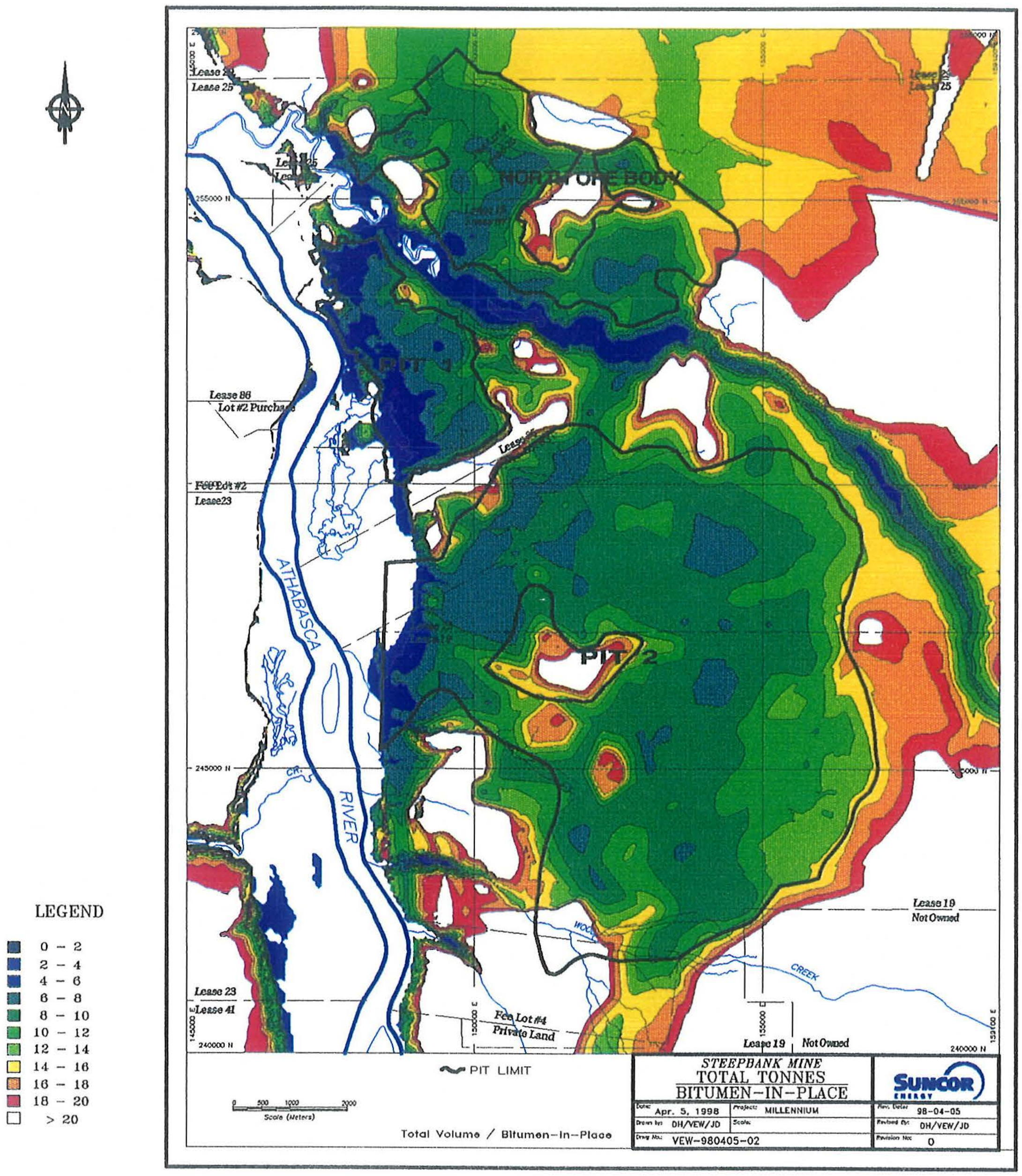


Figure C2.2-17 Total Volume / Bitumen-in-Place Contours

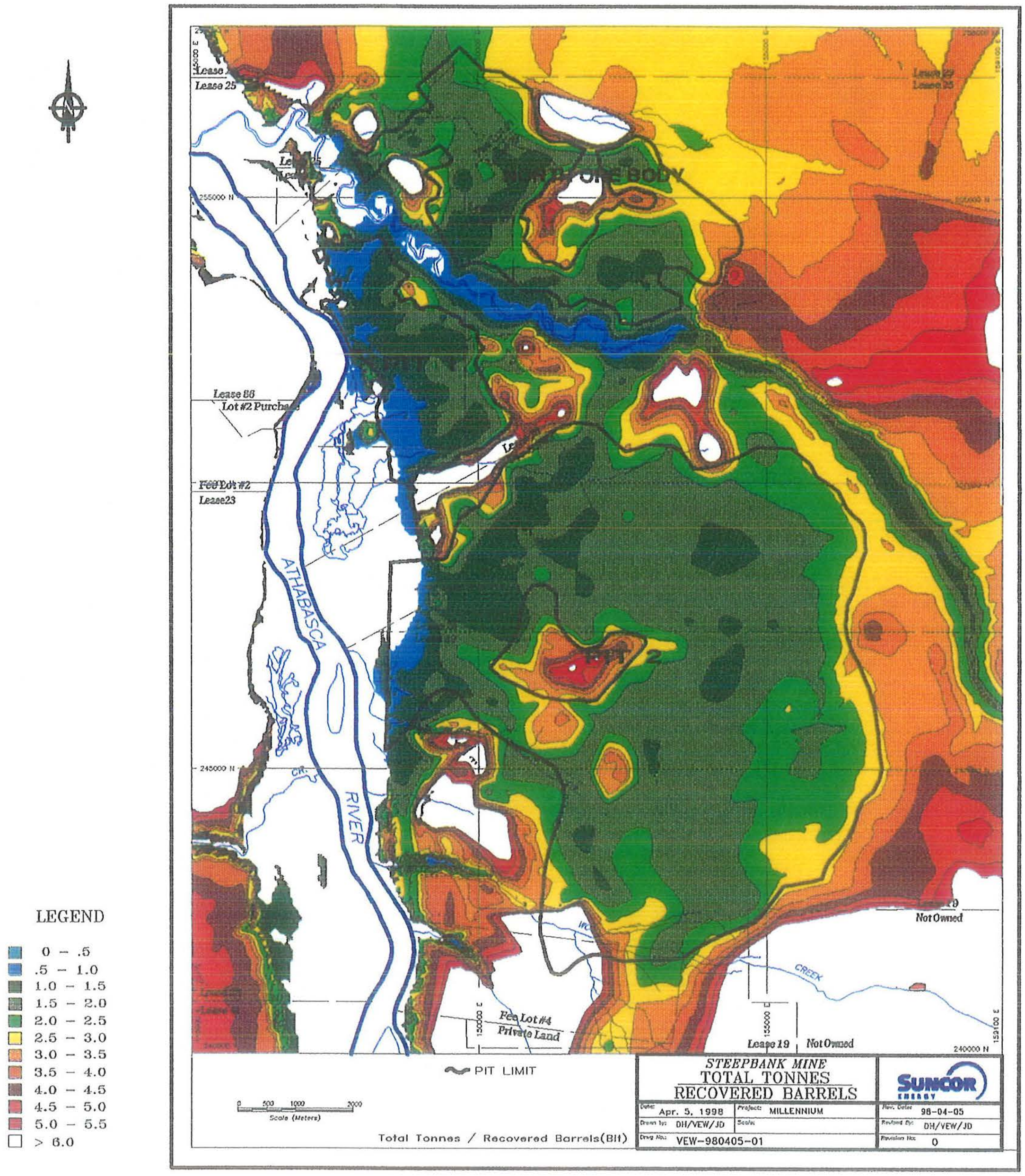


Figure C2.2-18 Total Volume / Net Recovered Barrels Contours

An adjustment was made to pit boundaries for a 200-m setback from the crest of the Steepbank River escarpment to allow for a 100-m no-disturbance zone and 100-m road allowance. The pit was evaluated further in terms of ore zone thickness, stripping ratio and overall practicality of mining. A simple pitwall definition (consisting of one overall slope for oil sand and one overall slope for overburden) was used with implicit allowance for berms.

Reserve Potential

Reserves were calculated using the Reserves module of the Mincom modelling system. The pits (defined from the Net Cost modelling) were subdivided into blocks for reserve reporting and scheduling. It was assumed that there would be no dilution from overburden, interburden or pit floor material. Dilution of ore-grade material by lower-grade material (contained within ore zone) is included in the reserve calculations.

Total volume of bitumen-in-place for Pit 1 is 54 Mm^3 (342 Mbbl) and for Pit 2 it is 479 Mm^3 (3034 Mbbl). Additional details about reserves, tonnages and volumes are presented in Table C2.2-4.

Table C2.2-4 Potential Oil Sand Reserves: Pit 1 and Pit 2

	Pit 1	Pit 2	Total
Oil Sand			
Mass (mt)	477	4 127	4 604
Volume (M bank m^3)	222	1 920	2 142
Grade Bitumen (wt%(	11.5	11.5	11.5
Bitumen in Place (Mm^3)	54	479	533
Bitumen in Place (Mbbl)	342	3 034	3 376
Recoverable Bitumen	306	2 780	3 086
Interburden			
Mass (Mt)	33	543	576
Volume (M bank m^3)	15	252	267
Grade Bitumen (wt%)	4.8	4.7	4.7
Overburden			
Mass (Mt)	158	4 839	4 997
Volume (M bank m^3)	75	2 034	2 109
Lean Oil Sand Overburden			
Mass (Mt)	132	480	612
Volume (M bank m^3)	61	223	284
Total Waste			
Mass (Mt)	323	5 862	6 185
Volume (M bank m^3)	151	2 509	2 660
Indicator			
Overall Strip Ratio t/t	0.68	1.42	1.34

Pit 1 volumes are based on reasonably dense core hole data while Pit 2 volumes are based on relatively sparse core hole data. Drilling density for these two pits is 30 drillholes/km^2 and 2.4 drillholes/km^2 respectively.

Based on these drilling densities, the bitumen resources for Pit 1 are classified as proven and Pit 2 as potential. Suncor believes that the Pit 1 drilling density provides adequate geological data to facilitate mine planning and development. The Pit 2 density is sufficient for ore body identification, general characterization, and preliminary engineering design and planning work. Future drilling in Pit 2 will permit reclassification of reserves to a probable category once a density of 11 to 12 drillholes/km^2 is achieved and ultimately into a proven category.

Ore Grade Cut-Off

In the Steepbank Mine application (Suncor 1996b), Suncor proposed an 8% ore grade cut-off to define mineable reserves. The AEUB submitted that a cut-off grade of 7% would be more appropriate. A project was initiated in May 1996 to further establish an appropriate cut-off grade analysis and apply it to Steepbank. The process utilized involved the definition of relationships between various cost and operating parameters relative to cut-off grade. Results of this work were discussed with the AEUB in November 1996.

The discussion revealed and reconciled technical differences between Suncor and the AEUB in the application of core sample compositing procedures and the application of a recovery equation. It was determined that the non-standard compositing procedures used by Suncor resulted in the inclusion of as much ore tonnage at 8% cut-off grade as the AEUB standard procedure at 7% cut-off.

It was concluded that a cut-off grade of 7% bitumen with a 3-m minimum mining thickness is appropriate for Steepbank Mine, based on results using standard drillhole compositing. Suncor has applied this procedure in establishing the mineable reserves for the entire east bank mining area.

Suncor's analysis also showed that reducing the cut-off grade to 6% is not appropriate. Although about 10% more tonnage would be included as ore than at 7%, there would only be a 2.5% increase in recovered bitumen. The increased capital and operating costs and impact on tailings handling could not be justified by the small increase in recovered bitumen.

Impact of Clearwater on Reserves

Reserve potential for the two pits was calculated on the basis of the \$10/bbl cost contour line and pit slope angles of 27° in overburden and 45° in ore. As identified earlier, there is potential for the presence of a weak geotechnical zone - the Clearwater Formation. Detailed design of the pitwalls may require flattening the slope angle in particular sections to maintain pit slope stability. This slope flattening could result in a loss of potential reserves.

The potential impact on reserves cannot be stated precisely as the detailed pit slope designs have not been undertaken at this time. An estimate, assuming 60% of the pitwall area is flattened to 11° in the overburden zone, results in the potential loss of about 150 million bbl in-situ bitumen barrels. This amount of reserve loss (about 5%) would have no appreciable impact on the viability of the project. The ultimate pit slopes will be designed to the steepest slope angle that is geotechnically and operationally acceptable.

C2.3 Mining Technology and Mine Plan Options

C2.3.1 Selection of Mining Area

The proposed Project Millennium overall mining layout is shown on Figure C2.3-1, while Figure C2.3-2 presents a topographic map. Figure C2.3-3 presents an aerial photo of the east bank mining areas.

Suncor owned Lease 23 (on the west side of the Athabasca River) was dismissed as a non-viable option in the process of mine site selection leading to development of Steepbank Mine because of insufficient resource to justify a remote desanding plant, a high lease strip ratio and potential for widespread environmental disturbance.

East-side leases form the site of Steepbank Mine and provide the logical supply of ore for Project Millennium. The resources are neighbouring and are sufficient for the proposed rate for about thirty years. The following table summarizes current estimates of east bank resources, with reference to Figure C 2.3-1.

Table C2.3-1 Summary of East Bank Resources

Ore Body	Oil Sand (Mt)	Waste (Mt)	Stripping Ratio (t/t)	Bitumen (wt%)	Years 260 000 bbl/cd Bitumen
North	820	1 220	1.5	11.5	6
Pit 1	480	320	0.7	11.5	8
Pit 2	4 130	5 860	1.4	11.5	29
Total Resource	5 430	7 400	1.4	11.5	36

At this point, the remaining issue becomes how to best develop the east bank resources while integrating efforts with the existing Steepbank Mine plan.

Three options for an additional mine opening were considered.

Option 1: Pit 2 on Lease 25 / Fee Lot 3

This option would see the opening of a second mining area on the east bank in the area of Fee Lot 3. It has been selected for the mine expansion component of Project Millennium and has the following advantages:

- By keeping the expansion close to the existing mine, the area of surface disturbance is less for a longer period of time (because less corridor infrastructure is required initially) than any other option.

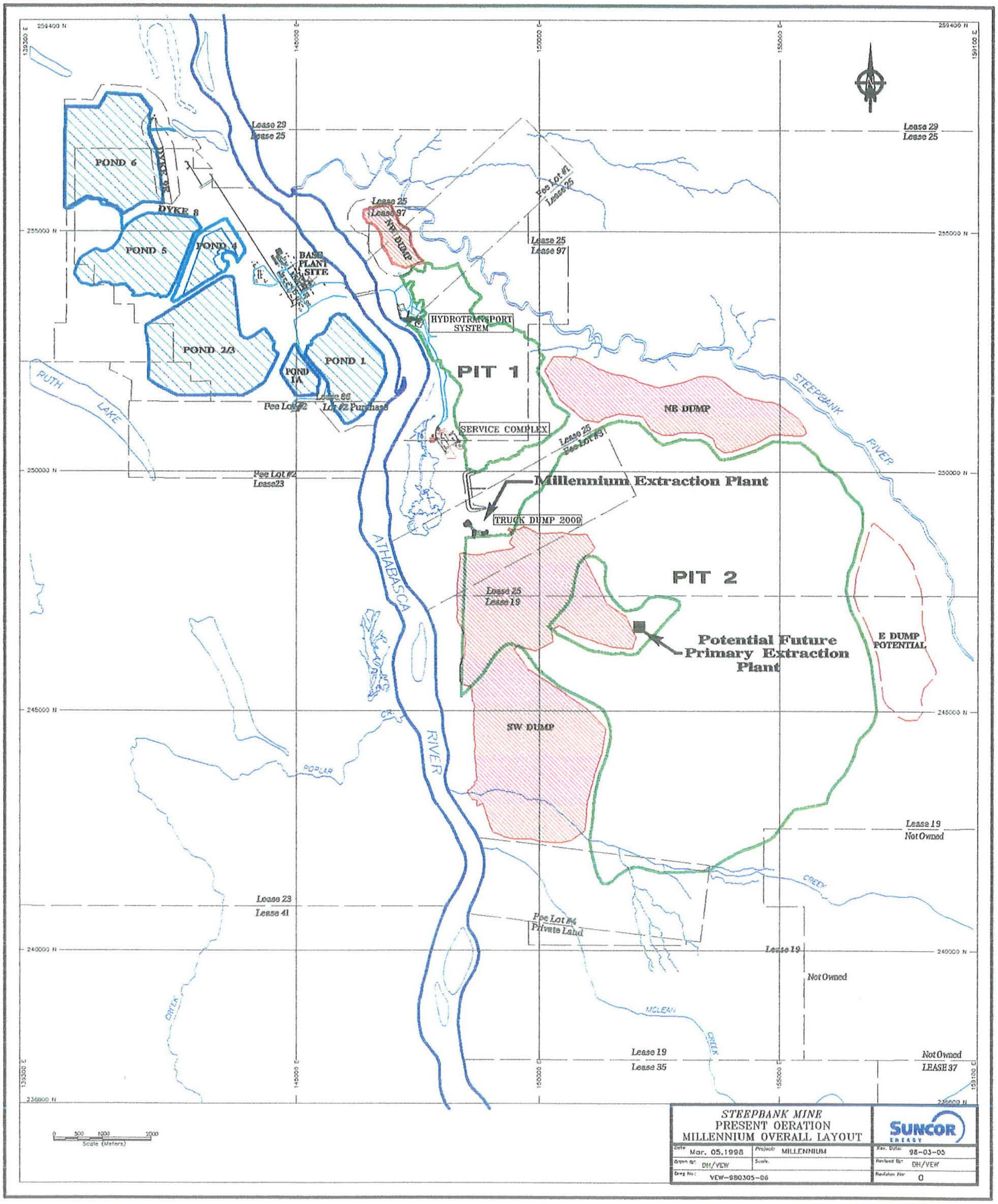


Figure C2.3-1 Millennium Overall Layout

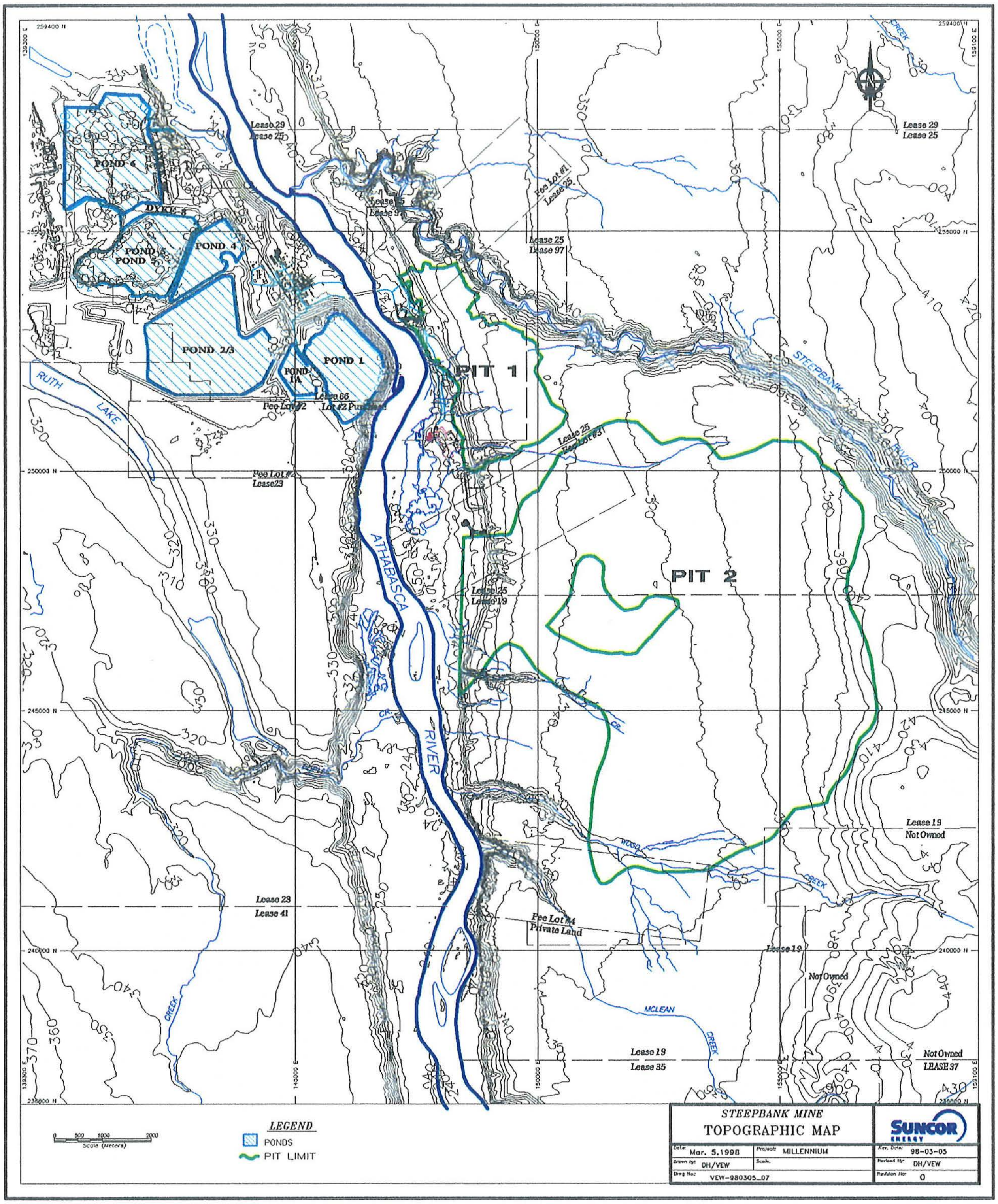


Figure C2.3-2 Topographic Map

Figure C2.3 -3 Aerial Photo of East Bank Mining Area

- Low initial stripping ratio and good bitumen grade make this area economically attractive.

- Minimal depressurization of aquifers would be required near the escarpment.

- Minimal Clearwater formation is expected in the initial mine area.

- Good foundation material for a plant exists in this area.

- Proximity of the two mining areas (initial Steepbank Pit 1 and expansion Pit 2) allows for integration as well as energy and operational efficiencies which will produce lower costs and lower resource requirements with resultant environmental benefits.

Option 2: South End of Pit 2

A separate, stand-alone mining area located at the south end of Pit 2 has been considered. It was concluded that this area was best left for the end of mine life for several reasons:

- If this area was mined first, the extent of disturbed area would be initially larger than for the preferred option.

- Both ore grade and stripping ratio are better in the area of the preferred option.

- Because of the distance from the Steepbank and Lease 86/17 facilities, there is minimal opportunity for integration, resulting in higher initial capital and operating costs.

Option 3: North Ore Body

The option of opening a mine in the ore body north of the Steepbank River was considered. It has the advantage of extending the use of Lease 86/17 and Steepbank facilities because of its close proximity to the existing Base plant.

These resources have been excluded from the Project Millennium plan for the following reasons:

- Life of the available resource is relatively short.
- The stripping ratio is relatively high compared to other options.
- Potential disturbance to the Steepbank River.

These resources are nevertheless significant and will be considered for development in the future.

C2.3.2 Selection of Mining Technology

Technology reviews were conducted in advance of Steepbank Mine plan decisions in 1996. As a result of these reviews, as well as favourable experience in current operations and elsewhere, truck and shovel mining linked to hydrotransport of oil sand to the Base Extraction plant (the existing Extraction plant on Lease 86/17) was selected.

Suncor intends to continue with the Steepbank design for mine expansion and will use identical technology for mining, ore preparation and ultimately hydrotransport as described in Volume 1, Section B of this application. A second primary extraction facility (Millennium Extraction plant) will be constructed on the east bank. Extraction technology selection is discussed in Volume 1, Section C2.5.

C2.3.3 Selection of Plant Location

The Pit 2 mining area will require facilities for ore preparation, primary extraction and support.

Two locations for these facilities have been identified for consideration:

- North (northwest of Pit 2 at elev 260 m ASL)
- Centre (central to Pit 2 on an ore-deficient waste island)

North Location

This location is immediately northwest of Pit 2 (Figure 2.3-1) at elev 260 m ASL and some 1 000 m from the Athabasca River.

Compared to the Centre option, this location has the following advantages:

- It limits the area disturbed for facilities to that which was already included in the Steepbank application.

- It has the lowest initial capital cost due to shorter pipeline and utility routes.

- A portion of the ore haul route to the truck dumps and sizers is downhill, providing initial energy savings and commensurate environmental advantages.

- It is close enough to use an expansion of existing Steepbank infrastructure such as mine shops, offices and change room facilities rather than construction of new facilities.

- Opportunities for lower cost of operation are expected due to proximity to existing Steepbank and Lease 86/17 facilities.

Centre Location

This location (Figure C2.3-1) is in an area above the escarpment devoid of mineable resources. Advantages of this location include:

- The plant would be in the centre of the Pit 2 deposit, resulting in the lowest overall oil sand haulage distances and costs.
- Tailings disposal distances are less than for the North location.
- The new facilities would be out of the river valley.

Disadvantages of this location include:

- higher capital cost
- initial utility corridor is longer
- higher logistics cost

Neither location will sterilize bitumen reserves. While the North plant is within the Athabasca River Valley (in an area previously approved for development), Suncor believes the long-term values of the "Fort McMurray-Athabasca Oil Sands Subregional Integrated Resource Plan" (AEP 1996a) can be satisfied. By retaining treed buffers and setting facilities back from the river shore, visual impact of the mine infrastructure will be minimized. Structures will be removed at the end of mine life (in approximately 2033) and the site will be reclaimed.

On balance, the North location is more attractive to Suncor and therefore is the selected location.

C2.4 Mine Development

C2.4.1 Steepbank Mine Expansion Plan

Introduction

Alberta Energy and Utilities Board (AEUB) and Alberta Environmental Protection (AEP) approval for Suncor's Steepbank Mine was granted in January 1997. Steepbank Mine ore production will replace depleting ore reserves at Suncor's Base plant operation on Lease 86/17.

The proposed Steepbank Mine expansion component of Project Millennium will be located in Pit 2, with the opening cut in the northwest corner of that pit. Initially, Pit 2 ore will be delivered for processing to a new primary extraction facility (Millennium Extraction plant) located near Pit 2, approximately 6 km south of the Suncor Bridge (Figure 2.3-1). Ore and waste removal at both mining areas will be by truck and shovel methods.

Integrated General Mine Plan

Mining on Lease 86/17 started in 1967 and will be completed in 2001. Steepbank ore will be phased with Lease 86/17 to provide plant feed. Steepbank Mine will commence operations in Pit 1 in late 1998. Ore will be transported to truck dumps, where it will be crushed and then conveyed a short distance to rotary drum breakers. In the breakers, ore is mixed with warm water. The resultant slurry is pumped initially to surge storage tanks, and subsequently via three 660-mm-diameter pipelines across the Suncor Bridge to the Base Extraction plant.

Pit 2 operations will commence in 2001. As at Pit 1, ore will be transported to truck dumps where it will be crushed, conveyed a short distance to rotary drum breakers, mixed with hot water and then pumped to the adjacent Millennium Extraction plant for primary extraction of bitumen. Product from the Millennium Extraction plant will be raw bitumen (deaerated bitumen froth), which will be piped across the bridge to the existing Base Extraction (secondary) plant for further processing. Pit 1 and Pit 2 mine equipment fleets will share a common maintenance facility approximately halfway between their respective crushing installations.

When all the ore has been mined from Pit 1 (approximately first quarter 2005), the ore production fleet will be relocated to Pit 2. Prior to the relocation, new crushers will be installed near the Millennium Extraction plantsite. All ore production would then be from Pit 2. One half will be processed by the Millennium Extraction plant and the other half will be conveyed to the Steepbank hydrotransport facility, then pumped across the bridge to the Base Extraction plant.

A major milestone for bitumen extraction will occur in approximately 2012. Because the Base Extraction plant facility will then be too far away from the ore delivery system and the tailings disposal areas, additional primary extraction capacity will be constructed on the east side of the Athabasca River. Raw bitumen will be delivered to the Base Extraction plant for secondary extraction.

Mine Planning Basis

Criteria used in the design of Steepbank Mine are either those used successfully for the existing mine operation or those that have been developed specifically for the new mine. Key mine planning criteria are listed in Table C2.4-1.

Table C2.4-1 Key Mine Planning Criteria

Timeline	
Plan Duration	**1998-2035**
Bitumen Production	
Item	**Criterion**
Bitumen required 1998-2000	160 000 bbl/cd
Bitumen required 2001-2033	260 000 bbl/cd
Overall bitumen recovery	92.5%
Ore stream capacity 1998-2000	8 100 t/ch
Ore stream capacity 2001-2025	16 500 t/ch
Ore stream capacity 2026-2033	18 000 t/ch
Orebody and Pit Design	
Minimum ore grade	7 wt%
Minimum thickness of recoverable oil sand	3 m
Minimum thickness of interburden removed	3 m
Dilution of ore	0%
Mining recovery	100%
Pitwall overburden slope angle	27°
Pitwall ore slope angle	45°
Bench height (nominal)	15 m
Safety berms: overburden toe to ore crest	30 m
: every second ore bench	10 m

Clearing and Drainage

Clearing and stockpiling of commercial timber as well as muskeg removal in the area of Pit 1 opening cuts began in 1997.

Surface topography in the Pit 1 area is naturally drained so very little pre-drainage is required. At Pit 2, surface topography is similar to Pit 1 but with more muskeg, and the initial mine area is naturally drained. Around the Pit 2 mining area as well as and the external waste and tailings disposal areas to the south of the mine, drainage patterns will be established utilizing existing seasonal drainage gullies.

Surface soils will either be stockpiled for reclamation purposes or applied directly to areas undergoing reclamation.

Recognition of Other Interests

Certain other parties have rights and interests in the area of Steepbank Mine. Suncor acknowledges these interests and has held discussions with each party to accommodate their interests, particularly with respect to timely access to exercise their interests. These interests are:

- Alberta-Pacific Forest Industries Inc. rights to commercial pulpwood
- Northland Forest Products rights to commercial timber in parts of the mine area
- Birch Mountain rights to minerals underlying oil sands deposits in the mine area
- Province of Alberta with respect to gravel. Suncor will develop a gravel management plan to conserve the resource as appropriate.

Suncor is aware that several gravel operators have applied for surface rights dispositions in the proposed development area. Suncor will hold discussions with those parties.

Overburden Removal

Table C2.4-2 shows projected annual production of waste and ore for the Mine while Table C2.4-3 presents the proposed disposal location schedule for waste material. Scheduling of overburden removal is based on up to six months lead time to mining of ore. Amounts of waste material required for dyke construction are approximately 40% for Pit 1 and 50% for Pit 2. Waste material too unstable for placement on dumps or dykes is scheduled for in-pit disposal. Table C2.4-3 includes about 9 Mt of muskeg which is stockpiled for reclamation needs.

Pit 1 Overburden

Overburden pre-stripping at Pit 1 began in fourth quarter 1997. Muskeg is being stockpiled for future reclamation of the waste dumps and in-pit dykes. Suitable pre-strip material will be used for road construction while the remainder will be placed in the Northwest Dump (Figure C2.3-1). All waste material will be placed in the Northwest Dump through 2002. As sufficient area becomes exposed in the mined-out bottom of Pit 1, waste material will apportioned between the Northwest Dump and the in-pit tailings impoundment Dyke 10. Waste excavation and disposal will continue in Pit 1 through approximately 2004, then waste removal shovels and trucks will be relocated to Pit 2.

Pit 2 Overburden

Overburden pre-stripping will begin at Pit 2 in the second quarter 2001. Some pre-strip waste will be hauled to the external tailings disposal site, immediately south of the initial mine excavation area (Figure C2.3-1). Waste

Table C2.4-2 Materials Handling Schedule - Mtonnes

	Total Waste				Ore			
Year	**L86/17**	**Pit 1**	**Pit 2**	**Total**	**L86/17**	**Pit 1**	**Pit 2**	**Total**
1998	22 121	23	0	22 144	59 222	7 492	0	66 714
1999	14 921	24	0	14 945	45 879	47 107	0	92 986
2000	7 498	25	21	7 544	48 591	45 878	0	94 469
2001	3 813	36	28	3 877	29 975	59 706	15 298	104 979
2002		59	39	98		95 530	53 345	148 875
2003		66	67	133		89 319	54 228	143 547
2004		63	61	124		86 872	53 914	140 786
2005		27	95	123		44 666	92 723	137 389
2006			178	178			133 583	133 583
2007			222	222			137 655	137 655
2008			215	215			141 890	141 890
2009			177	177			133 759	133 759
2010			210	210			142 651	142 651
2011			199	199			142 667	142 667
2012			203	203			142 322	142 322
2013			189	189			135 763	135 763
2014			198	198			142 066	142 066
2015			246	246			141 996	141 996
2016			238	238			136 331	136 331
2017			202	202			132 600	132 600
2018			194	194			140 411	140 411
2019			271	271			139 922	139 922
2020			240	240			143 819	143 819
2021			194	194			131 692	131 692
2022			196	196			137 157	137 157
2023			196	196			137 495	137 495
2024			196	196			138 185	138 185
2025			196	196			133 394	133 394
2026			196	196			139 548	139 548
2027			196	196			139 337	139 337
2028			196	196			144 676	144 676
2029			196	196			143 368	143 368
2030			196	196			150 029	150 029
2031			196	196			145 942	145 942
2032			196	196			147 458	147 458
2033			16	16			82 296	82 296
Total	**48 353**	**323**	**5 862**	**54 538**	**183 667**	**476 570**	**4 127 523**	**4 787 760**

Table C2.4-3 Overburden Disposal Schedule - Mtonnes

Year	Dyke 11a	Dyke 11b	Dyke 11	Dyke 11c	Dyke 12	Dyke 14	Dyke 15	Dyke 16	Pond 8a	Pond NE	Pond 8	Pond 9	Pond 10	Pond 11	Pond 12	Total
2000	10.0								11.0							21.0
2001	8.6								19.3							27.9
2002	9.4	9.4	7.5						12.6							38.9
2003	9.4	9.4	27.1						21.3							67.2
2004	3.8		37.5						0.1		19.4					60.8
2005	3.7		48.8	12.3					0.1		30.4					95.3
2006	3.7		39.2	37.3	18.7				22.6		56.8					178.3
2007			39.2	46.7	9.3					34.4	92.3					221.9
2008						9.3				41.9		163.7				214.9
2009						18.6						158.7				177.3
2010						37.2						172.5				209.7
2011						46.6						152.1				198.7
2012						46.6						156.8				203.4
2013						48.5	37.3						103.5			189.3
2014							74.5						124.0			198.5
2015							74.5						171.7			246.2
2016							74.6						162.9			237.5
2017							74.6						127.2			201.8
2018							74.6						119.8			194.4
2019							74.6						196.6			271.2
2020							55.9	18.6						165.2		239.7
2021								65.3						128.3		193.6
2022								65.4						130.2		195.6
2023								65.4						130.2		195.6
2024								65.4						130.2		195.6
2025								65.4							131.0	196.4
2026								65.4							131.0	196.4
2027								65.4							131.0	196.4
2028															196.4	196.4
2029															196.4	196.4
2030															196.4	196.4
2031															196.4	196.4
2032															196.4	196.4
2033															16.0	16.0
Total	48.6	18.8	199.3	96.3	28.0	206.8	540.6	476.3	87.0	76.3	198.9	803.8	1 005.7	684.1	1 391.0	5 861.5

will be used to construct a berm for tailings lines, access roads and a containment starter dyke for the deposition of Millennium Extraction plant process tailings.

For the initial three to four years of mining, waste will be trucked to the Dyke 11a area. When sufficient space is made available in the Pit 2 mine bottom, waste interburden and overburden will be used to construct the tailings in-pit impoundment Dyke 11, creating Pond 8.

Most of the waste not required to construct Dyke 11 will be placed in the Dyke 11a area, maximizing the space available in Pond 8 for tailings and minimizing the size of the external tailings pond. After Pond 8 is established, most of the waste from the remainder of Pit 2 will be placed in-pit, either on dumps or used to construct tailings impoundment dykes

Oil Sands Mining

Mining of oil sands is scheduled to begin at Steepbank Mine (Pit 1) in late 1998 and at Pit 2 in third quarter 2001. Experience gained from Steepbank Pit 1 will guide the Pit 2 expansion operation, and full production rates are expected prior to the end of 2001.

The mine plan progression is discussed in the sections that follow. Figures C2.4-1 to C2.4-12 illustrate mine development (also tailings placement) for the first six years and for milestone events thereafter.

Pit 1 Mining: 1998 to 2005

Excavation of Pit 1 oil sand ore will begin in an area immediately east of the Steepbank truck dump. From 1998 through 2002, mining will be extended along the length of the Pit 1 escarpment. This initial sequence will maintain a high average ore grade through ore blending, and will also expose the pit floor for early construction of in-pit tailings impoundment Dyke 10. The majority of Pit 1 ore will be hauled to the Steepbank truck-dump and ore-preparation facility (some may be hauled to Pit 2 on an opportune basis) over a period of approximately six years through to first quarter 2005.

Pit 2 Mining: 2001 to 2005

Pit 2 ore production will begin in third quarter 2001. Excavation will initially take place along the escarpment immediately south of the Millennium plant area and then mining will proceed east into the escarpment. This opening sequence results in a low startup strip ratio and will also expose the western edge of Dyke 11 footprint early, by about 2002. Ore excavation will then progress eastward.

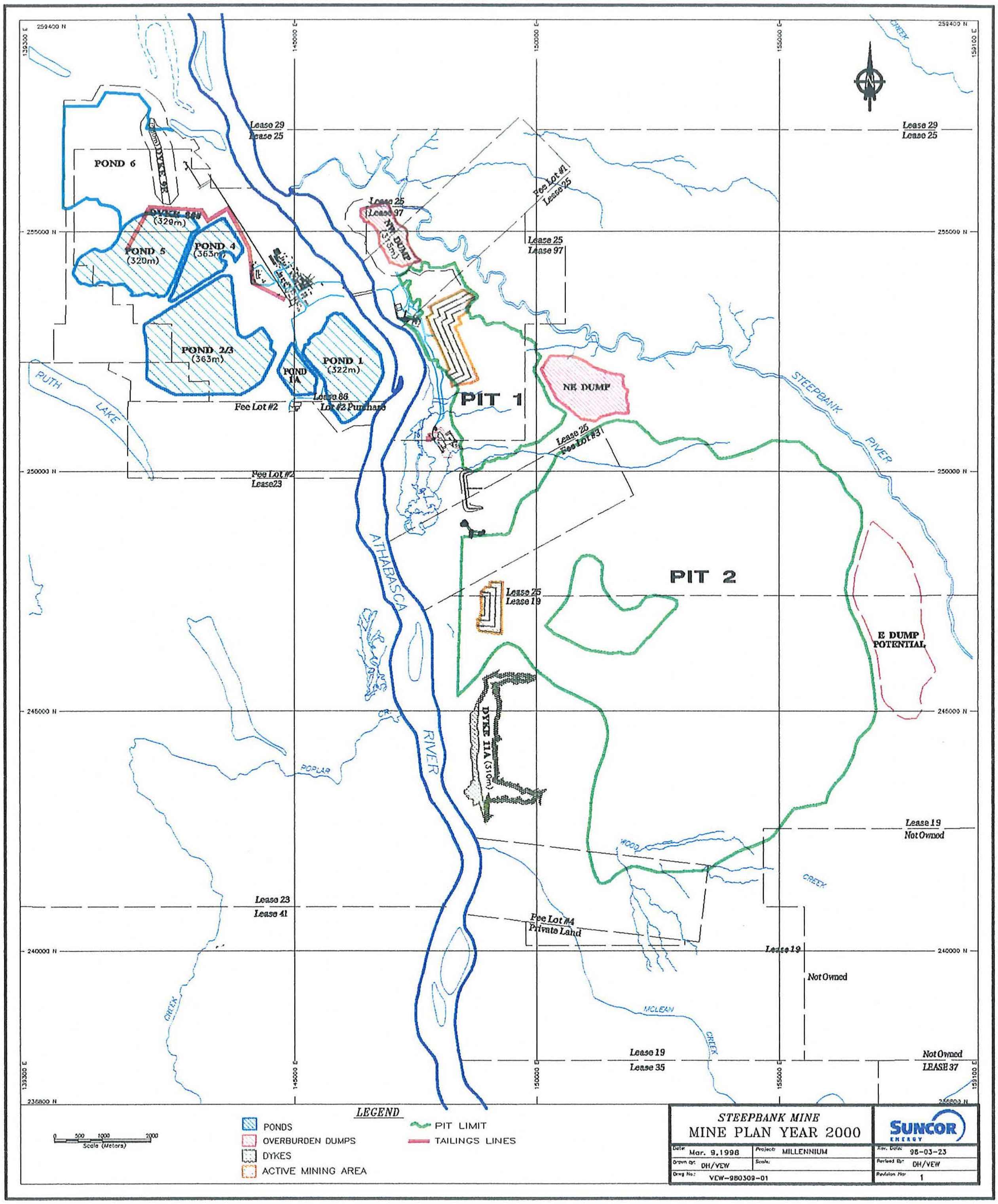


Figure C2.4-1 Mine and Tailings Plan Year 2000

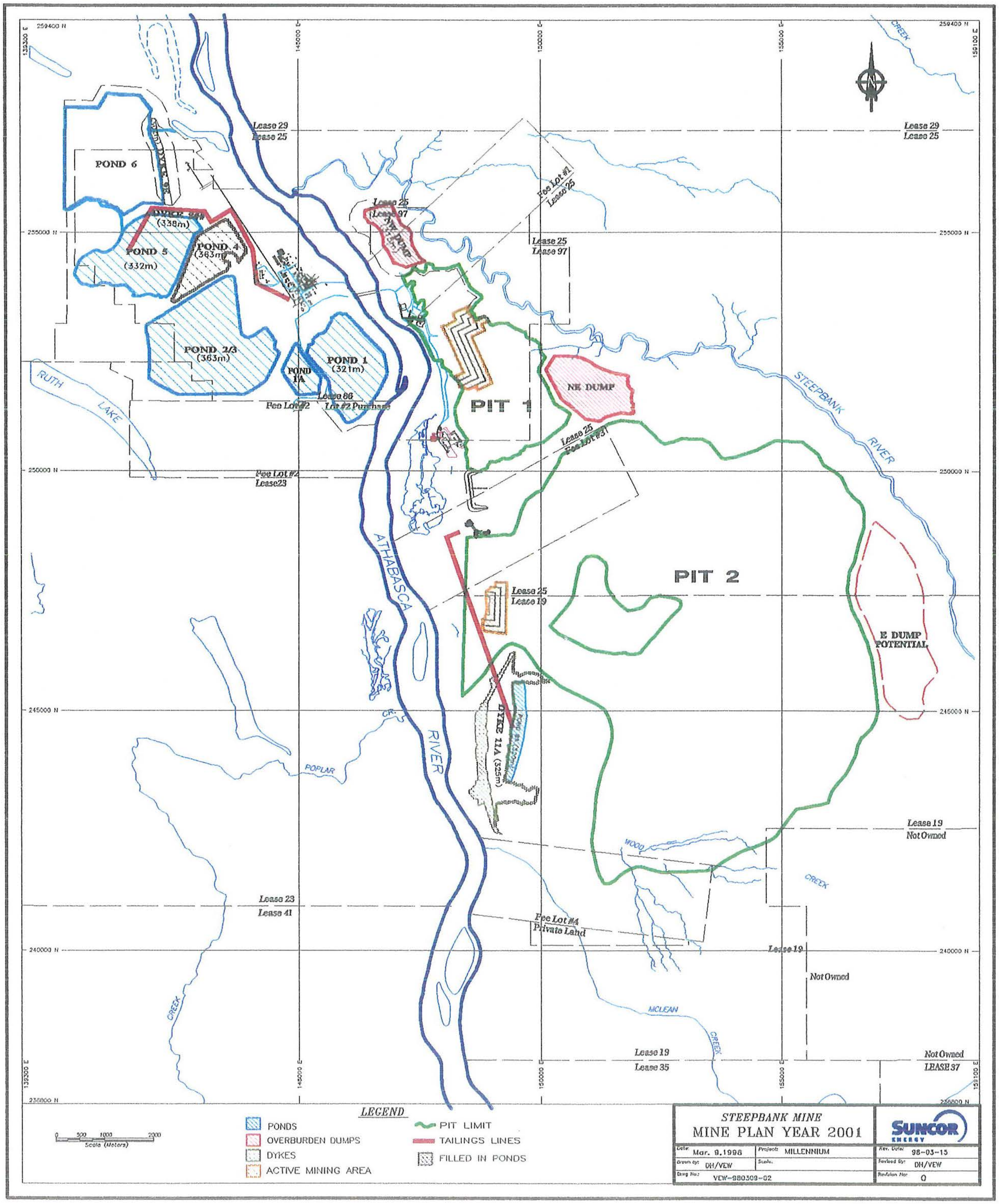


Figure C2.4-2 Mine and Tailings Plan Year 2001

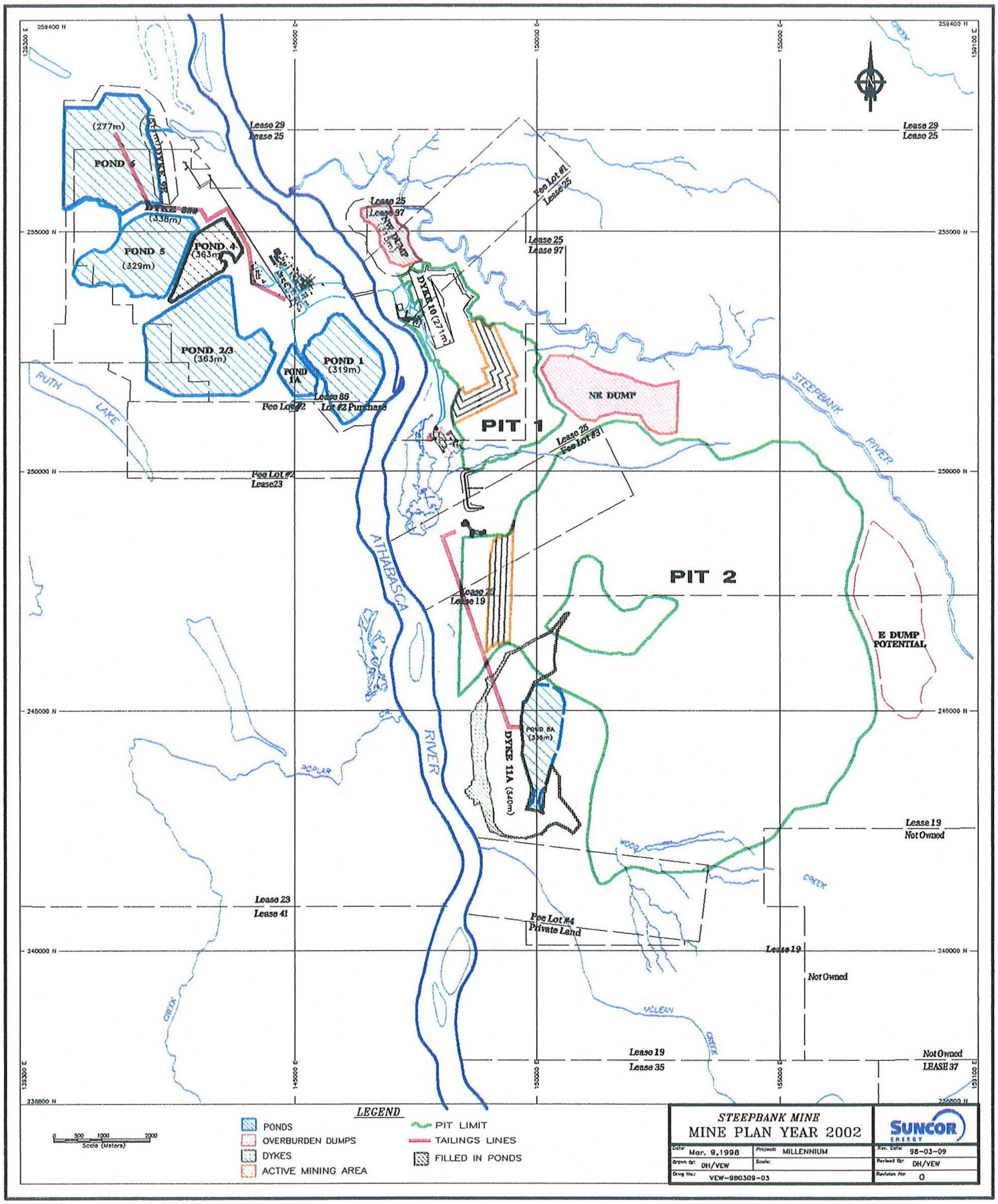


Figure C2.4-3 Mine and Tailings Plan Year 2002

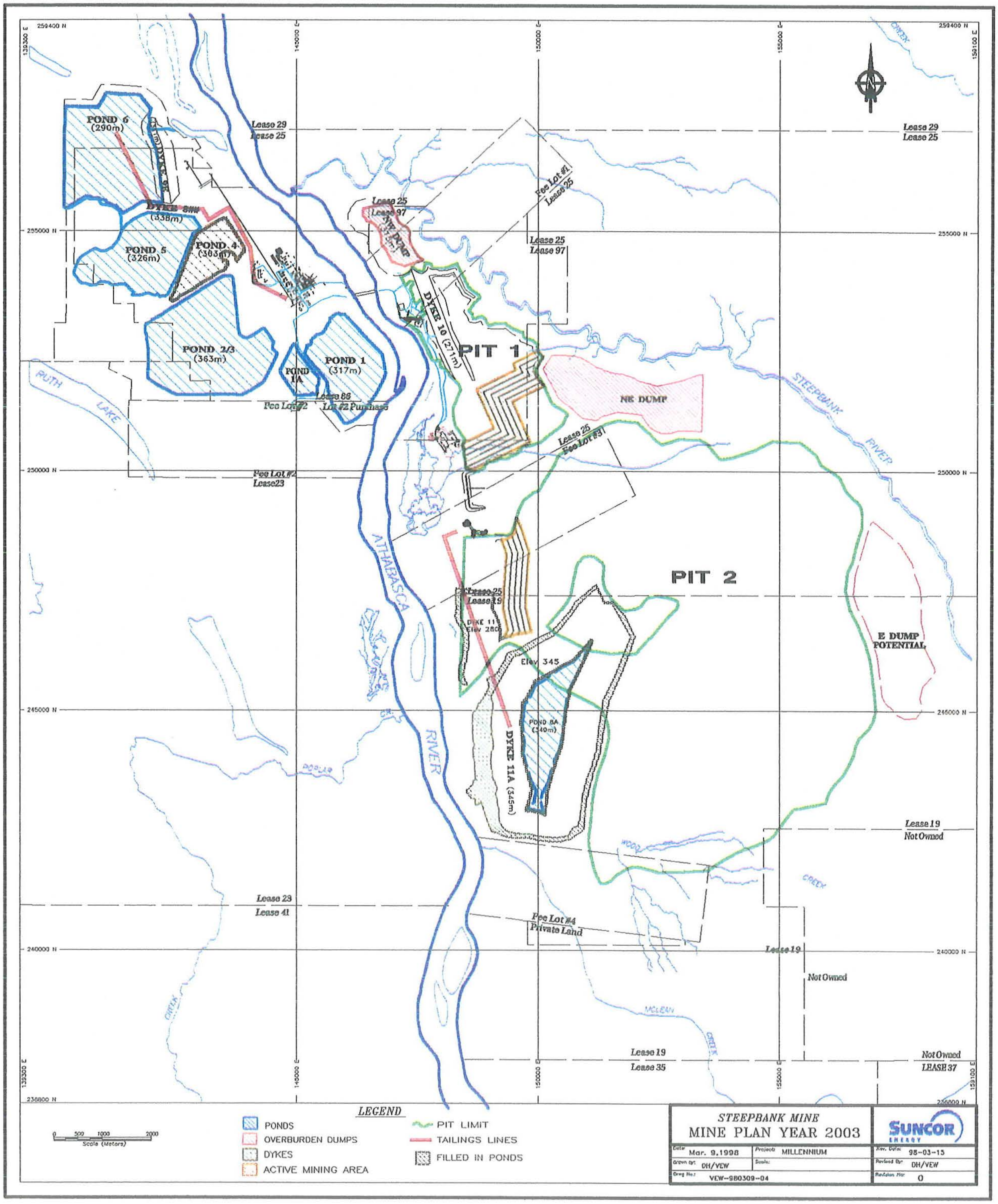


Figure C2.4-4 Mine and Tailings Plan Year 2003

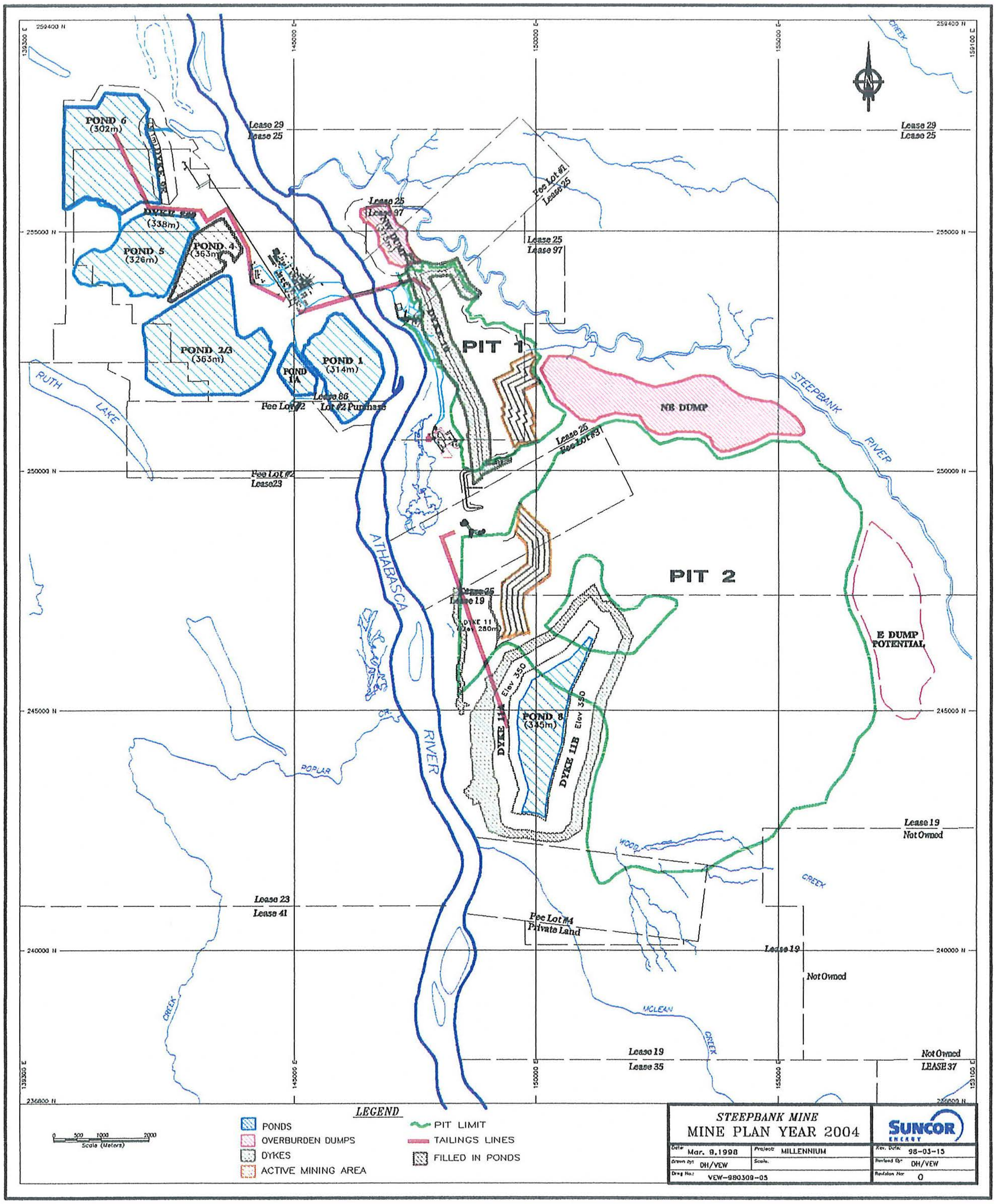


Figure C2.4-5 Mine and Tailings Plan Year 2004

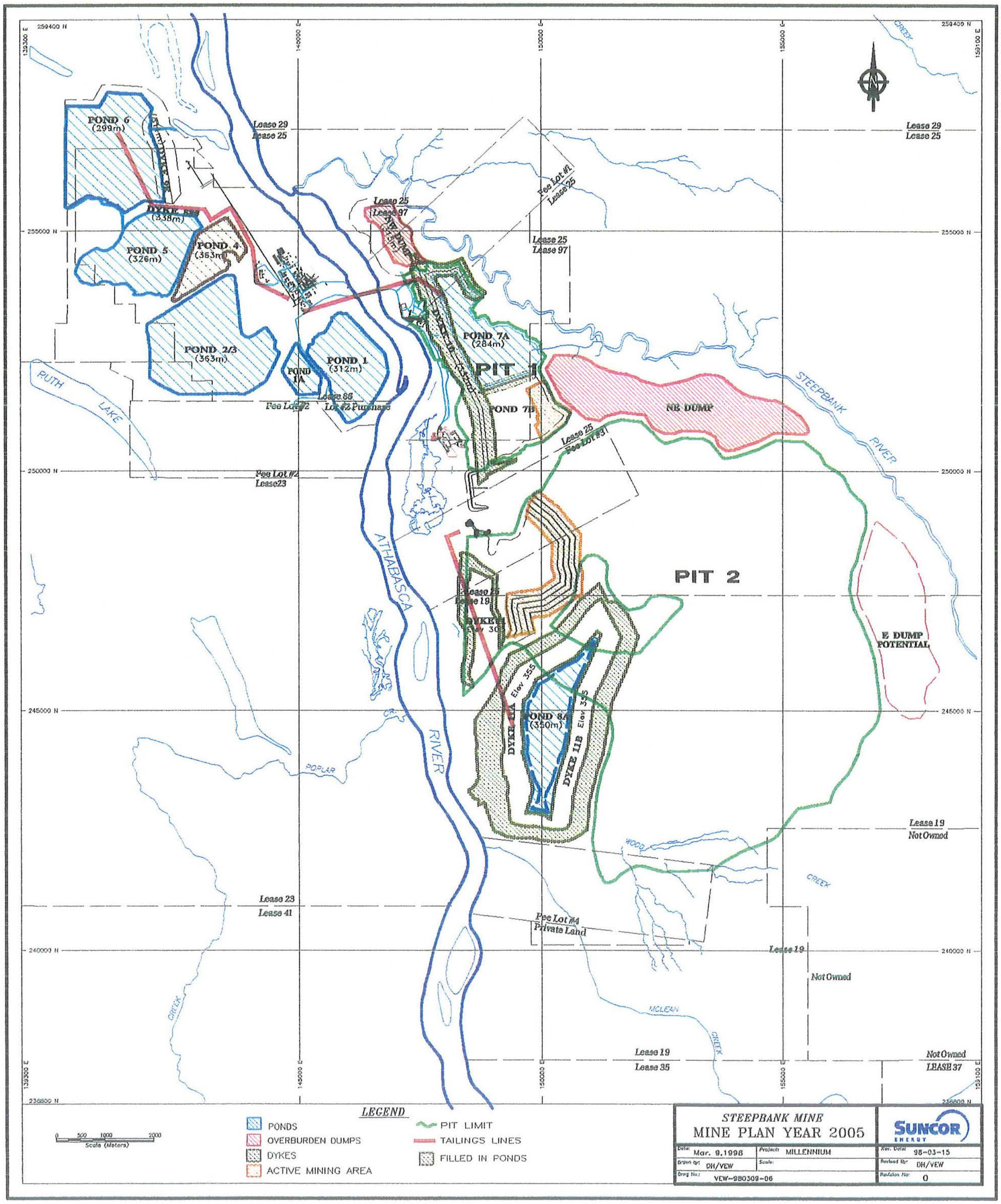


Figure C2.4-6 Mine and Tailings Plan Year 2005

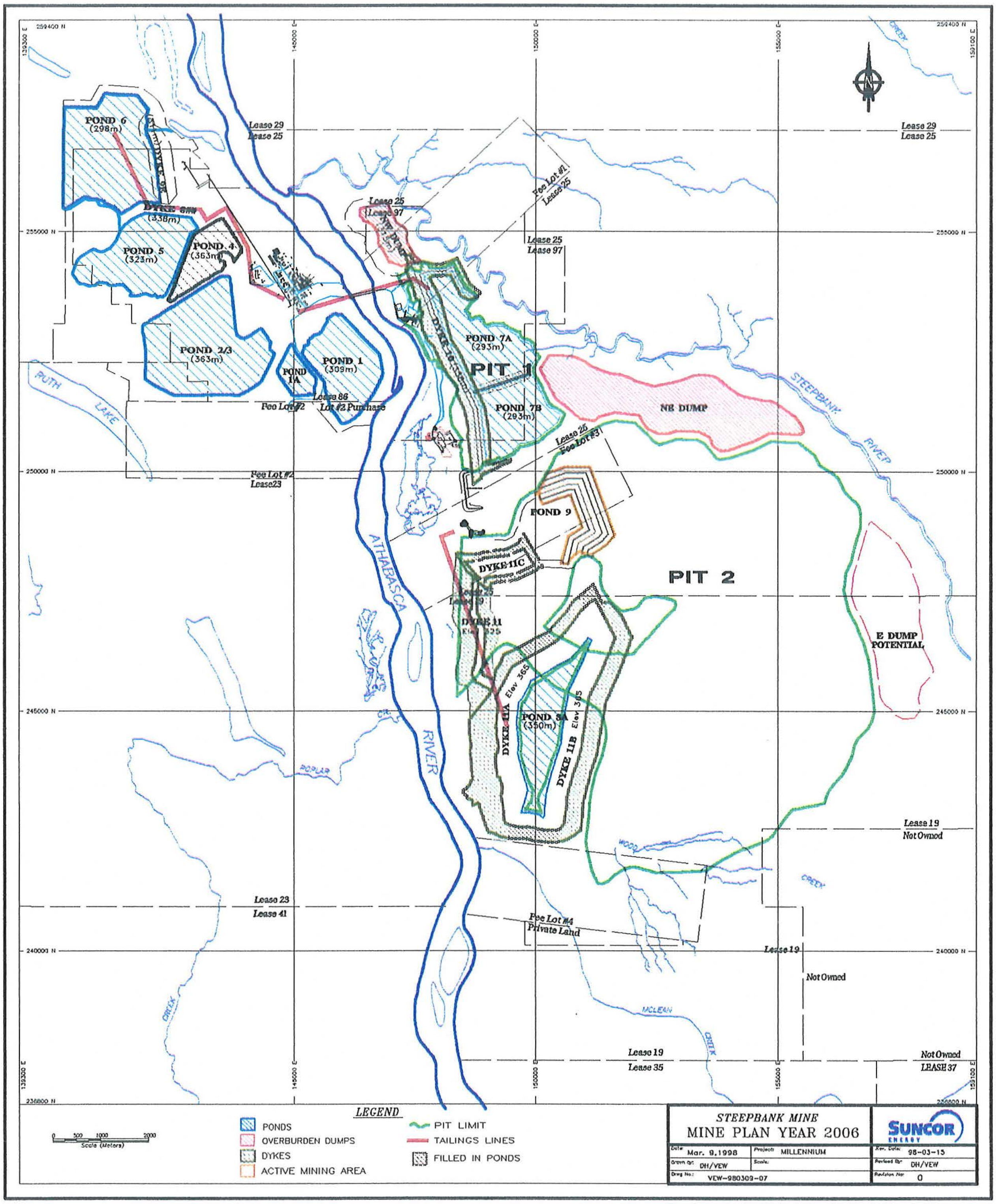


Figure C2.4-7 Mine and Tailings Plan Year 2006

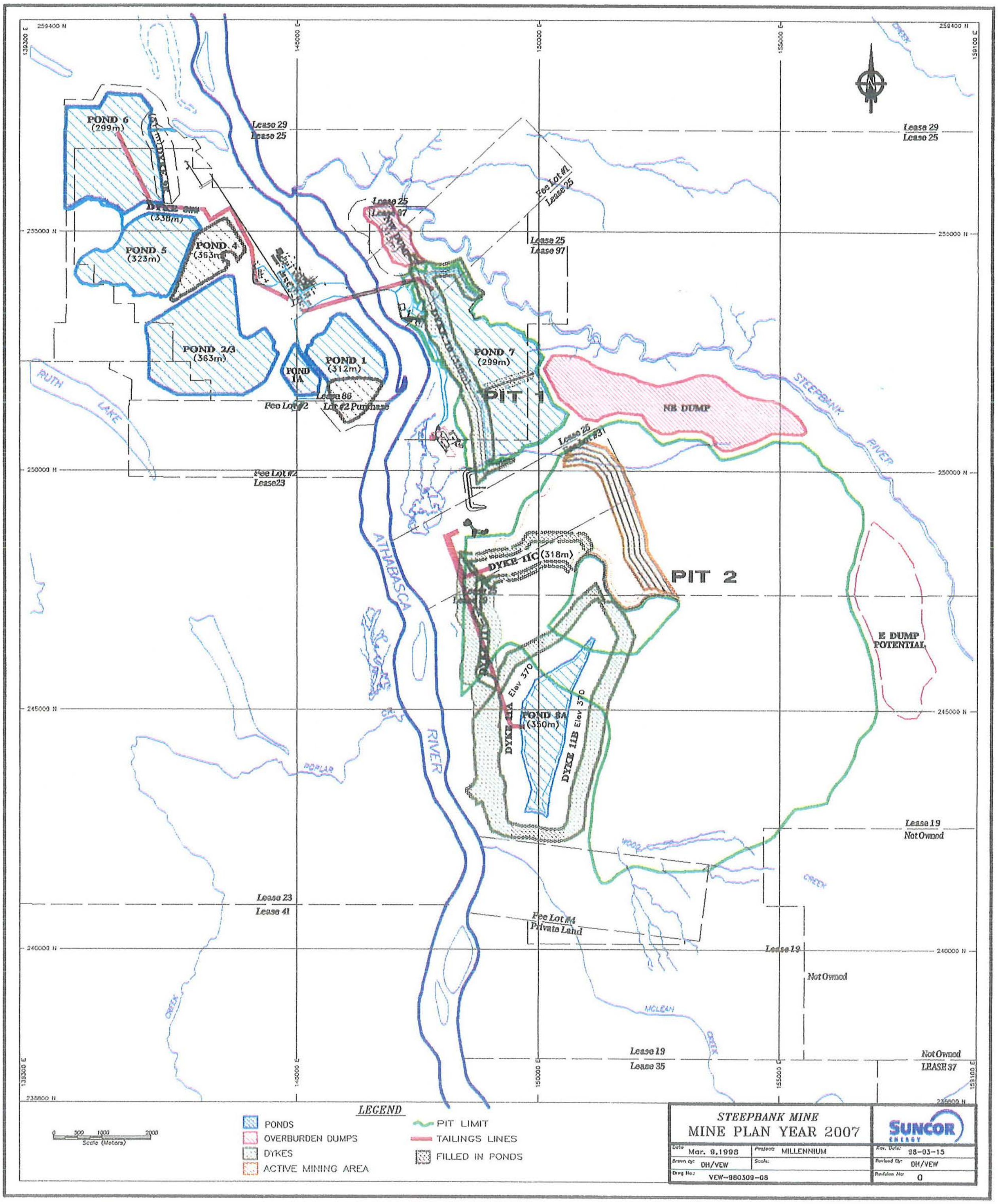


Figure C2.4-8 Mine and Tailings Plan Year 2007

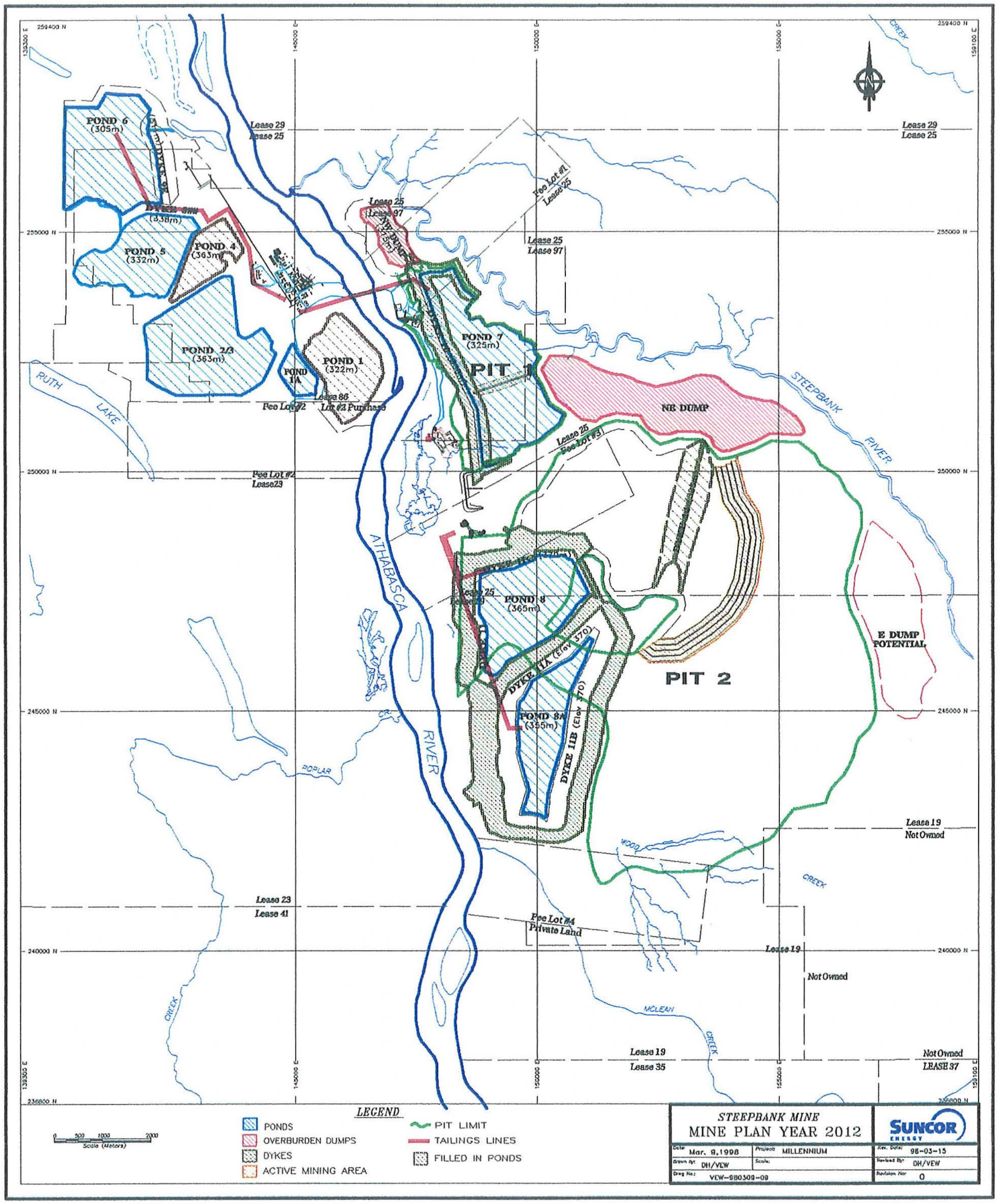


Figure C2.4-9 Mine and Tailings Plan Year 2012

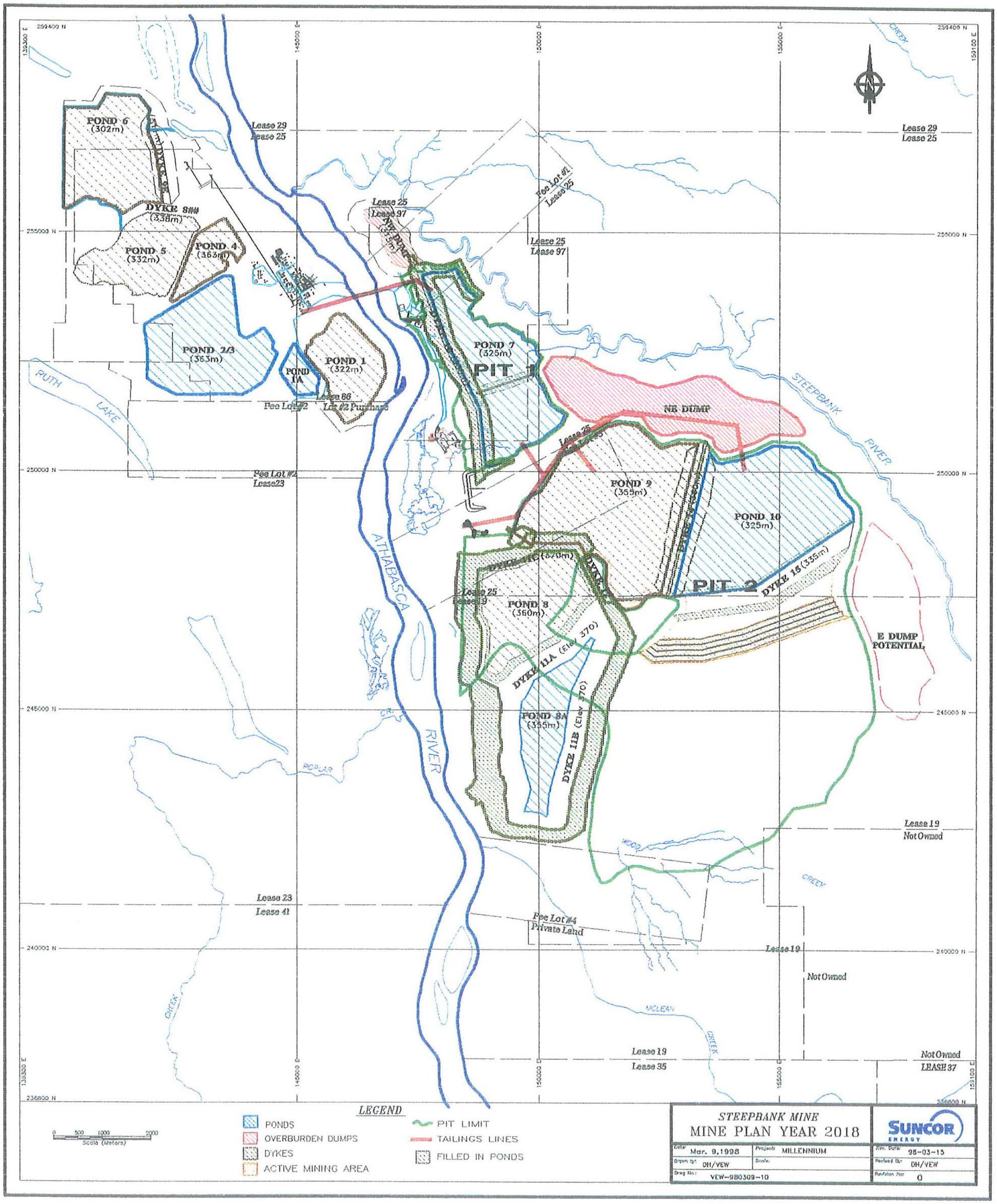


Figure C2.4-10 Mine and Tailings Plan Year 2018

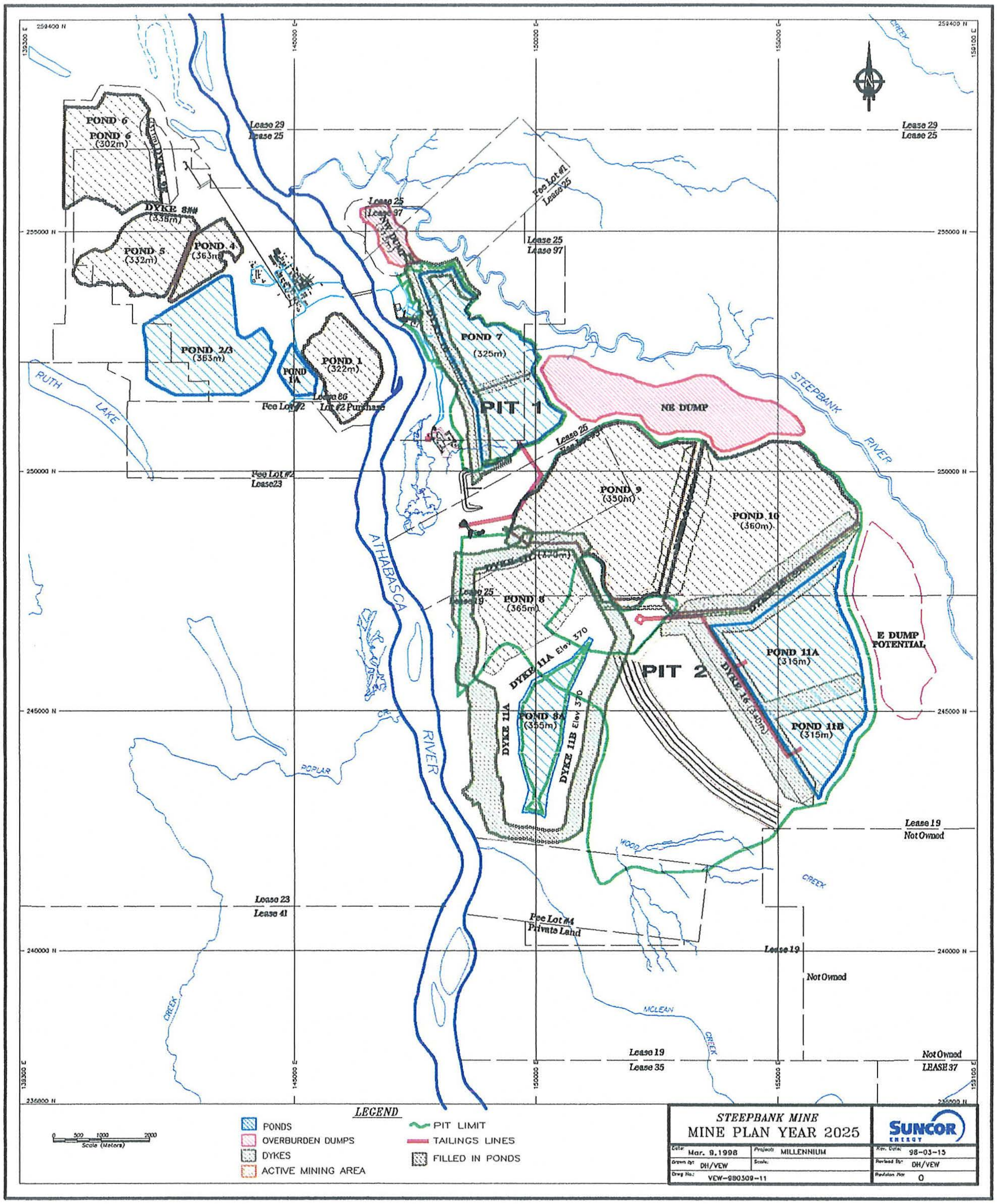


Figure C2.4-11 Mine and Tailings Plan Year 2025

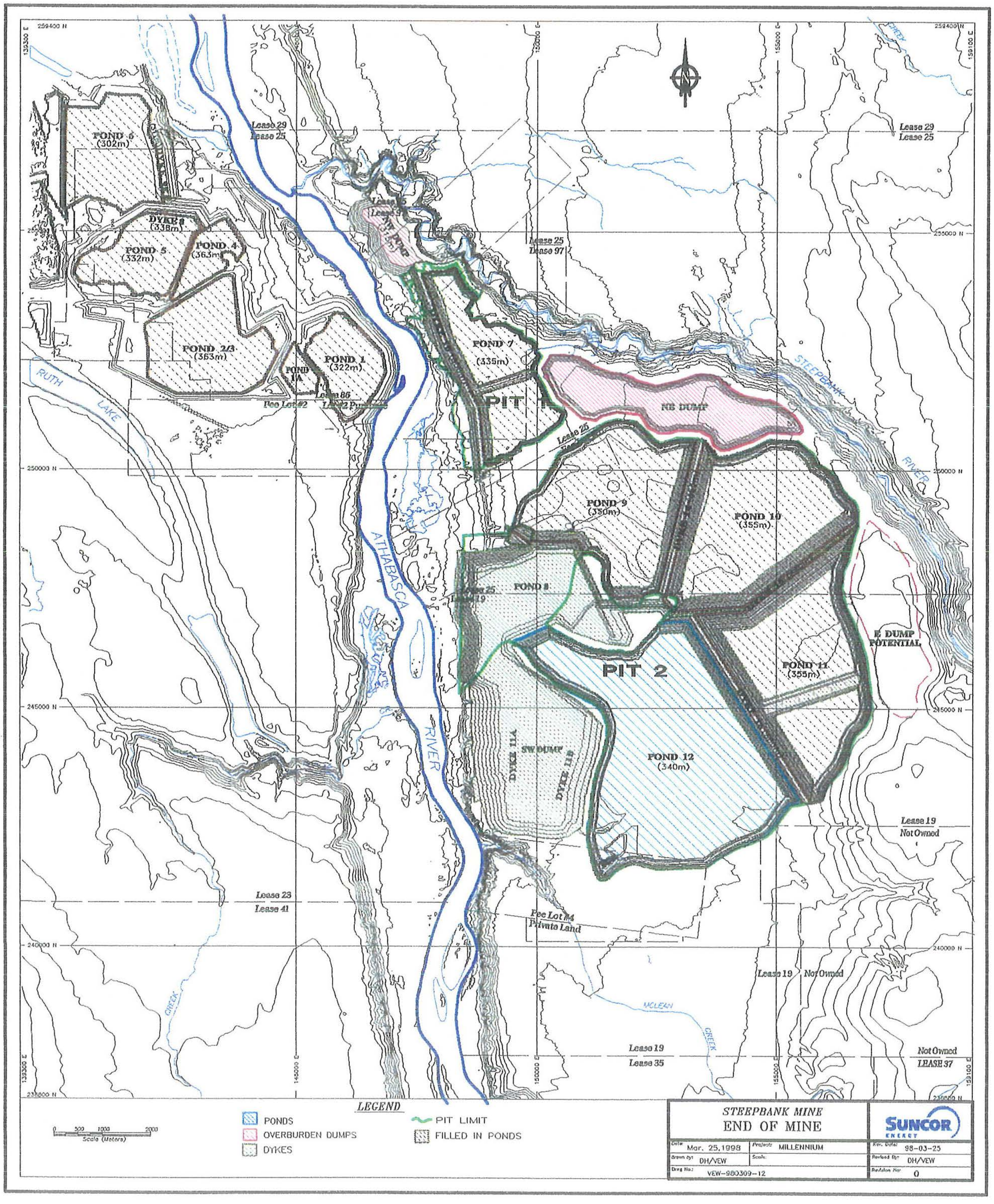


Figure C2.4-12 Mine and Tailings Plan End of Mine

Pit 2 Mining: 2005 to 2011

By early 2005, all ore in Pit 1 will be depleted and the ore excavation fleet will be relocated to Pit 2. Prior to this relocation, a truck-dump and two crushers will be installed near the two Pit 2 crushers. These crushers will continue to supply the Steepbank Ore Preparation plant by means of a twinned, two-flight, 5-km-long conveyor system. The crusher facility will also be equipped with a short, telescopic conveyor which will allow ore to be delivered either to the Steepbank Ore Preparation plant or the Millennium Extraction plant.

During this period, tailings deposits will begin into Pond 8. Access from the mine face to the Pit 2 truck-dump and crushers will be by a main haul road established between the north pitwall and Tailings Pond 8. Mining will continue eastward into Pit 2.

Pit 2 Mining: 2012 to 2030

Mining and Ore Preparation Facilities: Centre Plant

As the mine face continues to advance in a southeast clockwise direction through Pit 2, it is projected that truck-dumps and crushers must be relocated closer to the active mining area, due to long ore haul distances and in-pit dyke construction. The truck-dumps and crushers will be relocated to a site on the waste island near the centre of Pit 2. Disassembly and relocation of Millennium plant crushers will be staged over a period of time and could include early installation of a surplus crusher from Lease 86/17.

An additional mine equipment maintenance shop, change rooms and offices will be constructed at the Centre Plant location.

The precise timing of this reconfiguration of facilities will be determined on the basis of economics at the time but the current best estimate is about 2012. After the new Centre location crushers are established, mining in Pit 2 will continue east, then clockwise around the Centre Plant location until the ore in Pit 2 is completely mined.

Additional Primary Extraction Capacity: Millennium Extraction Plant or Centre Location

Coincident with the relocation of the Pit 2 truck-dumps and crushers to the Centre Plant location, there will be a requirement for new primary extraction capacity on the east side of the Athabasca River. Base plant primary extraction capacity will have to be replaced for the following reasons:

- The hydrotransport distance from the Centre location truck-dumps and crushers to the existing Base Extraction plant on Lease 86/17 will be over 11 km, beyond the practical limit for hydrotransport of ore.

- By 2012, Pond 7 (Pit 1) will be filled to capacity with Base Extraction processed tailings and future tailings would have to be pumped over 10 km to Pond 9 (an additional 5 km beyond Pond 7).

There are two possible locations for this new primary extraction plant capacity:

- at the Centre location (waste island) near the truck-dumps and crushers
- at the Millennium Extraction plant location

The Centre location has the following advantages over the Millennium plant location:

- Only half of Pit 2 ore would be hydrotransported to the Millennium plant location (as opposed to all), saving energy.

- Disposal of Centre location tailings (half of total tailings) would be downhill and disposal distance over the remaining life of the mine would not change.

- Much of the infrastructure and utilities (power, slurry water) are required in any case for the Centre location crushers and ore preparation facilities.

The Millennium plant location would have the following advantage over the Centre location:

- Operating efficiencies would be realized from shared primary extraction facilities in one physical location.

Suncor believes at this time that the most appropriate location of the required additional primary extraction capacity is the Centre plant. Suncor will make the final location decision at the appropriate time (in advance of 2012) on the basis of current information.

Regardless of location, construction of the new bitumen extraction facility will result in the decommissioning of most of the facilities at the Steepbank Ore Preparation Plant and Maintenance Complex, except for pipeline and pumping equipment, which will then be used for bitumen froth transport.

Rehandle of External Tailings Pond

The external tailings pond has been sited in an area which covers 77 million bbls of recoverable bitumen. A portion of the pond will be removed prior to the end of mining to allow the recovery of the ore. Justification for this pond site is discussed further on in this section.

By 2027 all fluids that had been stored in the external pond (Pond 8a) will be withdrawn, as MFT for use in making CT, to the active recycle pond or to Pond 12 for ultimate storage in the end pit. A portion of the remaining solids, sand and overburden, will be rehandled into the interior of Pond 8a to expose the ore below. A total of 137 Mm^3 of material will be moved, comprised of 19.2 Mm^3 tailings sand, 2.8 Mm^3 overburden starter Dyke 5 Mm^3 CT, and 110 Mm^3 of insitu overburden. The design slopes for this excavation have been assumed at 3H:IV (three horizontal units to one vertical unit).

Tailings Disposal and Pond Management

This section discusses pond development and management with reference to Figures C2.4.1-1 to C2.4.1-12.

Integrated Plan

Lease 86/17 and Steepbank tailings disposal will be integrated to optimize the use of available capacity.

Base Extraction tailings will continue to be placed in Lease 86/17 ponds until Pond 7 in Steepbank Mine Pit 1 becomes available in 2005. Pond 2/3 will continue to be used as a recycle water pond throughout. During the period 2005 through approximately 2012, three 610-mm-diameter tailings lines will cross the Suncor Bridge, transporting Consolidated Tailings (CT) for disposal from Base Extraction plant to Pond 7. Released water from the Pond 7 CT deposit will be pumped back across the bridge to the Base plant by means of a 760-mm-diameter water return pipeline.

Millennium Extraction plant tailings will temporarily be deposited as conventional tailings, beaching sand and storing MFT (the methodology used prior to CT technology) in an external tailings pond (Pond 8a) approximately 5 km south of the plant. Subsequently, Millennium Extraction plant tailings will be deposited as CT tailings in Pond 8 when it becomes available in 2007. The fine tailings temporarily deposited in the external tailings pond will be reclaimed and deposited as CT in Pond 8 starting in 2007.

When the next primary extraction facility is commissioned on the east side of the river (in about 2012) all process tailings created will be disposed into in-pit ponds (Pit 1 and Pit 2), as CT tailings.

One external tailings pond, located 5 km south (Figure 2.3-1) of the Millennium Extraction plant, will be established for the storage of both MFT and regular tailings from the Millennium Extraction Plant. Consolidated Tailings will be stored in Pond 8 as soon as sufficient inventory of MFT has been developed in the external pond and space is available in the pit. Five major ponds will be established in the mined-out pits. Other than the external pond (designated Pond 8a and impounded by Dykes 11a and 11b), nomenclature for dykes and ponds at the Millennium operation will continue the present sequence. These ponds will contain consolidating tailings and water released in the process of consolidation.

Pit 2: External Pond

When Project Millennium comes on stream, the total amount of tailings will be 2.5 times the current amount. Insufficient storage capacity is available to accommodate that amount in the existing ponds, nor can in-pit storage be created fast enough. In addition, due to the lack of MFT on the east side of the river, CT cannot be made from the onset. Hence, an external pond is required, both to store tailings, and to create an inventory of MFT. An external tailings pond located close to the Millennium extraction plant has been chosen as the most viable option.

Numerous other options were considered including:

- A three-sided pond abutting the natural topography in a location 15 km southeast of the Millennium Extraction plant. This option was rejected because of increased environmental disturbance as well as very high capital and operating costs.
- A large overburden storage facility tied into a four-sided tailings pond located over 10 km to the south of Millennium Extraction plant was also rejected due to cost, as well as the resulting amount of surface disturbance and the impact on drainage creeks in the area.
- Various mechanical methods of thickening tailings including paste technology and Deep Cone Thickening. Both were rejected at this stage due to cost and technology risk.
- Initiating CT from the outset at Millennium Extraction plant by utilizing Lease 86/17 MFT inventory. This was rejected due to difficult logistics and high cost.
- An external pond enclosed entirely with overburden. This was deemed to be prohibitively costly as it would involve a minimum 8 km uphill haul.

It was concluded that the most affordable and achievable design with the least environmental disturbance is the establishment of a conventional tailings pond just south of the Millennium Extraction plant. This pond will be operated as follows:

- 2000: start construction of overburden starter dyke
- 2001: start storage of conventional tailings

- 2007: cease deposit of conventional tailings, start MFT withdrawals
- 2001-2014: deposit cyclone overflow (fine tailings)
- 2018-2027: withdraw MFT inventory
- 2027: commence filling

Pit 2 Tailings Disposal: Ponds 8 to 11

Pond 8 will eventually be enclosed by two major dykes: Dyke 11 (parallel to the Athabasca River, enclosing the pond to the west) and Dyke 12 (to the east). Construction on Dyke 11 will begin in 2002, as soon as the footprint has been established. Dyke 11c will run east-west between Dyke 11 and Dyke 12. The three dykes will form an inverted horseshoe abutting the central waste hub of the ore body.

As mining progresses clockwise around the hub, a process of establishing major dykes and minor intermediate dykes will continue as required, together with backfilling established ponds with CT and waste overburden. The last dyke to be constructed is forecast to be Dyke 16, to establish Pond 12. This pond is forecast to be the last tailings pond required for the operation.

The approximate timing for each pond to actively receive CT is as follows:

- Pond 8, from 2007 to 2012
- Pond 9, from 2012 to 2017
- Pond 10, from 2017 to 2022
- Pond 11, from 2022 to 2032
- top-up all ponds from 2027 to 2033
- Pond 12, from 2023 to 2033

A total of 450 Mm^3 of fine tails will be generated during the life of the Steepbank Pit 2 operation. Although placement of CT is not forecast to begin until 2007, over 95% of the fine tails will be completely incorporated into CT by 2033. Suncor's intent is to reduce the inventory of fine tailings to the lowest practical level by mine end.

Millennium End Pit Lake: Pond 12

Pond 12 will be enclosed by Dyke 16 and infilled Pond 11 to the east and an in-situ plug of ore and overburden to the west. As the mine advances westward following the clockwise progression, it will reach a point where external tailings Pond 8a will be encountered by overburden removal equipment.

Starting in approximately 2027, the remaining fluid contents (all MFT) of Pond 8a will be drained into a small, interior pond within Pond 12. This will facilitate removal of portions of Pond 8a (dewatered sand and overburden material) to uncover the last of the ore reserves for Pit 2. A small in-situ plug of ore (1 000 000 bbl) will be left between the pit area and Pond 8, to ensure the integrity of both Pond 8 and the end pit lake (Pond 12). The CT deposit in Pond 8 will be fifteen to twenty years old at this time.

Pond 12 will be an end pit lake (Figure C2.4-12) that will fill with surface runoff and CT release water. In the year 2033, all remaining water in all tailings ponds will be drained off into Pond 12.

Suncor has established the following criteria for an acceptable end pit lake:

- the lake must be geotechnically secure
- it must fill in a reasonable timeframe (about ten years)
- it must support a healthy aquatic ecosystem

The tailings plan will be continually optimized with the intention to reduce the volume of process-affected fluids (water, lean fine tails and MFT) that will be placed in the end pit lake. Initiatives that are being studied and may be implemented include:

- confirmation of the volumes of MFT formed in the new operation
- confirmation of the amount of fluid retained within the CT matrix, which is then released in the reclamation phase
- potential for the addition of thickeners or other technologies, which in the later stages of the mine life would reduce the need to maintain an inventory of MFT to create CT

Dumps, Dykes and Pitwalls

Three types of landforms will be designed and constructed to specification during the course of mining operations at the east bank mining area: an external tailings pond dyke; in-pit tailings impoundment dykes; and waste dumps containing surplus waste material. Design slopes for various foundation conditions and landform types are discussed in Volume 1, Section C2.4.2 and Figure C2.4-13 shows typical cross-sections for dumps, dykes and pitwalls. Detailed cross-sections, construction methods and material specifications for each structure will be determined, then submitted for regulatory approval as required in advance of construction. The design slopes shown on Figure C2.4-13 were used in defining the mine plan for this application.

External Tailings Pond

Containment dykes for the external pond will be constructed primarily of tailings sand. An initial starter dyke one-third of total dyke height, will be

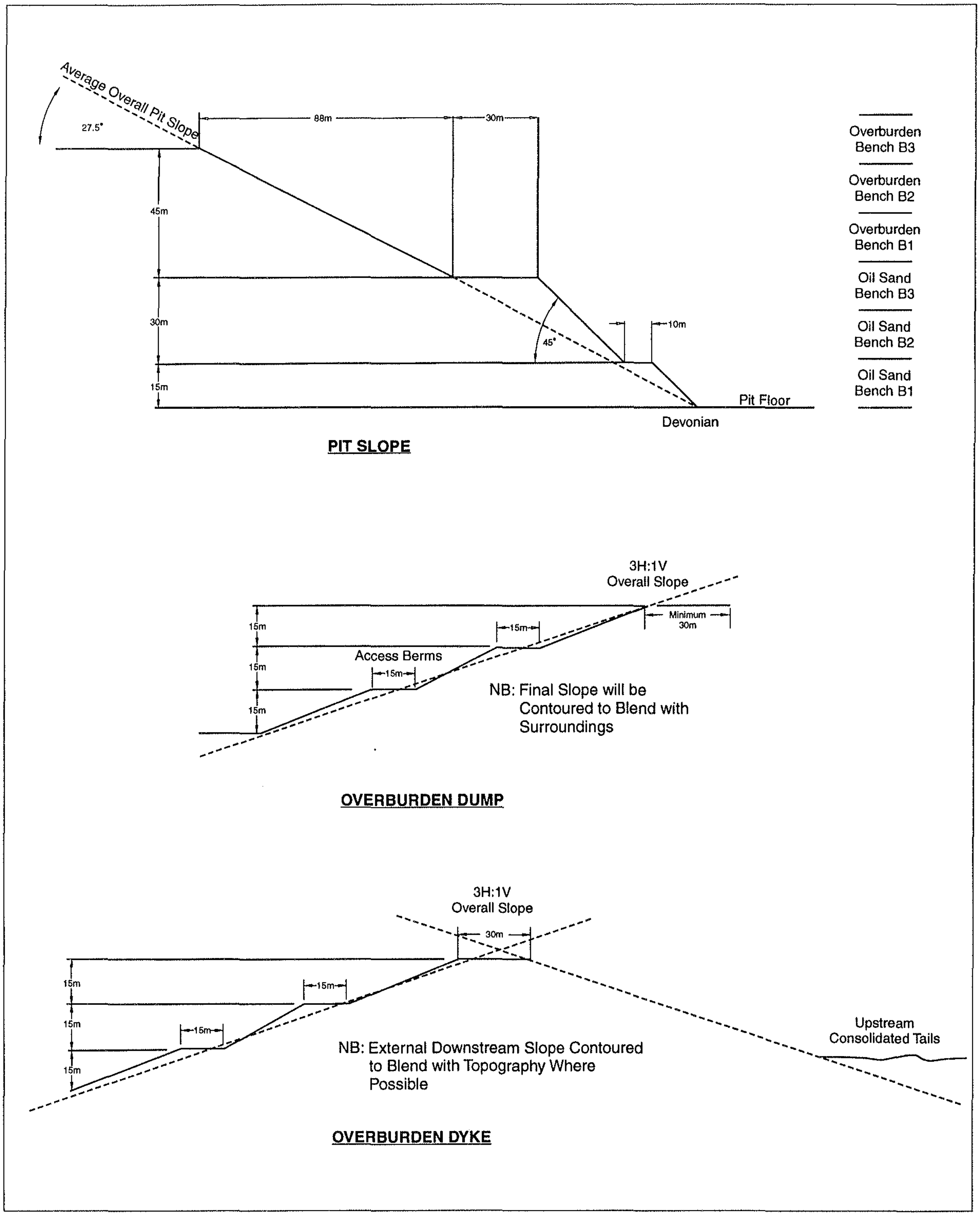


Figure C2.4-13 Typical Cross-Sections for Dumps, Dykes and Pitwalls

constructed of overburden material. The starter dyke will impound the startup process water inventory and act as a right-of-way for tailings pipelines. Tailings sand will be placed on top of the overburden starter dyke, using upstream and downstream construction techniques to achieve the desired slope angles. The preliminary design for this structure includes 8H:1V slopes on the west (escarpment) side and 12.5H:1V slopes on the east (pit crest) side. These slope designs are based on initial geotechnical guidelines.

In-Pit Dykes

Other than Dyke 11C, which will be partially constructed with sand, all in-pit tailings impoundment dykes will be constructed entirely of suitable waste overburden and interburden. Rate of rise will be driven by tailings level and safe geotechnical practices. Dyke slopes will vary as pit bottom conditions and material quality dictate. Overall slopes are expected to vary between 6H:1V and 3H:1V for unsupported slopes. A 2H:1V upstream slope can be designed if supported by tailings placed against the dyke.

Dyke 11C will be partially constructed of tailings sand because sand construction provides the quickest construction method to create in-pit space and thus reduce the size of the external Pond 8a. As well, the dyke is needed relatively quickly to preserve haul road access.

External Dumps

External dump slopes will depend on underlying formations. It is expected that the range will be from 3H:1V in stable areas to 6H:1V in areas of weak underlying formations. Wet or weak waste material will be placed selectively in the dumps.

Pitwalls

For both Pits 1 and 2, the overall pitwall slope angle is 27° in overburden and 45° in ore. A 30-m berm will be located from the toe of overburden to the crest of ore. Within the ore formation, 10-m safety berms will be located every second bench. Nominal bench heights will be 15 m in both ore and overburden.

Muskeg Stockpile

In the mining area, muskeg will be excavated and stored (if not placed directly on reclamation areas) in temporary dumps, from where it will later be recovered and used for reclamation of constructed landforms.

River Setback Criteria

Along the south side of the Steepbank River a minimum 100-m setback from the crest of the river valley escarpment to the mining crest will be maintained. Results from drilling along the Steepbank River escarpment indicate that a relatively small amount of ore in both Pit 1 and Pit 2 would be sterilized by this criterion.

Along the Athabasca River, the proposed criterion is as follows: wherever the bottom bench mining floor "daylights" (i.e., is exposed) along the escarpment, the elevation of the bottom bench floor shall be well above the 1-in-100-year ice-flood level of elev 241 m ASL. Along Pit 2 mining area, this criterion results in an undisturbed river-to-mine setback of over 500 m. (However the undisturbed zone is reduced to 300 m in the vicinity of the External Tailings Pond). Figure C2.4-14 and C2.4-15 illustrate river set-back at several points along Pit 2.

Mine Haul Roads

Mine haul roads will be classed as "permanent" if they are used for a substantial period while all others will be classed as "temporary". Average haul distances over the mine life are shown in Table C2.4-4.

All haul roads (except bench roads) will comprise varying thicknesses of a sub-base of compacted till or lean oil sand; a base of pit-run limestone or rock; and a surface of crushed gravel (<75 mm) or a crushed gravel/clay mixture. With the considerable experience Suncor has gained at the existing Lease 86/17 Base Mine, weather delays are expected to have minimum impact on production. Road construction specifications are listed in Table C2.4-5.

Table C2.4-4 Average One-Way Haul Distances (km)

Site and Stage	Waste	Ore
Pit 1	2.0	2.0
Pit 2, 2002-2005	3.4	2.0
Pit 2, 2006-2012	2.8	2.5
Pit 2, 2013-2025	2.9	2.6

Table C2.4-5 Mine Road Design

Item	Specification		
Maximum haul road grades	5%		
Minimum running surface	30 m		
Safety berm height	1.5 m		
Surface grade for drainage	1%		
Minimum ditch depth	0.5 m		
Ditch-wall slope	45°		
	Road Surface	**Road Base**	**Road Sub-Base**
	Crushed gravel, clay mixture <75 mm	Pit-run limestone	Compacted till or oil sand
Permanent road	0.3 m	2.0 m	1.0 m
Temporary road	0.3 m	1.3 m	1.0 m
Bench road	n/a	n/a	1.0 m

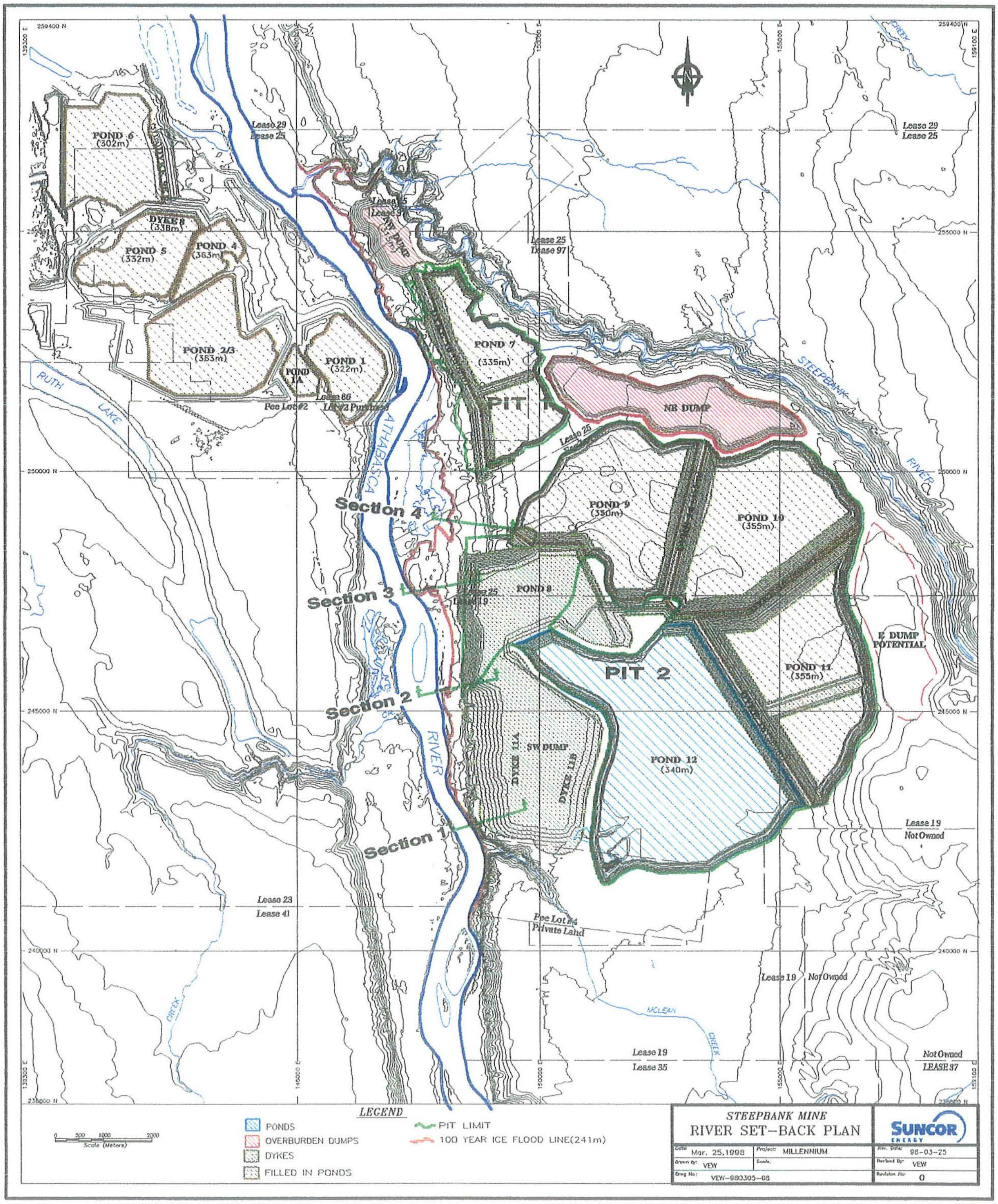


Figure C2.4-14 RIVER SET-BACK CROSS-SECTION KEY

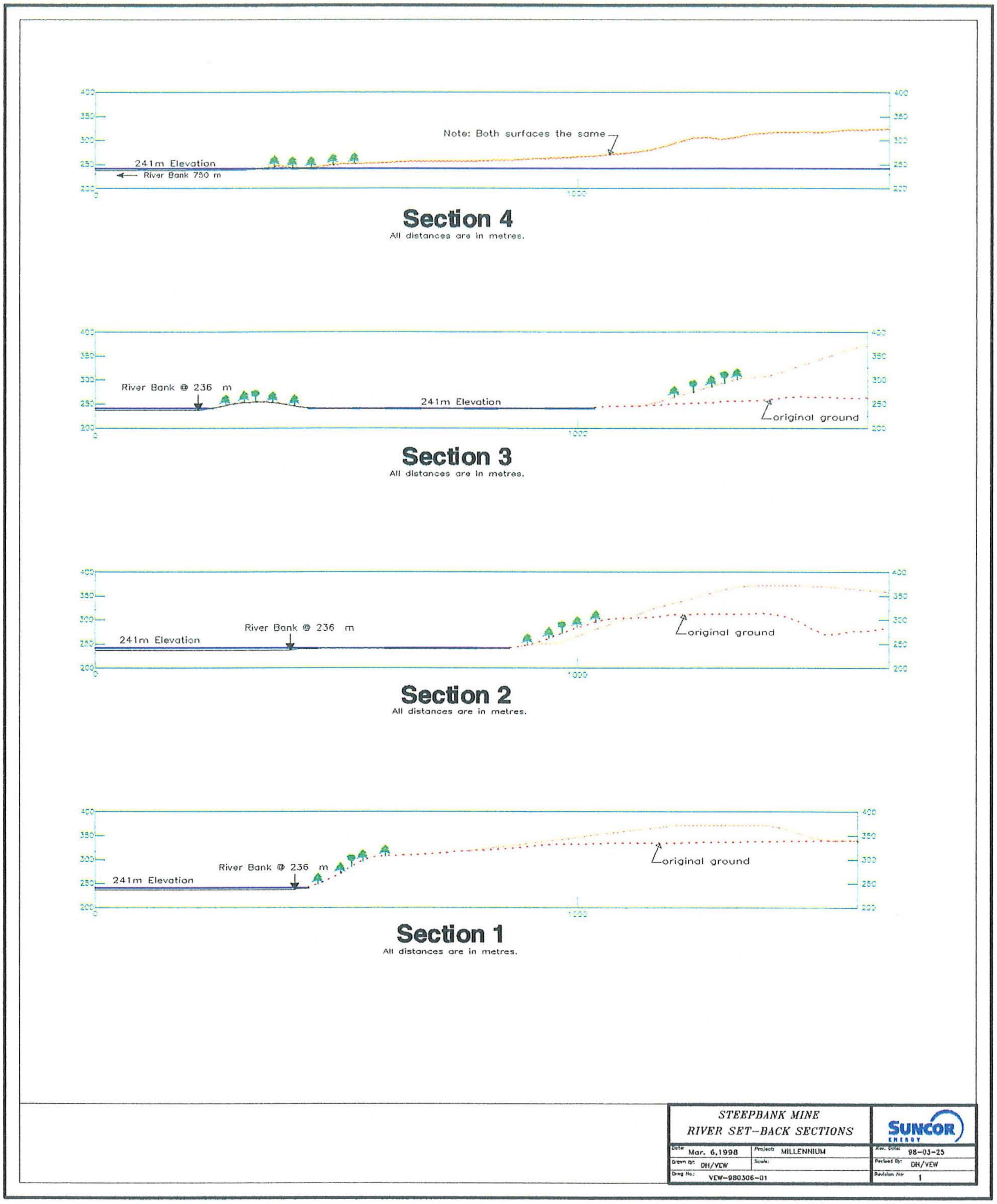


Figure C2.4-15 RIVER SET-BACK CROSS-SECTIONS

Limestone and Granular Material

Limestone to be used in the process of Flue Gas Desulphurization at the Base plant will continue to be extracted from a pit on Lease 86/17, which is a reliable, long-term supply.

Availability of suitable granular materials for construction purposes will be determined from the results of ongoing drilling.

Mining Equipment

Truck and shovel methods will be used to excavate overburden and ore. The loading fleet will comprise cable shovels (44 m^3) and hydraulic shovels (23 m^3). Front-end loaders will be used to remove muskeg, for cleanup, and to load trucks with road-building material. The ore and waste haulage fleet will consist primarily of 218-t trucks. Smaller (85-t) trucks will be used for muskeg removal and road materials haulage. Support equipment will be required for tailings disposal, road maintenance and dyke/dump construction. Table C2.4-6 lists projected mine equipment requirements. Equipment sizes will change with ongoing improvements in this field. It is expected that a move to larger trucks will be made during the life of this operation.

Table C2.4-6 Major Mine Equipment Fleet

Equipment	Size	Pit 1		Pit 2		
		2000	2004	2000	2004	2010
Cable shovel	44 m^3	3	7	1	4	11
Hydraulic shovel	23 m^3	1	2	1	2	3
Front-end loader	11 m^3	1	1	1	1	2
Front-end loader (fork)		1	1	1	1	1
Truck	218 t	15	31	5	24	70
Truck	85 t	2	2	2	4	4
Dozer	127 kW	1	1	1	2	2
Dozer (sideboom)	212 kW	1	1	1	1	1
Dozer	388 kW	4	9	2	12	25
Grader	4.9 m	4	10	2	7	17
Water truck		2	3	1	5	8
Rubber-tired dozer		2	3	1	2	5
Backhoe	3 m^3	2	2	1	3	5

C2.4.2 Geotechnical

Suncor and its consultants have over thirty years' experience in designing and maintaining earth structures associated with mine activities. For Project Millennium, Suncor will continue to ensure that its earth structures will meet or exceed applicable Canadian standards for geotechnical security. The company's objectives for landform stability are discussed in Volume 1, Section E.

General subsurface conditions are described in Volume 1,Section C2. Feasibility assessment for this project has been conducted using slope parameters identical to those for Steepbank Mine. Generalized slope profiles are shown on Figure C2.4-13.

The Clearwater Formation requires attention because it is frequently associated with low geotechnical strength. Its possible presence is recognized, and the extent and degree of possible Clearwater-induced pre-shearing are currently under investigation. Preliminary assessment of design slopes in Clearwater is shown in Table C2.4-7, which also provides a comparison with Steepbank design criteria used for feasibility planning. Detailed designs for each earth structure will be submitted for approval through the AEP Dam Safety procedures and will include careful assessment of Clearwater Formation impacts on stability.

Table C2.4-7 Summary of Geotechnical Criteria: Slope H:V

Mine Component	Foundation Condition	
	Steepbank Criteria	**Weak Clearwater**
External tailings pond	3:1	10:1 w/200-m-wide toe for possible berm
Crest of tailings shell to top of km as exposed in final pitwall		15:1
Unsupported perimeter pitwalls	2:1	5:1
Unsupported perimeter pitwalls at critical locations		8:1
Crest of dump to top of km for existing dump with advancing pit		8:1
Dump slopes	3:1	6:1 (D/H<0.25) 5:1 (D/H>0.25)
	Fill Condition	
	Little Kc	**Dominant Kc**
In-pit dykes	3:1	6:1
Steeper upstream slope if CT-supported	2:1	2:1

C2.4.3 Millennium Mine Drainage Plan

The drainage plan for the Project Millennium mining area will involve an expansion and acceleration of that proposed for Steepbank Mine. This section discusses Suncor's drainage philosophy and development of the mine drainage plan for the east bank mining area.

Design Philosophy

Suncor's drainage design philosophy for all of its operations is:

All natural runoff and shallow groundwater will be discharged to the Athabasca River while all runoff that is exposed to oil sand will be *contained within the mine drainage system and either used for the process or adequately treated prior to release.*

To comply with Suncor's overall water management plan and drainage design philosophy, Steepbank Mine employs two drainage systems for runoff waters. The two systems are:

- an interception drainage system, for run-on water from undisturbed areas and shallow aquifer groundwater. This water will be discharged to the Athabasca River.

- a mine drainage system, for surface runoff from mined, stripped and developed areas and any basal aquifer depressurization waters. This water will be routed through collection ditches to internal water retention basins. This water will be used as process water or released to Athabasca River providing it meets appropriate water quality standards.

Conceptual drainage plans were developed based on two reports: "Hydrogeology Baseline Report for Suncor's Project Millennium" (Klohn-Crippen 1998a) and "Hydrology Baseline Report for Suncor's Project Millennium" (Klohn-Crippen, 1998b), which provide baseline data for the various streams as well as rainfall and runoff events and groundwater conditions for the east bank mining area.

The general approach used to develop the interception drainage system layouts was to minimize the impacts to receiving water bodies. In particular, Suncor is committed to maintaining the viability of the Shipyard Lake ecosystem. This commitment includes managing the drainage to this wetland to maintain baseline flows. The mitigation measures required to meet this commitment vary depending on the time of the mine life and are discussed in subsequent sections and in "Project Millennium Conceptual Plan for 'No Net Loss of Fish Habitat' " (Golder 1998i).

The approach used for the mine drainage system is to contain runoff from pit areas for use in the bitumen extraction process. During extreme conditions (that is, those exceeding the 1-in-50-year design condition), a release of some mine drainage water to the Athabasca River may be required. Measures will be implemented to minimize the likelihood of this occurring, including pumping excess water to emergency sumps excavated in the pit. Should a release still be necessary, steps will be taken so that impacts are minimized and releases are made at locations where water quality can be monitored. If there is adequate warning that a release is necessary, the required approvals will be obtained.

A specific drainage plan will be incorporated as part of the detailed engineering design for each expansion component. All drainage systems will comply with the overall drainage philosophy so that runoff is collected and channelled to the appropriate drainage system. The final detailed design for the drainage systems will address design parameters including outfall, and channel design specifics.

All facilities associated with Project Millennium will be located above the 1-in-100-year ice jam flood level of 241.5 m ASL for the Athabasca River.

Suncor's standard operating practice, includes the following contaminant and erosion control measures:

- containment ponds with impervious lining, for mine drainage waters
- rapid-response cleanup procedures, for accidental spills
- drainage channels with settlement ponds, to collect runoff from disturbed areas
- cross-berms on sloping disturbed areas, to retard runoff and reduce surface erosion
- rapid revegetation of disturbed areas, after construction activities are complete

Baseline (Pre-Disturbance) Drainage Patterns

Baseline drainage patterns are shown on Figure C2.4-16. Figure C2.4-17 shows the Macro Terrain types, which are discussed in detail in Section D2 of Volume 2. Major watercourses near the east bank mine are the Athabasca and the Steepbank Rivers. The Steepbank River is the major tributary to the Athabasca River in the area. Smaller watercourses in the Local Study Area include Unnamed Creek and Creek 2, which drain to Shipyard Lake, as well as Leggett Creek, Wood Creek, and McLean Creek.

The Athabasca River has eroded through the surficial soils and bedrock to the current floodplain at an elevation of about 235 m to 240 m ASL. Its banks form the Athabasca River Escarpment and have a total height of about 80 m. The average slope of the Athabasca River Escarpment is about 8% with local slopes at the toe of 20 % to 40%.

Approximately 35 km of Steepbank River borders the east mine development area. The Steepbank River escarpment is also approximately 80 m high. From the confluence of the Athabasca River to about 6 km upstream, the slopes are locally very steep with gradients of 60% or more. Further upstream the slopes flatten to about 18%. Natural discharge to the Steepbank River in the east bank mine area is from overland flow. Only the Northeast Dump and the potential East Dump encroach into the Steepbank River basin. No developed stream channels are present on the Steepbank River escarpment in the east bank mine area.

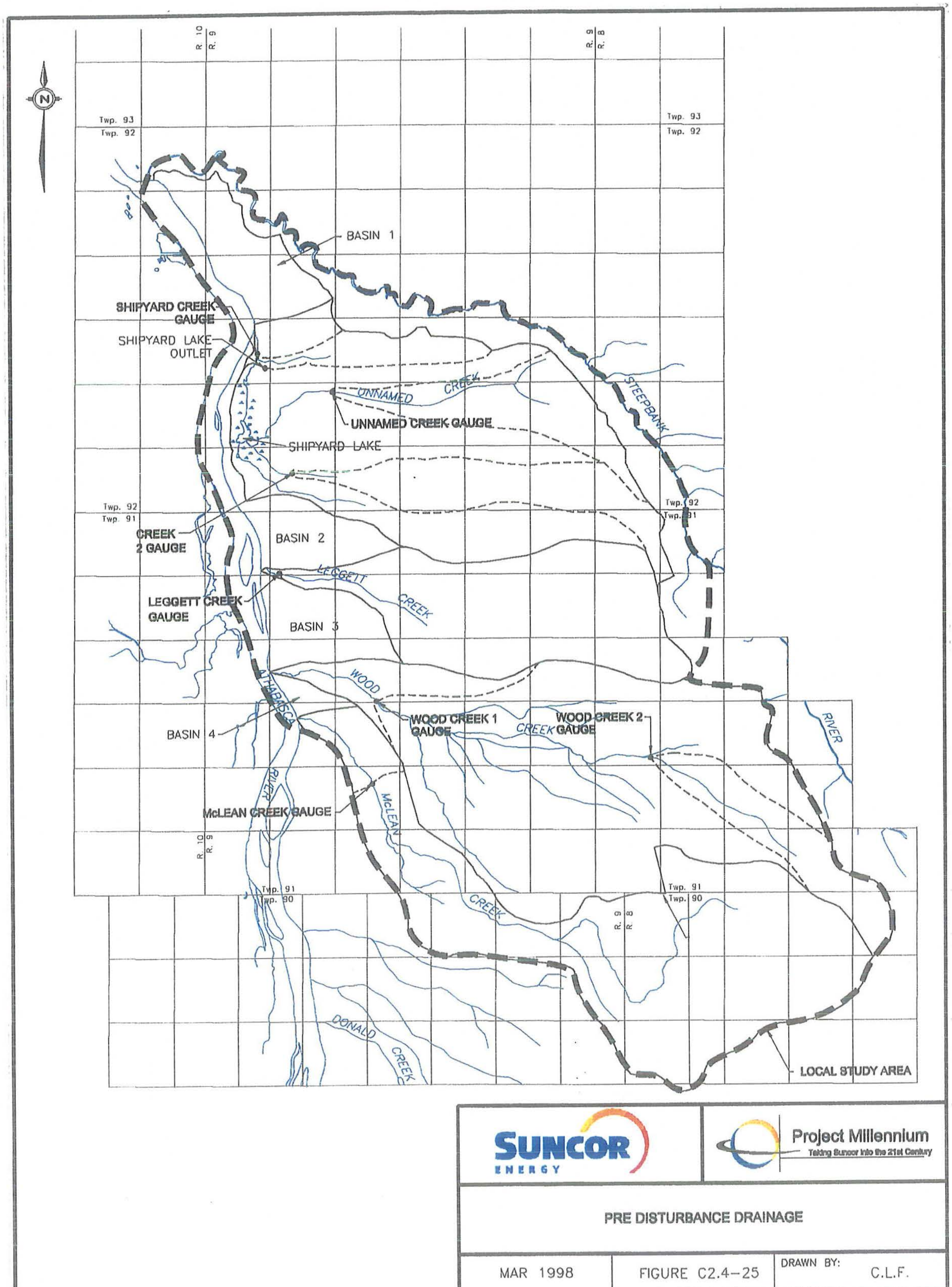


Figure C2.4-16 Pre-Disturbance Drainage Patterns

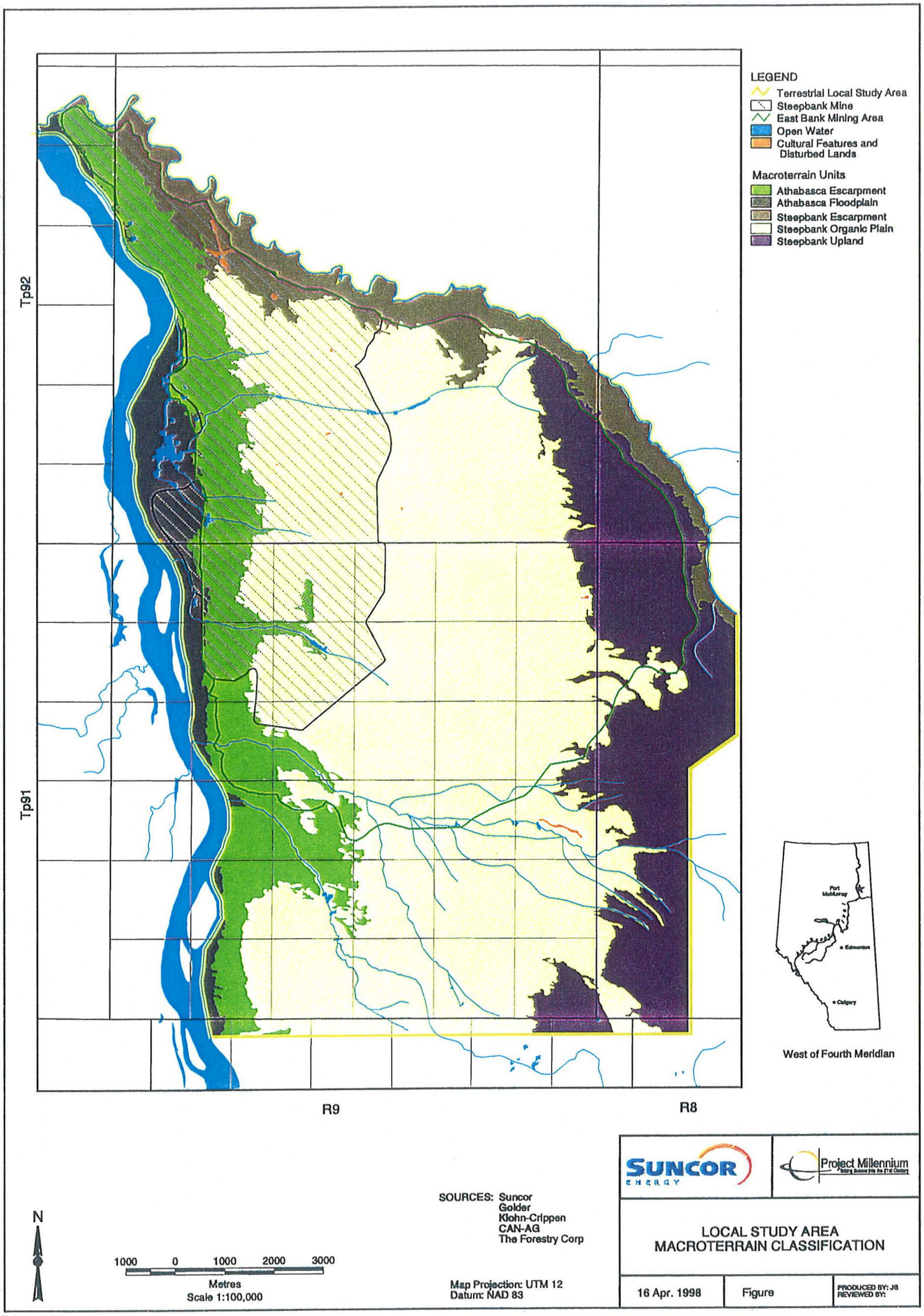


Figure C2.4-17 Macro Terrain Types

All smaller watercourses in the expansion area flow through muskeg above the Athabasca River escarpment. Within this area the watercourses are poorly-defined. Where they daylight on the Athabasca River escarpment, these watercourses have eroded steep-walled channels through the surface soils and bedrock.

The Shipyard Lake wetlands complex is located on the Athabasca River floodplain approximately 6 km upstream (south) of the Steepbank River confluence with the Athabasca River. This wetlands was identified in the Steepbank Mine Application as being an important aquatic ecosystem in the east bank mine area.

The creeks feeding Shipyard Lake (Unnamed Creek, Creek 2 and Leggett Creek) have their drainage basins entirely within the proposed expansion area. Wood Creek has about 17% of its drainage in the expansion area while about 1% of the McLean Creek drainage is in the expansion area.

Four small basins designated as Athabasca 1 through 4 on Figure C2.4-16, have no defined watercourses and appear to discharge runoff directly to the Athabasca River through overland flow or small ephemeral streams.

Surface Drainage Plan

The surface drainage plan developed and approved for Steepbank Mine includes provisions for controlling the release of surface water and groundwater from Pit 1 and Pit 2. Project Millennium is an expansion of Pit 2 to the east. The following discussion highlights the entire drainage plan with emphasis on the Pit 2 expansion. Where appropriate, specific modifications to the drainage plan from those approved for Steepbank Mine are highlighted. Development has been subdivided into three time periods:

- Construction (2000 to 2002)
- Operation (2002 to 2033)
- Closure (2033 to Far Future)

Construction: 2000 to 2002

Construction of facilities for Steepbank Mine commenced in 1997. This development primarily affects drainage basin Athabasca River 1 of the pre-disturbance area described above. This interception drainage system includes Pond A and the associated drainage channels to collect runoff from the Northwest Dump and muskeg dewatering flows. The mine drainage system includes Ponds B and F and associated drainage channels to collect runoff from Pit 1, the Ore Preparation Plant, and Mine Complex. Both systems are shown on Figure C2.4-18 for 2002.

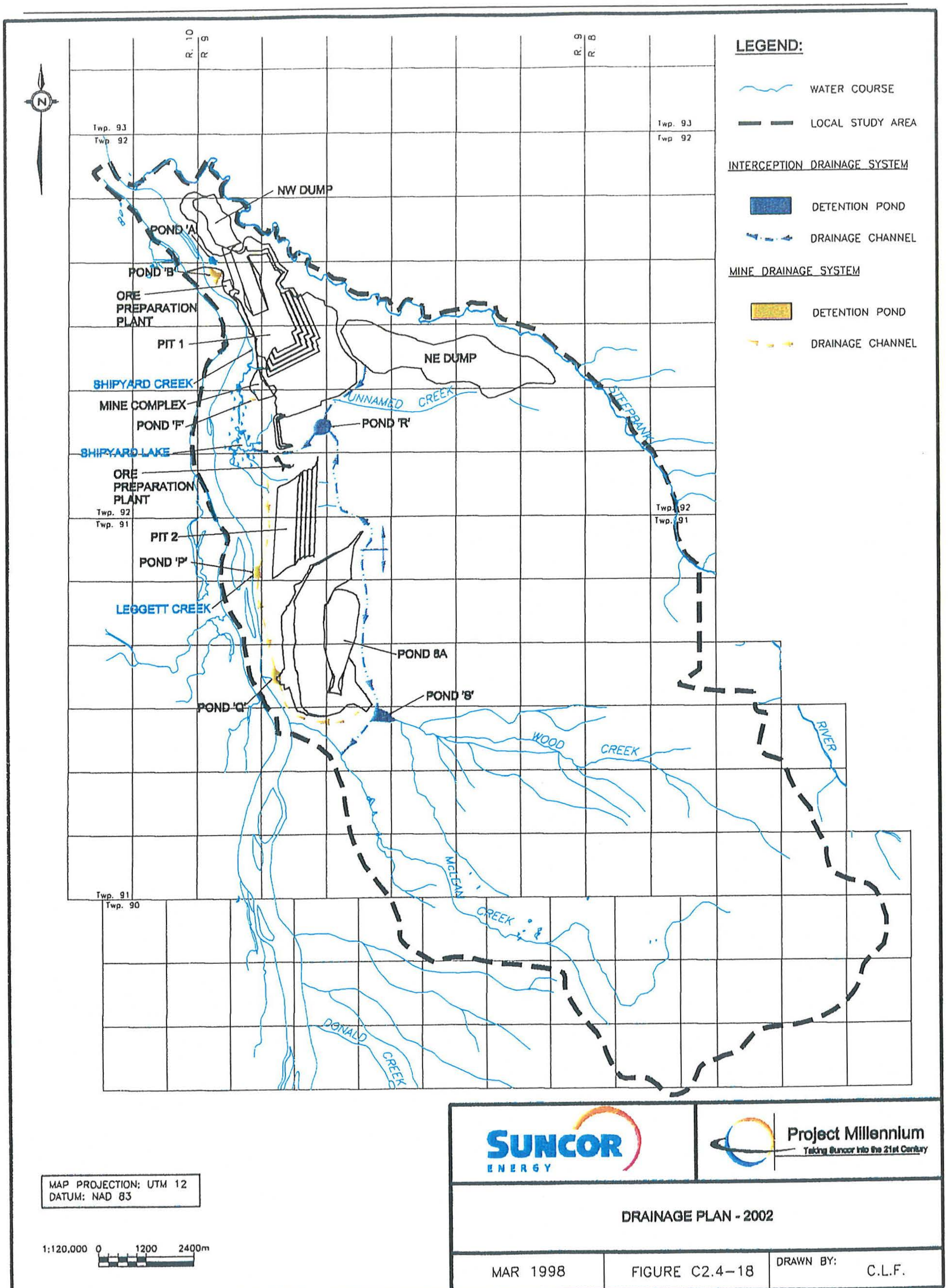


Figure C2.4-18 Drainage Plan - 2002

The proposed expansion construction in this period will include an additional ore preparation plant, starter dykes for Pond 8A and the shell for the Northeast Dump as outlined in Section C2.4.1. Main components of the drainage systems required for the development of Pit 2 will also be constructed during this time, as discussed below.

Interception Drainage System

Runoff to Shipyard Lake, Leggett Creek, Wood Creek and McLean Creek will be affected during this stage of development. Effects on flow include increased runoff from cleared and pre-stripped areas, as well as diversion of flows to different discharge points from baseline conditions via the interception drainage system.

Key interception drainage system components required for the 2000 to 2002 construction period are:

1. Run-on from Wood Creek upslope of the mining area will be intercepted and diverted south to McLean Creek to allow construction of Dyke 11A (for Pond 8A). This diversion was not required under the drainage plan presented in the Steepbank Mine Application.

2. Run-on from portions of Leggett Creek and part of the Shipyard Lake basin up-slope of the mine area will be intercepted and diverted north to Unnamed Creek and subsequently to Shipyard Lake, to facilitate initial mining at Pit 2 and construction of the ore-preparation plant. This diversion is required under the Steepbank Mine Application but is not scheduled to take place until about 2010.

3. Unnamed Creek, Creek 2, Leggett Creek and Wood Creek will lose a majority of their existing flow during this period. To ensure that flows to Shipyard Lake will not be interrupted, a diversion and drop structure will be constructed to convey flows from Unnamed Creek down the Athabasca River Escarpment to Shipyard Lake. These structures are included as part of the Steepbank Mine application.

The interception drainage system will include a series of ponds sized to regulate water flows to Shipyard Lake and McLean Creek. These ponds, which will also serve as sedimentation ponds, are shown on Figure C2.4-18.

During construction, sediment and erosion control methods will be utilized on a temporary, site-specific basis. These measures will include temporary sediment ponds and silt fences to be designed based on a one-in-ten year twenty-four hour peak storm event.

Mine Drainage System

The mine drainage system approved for Steepbank Mine includes a collector ditch at the toe of Dyke 11. Under Project Millennium this will be expanded to include a collection system at the toe of Dyke 11A (Pond 8A) to collect seepage from this structure. The system will include Ponds "P" and "Q" and collection channels as shown on Figure C2.4-18. The ponds are located in the former Wood Creek and Leggett Creek channels and take advantage of natural topography for water collection.

Operation: 2002 to 2033

Both the interception and mine drainage systems will be expanded as pit development proceeds. Figures C2.4-19 through C2.4-22 show conceptual layouts of the interception and mine drainage systems in 2012, 2018, 2025 and 2033. Key features of the drainage plan are summarized below:

1. Approximately 95% of the Shipyard Lake drainage basin will be lost to mine development or restructured during this period. The north west and east portions (about 15% of the drainage area) will become part of the Northeast and Northwest Dumps (both dumps were included in the Steepbank Mine application) and Reclamation Materials Stockpile while the balance will be taken up by the mine.

2. Runoff from stripped areas, active mine areas, worked-out mine areas, external dyke slopes, and dyke seepage will be contained in the expanded mine drainage system and used as process water. Runoff in excess of process requirements, if any, will be treated as required before being released to the environment.

3. For the period 2002 to about 2015, run-on from upslope of the mine face will be routed to Unnamed Creek using the interception drainage system. The channels will be progressively reconstructed upslope as the mine advances. This is the same approach as that approved for Steepbank Mine. Existing flow to Shipyard Lake will decrease to below baseline conditions during this period. Flows to Shipyard Lake will be supplemented with water from one of several potential sources, including the Athabasca River. This process will continue until landscape reclamation allows surface runoff to be restored.

4. Construction of Dyke 11A will not interfere with the seasonal overflow from the Athabasca River into Shipyard Lake (which occurs about once every three years). This reflects a change from the Steepbank Mine application where this flow was at least partially blocked and will help maintain the Shipyard Lake ecosystem.

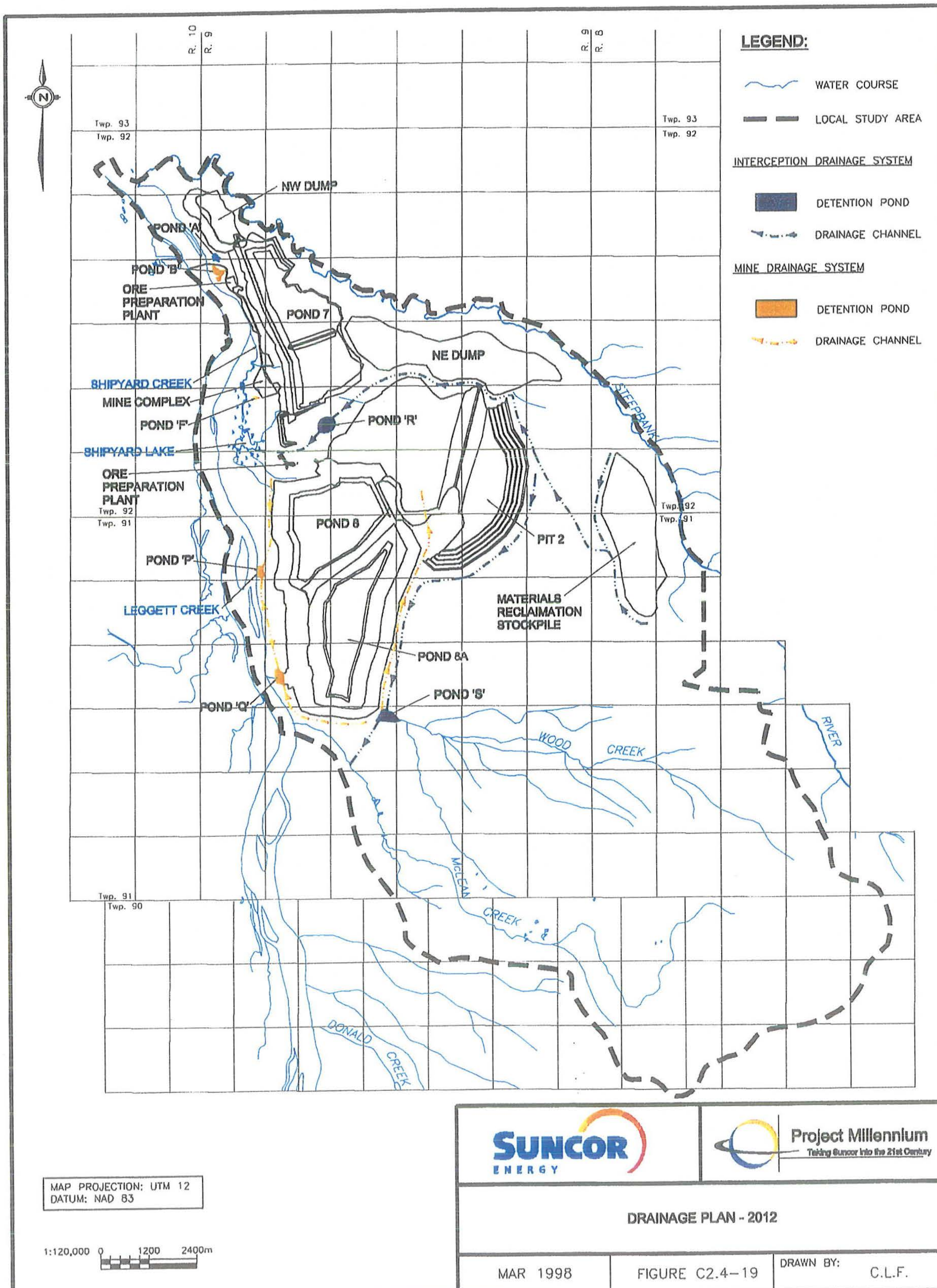


Figure C2.4-19 Drainage Plan - 2012

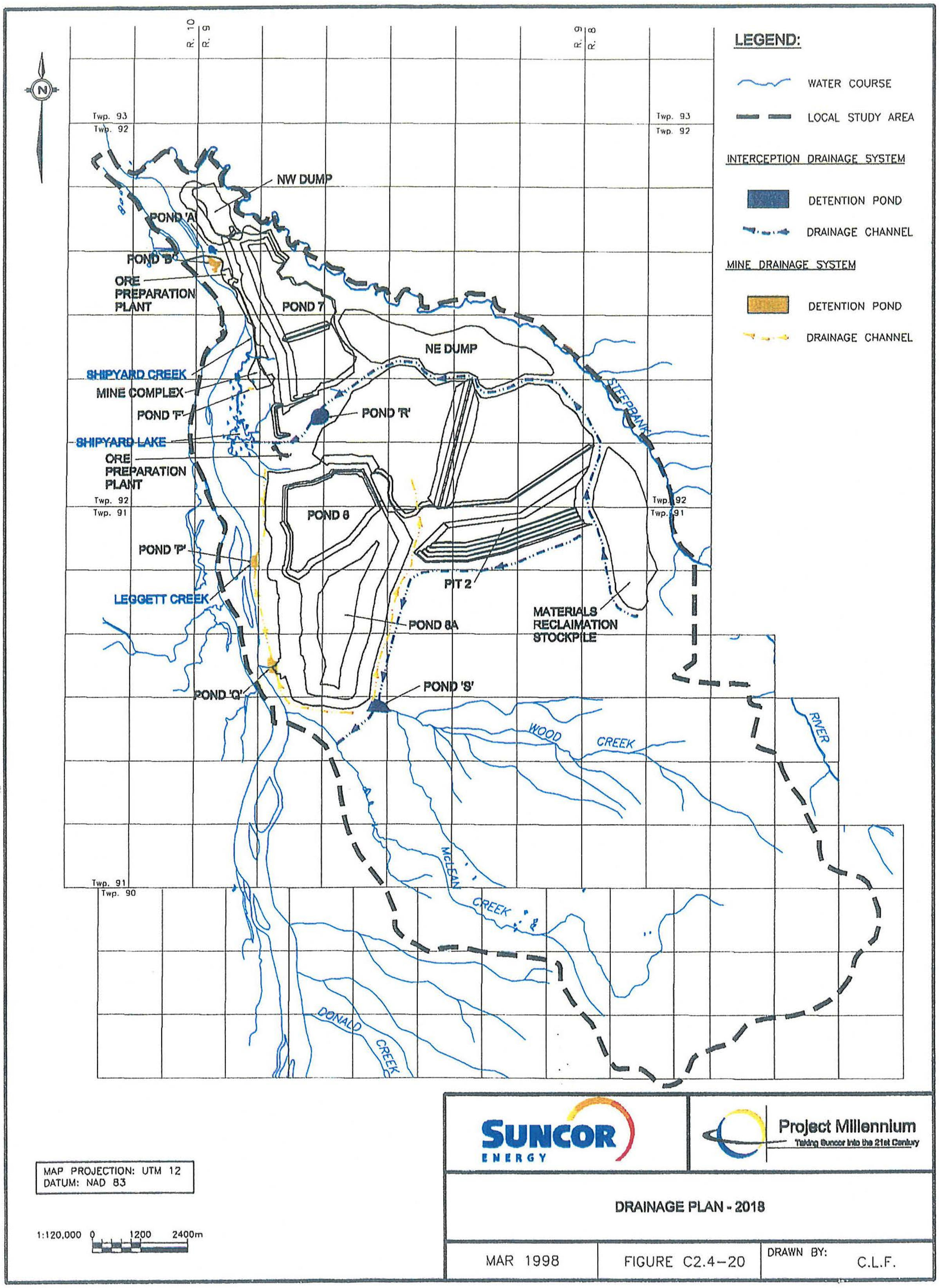


Figure C2.4-20 Drainage Plan - 2018

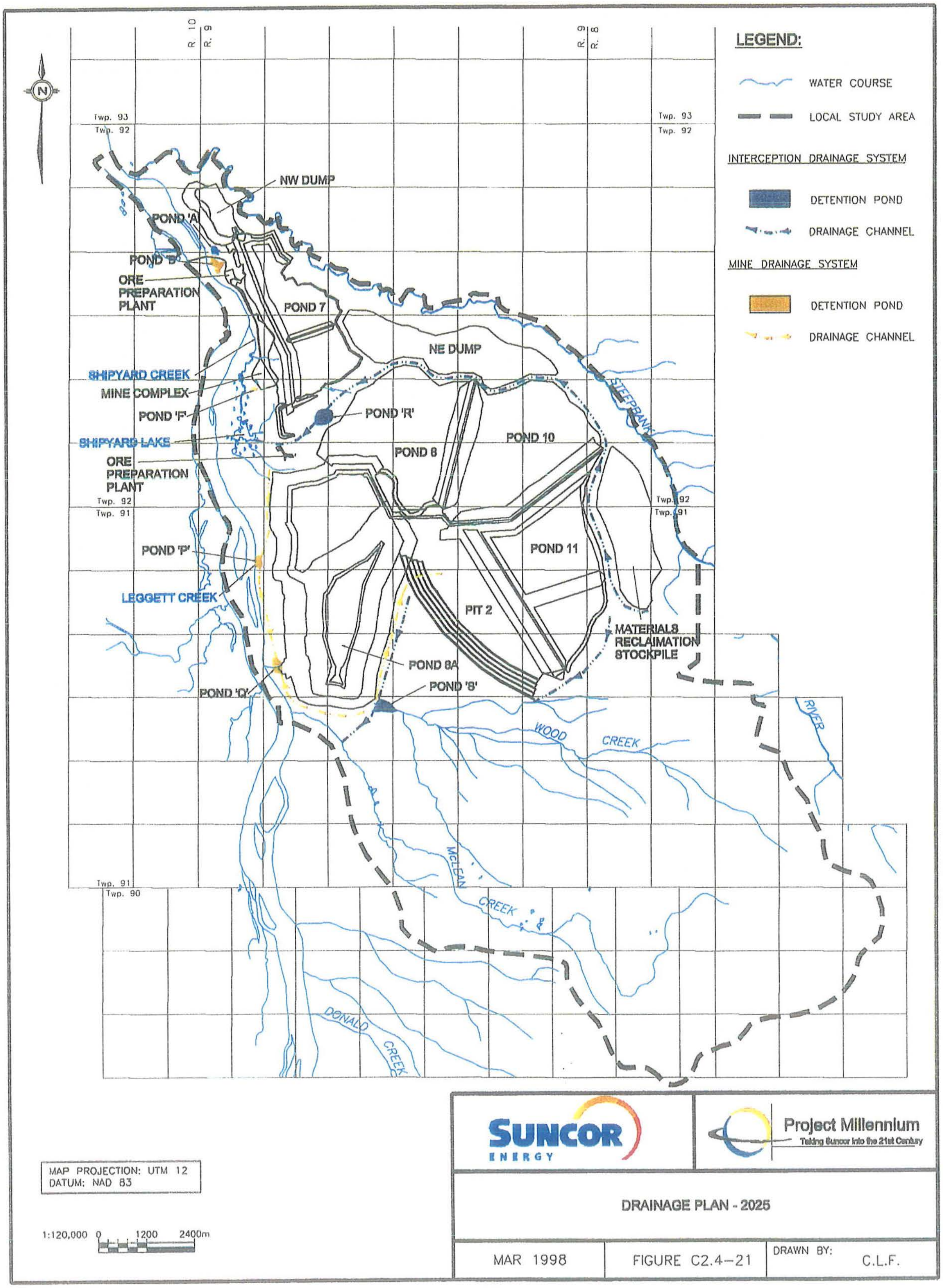


Figure C2.4-21 Drainage Plan - 2025

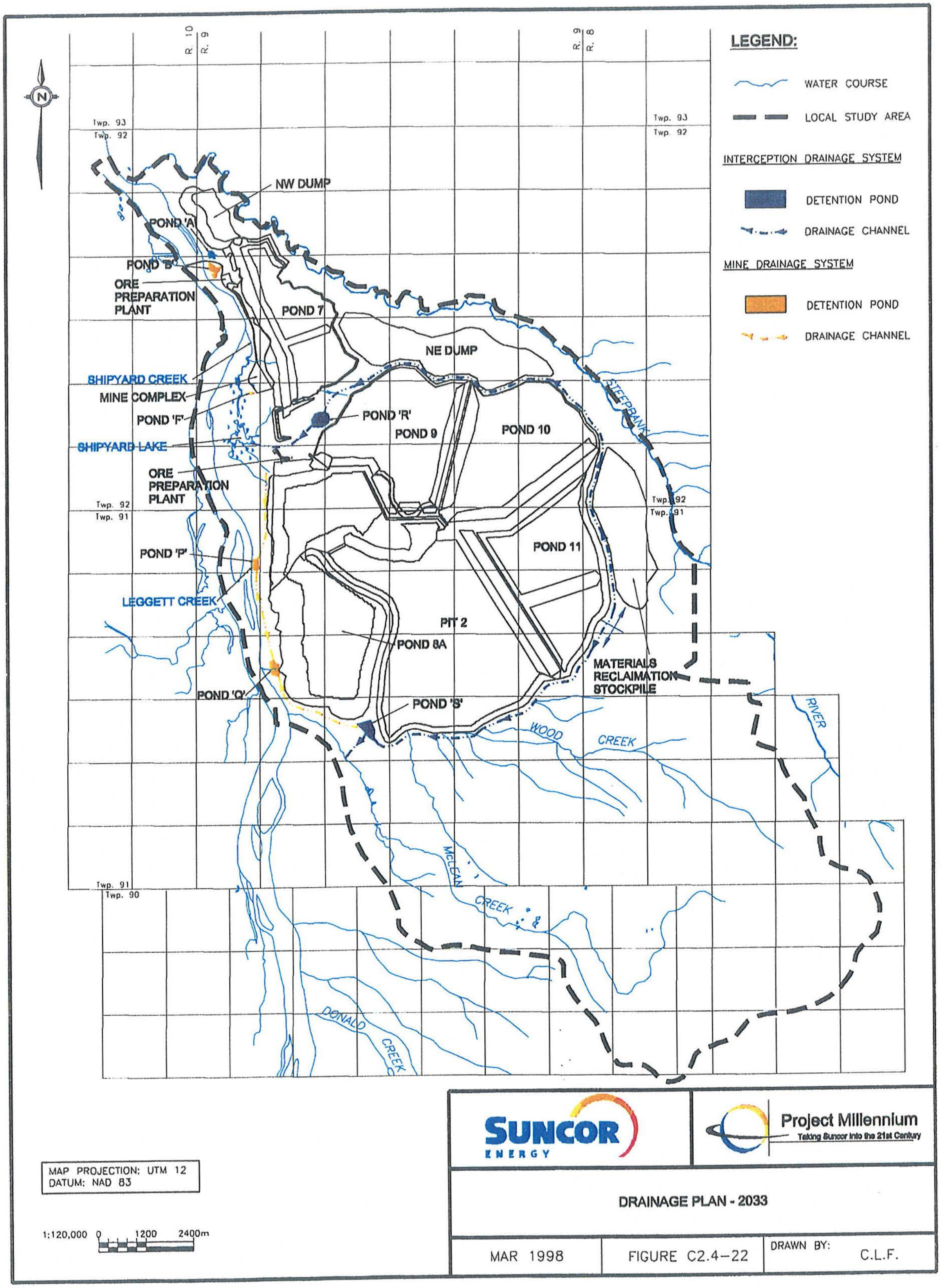


Figure C2.4-22 Drainage Plan - 2033

Closure: 2033 to Far-Future

The reclamation drainage plan for the far-future is presented on Figure C2.4-23. Key surface drainage features of this plan are discussed below.

In the far-future, the runoff water quality from the reclaimed landscape will be acceptable for release to Athabasca River. The release points will be Unnamed Creek (via Shipyard Lake) and McLean Creek. Overland flow of runoff from the Northeast Dump, potential East Dump and external dyke slopes will occur in a manner similar to that from the existing escarpment. Runoff from the NE Dump and potential East Dump will be routed through the reclaimed interception drainage channels to Shipyard Lake and McLean Creek, respectively. Runoff from the dyke slopes will be collected in drainage channels and released to the Athabasca River via the former Leggett Creek and Wood Creek outlets.

Flow to Shipyard Lake will continue to be supplemented until landscape reclamation is completed and runoff from the former CT Ponds 9 and 10 is acceptable for release to the wetland.

Studies presently underway will provide a more comprehensive understanding of the contribution of upland drainage to the Shipyard Lake ecosystem. These studies may increase the options available to Suncor for maintaining Shipyard Lake.

Surface Drainage Impacts

Environmental impacts of surface water diversions in the drainage plan are discussed in Volume 2, Section C2 (Surface Hydrology and Hydrogeology).

Groundwater Diversion Development

Groundwater diversions are primarily a direct result of mining (i.e., the aquifer is mined out). Groundwater diversions associated with Suncor's east bank mine area have been subdivided into the same timeframes as surface water diversions (construction, operation and closure) and are described below.

Baseline (Pre-Disturbance) Hydrogeology

The geology and hydrogeology of the Millennium Mine area are summarized below:

- There are three major aquifers in the east bank mining area: shallow surface aquifers, a basal sand aquifer and the Devonian limestone. The basal aquifer and the limestone may be hydraulically connected.

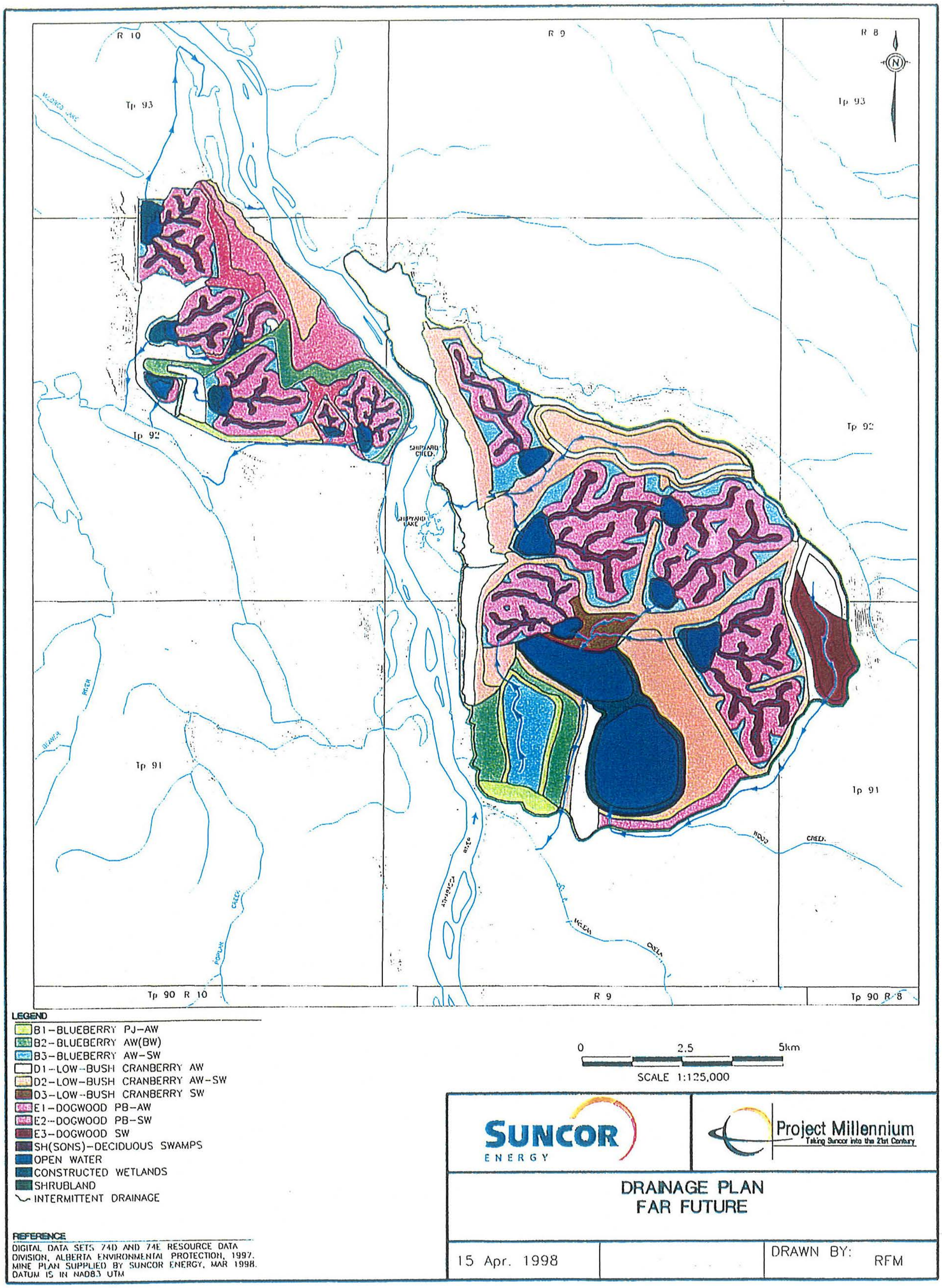


Figure C2.4-23 Drainage Plan - Far Future

- Locally, most groundwater flows toward the Athabasca River with a minor component toward the Steepbank River. Total groundwater discharges in the Local Study Area surface streams represent less than 0.01% of the low flow of the Athabasca and 0.1% of Steepbank Rivers.

- Suncor is the only groundwater user in the east bank mining area. There are no other water wells either on the east side of the Athabasca River or south of the Steepbank River within 10 km of the mine area.

Construction: 2000 to 2002

Groundwater diversions will be imposed on the hydrogeologic system due to the excavation of Pit 1 and pre-stripping near Pit 2. In the shallow aquifers, the direction of groundwater flow will be changed as a result of dewatering of the overburden. However, the discharge rate will not be affected. The flow in the shallow aquifers will be routed by the Interceptor Drainage system to either Shipyard Lake or McLean Creek. The total volume of groundwater discharged from the aquifers to surface water will not change.

No impacts to deep groundwater systems are expected during this period.

Operation: 2002 to 2033

Shallow deposits in the area will be dewatered during overburden stripping. As mining progresses to the east in Pit 2, the shallow aquifers will eventually be completely removed by the mining process except along the southern boundary of Pond 12. Discharge from this portion of the aquifer will ultimately go to the end pit lake.

Impacts to shallow aquifers adjacent to Pond 8A will be minimized through the use of seepage collection systems and collection ditches. Pond 8A will be in operation from 2002 to 2027. Seepage through the dykes of this pond will be intercepted and diverted to operations as part of the mine drainage system. Liquids in this pond will be removed in 2027 and the pond backfilled with overburden. Flows from this source will decrease after backfilling.

Effects on the deep bedrock groundwater system of the east bank mine during pit development are similar to those of Steepbank Mine except for changes in timing. In general impacts to groundwater flows are accelerated. However, as mined-out areas are infilled faster than described in the Steepbank Mine application, restoration of hydraulic head to the existing aquifers outside of the mining area will also be accelerated in some areas.

In the Basal Aquifer and Upper Devonian, the direction of groundwater flow near the pits will be changed as a result of mining below the baseline phreatic surface. Commencing in about 2002, Basal Aquifer depressurization may be required in the mine area. This depressurization could result in a significant reduction in natural discharge to the Athabasca and Steepbank Rivers from these units. However, as the existing flow represents <1% of the total flow in these rivers, no impacts are expected. Basal Aquifer depressurization flows will be diverted to the mine drainage system.

During operation, water from Steepbank River may recharge the deep aquifers due to the elevation difference between the river and the north side of the pit. Based on the hydraulic conductivity of deep aquifers and the difference in elevation between the river and the pit bottom, the maximum amount of water that may be diverted is 1.1 L/s to Pit 1. This diversion was described in the Steepbank Mine application. As Pit 1 is expected to be filled with CT by 2007, the head will be restored which will eliminate flows into the pit. Compared to the total flow in Steepbank River this flow is very small. The deep aquifers under Pit 2 are not expected to receive water from this source as they do not outcrop in the Steepbank River.

Closure: 2033 to Far-Future

Shallow aquifers in the reclaimed east bank mine area will likely have a lower permeability than existing aquifers due to the nature of the materials used to infill the tailings ponds (CT and tailings sand). In the short- to medium-term, the quality of the groundwater will reflect also reflect the infilling materials. However, seepage from these areas will be routed through the end pit lake for treatment prior to discharge to the Athabasca River.

In the deep aquifers, small changes in flow rates and water quality are expected as seepage of pore water from the CT in Ponds 7 through 11 flows through the aquifers to Athabasca River, Steepbank River and Shipyard Lake. These volumes represent only a small portion of the flows in these surface water bodies.

An additional source of seepage is the end pit lake. An estimated seepage flow of 1 L/s from the end pit lake will reach the Athabasca River.

Groundwater Impacts

Potential impacts of groundwater diversions from the Integrated Mine project are discussed in Volume 2, Section C2, Surface Hydrology and Hydrogeology.

C2.4.4 Mine Drainage Water Diversions: 1999 to 2006

Licence Requirements

Suncor is requesting an amendment to its existing approval (Files 27551 (Steepbank Mine) and 27549 (Lease 86/17)) to divert a portion of the surface water and groundwater on the east bank mine area under Section 11(1)(a)(iv) of the *Water Resources Act*. Suncor does not require this allocation for operating purposes, rather the water will be diverted in an effort to prevent runoff exposed to oil sand by Suncor's mining operation from entering the environment. Allocation volumes have been calculated and are presented in Table C2.4-8.

TABLE C2.4-8 EAST BANK MINE MAXIMUM WATER DIVERSION VOLUMES AT 2006

Source	Activity	Precipitation (k m³)	Evapo-transpiration (k m³)	Net Volume (k m³)	Volume Released (k m³)	East Bank Mining Area Allocation (k m³)
Surface Runoff	Mine Drainage[1]	11 100	26 000	8 500	0	8 500
	Interception Drainage	17 900	11 800	6 100	6 100	0
Shallow Aquifers	Interception Drainage	n/a	n/a	250	250	0
Bedrock Aquifers	Mining	n/a	n/a	430	235	195
Steepbank River	Mining	n/a	n/a	35	0	35
Athabasca River[2]	Potable Water Supply	n/a	n/a	600	40	560
Total East Bank Mine Allocation (k m³)						9 290
Lease 86/17 Allocation ('000 m³)						8 500
Total Suncor Surface and Groundwater Diversion ('000 m³)						17 790

1 Mine Drainage volume does not include net evaporation from ponds
2 Shallow groundwater supply from Athabasca River sand adjacent to Shipyard Lake

Fence Line for Millennium Mine Water Diversions

The "fence line" or perimeter for water diversions on Steepbank Mine is shown in Figure C2.4-24.

Water Balance: 2006

The maximum water diversion volume in the licence period will be in the year 2006. The water balance for this time period is shown in Table C2.4-8. The drainage plan for 2006, including proposed outfall locations and activity areas is shown on Figure C2.4-25.

The outfall at Leggett Creek planned for Steepbank Mine is no longer required under Project Millennium. An outfall from the interception drainage system to McLean Creek is required. Details of the outfall design will be supplied following the detailed mine drainage plan design.

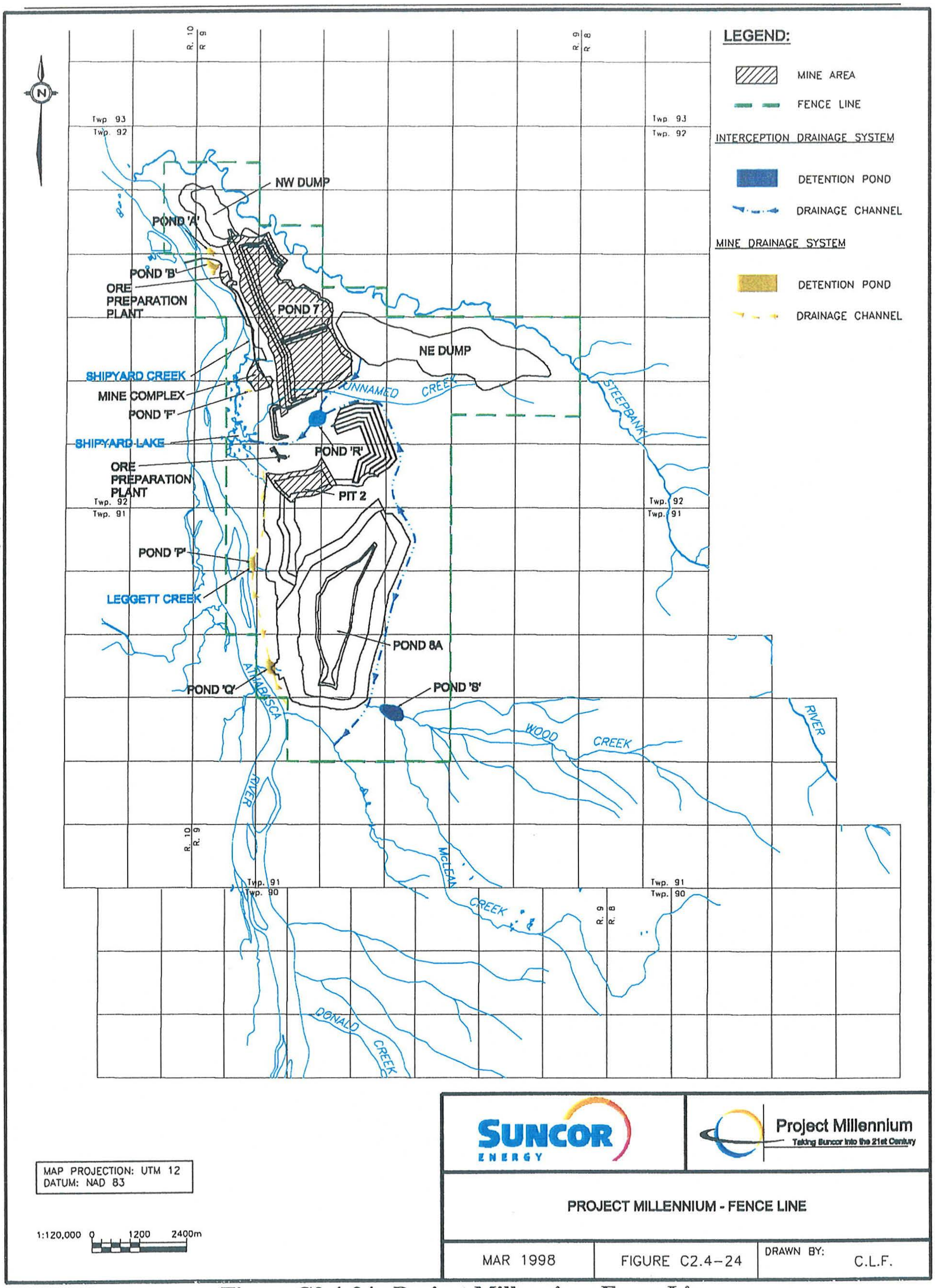


Figure C2.4-24 Project Millennium Fence Line

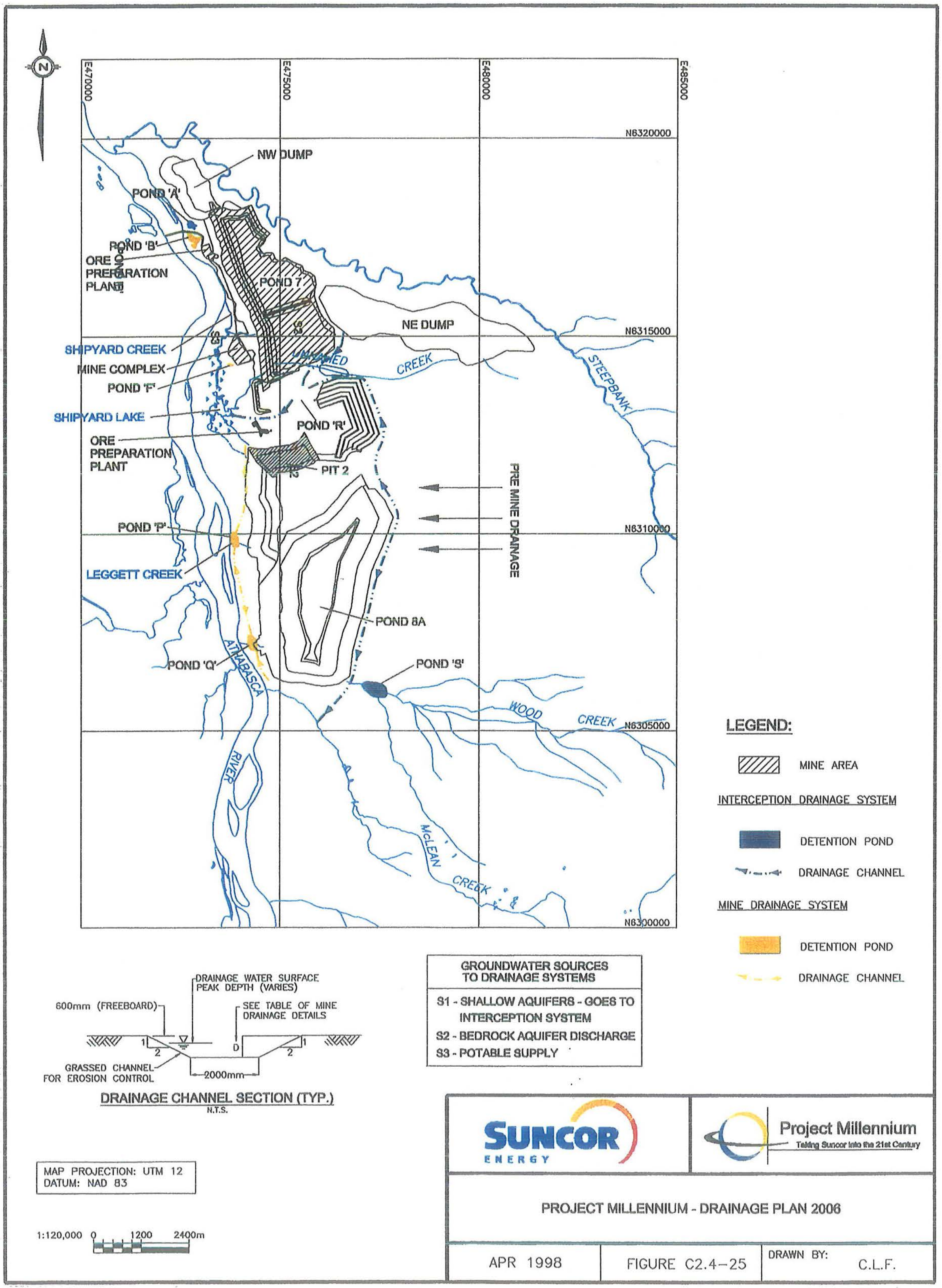


Figure C2.4-25 Drainage Plan - 2006

Suncor requests a water diversion allocation of 9.3 million m^3 per year for the east bank mine area. This allocation replaces the 5.4 million m^3 approved for the Steepbank Mine. It does not include the 8.5 million m^3 approved for the Lease 86/17 minesite. Therefore the diversion allocation requested for the integrated Lease 86/17 and east bank mining areas is 17.8 million m^3.

Consolidated Tailings Water Release

The implementation of consolidated tailings (CT) technology will greatly enhance Suncor's ability to reclaim its former mining areas. Under the current approved plan for Steepbank Mine, CT release water exceeds

Suncor's process requirements. One option presented in the Steepbank Mine Application for managing this excess water was to discharge it to the Athabasca River after treatment. Water balance estimates indicate, however, that discharge of excess water is unlikely and almost certainly not required in the licence period at Project Millennium production rates.

C2.5 Extraction Process

C2.5.1 Introduction

Section C2.4.1 described the Steepbank Mine expansion plan. As indicated, in the initial years to about 2012, about one-half of Steepbank Mine ore is conditioned at Steepbank Ore Preparation facility and is hydrotransported to the Base Extraction plant for primary extraction and secondary extraction froth cleanup. The other half of ore is processed through the Millennium Ore Preparation plant and Extraction plant, and raw bitumen is transferred to the Base Extraction plant for secondary extraction froth cleanup. After 2012, additional primary extraction capacity is constructed in the Steepbank Mine area.

This section describes the Millennium Ore Preparation and Extraction plant process and the combined Secondary Extraction froth treatment process.

The Millennium bitumen production process is a modest extension of the enhanced Steepbank process. Opportunities for further enhancements are under consideration, in particular the following:

- A design-basis test program is in progress and will be concluded by mid-1998.
- Initial data from the startup of Steepbank will be assessed, to identify possible improvements over Steepbank facilities.

C2.5.2 Description of Process

Incorporated into the Millennium extraction process are:

- a streamlined approach to oil sand transport and conditioning
- the Steepbank process for bitumen recovery and froth handling
- an extension of Steepbank technology for froth treatment
- Consolidated Tailings (CT) management technology

Oil Sand Transport and Conditioning

During the initial years of operation, a distinct oil sand transport operation (such as the hydrotransport lines incorporated in the Steepbank design) will not be required since the Millennium bitumen separation plant will be located in the immediate vicinity of the truck dump and ore preparation plant.

Conditioning will be accomplished in agitation tanks, using technology developed for Steepbank operations.

The Millennium process flow diagram is shown on Figure C2.5-1. Ore is delivered by truck to either of two hoppers, each of which supplies a dedicated sizer whose function is to crush the ore to less than 400 mm in size. Two sizers will be installed initially, with provision for a third when required. The capacity of each sizer is sufficient to sustain full production.

Crushed oil sand is delivered by conveyor to rotary drum breakers, where it is further reduced to less than 50 mm. Pulverization is facilitated by the addition of hot water to the breakers and a slurry is formed. There are four breakers, two for each sizer. Oversize from the breakers is rejected and is trucked to disposal. Underflow from the breakers is collected in a sump, from which the slurry is pumped to conditioning tanks. Mineral and bitumen are maintained in suspension by agitators. Slurry temperature during conditioning will be about 55° C.

Conditioning tanks also provide the necessary surge storage to minimize irregularities in oil sand delivery rate from the mine, needed as downstream equipment performs best under steady operating conditions.

Transfer of heat and mechanical energy to the oil sand in the breakers and conditioning tanks is sufficient to both release bitumen from the oil sand matrix and ready the slurry for bitumen recovery.

Bitumen Separation Circuit and Froth Handling

Figure C2.5-2 shows the process flow diagram for the Millennium bitumen separation circuit and froth handling. Slurry from the conditioning tanks is combined with warm water, then discharged into the separation circuit, which consisting of the following:

- two separation cells in parallel
- a secondary circuit comprised of flotation cells associated with each separation cell
- hydrocyclones
- a tertiary circuit comprised of flotation cells

Bitumen froth recovered from secondary and tertiary flotation cells is recycled to the inlet of the separation circuit. Feed temperature in the separation circuit will vary between 50°C (winter) and 55°C (summer).

The principal recovery mechanism in the separation circuit is the separation cell. Surface area and residence time in these cells are sufficient for:

- a layer of bituminous froth to separate from the feed slurry
- the bulk of the sand in the slurry to settle to the bottom of the vessel

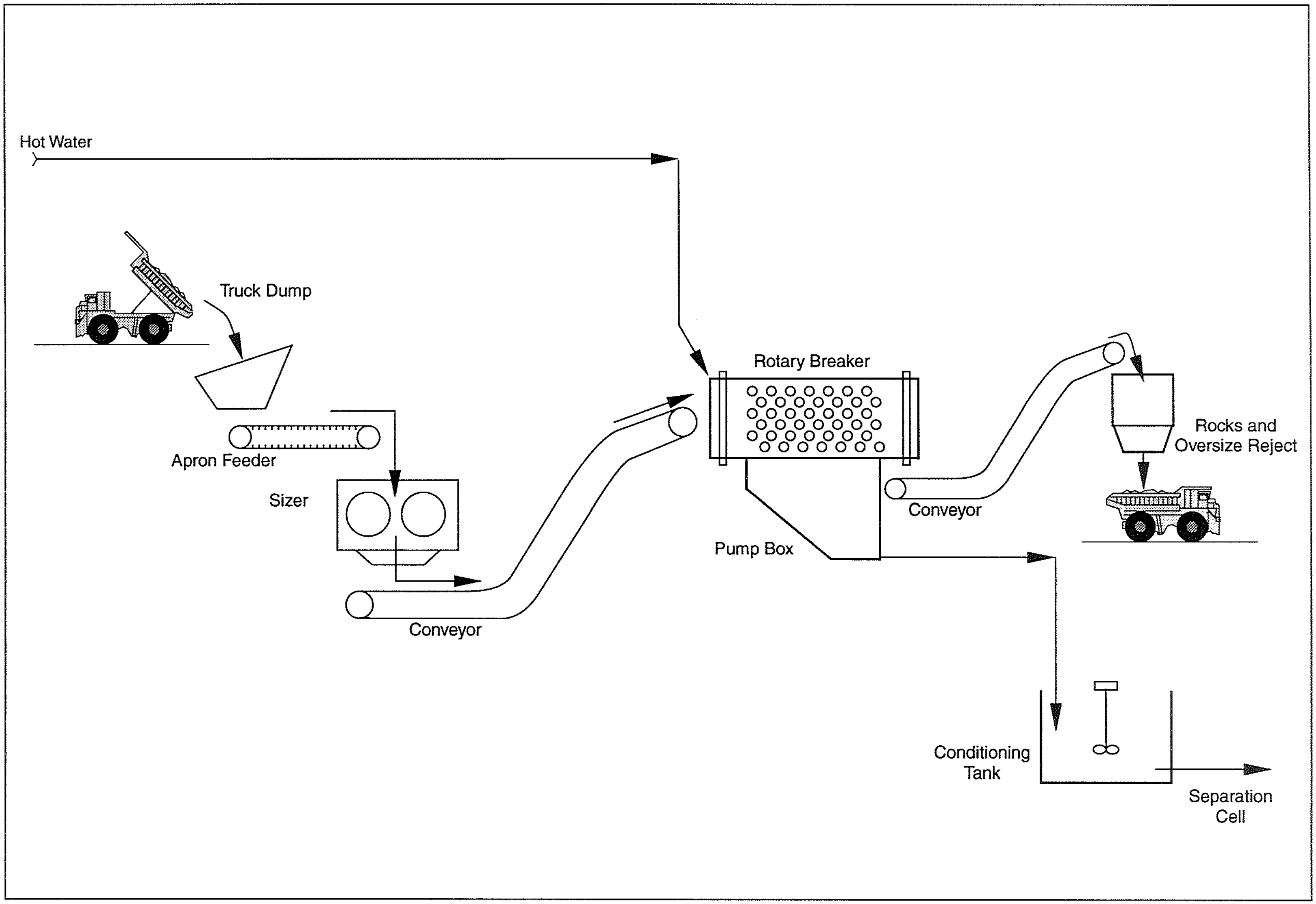


Figure C2.5-1 Millennium Ore Preparation Plant

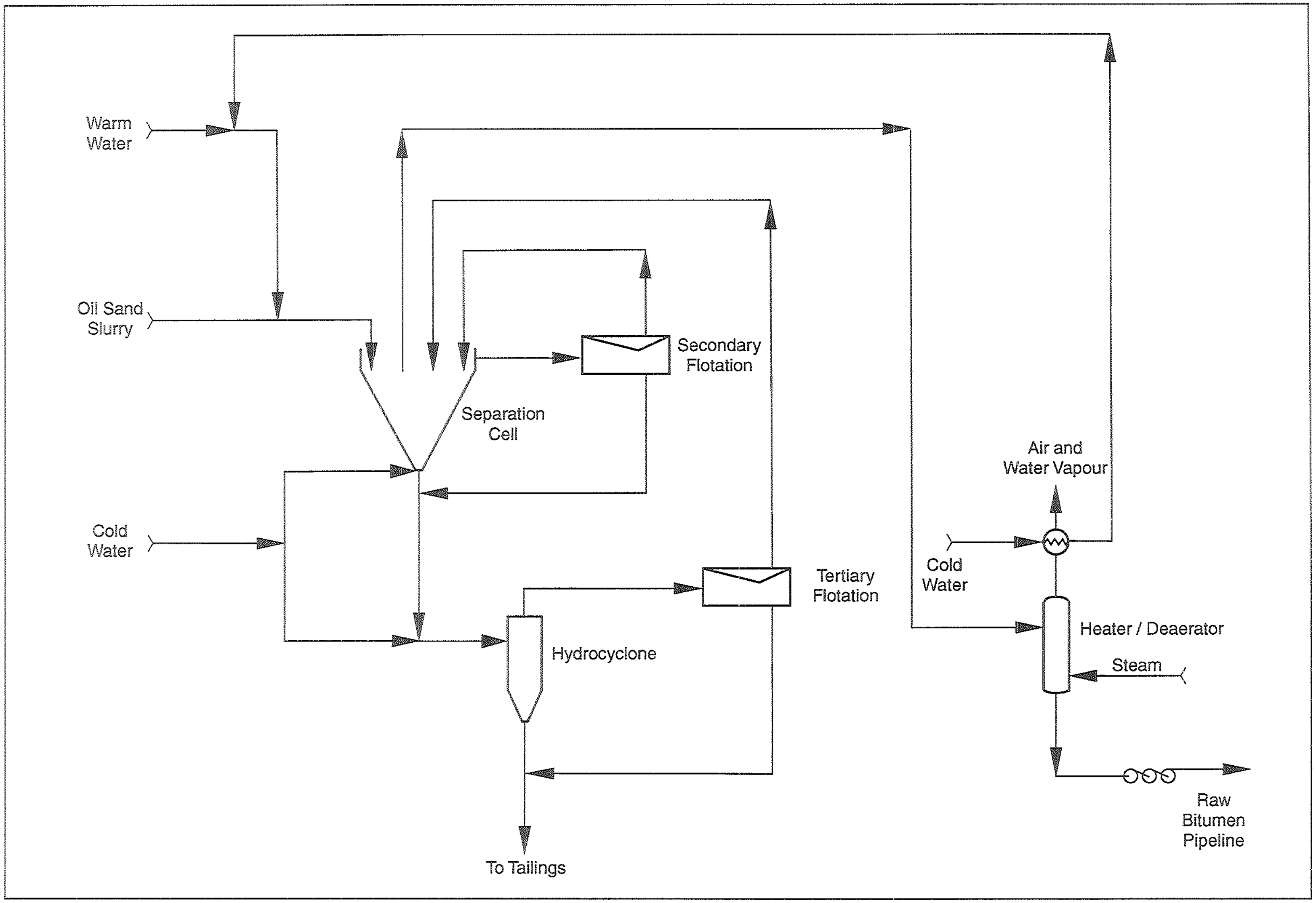


Figure C2.5-2 Millennium Separation Circuit and Froth Handling

Separation cell product is a froth, predominantly bitumen recovered directly from the conditioning tank slurry, but also containing bitumen recycled from the secondary and tertiary flotation circuits. Relatively dense sand slurry is withdrawn from the base of the separation cell and sent to tailings hydrocyclones. A middlings stream (a dilute suspension of sand, fines and bitumen) is withdrawn from the side of the separation cell and sent to the secondary flotation cells. The bulk of the middlings bitumen is recovered from the secondary flotation cells as a dirty froth and is recycled to the separation cells. Tailings from the secondary flotation circuit and separation cell are processed in banks of hydrocyclones, which separate the combined tailings into a sand-laden underflow stream and a fluid-rich overflow stream. The overflow stream contains residual bitumen, most of which is recovered in the tertiary flotation cells. Tertiary froth is also recycled to the separation cell feed.

Froth from the separation cell is sent directly to a heater/deaerator for heating and deaeration, accomplished by passage of live steam upward through curtains of froth cascading down through the column. Recent improvements in column design will enable heating efficiencies of at least 80% to be achieved. In essence, deaerated froth is bitumen contaminated with water and mineral. This hot, "raw" bitumen will be pumped to an interstage bitumen tank.

Froth Treatment

The froth treatment process flow diagram is shown on Figure C2.5-3. Raw bitumen from the tank is combined with hot diluent and processed in inclined plate gravity separation vessels. Gravity separation is controlled so that overflow product meets the quality specifications for diluted bitumen. Underflow from the gravity separation is further diluted with hot diluent and sent to a two-stage classifying cyclone circuit, with demulsifiers added as required. The cyclones remove the bulk of mineral from the feed. Product from the cyclones is fed to disc centrifuges where mineral and water contents are reduced to 0.5 wt% and 4 wt% respectively. The product stream from the disc centrifuges is combined with gravity separator overflow and then pumped to storage. Waste streams from froth treatment are combined and sent to a diluent stripping tower.

Overall Balance

Figure C2.5-4 shows a simplified flow diagram for the extraction process. Volume 1, Section D details material and energy balances for the overall operation including bitumen production.

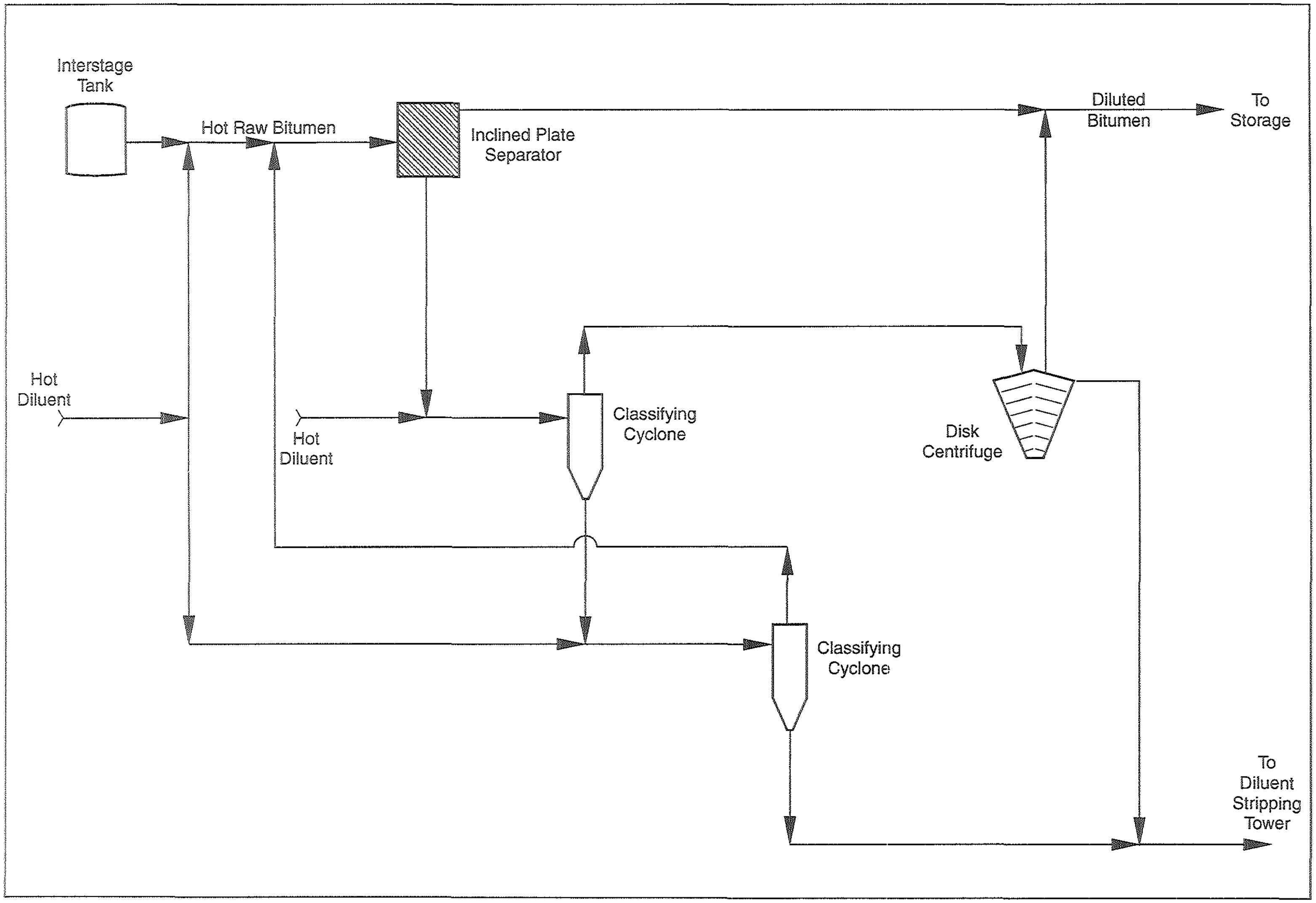


Figure C2.5-3 Millennium Froth Treatment Process

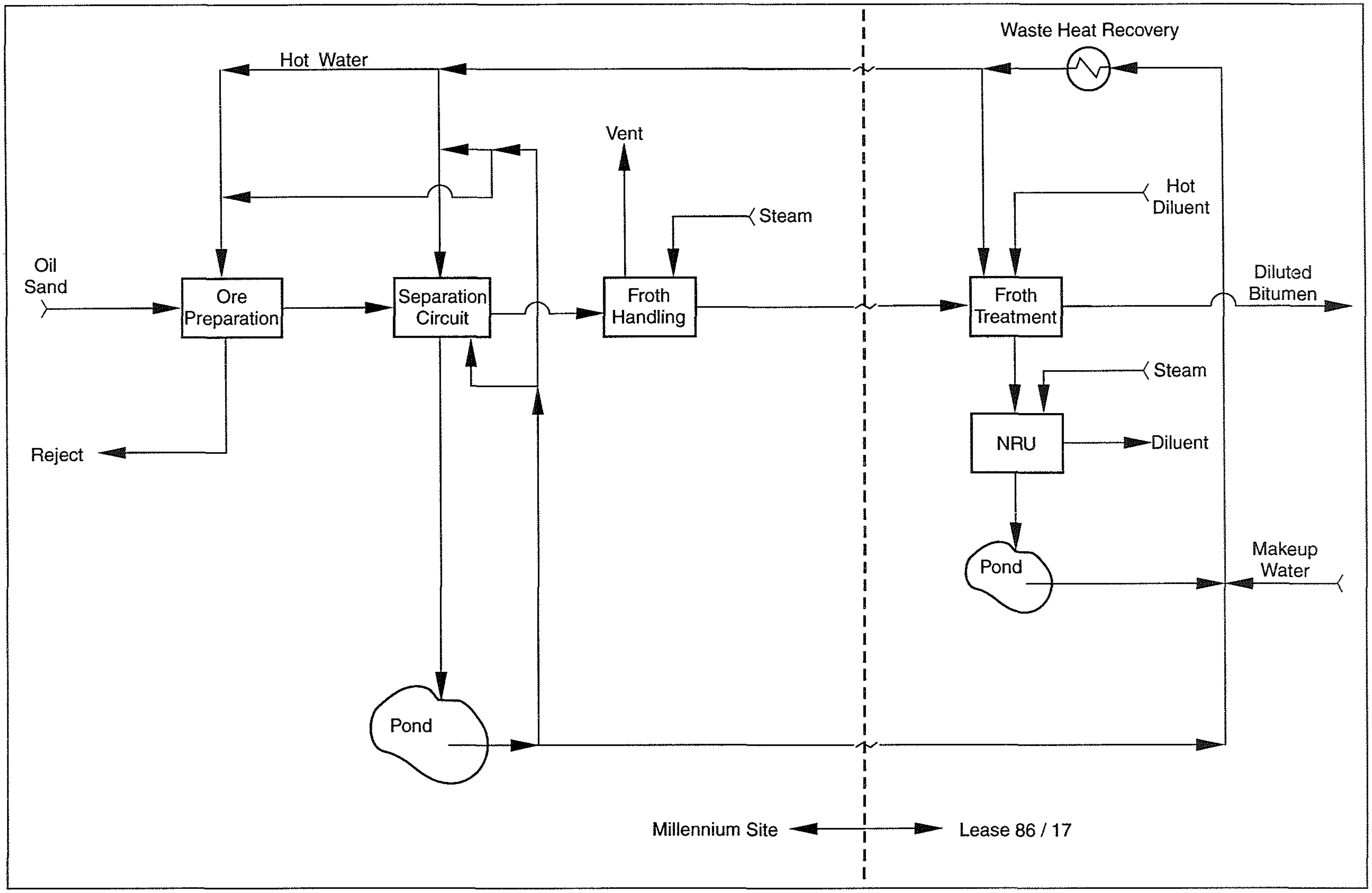


Figure C2.5-4 Millennium Overall Extraction Process

Tailings Management

Separation Circuit Tailings

The bulk of the tailings from operations will be deposited using CT technology; some tailings sand will be used for dyke construction. In the longer term, the principal means for disposing of Millennium Extraction plant tailings will also be CT, but during the first six years of Millennium operation, an external conventional tailings pond will be used. After six years, CT can be implemented in-pit using the inventory of mature fine tails in the external pond. Until 2014, separation circuit tailings (composed of hydrocyclone underflow and tailings from the tertiary flotation cells) will be combined and discharged to the external tailings pond. The duration for out-of-pit tailings storage is determined by:

- ore body geometry
- most cost-effective mine-opening strategy, which in itself is influenced by local topography as well as its impact on tailings delivery and storage costs

Once CT has been implemented, the process flow diagram for separation circuit tailings is as shown on Figure C2.5-5. Combined tailings from the separation cells and secondary flotation cells continue to be merged, diluted and sent to the hydrocyclones (no change from startup operation), where the stream is divided into high-mineral underflow and low-mineral overflow. Key parameters for CT operation pertain to the underflow. It is desirable that essentially all the sand and only minimal water in the tailings feed stream divert to the underflow, which is then combined with mature fine tailings retrieved from existing inventory. Relative amounts of fine tailings and underflow are set by the target density and sand/fines ratio values in the resulting mixture.

A small amount of calcium ion is added in the form of gypsum, which is produced as a byproduct of Flue Gas Desulphurization (FGD) in the Energy Services plant. This calcium ion renders the mixture non-segregating, i.e., the sand and clay in the fine tailings will settle together, rather than the sand settling out and the clay remaining in suspension. This aggregation forms the basis for CT technology. The chemically-treated tailings mixture is pumped to a CT pond, where it consolidates to a stable deposit.

Tailings from tertiary bitumen recovery flotation cells are pumped as a separate stream to storage in the recycle water pond.

Most of the tailings sand will be used exclusively for CT. A small portion will be used for dyke construction on Dyke 11C during summer months. Otherwise, overburden will be used for dyke construction.

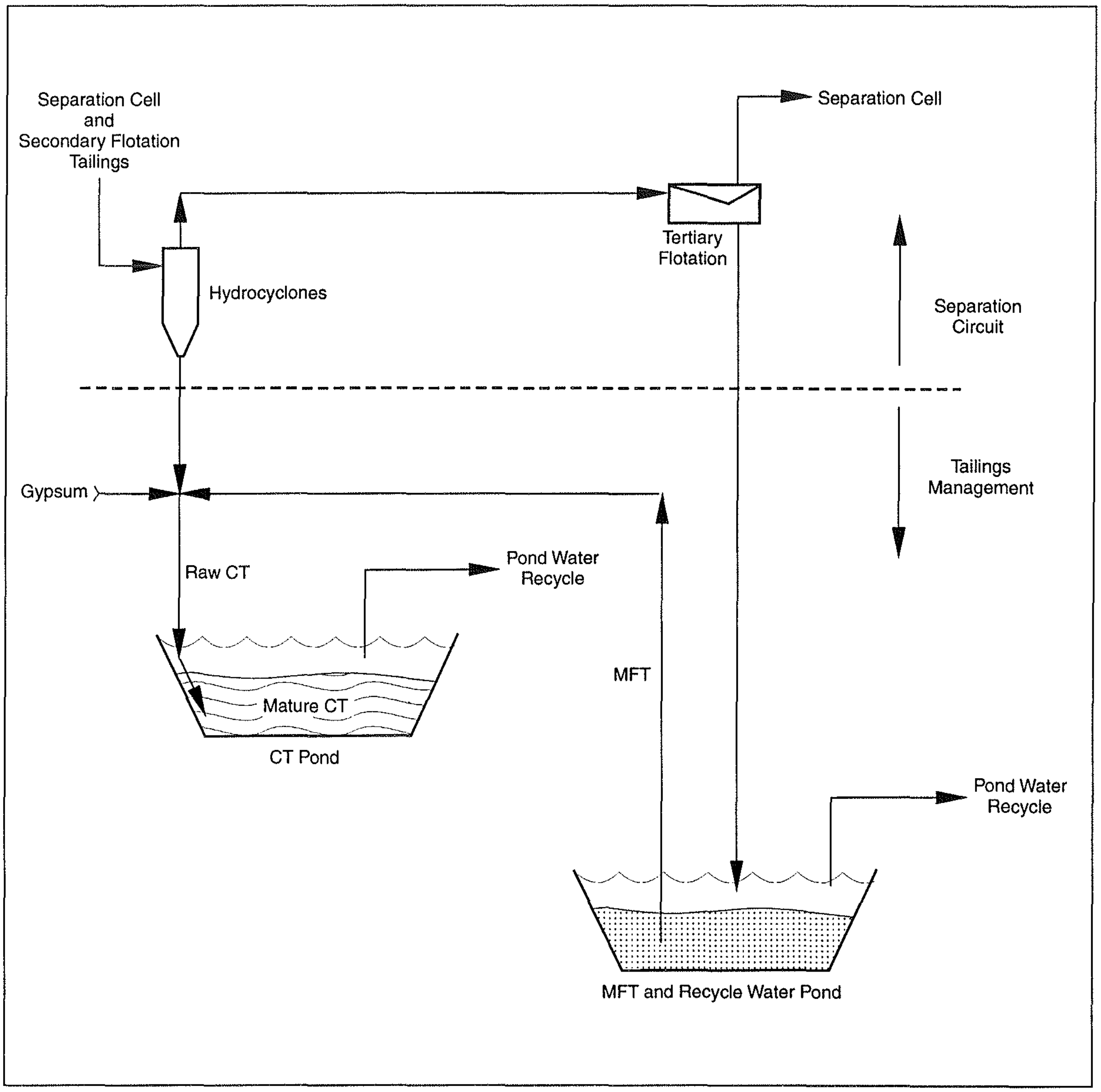


Figure C2.5-5 Millennium CT Process

Tailings pumps, hydrocyclones and pipelines will be designed to incorporate sufficient flexibility to meet all operational demands.

Froth Treatment Tailings

Froth treatment tailings from the combined production from expanded operations are routed to a Naphtha Recovery Unit (NRU), where most of the diluent is separated for recycling by flashing and countercurrent contact with live steam. Lean tailings are then pumped for storage to Pond 2/3.

A new NRU is being constructed for PEP production levels. The column itself is large enough to accommodate combined flow rates at Project Millennium levels, but, ancillary equipment such as overhead condensers, pumps and cooling water supply piping will be installed for Millennium production.

The existing NRU column will be brought into service whenever the new column is taken out of service for planned maintenance. This is expected to occur when a maintenance turnaround for one of the two upgrader trains is in progress. On these occasions, the existing NRU will be sufficient to maintain diluent recovery at a minimum of 99.3%.

C2.5.3 Technology Initiatives

Project Millennium design incorporates several technology initiatives that are also found in the expanded Steepbank design. Some are currently operating while others will start up in 1998. These initiatives are as follows:

Current Operations:

- froth underwash technology, intended to improve separation circuit froth quality when high-fines ore is processed
- new froth heater/deaerator internals, which have improved thermal efficiency from about 50% to 80%
- an interstage storage tank for hot, deaerated froth
- satisfactory operation of CT technology
- enhanced use of present installed capacity through focused identification, assessment and then mitigation of production impediments

1998 Startup:

- ore preparation and initial conditioning of oil sand in rotary breakers
- final conditioning in agitation tanks
- increased waste heat recovery from the Upgrader
- slurry conditioning at 55°C; bitumen separation at 50°C to 55°C

- tertiary flotation cells for recovery of residual bitumen from hydrocyclone overflow
- inclined plate separator, which process two-thirds of the diluted bitumen feed

In addition to the preceding initiatives—all of which will be implemented and further developed once Steepbank operations commence—Suncor has evaluated several ideas which have the potential to effect further improvements in extraction performance.

Initiatives under active assessment and considered part of the current design for Millennium include the following:

- a froth treatment process in which 100% of the combined diluted froth production is processed in gravity separators
- use of hydrocyclones in place of scroll centrifuges to reduce the mineral content in the underflow stream from the gravity separators
- new specification for froth treatment diluent to reduce diluent loss

Initiatives under active assessment, with the potential for inclusion in the Millennium design, consist of the following:

- a froth deaerator which requires no steam, eliminating the need for boilers at Millennium Extraction plant
- a low-temperature raw bitumen pipeline
- an additional recovery step in the froth treatment tailings process
- use of thickener/clarifier technology (including its extension to paste technology) to recover and recycle warm water from tertiary flotation tailings. Furthermore, the clarifier underflow (in which mineral content is dominated by fines) can be used directly in the recipe for Consolidated Tailings.

Some of these ideas are the subjects of a design basis testing program, which will generate sufficient data for orderly decisions to be reached both prior to and during detailed engineering.

Ideas which have been put to the side for the time being include:

- A separation circuit (based on hydrocyclone technology) consisting of three stages of hydrocyclones, a clarifier (for recycle of warm process water and a settler (for concentrating bitumen in bitumen-rich streams).

- Technology demonstrated by Bitmin, in particular: ablation drums (either co-current or countercurrent) for oil sand conditioning; and dry tailings manufacture as an integral part of the separation circuit process.

- use of a conventional clarifier in place of inclined plate separator units at the front end of the froth treatment plant
- separation circuit temperatures less than 50°C. The 50°C to 55°C range that will be used at Steepbank and is proposed for Millennium is a step out from Suncor's current practice, which is to operate at temperatures of about 70°C

C2.5.4 Process Selection Criteria

Suncor's extraction process for Project Millennium is a natural progression from the process that will operate at Steepbank. Its selection based on the following criteria:

- capital and operating costs
- technical risk
- bitumen recovery
- thermal energy efficiency
- fine tailings generation, storage and reclamation
- water balance
- diluent losses

The last four criteria relate to environmental impact. This list also includes relevant objectives set forth by the AEUB for integrated, mining oil sands projects.

Capital Costs

Capital costs have been optimized by incorporating Steepbank innovations; assuming a modest improvement in bitumen production service factor (based on recent Base plant performance); and taking full advantage of the potential in existing froth treatment facilities. Implementation of this strategy will be as follows:

- Suncor intends to produce a hot, raw bitumen stream at the Millennium Extraction plant, transport it by pipeline to the Base Extraction plant, combine it with production from Steepbank Mine, and treat the combined stream in an expanded froth treatment plant.
- Ore Preparation plant design is identical to that of the Steepbank plant currently under construction. Possibly there is excess capacity in the design, but early experience with the Steepbank system will enable an improved final design for the Millennium plant.
- The bitumen separation circuit embodies simplifications inherent in the sixth line under construction for Steepbank including:
  - Secondary and tertiary froth streams are recycled to the separation cell, which generates a combined froth product.
  - Enhanced froth properties are realized through the use of froth underwash.

- Improved isolation of separation cell contents from the middlings and underflow streams, which will aid in maintaining steady conditions in the separation cell, thus enhancing bitumen recovery.
- Two trains at the front end of the separation circuit. Tailings from both trains are combined and further processed for tertiary bitumen recovery.

- Combined raw bitumen production will be stored in the interstage tank. Additional tankage to accommodate increased production when Millennium comes on-stream is under study.
- Savings will be realized in froth treatment by augmenting the capacity of the existing plant with additional gravity separation vessels and new classifying cyclones, used for processing gravity separator underflow. The combined production at Project Millennium levels will be processed in the augmented froth treatment plant.
- A new column for stripping diluent from froth treatment tailings is planned as part of PEP. The column, which embodies existing technology for diluent stripping, is sized to process the combined tailings at Millennium production levels.

Major Equipment

Major new equipment is summarized in Table C2.5-1.

Table C2.5-1 Major Equipment for Millennium Extraction Facilities

Activity or Process	Equipment	
Ore preparation	2	Truck dump hopper
	2	Apron-feeder
	2	Sizer
	4	Feed conveyor
	4	Rotary breaker
	1	Reject conveyor
	1	Reject bin
	3	Conditioning tank
Primary extraction	2	Separation cell
	1	Secondary flotation system
	4	Hydrocyclone bank
	1	Tertiary flotation system
	1	Tailings pump station
Froth handling	1	Deaerator
	1	Raw bitumen pipeline
		Additional tankage
Froth treatment	12	Inclined plate separator
	2	Classifying cyclone bank
Separation circuit tailings	3	Tailings line
Froth treatment tailings	1	Tailings line

Operating Costs

Extraction operating costs are dominated by:

- the cost of power: Principal areas of consumption are tailings transport to the tailings pond and interplant pipelines (tailings recycle water and raw bitumen to Lease 86/17; hot tailings recycle water return from Lease 86/17) as well as material movement within the plant itself. Power consumption by the pipelines was a consideration in siting the Millennium Extraction plant.

- the cost of thermal energy: Suncor intends to operate the Millennium Extraction plant in the range of temperatures anticipated for Steepbank operations: 50°C to 55°C. Energy costs will be minimized by:

  - recovering the optimum level of waste heat from Upgrading
  - exploiting to its fullest potential the opportunity to use an efficient cycle for power generation and low-pressure steam use
  - continuing the use of coke as the primary fuel for the existing Energy Services boilers

- labour and maintenance costs: These are minimized through the use of large equipment (hence requiring fewer facilities per tonne of ore processed) relative to current operations.

Technical Risk

At issue here is the potential for failure to meet expectations. Technical risk is of two kinds:

- Significant step-outs from the Steepbank design are contemplated for Project Millennium. As noted in the discussion of technical initiatives, those deemed attractive will be demonstrated in a design basis testing program. Most of these tests will be conducted in small-scale facilities on-site. While the tight testing schedule may preclude Suncor's ability to incorporate some of these initiatives in the Millennium design, it is also possible that successful (though not exhaustive) runs can and will be used to justify use of novel concepts. Such a conclusion would carry some risk but it will be controlled by a safe fall-back design.

- The imperatives of maintaining cost and schedule targets for the construction of Project Millennium mean that a window of about four months is available to incorporate knowledge from the startup of Steepbank's Ore Preparation plant, deep-cone separation cell and newly- configured froth treatment plant. Steepbank facilities will not have been optimized in that time interval, resulting in judgment and associated technical risks when establishing a detailed design of the corresponding Millennium facilities.

Loss of production may result until sufficient operating experience is gained or until equipment modifications have been completed.

These are risks that Suncor is prepared to accept.

Bitumen Recovery

Suncor is committed to achieve an average of 92.5% bitumen recovery from ore. Suncor is also committed to sustain a program of recovery improvement initiatives consistent with those identified in the Steepbank Mine application.

For current plant operations, calculation of bitumen recovery is based on a procedure developed in collaboration with the AEUB. The calculations proceed sequentially upstream from froth treatment and the NRU using selected stream assays and flow rates to estimate bitumen content in the oil sand feed. Results of these calculations for 1996 and 1997 are summarized in Table C2.5-2.

Bitumen losses to rejects, separation circuit tailings and froth treatment tailings are discussed in the following sections.

Table C2.5-2 Extraction Plant Recoveries in 1996 and 1997

Month	Calculated Recovery (wt%)	
	1996	1997
January	92.4	92.9
February	92.5	93.2
March	91.5	93.2
April	92.0	93.8
May	91.4	89.7
June	90.9	91.8
July	92.0	91.9
August	92.8	90.1
September	91.5	93.6
October	93.4	91.8
November	94.3	91.0
December	93.6	92.2
Weighted Average	92.4	92.4

Losses to Reject

In the test program (which demonstrated the feasibility of rotary breakers for oil sand slurry preparation), bitumen loss to rejects was estimated at about 1 wt% of the bitumen in the oil sand feed. This compares with about 2 wt% to 3 wt% in current operations. A conservative estimate of 2.1% has been assumed in Table C2.5-3.

Table C2.5-3 Allocation of Bitumen Losses in Extraction (wt% of Bitumen in Oil Sand Feed)

	1997	PEP	Millennium
Bitumen recovery (%)	92.4	92.5	92.5
Bitumen losses (%):			
• Reject	1.8	2.1	2.1
• Separation circuit tailings	3.4	3.0	3.0
• Froth treatment tailings	2 4	2.4	2.4
Total (%)	100	100	100

Losses to Separation Circuit Tailings

In recent years, Suncor has reduced bitumen loss to primary extraction (separation circuit) tailings by achieving relatively constant, high densities in the separation cell underflow streams. Improvement is attributed to both the conversion to truck and shovel mining (which provides a more uniform feed rate) and to modifications made to the separation cell rake mechanisms. The Millennium plant, which is of the same design as the sixth line being constructed for Steepbank operations, should improve current performance by:

- use of deep-cone separation cells in place of shallow cells with a rake mechanism
- a tertiary recovery step incorporating flotation cells

It is estimated that bitumen loss to separation circuit tailings will be about 3%.

Losses to Froth Treatment Tailings

In good-quality ore, bitumen loss to froth treatment tailings is about 2% of oil sand feed bitumen, while in poor-quality ore the loss can be as high as 3%. Suncor expects that the design basis test work on classifying cyclones in froth treatment service will demonstrate that losses to Millennium froth treatment tailings will not exceed current experience. An anticipated loss of 2.4% is shown in Table C2.5-3.

The preceding discussion suggests total bitumen losses for PEP and Millennium operations will be about 7.5%, resulting in overall recoveries of about 92.5%.

Impact of Increased Fines

Fines content (less that 44 microns) in the east bank mining area ore will be higher than that from the Lease 86/17 mine. Drillhole evaluation is continuing but present indications are that Steepbank fines content may average about 17% (expressed as a percentage of mineral in ore) compared to about 15% in the Lease 86/17 mine.

Experience dictates that bitumen recovery would be adversely affected by higher fines in the current extraction configuration. The main area of potential loss (due to high fines content in the present circuit) is increased loading and bitumen losses in the flotation cells that process separation cell middlings. There is reason to believe these losses can be counteracted by using tertiary recovery flotation cells in the separation circuit.

Extraction Process Thermal Energy Demand

The dominant factor affecting energy intensity in bitumen production is the amount of thermal energy consumed by the extraction process. Table C2.5-4 summarizes the thermal energy balance for extraction. Data are presented for calendar day rates. A calendar day rate is determined by averaging the quantity in question over one year.

Three main parameters which affect thermal energy demand are: oil sand rate; ratio of water to oil sand used in the extraction process; and temperatures of the streams as they enter and leave the process. These parameters appear near the top of the table. Note that:

1. The proportion of water has been adjusted in anticipation of projected PEP and Millennium ore qualities.

2. Oil sand feed and water temperatures are the same for all cases and are estimates of annual average values.

3. The separation circuit temperature is lower (53°C versus 86°C) for Millennium operations.

Thermal energy requirements calculated from input data are presented as total heat demand rate and heat demand per tonne of oil sand. Note that heat demand per tonne of oil sand decreases from the current 259 MJ/t to 206 MJ/t for Millennium operations.

Thermal energy is supplied by live steam, recovered waste heat and by condensing steam as follows:

- Live steam consumption at Millennium production levels remains about the same as for current production levels because oil sand is no longer conditioned in a drum, and because improved deaerator internals have increased froth heating efficiency from about 50% to 80%.

Table C2.5-4 Extraction Thermal Energy Demand

Parameter	Units	1997	PEP	Millennium
Synthetic crude production	bbl/cd	79 400	130 000	210 000
Oil sand rate	t/h	6 180	10 150	16 800
(Slurry Prep + Sump Water) /Oil Sand	wt/wt	0.555	0.633	0.632
Temperatures:	°C			
- Oil sand feed		1	1	1
- Make-up water		10	10	10
- Diluent feed		48	48	48
- Separation circuit		68	55	53
- Diluted bitumen		84	91	84
Thermal energy required:				
- Total	MW	445	638	963
- Per tonne of oil sand	MJ/t	259	226	206
Thermal energy supply:	MW			
- Live steam		143	89	150
- Waste heat:		63	144	424
- Cooling water				
- Low-grade heat recovery				
- Miscellaneous				
- Condensing steam		382	406	389
Total process steam:				
- Energy rate	MW	525	494	539
- Mass flow	t/h	835	803	856
Total steam supplied:				
- Mass flow	t/h	919	883	942

- The main waste heat item is waste heat recovered from expanded Upgrading facilities.

- Condensing steam supplies the balance of extraction heat.

Total process steam is the sum of live and condensing steam requirements. Total steam supplied is 110% of process steam required, with the additional 10% accounted for by miscellaneous heat sinks such as losses, heating, ventilation and steam tracing.

It is noteworthy that Millennium's thermal energy consumption per tonne of oil sand is 20% lower than that for existing operations. This is a consequence of lower operating temperature, lower live-steam consumption and credit for low-grade heat recovery. This reduction in consumption has a positive influence on greenhouse gas emissions.

Fine Tailings Generation, Storage and Reclamation

Tailings fines consist of mineral (less than 44 microns) released from oil sand during conditioning, then suspended in the fluid phase of the tailings stream. Upon deposition in tailings ponds, the portion of tailings fines not trapped in a sand matrix (e.g., in the beach or the pond bottom) remains in the fluid portion of the pond. Fines continue settling (over a period of two to three years) until a layer with a mineral content of about 25 wt% to 30 wt% is attained, at which point further settling and consolidation is indiscernible. The resulting stable suspension is classified as mature fine tailings (MFT).

Since start of operations in 1967, Suncor has accumulated about 100 Mm^3 of MFT. This fluid is stored in ponds that have perimeter walls constructed of overburden and tailings sand.

Factors which affect the amount of fine tailings generated include:

- amount of clays and extent of their dispersion in the oil sand
- temperature of conditioning process (high temperatures create more fines)
- chemical environment during oil sand processing (the high alkalinity required in current operations increases creation of fine tailings)

Consolidated Tailings (CT) technology is an effective means of converting MFT to a stable deposit. This conversion is achieved by chemically altering the MFT mineral so that it has sufficient strength to prevent differential settling of sand in the MFT (relative to the suspended fines). Thus, if sand is intentionally mixed into chemically-treated mature fine tailings, the additional load imposed on suspended fines by the suspended sand will accelerate the consolidation process, permitting significant shear strength to be achieved in one or two decades.

There is sufficient flexibility in the CT recipe so that Suncor's inventory of MFT can be gradually drawn down. In steady-state operation, storage would be necessary for about three years' inventory of maturing fine tailings as well as for plant recycle water.

The extraction process (including tailings management) which Suncor proposes for Millennium operations may generate fine tailings at a slightly higher rate than at present. Variables include the quantity and characteristics of fine minerals in the oil sand as well as the conditioning environment. Higher fines content in Millennium ore (17 wt% vs 15 wt% of mineral) will be offset by lower conditioning temperature (53°C vs 68°C).

Combined Millennium and Steepbank operations will require progressively less storage for tailings fluid owing to the gradual conversion of current MFT inventory to a stable solid by means of CT technology. Over twenty to thirty years of operations, MFT inventory will be reduced to a low amount and then MFT will be consumed at the same rate they are created.

Water Balance

The current extraction operation is a net importer of water which then accumulates in tailings ponds and in MFT. While the combined Steepbank and Millennium CT operations are in steady-state, the extraction/tailings operation will continue to be a net importer of water. Suncor's objective at all times is to maximize the use of CT release water, thereby reducing water demand from the Athabasca River.

Diluent Losses

Parameters that affect the quantity of diluent lost to the tailings pond are:

- bitumen feed to secondary extraction
- diluent to bitumen ratio in the stream processed by hydrocyclones and disc centrifuges
- overall hydrocarbon recovery in secondary extraction
- NRU diluent recovery

Additional operating parameters are associated with the introduction of IPS units into secondary extraction, including:

- the fraction of secondary extraction feed processed by gravity separation
- the diluent to bitumen ratio in IPS feed

Use of IPS units for froth treatment is expected to result in a lower diluent/bitumen ratio in froth treatment than is currently experienced. The diluent/bitumen ratio is forecast to decrease from 0.86 v/v at present to 0.74 v/v at Millennium production levels. For a constant overall diluent recovery of 99.3%, the diluent lost per barrel of bitumen will decrease by 10% for Millennium operation relative to current practice.

C2.5.5 Initiatives to Improve Recovery

In the Steepbank application, Suncor identified several means by which bitumen recovery might be improved. The status of these initiatives is as follows:

1. New Second-Stage Centrifuge: Acceptance tests for this machine were completed in December 1997, eighteen months later than originally anticipated. The machine can sustain 97.5% hydrocarbon recovery but product quality and through-put are modestly lower than initial expectations. Suncor has entered into a continuous improvement agreement with the equipment vendor.

2. Upgraded First-Stage Centrifuge: Upon completion of a joint program with Syncrude, Suncor retrofitted six first-stage centrifuges. A test program on one of these machines showed that, when operated at 25% higher through-put, the hydrocarbon loss to tailings increases from about 0.5% to about 0.6% on feed hydrocarbon. Further retrofitting is not justified.

3. Larger Drum Slurry Screens: Larger drum slurry screens have been installed, however the benefits anticipated for the new screens have been masked by the significantly higher through-puts that Suncor has achieved in current operations relative to 1995 i.e., total oil sands feed rate of about 7 100 t/h versus about 6 500 t/h.

4. NRU Enhancements: Modifications to the NRU have enabled Suncor to maintain an overall extraction diluent recovery of 99.3% on input diluent. This has been achieved even for the higher through-puts in current operations.

5. Froth Underwash: This process has been implemented in four of five separation cells in the current plant with a slightly different configuration in each of the cells. Test work has shown that:

   - an improvement in froth quality (i.e., a higher bitumen content) relative to operation without the underwash is achieved in only one of the cells
   - hot froth underwash is able to raise just the temperature of separation cell froth without having to raise the temperature of the entire cell contents by the same amount
   - Suncor will continue efforts to further capitalize on froth underwash technology.

6. Bitumen Recovery from Hydrocyclone Overflow: The Steepbank facility for tertiary bitumen recovery associated with hydrocyclone overflow is in the final stages of construction. A performance test will be completed in second quarter 1998. Incremental recovery from this third-stage operation is expected to make a significant contribution to the target overall bitumen recovery of 92.5% when Millennium ore is processed.

7. Bitumen Recovery from Mature Fine Tailings: Suncor has not proceeded with this initiative because it is not economical.

8. Interstage Tank: This has been installed. Its main contribution has been to facilitate higher production rates through providing buffer storage between primary and secondary extraction.

9. Diluent-to-Bitumen Ratio in Froth Treatment Plant Feed: Diluent-to-bitumen ratio has been reduced to about 0.65 w/w from the 0.69 w/w assumed in the "Steepbank Mine application" (Suncor 1996b). If overall diluent recovery remains about 99.3%, the absolute loss of diluent for Steepbank operations will be less than anticipated.

C2.6 Infrastructure

This section discusses the incremental infrastructure which will be required to support the Bitumen Production component of Project Millennium.

C2.6.1 Site Facilities

The mine expansion will require additional support facilities, the installation of a facilities corridor and an extension to existing utilities.

The Steepbank Maintenance Complex will be expanded to include ten additional truck maintenance bays, a new lube and fuel island and larger dry facilities.

A facilities corridor will connect Steepbank services to the Millennium Extraction plant area. These services will include road access, power lines, a process hot water line, a pond water return line, a natural gas line and a raw bitumen line. Space will also be provided for the following future pipelines: raw bitumen, gypsum and tailings. Figure C2.6-1 shows the Steepbank facility layout and Figure C2.6-2 shows the Millennium plant area layout (preliminary) as well as the general layout and location of the connecting corridor.

Extensions will be made to the following utilities, from the Steepbank Pit 1 operation to the Millennium plant area:

- substations, electrical power and distribution lines
- diesel fuel and natural gas lines
- process water
- firewater, potable water plant and distribution
- gland water
- sewage plant and lines
- compressed air
- communications

C2.6.2 Site Facilities Rationale

Location of the Maintenance Complex, facilities and utilities and the connecting corridor as well as use of Millennium plantsite was based on environmental, technical and economic factors and was previously approved by AEUB and AEP.

The "Fort McMurray-Athabasca Oil Sands Subregional Integrated Resource Plan" (AEP1996a) has classified the river valley as a Resource Development Area with specific objectives for environmental protection. Through the EIA, effects have been assessed relative to IRP criteria and have been determined to be of a temporary nature.

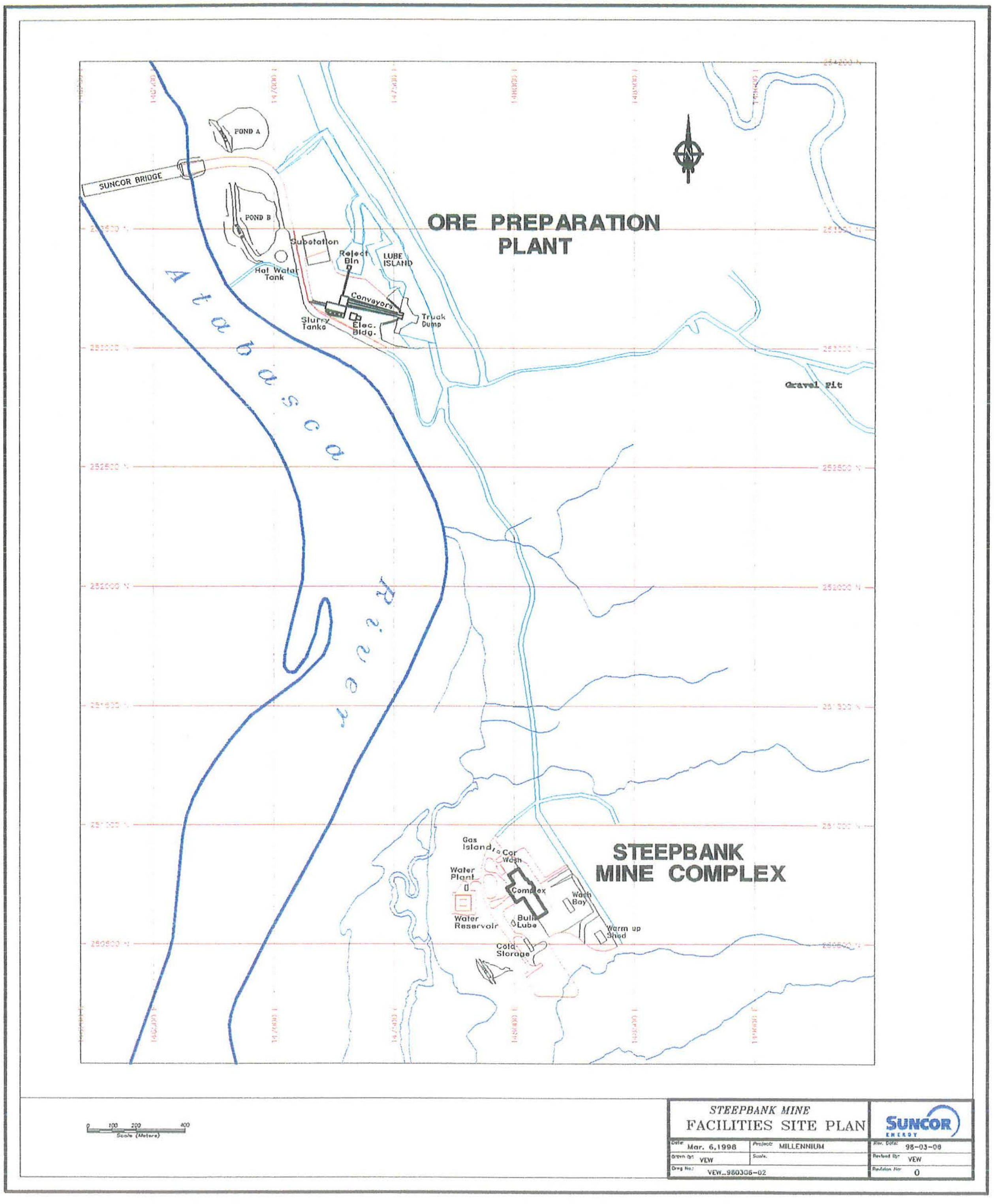


Figure C2.6-1 Steepbank Facility Layout

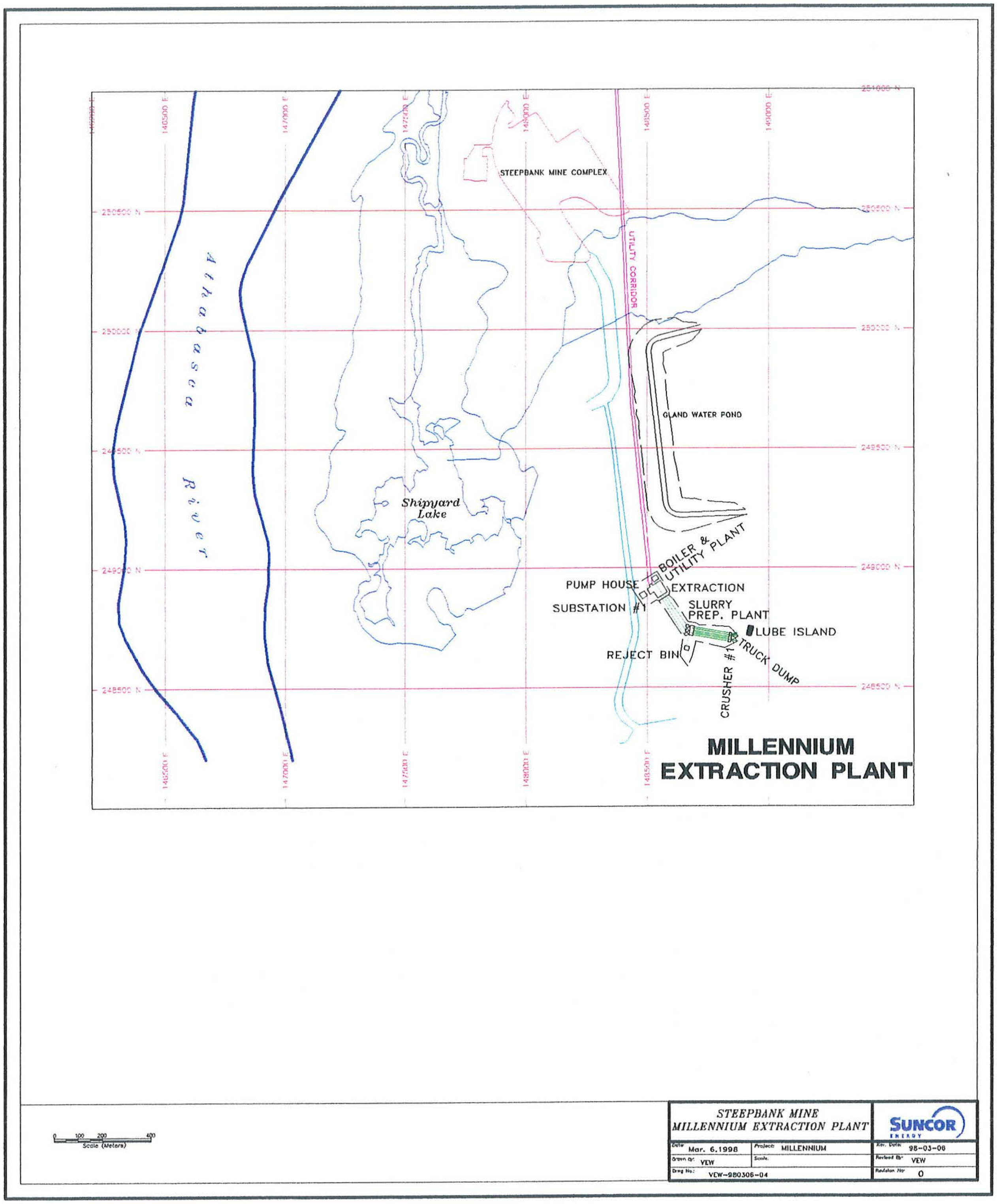


Figure C2.6-2 Millennium Facility Layout and Utility Corridor

Wildlife habitat, one of the more significant areas of concern, can be restored through innovative reclamation of overburden dyke and dump structures comprising the new escarpment. As well, mining direction and production rates indicate that the area will be mined out and mostly reclaimed by 2035, providing for the rapid re-establishment of valley ecological values. The bridge (approved under previous application) and the Millennium access road to the upland area will remain indefinitely. When considering technical and economic factors, overburden and ore haulage have been optimized relative to escarpment slope gradients and distance to the mine face. Other advantages to the proposed site include quality of foundation, fewer roads and utilization of the existing Steepbank shop location.

C2.6.3 Operations and Maintenance Complex

Servicing of all mine equipment operating at Pit 2 for about ten years will be done in the maintenance complex established for Steepbank Mine (in about 2012, some support services will be relocated to the Centre location). Some of these facilities will be expanded to accommodate the extra workforce and equipment from Steepbank Mine. Description of these modifications follows.

Heavy Truck Shop

The Steepbank Mine shop will be extended to the south by ten bays. This extension, noted as a future expansion in the "Steepbank Mine Application" (Suncor 1996b) will be supported by the existing warehouse, tool crib and first aid facilities.

Change Room Area

This facility will be expanded to the west to handle the necessary workforce increase.

Mobile Fuel and Lube Islands

In order to minimize heavy truck traffic to the Maintenance Complex, fuel and lube islands will be provided in the vicinity of the Pit 2 truck dump.

C2.6.4 Access Corridor

Location

The access corridor will extend south from the south side of the Steepbank Maintenance Complex to the Millennium Extraction plant, approximately following the elev 255 m ASL contour grade. From the Extraction plant, the corridor will continue southeast to the Pit 2 truck dump. The corridor road will be unpaved and 18 m wide. Also included in the corridor will be overhead power lines as well as buried diesel fuel, natural gas, potable water and sewage pipelines. An elevated trestle will carry the raw bitumen pipeline and process water, with space included for future gypsum, tailings and raw bitumen lines.

Environmental Considerations

Environmental concerns for the access corridor include leakage prevention, containment and drainage.

Leakage will be mitigated by designing the pipelines with additional strength and wear resistance at elbows, bends and other critical sections. This design will accommodate differential expansion and will provide secure support for the lines. The program instituted for Steepbank Mine will be continued, comprising continuance of non-destructive testing, routine inspection and observation by corridor traffic to provide advance notice of problems.

Pipelines

The following additional pipelines are required for Project Millennium:

- One raw bitumen pipeline (610 mm OD)
- One natural gas pipeline (152 mm OD)
- One gypsum pipeline (203 mm OD)
- Water pipelines:
  - One hot water (915 mm OD)
  - One cold water (508 mm OD)

These pipelines will extend from the Millennium Extraction plant to the Base plant and will cross the Suncor Bridge. Spill containment and mitigation practices (as per Steepbank Mine) will continue for these lines.

C2.6.5 Electrical Power Distribution

Power transmission to Millennium plant main substation will be supplied from the Steepbank substation through a 72 kV overhead line, then distributed to the Extraction plant, ore preparation and the mine.

C2.6.6 Communications

A multicore fibre-optic cable will be routed from the Steepbank communications facility to the Extraction plant, ore preparation, and the mine.

C2.6.7 Sanitary Sewage

The sewage treatment facility (to treat grey water and sanitary sewage) at Steepbank Maintenance Complex will comprise a septic/surge tank and a sewage treatment plant. Treated water from the sewage treatment plant will either be discharged to the Athabasca River via Shipyard Lake or contained within the process water system.

To accommodate the increased population for the proposed Millennium expansion, the treatment plant will be expanded with additional units and a sewage line will connect the facility to the Millennium plant area.

Wastewater from the shop area will be separated into oily-water and grey-water streams. Oily wastewater will be temporarily stored in underground tanks at the main shop area and the light-vehicle shop. These tanks will be emptied as required and the contents either reprocessed or transferred to the liquid waste disposal site.

C2.6.8 Potable Water

The Steepbank Mine potable water system draws water through wells from a shallow sand-gravel aquifer. Water will be chemically treated to meet current approval limits. The system will be expanded to accommodate the increased population from Project Millennium expansion. Potable water will be pumped to the Millennium plant area.

C3 UPGRADING

This section describes:

- the guiding principles, objectives and criteria for the upgrading portion of Project Millennium
- the technical and process options that have been evaluated
- the proposed upgrading facilities

C3.1 Principles, Objectives and Criteria

The upgrading component of Project Millennium supports Suncor's oil sands growth strategy and is based on the following guiding principles:

- to provide a mix of crude oil products that meet North American market demand
- to ensure that the Suncor operation is cost-competitive with other oil sands and conventional oil producers in North America
- to maintain technical and operating flexibility and reliability
- to use technology that is the best considering cost, performance and commercial viability factors
- to continually improve environmental performance

Product mix from the expanded plant will consist of light, sweet and sour crude oils and diesel, formulated to meet market demands. Products recovered before coking are referred to as virgin sour crude. Products recovered after coking are called sour coker crude. Either of these products can be further upgraded to light, sweet crude. Suncor plans to continue to blend oil products to meet individual customer requirements. Market evaluations have determined the optimal upgrader configuration for the best return on investment.

The proposed Millennium Upgrader will be built as a parallel complex with appropriate strategic interconnections and integration with the existing facilities. This design approach offers the opportunity to incorporate numerous advanced features into the plant that (for reasons of process and space availability) would be difficult to retrofit into the existing operation. The plant will be fully integrated with the Extraction and Energy Services facilities.

The Millennium Upgrader is designed to run for up to five years between total maintenance shutdowns, by using appropriate:

- sparing and isolation criteria for equipment
- design criteria
- material selection for equipment

- catalyst type and volume selection

Both the Project Millennium Upgrader and the existing Base plant Upgrader are designed to be fully functional when the alternate Upgrader is down for turnaround maintenance. If a significant process upset or emergency occurs on one Upgrader train, the other train is designed to remain unaffected.

Objectives used to scope the new upgrading facilities include:

- optimize site-wide plant integration
- optimize product yield and byproduct recovery
- optimize energy integration and efficiency
- maximize gathering and use of produced gases
- minimize use of external energy
- ensure protection of environmental and public health
- minimize air emissions
- minimize liquid and solid waste
- minimize freshwater use and maximize water recycle
- use commercially-proven, reliable and economically-viable technologies
- consider potential regional cooperative opportunities

These objectives, related design criteria and proposed technology and operating improvements are outlined in Table C3-1.

C3.2 Technical and Process Options

Major factors considered in evaluation of all technology alternatives include:

- proven commercial technology
- operating experience
- operating reliability
- capital cost
- operating cost
- environmental performance
- construction and procurement schedule
- desired yield, quality and recovery
- product value
- risk impact of catastrophic failure
- energy intensity and efficiency

Table C3-1 Objectives, Criteria, and Technology and Operating Improvements

Issue	Objectives	Criteria	Technology and Operating Improvements
Plant Integration	• Optimize site-wide plant integration	• Segregate new and existing upgrading facilities • To maintain partial production during turnarounds • Target opportunities for optimum energy and water conservation • Capture advanced operating features	• Upgrader waste heat will be transferred to Extraction process water system • All makeup diluent will be supplied from the new Gas Recovery Unit, resulting in reduced emissions
Resource Conservation	• Optimize liquid volume and other product yield	• Design target yield to a minimum of 81.2% gross	• Delayed coking technology has been selected, because of advances in its product slate and lower operating costs
	• Maximize diluent recovery	• Recover a minimum of 99.3% of diluent used in Extraction	• Makeup diluent will be reformulated, to have a narrower boiling range with fewer light and heavy ends and reduced benzene
	• Optimize sulphur recovery, storage and use	• Recover a minimum of 99.5% of sulphur in acid gases produced by Millennium Upgrader	• Tail gas treatment technology was selected based on best-practicable technology, with a design sulphur recovery of 99.5% • Two-stage rather than three-stage conversion will eliminate a sour process gas blower (otherwise required to send process gas through the Tail Gas Treating Unit) • Tail Gas Treating Unit (which is significantly larger than required for Millennium only) will process a portion of Base plant gas to reduce overall SO_2 emissions • No sour process streams will be continuously routed to the flare system • Millennium sulphur storage requirements will be met by Base plant facilities.

Issue	**Objectives**	**Criteria**	**Technology and Operating Improvements**
Energy Efficiency	• Optimize energy integration and efficiency • Reduce energy intensity per unit of production	• Design for optimal heat integration as well as minimum heat rejection to atmosphere or cooling water • Minimize natural gas consumption • Capture and utilize gas streams	• Delayed Coking Unit 2 heater furnaces will be fired using refinery fuel gas and are designed for >90% heat efficiency • Diluent Recovery Unit 3 will be heat-integrated with the coker fractionator pumparounds, to maximize heat recovery from the hot process streams and to minimize the use of steam or fired duty • No process units will be continuously routed to the flare system
	• Maximize the gathering and use of produced gases • Minimize external energy use	• Assess alternative technologies and economics for all streams • Optimize driver selection for energy efficiency	• Waste heat used to generate steam in Upgrading units where feasible • Driver selection in Upgrading based on integrated plant steam balance
Environmental Protection	• Ensure protection of environmental and public health • Minimize air emissions	• Control air and water emissions to lowest practical levels • Use commercially-proven pollution prevention and control technologies • Allow no new continuous flaring sources	• Delayed Coking Unit 2 is designed with a closed blowdown system, to minimize emissions during normal operation and to maximize both hydrocarbon recovery and water recycle • VOCs will be controlled: - using double seals on compressors and on pumps handling light hydrocarbons - routing process vessels to flares during emergency upsets • Furnace burners will be designed for low NO_x and CO emissions • Low-sulphur fuels will be used to minimize SO_2 and particulate emissions • New tanks will be designed with vapour recovery systems or floating roofs as required

Issue	Objectives	Criteria	Technology and Operating Improvements
Environmental Protection Cont.	• Minimize liquid and solid waste	• Extend catalyst life through appropriate design and technology selection • Continually evaluate technology opportunities and seek economic markets for discard materials and potential byproducts • Use advanced technology to minimize chemical use	• Chemical use will be reduced by using pressure swing absorption unit rather than catacarb to purify produced hydrogen • Hydrotreater catalyst will be selected to achieve a minimum two-year run length • Closed amine disposal system will recycle amines directly to the process
	• Minimize freshwater use • Maximize water recycling • Minimize discharge of process-affected waters to the Athabasca River	• Use wastewater as makeup to compatible systems • Reduce the discharge from the upgrading wastewater treatment system to the Athabasca River • Use cooling towers to minimize fresh cooling water requirements	• Upgrading wastewater stream will be used as makeup to the recycle water system, which is used to process oil sands in the Extraction facilities • The wastewater stream will also be used as Utility water and as makeup to the cooling water loops to ensure minimal discharge from the wastewater system during normal operation • Waste heat recovery system designed into Upgrading facilities will result in no additional once-through cooling water discharge to the Athabasca River. Combined river outfall of cooling water plus wastewater is expected to be significantly reduced during routine plant operation • A portion of the stripped sour water stream will be recycled for use as wash-water, makeup water in process units, and coker quench and cutting-water. Freshwater makeup will not be used in the coke removal system

C3.2.1 Upgrading Technology

Delayed Coking Technology (Bechtel/Conoco Coking Alliance) has been selected after consideration of several other potential conversion technologies, including fluid coking and various hydrogen addition processes. A comparison of upgrading technology alternatives is shown in Table C3-2.

Table C3-2 Comparison of Upgrading Technology Alternatives

Technology Considered	Capital Cost	Operating Complexity	Operating Pressure (kPa)	Operating Cost	Liquid Yield (525°C)	Units in Operation World-Wide
Delayed Coking	Low	Medium	350	Low	80%	137 sets
Visbreaking	Low	Low	350	Low	60%	186
Fluid Coking	Medium	Medium	350	Low	86%	8
Flexi-Coking	Medium	Medium	350	Low	85%	5
Canmet	High	High	14 000 to 21 000	High	105%	Demo only
VEBA	High	High	14 000 to 21 000	High	105%	Demo only
L-C Fining	High	High	14 000 to 21 000	Very High	99%	2
H-Oil	High	High	14 000 to 21 000	Very High	100%	6

In addition to the factors used to evaluate all technical and process options, the following factors were of particular significance in the selection of technology:

- proven commercial technology
- Suncor's operating experience
- operating flexibility, complexity and risk
- product quality and yield
- capital costs, including ancillaries such as hydrogen and SO_2 scrubbing units
- risk of catastrophic failure

Suncor examined these alternatives to determine the best choice considering its performance expectation in the areas of safety, environmental care, productivity and reliability; and its marketing strategy; while providing the required economic return to shareholders. Based on this evaluation Suncor chose Delayed Coking Technology.

Delayed Coking Technology is the most well-known, widely-used and understood technology for upgrading bitumen or vacuum residue material to lighter boiling range distillates used in the world today. As a result, information is readily available for direct comparison to other operators for cost control, unit performance and troubleshooting. Lower operating pressure of delayed coking systems significantly reduces the potential for damage resulting from equipment failure. Suncor's experience and competence with delayed coking as the primary conversion mechanism was also a factor in the decision to continue using the technology.

Additional major reasons for choosing Delayed Coking Technology include the following:

- new advances in Delayed Coking Technology, which enable an improved product slate and lower operating costs
- equipment availability
- design engineering experience
- production expandability
- constructability
- maintainability

C3.2.2 Hydrotreating Technology

Several hydrotreater technology alternatives have been considered and a comparison of these alternatives is summarized in Table C3-3.

Table C3-3 Hydrotreater Technology Alternatives

Technology Considered	Capital Cost	Operating Complexity	Operating Pressure (kPa)	Operating Cost	Product Value	Units Operating on Coker Feedstock
No further treatment	---	---	----	---	Low	---
Unionfining	Low	Low	5 000-13 000	Low	Medium	<10
Combo-hydrotreating	Low	Low	5 000-13 000	Low	Medium	0
Unisor	Medium	High	14 000-21 000	High	High	0
Synsat	High	High	14 000-21 000	High	High	0
Hydro-cracking	High	High	14 000-21 000	Very high	High	<10

Unionfining hydrotreating (a UOP technology) was chosen for upgrading a portion of the sour crude products to enable Suncor to:

- produce and market finished diesel fuel that meets all seasonal specifications
- supply custom-blended products to a wider range of customers
- provide products with a wider blended-quality range to meet specific customer demands

State-of-the-art catalysts, reactor designs and recycle gas amine scrubbing minimize hydrogen demand and the need to purge recycle gas to fuel gas. Heat integration minimizes fuel gas consumption. Chemical usage is reduced by using a pressure swing absorption unit rather than catacarb to purify the hydrogen produced. UOP was selected because of its experience and expertise in providing technology suitable for delayed coker products.

C3.2.3 Sulphur Recovery Technology

The sulphur recovery technology selected for Project Millennium is similar to that in the existing Suncor operation. Two-stage rather than three-stage conversion has been selected, in order to eliminate the sour process gas blower required to send process gas through the Tail Gas Treating Unit. A sour process gas blower and third-stage converter would have negative reliability, personnel safety and capital cost impacts. As well, during normal operation, there would be no expected sulphur recovery improvement with a three-stage conversion unit versus a two-stage process, given that a Tail Gas Treating Unit is downstream of the two Sulphur Recovery Units.

Two 100% trains were selected based on a balance of:

- reduced throughput during sulphur train maintenance
- capital cost of additional sulphur plant capacity
- unit operability at reduced rates

A detailed analysis is being conducted to evaluate the costs and benefits of increased sulphur plant capacity. A final decision is expected by May 1998.

Tail gas treatment technology has been selected based on best available technology, with a design overall sulphur recovery of 99.5%. The unit is sized to process all Millennium Upgrader tail gas as well as a portion of the Base plant acid or tail gas.

C3.3 Proposed Upgrading Facilities

This section describes:

- location and layout of proposed Upgrading facilities
- products and volumes
- preliminary design and operating parameters for individual operating units

C3.3.1 Location and Layout

Location and layout of the facilities are shown on Figure C3-1 and Upgrading units listed in Table C3-4.

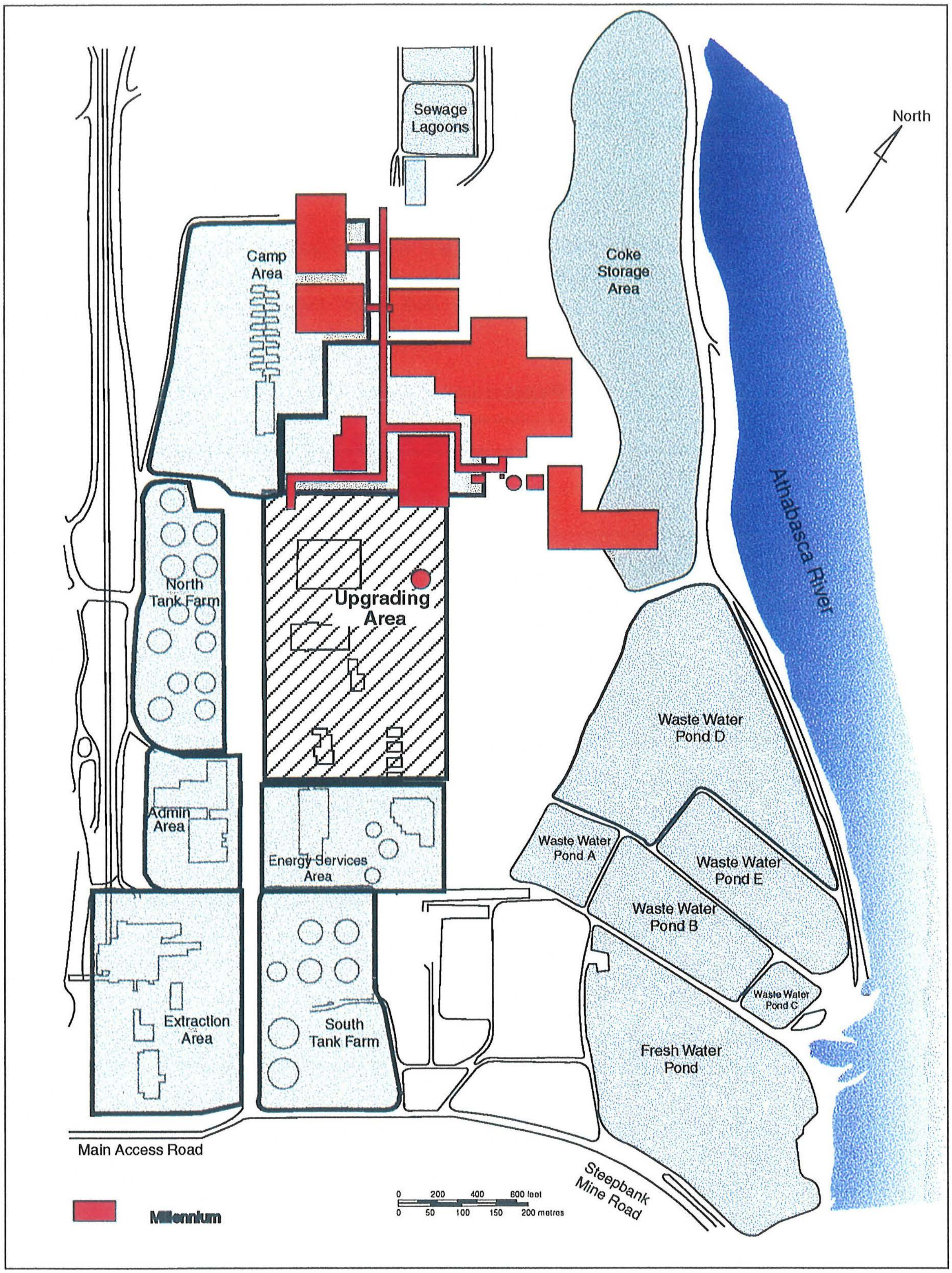


Figure C3-1 Suncor Plant Site - Proposed Millennium Upgrading Facilities

Diluent Recovery, Coking and Hydrotreating Units

These proposed facilities will be located north of, and immediately adjacent to, the existing Upgrading area and North Tank Farm. This location has been selected for these reasons:

- to minimize interconnecting and utility line lengths for new process units
- to avoid locating process units closer to the Athabasca River
- to take advantage of the existing level, graded site for the coker plant location. Existing camp and other facilities in the area will be relocated.

Table C3-4 Proposed Upgrading Units and Plant Numbers

Upgrading Units
Diluent Recovery Unit 3 Delayed Coking Unit 2 Gas Recovery Unit 2
Amine Unit 2 Sulphur Recovery Units 3 and 4 Tail Gas Treating Unit 2 Thermal Oxidizer Unit 2 Sour Water System 2
Hydrogen Plant 2
Naphtha Hydrotreater Unit 2 Diesel Hydrotreater Unit 1 Gas-Oil Hydrotreater Unit 2
Product Storage and Tankage

Sour Water Stripper Feed Preparation Tank

The new sour water stripper feed preparation tank will be located adjacent to the existing tank.

Sulphur Complex and Related Process Units

Both the sulphur complex and its related process units will be located directly to the north of the existing Sulphur Recovery Units and east of the existing camp facility.

Lay-Down and Storage Facilities

Various existing lay-down storage facilities will be relocated to make room for the new Upgrading units. Work is underway to select a new location for the facilities.

The hazardous waste facility will be relocated (see Volume 1, Section F2).

Process Control Room

A new process control room will be located directly north of Diluent Recovery Unit 2 and the Vacuum Unit. This will be a state-of-the-art, dedicated process control system compatible with the Base plant facility.

Flare Stack

The new flare stack will be located north of the existing flare area, at a similar elevation as the existing stacks.

C3.3.2 Products and Volumes

Total combined projected volumes and products from existing and planned (new Millennium) Upgrading facilities are:

- a minimum of 210 000 bbl/cd of total net hydrocarbon production
- 48% light sweet crude oil
- 38% sour and virgin crude oils
- 14% diesel and kerosene products

Once the proposed Athabasca Pipeline (by Wild Rose Pipeline Inc.) has been completed, it is intended that all intermediate coker and virgin sour products will normally be shipped through this system. The existing Suncor Oil Sands Pipeline will normally be dedicated to the shipment of hydrotreated and light oil products. Suncor will continue its current strategy to achieve maximum value for its products by custom-blending components to meet customer needs.

Product mix and degree of upgrading are based on market analysis for expected demand, projected price level and customer expectations. Predicted production volumes of comparable-quality materials together with capital, operating and maintenance costs for Upgrading facilities will be used to determine the optimal treatment levels for the new facility.

Material and energy balances for the proposed Upgrading facilities are presented in Volume 1, Section D.

C3.3.3 Proposed Units

Proposed major equipment and upgrader process flows are illustrated on Figure C3-2.

Diluent Recovery Unit 3

Figure C3-3 illustrates the Diluent Recovery Unit 3 major equipment and process flows. The unit will recover diluent for recycle, and will produce

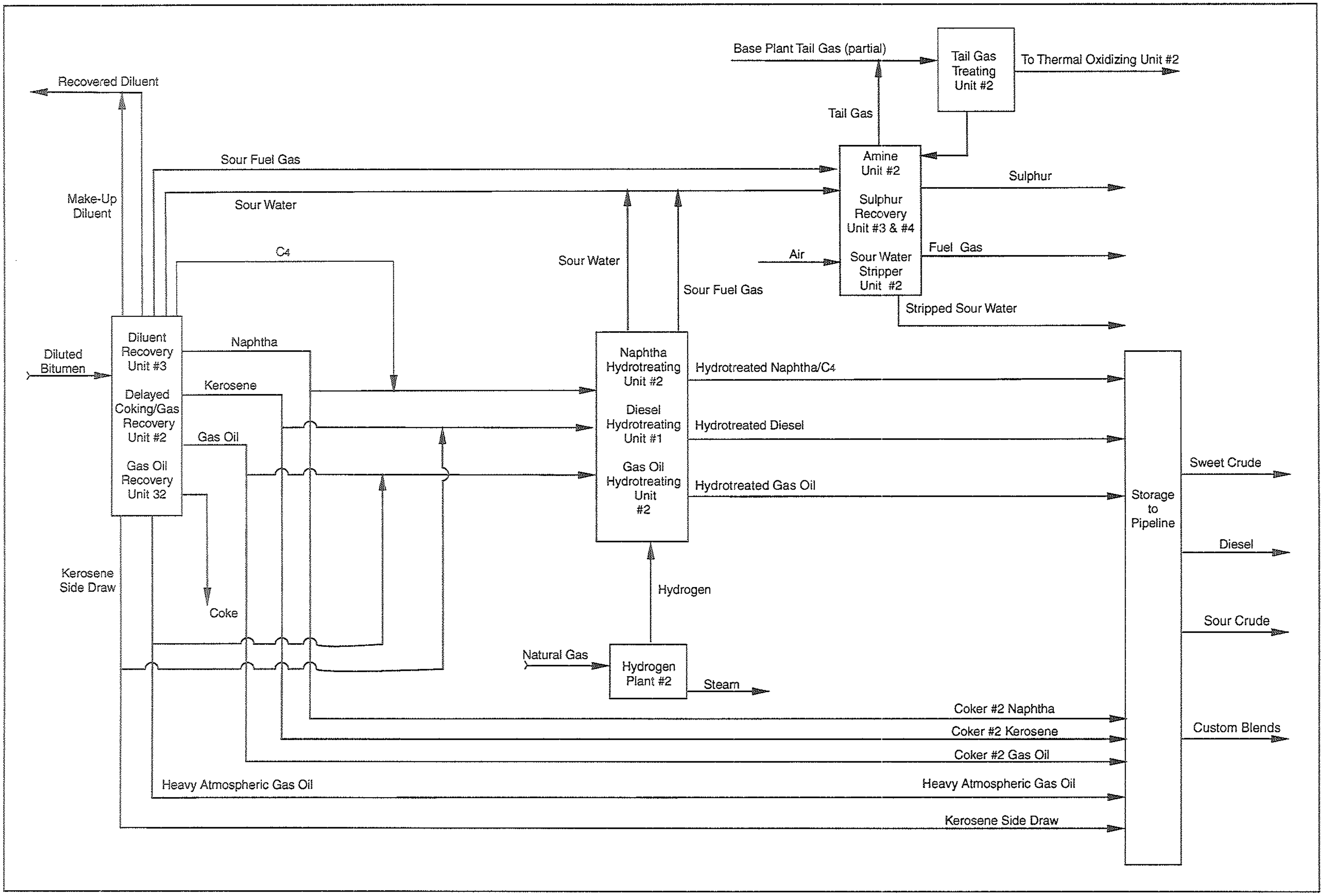


Figure C3-2 Millennium Upgrader Block Flow Diagram

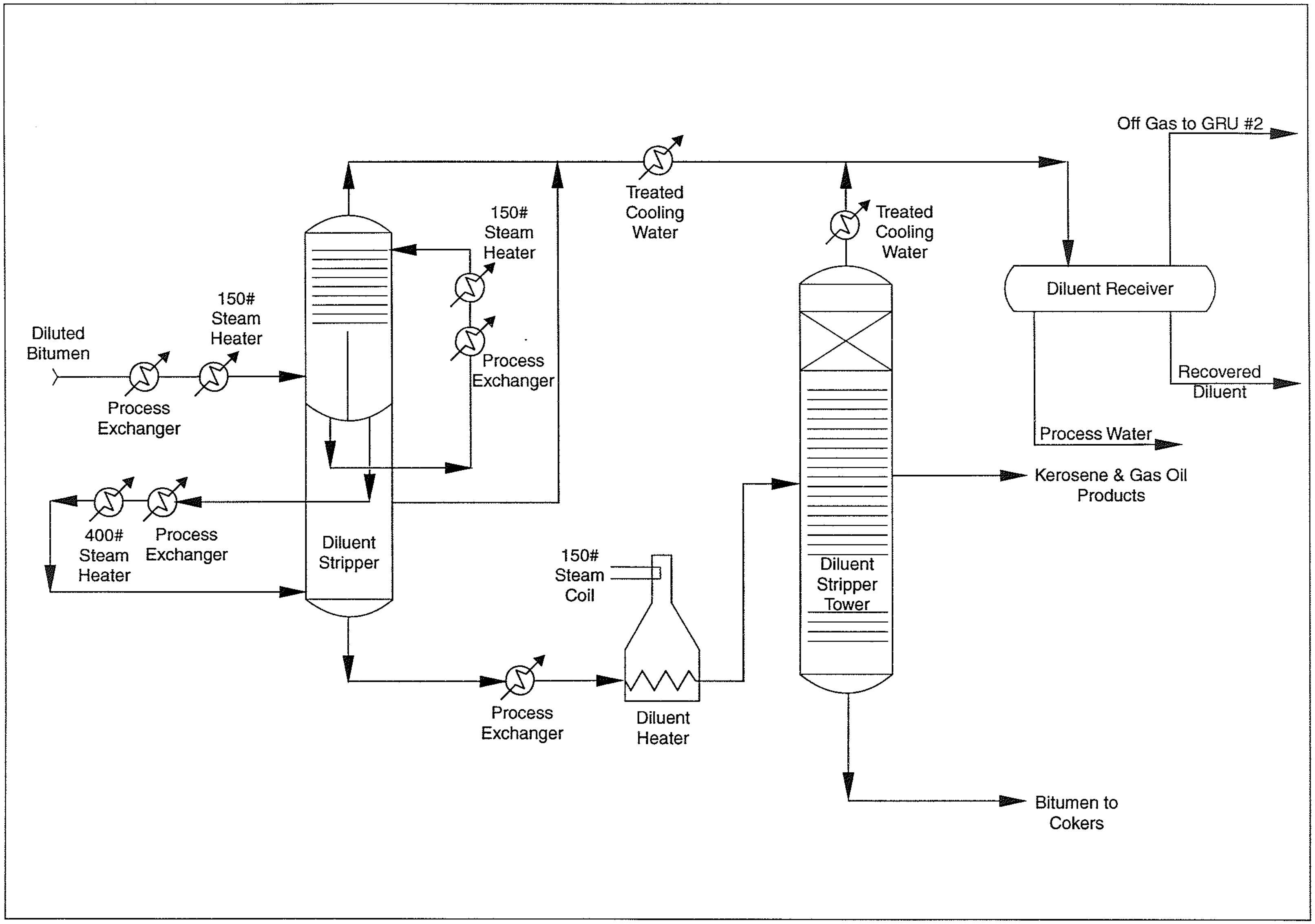


Figure C3-3 Diluent Recovery Unit 3 Process Flow Diagram virgin kerosene and atmospheric gas-oil in the diluent tower. Diluent will be recovered in a three-stage process. Bitumen feed to the first-stage flash will be heated initially by other process streams and finally by steam. Flashed liquid from the first stage will be further heated and sent to the stripper tower. Liquid from the second stage will then be heated and pumped to the third stage flash section at the bottom of the stripping tower.

The stripper bottoms will be further heated using process heat before being charged to two heaters and routed to the diluent tower. The diluent tower overhead vapour will be condensed and combined with the condensed stripper overhead vapours before entering a common accumulator. Here process water will be separated from recovered diluent product. Offgases will be sent to Gas Recovery Unit 2 for processing. Recovered diluent will be cooled and sent to tankage.

Delayed Coking Unit 2 and Gas Recovery Unit 2

Figure C3-4 illustrates Delayed Coking Unit 2 major equipment and process flow. The process technology is licensed by the Conoco/Bechtel Coking Alliance, and incorporates patented features, which selectively enhance the product slate and the operability of delayed cokers. Products from delayed coking are fuel gas, naphtha, kerosene, gas-oil and coke.

Delayed Coking Unit 2 will use two pairs of the largest commercially-proven coke drums currently in operation worldwide. The process is cyclical, with one of each drum-pair in operation while the companion drum is being emptied of coke. The fuel gas and naphtha products will be sent to the Gas Recovery Unit 2, while kerosene and gas-oil will be removed as products in the coker fractionator, stripped of H_2S, and either hydrotreated or sold as sour product. Diluent Recovery Unit 2 will be effectively heat integrated with the coker fractionator pumparounds to maximize heat recovery from the hot process streams and minimize energy input.

Two coker heater furnaces, designed for 90% efficiency and fired using refinery fuel-gas, will provide heat to the coker feed stream. The four furnace cells of each furnace will be provided with independent coke removal capability, which will improve process stability. A closed blowdown system in Delayed Coker Unit 2 will be provided to:

- minimize emissions during normal operations
- provide a means for cooling the coke drums
- maximize hydrocarbon recovery and water recycle

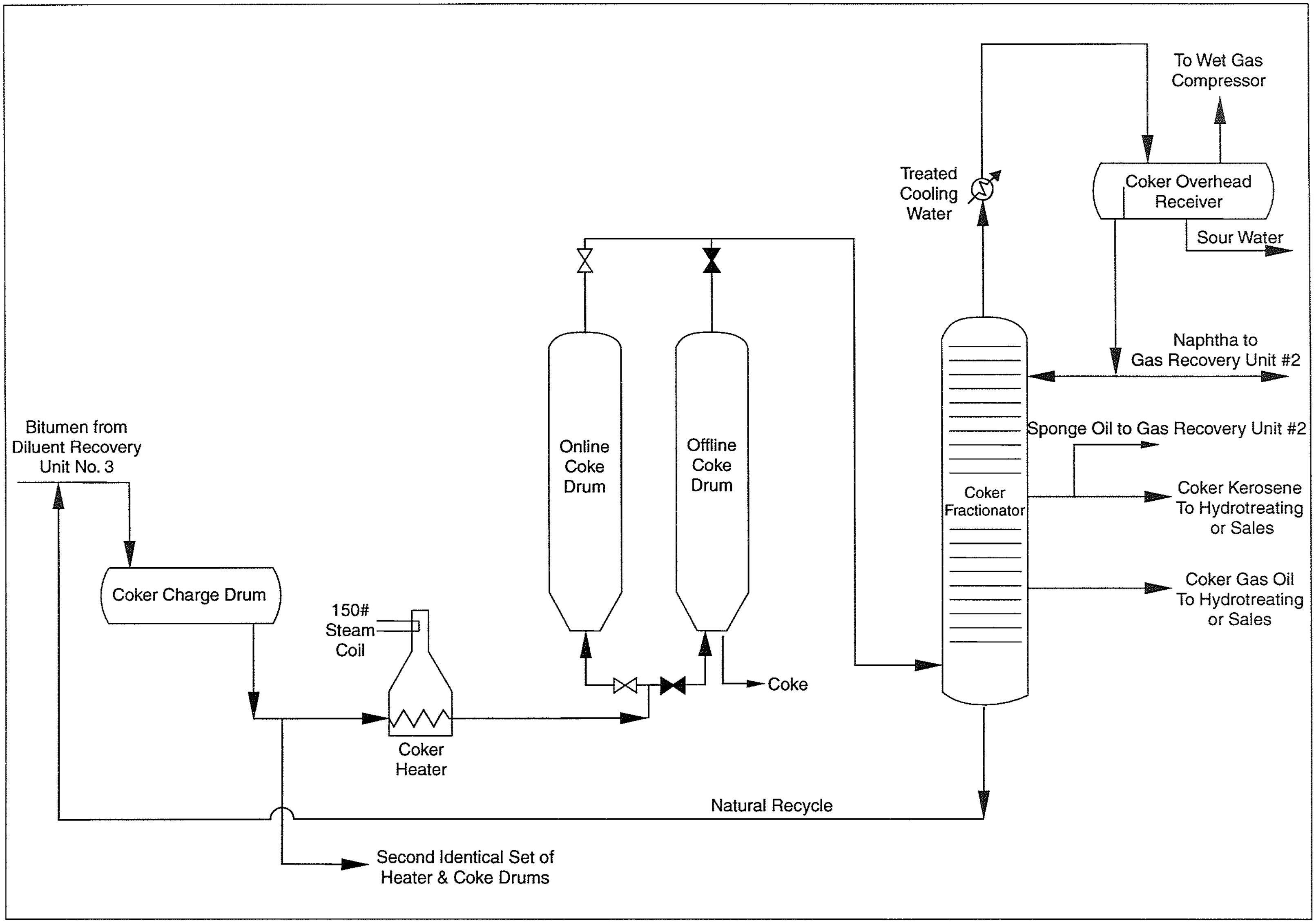


Figure C3-4 Delayed Coking Unit 2 Process Flow Diagram

Coke drum overhead vapours will be condensed and fractionated in the Coker Fractionator, producing gas-oil and kerosene products. Fractionated overhead vapours will be partly condensed and a portion pumped forward to Gas Recovery Unit 2.

The Gas Recovery Unit 2 (see Figure C3-5) will receive gas and naphtha, then process these into sour fuel gas, naphtha and a C4/C5/C6 stream, which will be combined for hydrotreating. Gases will be sent to the sulphur complex for sweetening and use as fuel-gas. Makeup diluent will be drawn off the Gas Recovery Unit 2 and will be used to supply the total requirements for both existing and new froth treatment facilities. Millennium Upgrader diluent has been designed with a narrower boiling range and lower benzene content than is achievable in the Base plant Gas Recovery Unit 1. It is predicted that this improvement in diluent quality will improve Extraction overall diluent recovery and reduce Volatile Organic Compounds (VOCs) emissions from tailings ponds.

All columns and drums will have fireproof skirts and saddles. Emergency shutdown and isolation valves will be included on vessels where appropriate, to minimize extent of damage in the event of a fire.

Delayed Coker Unit 2 will be designed to minimize the release of emissions associated with combustion, wastewater, coke handling systems and leaking components (fugitive emissions). VOCs will be controlled using the following measures:

- double seals on pumps handing light hydrocarbons
- double seals on compressors
- routing process vents and emergency upsets to flares

Furnace burners will be designed for low amounts of NO_x and CO_2 emissions. Low-sulphur fuels will be utilized to minimize SO_2 and particulate emissions.

Coke will be removed from the coke drums and then allowed to cool and dewater at a new coke pad, east of Delayed Coking Unit 2. This system will provide good coke dewatering in conjunction with a safe operating environment.

Coke will be allowed to drain naturally in a coke pit. Drainage water will be collected, particulate material will be removed, and then the water will be returned to a storage tank. The storage tank will provide surge capacity and will supply water to the coke cutting and quench system. Makeup water will be provided as necessary from the stripped sour water system.

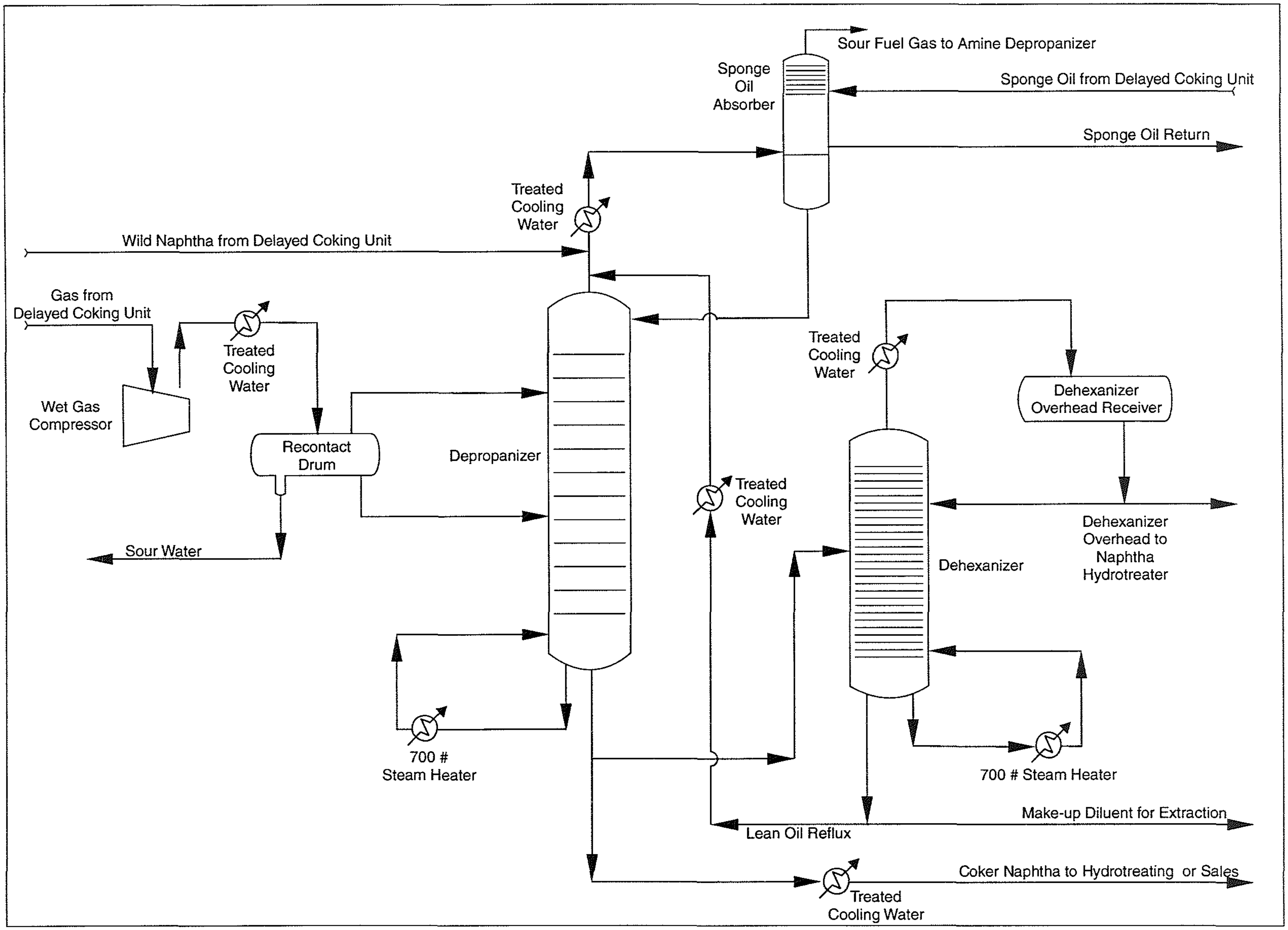


Figure C3-5 Gas Recovery Unit Process Flow Diagram

Hydrotreating and Hydrogen Production

New secondary upgrading equipment will consist of the following:

- Naphtha Hydrotreater Unit 2
- Diesel Hydrotreater Unit 1
- Gas-Oil Hydrotreater Unit 2
- Hydrogen Plant 2

The hydrotreater units are designed for a feed stream consisting of 100% coker product from Delayed Coker Unit 2. The actual feed-stream may include some virgin material, depending on market conditions and customer needs. The units will be heat-integrated for maximum energy conservation, with final product cooling by air-fin exchangers. Individual recycle gas amine scrubbers will be installed to remove H_2S, thus reducing the purge gas rate from the reactor circuits and losing less hydrogen. This will reduce the required hydrogen manufacture, producing a more efficient operation and is reducing CO_2 produced.

The UOP technology for the new hydrotreaters is similar to the existing units. A typical hydrotreater process flow is shown on Figure C3-6. Significant improvements include:

- product quality improvements
- a two- to three-year catalyst life
- improved heat integration for optimal energy efficiency
- naphtha diene treaters
- amine scrubbers for recycle gas

The Naphtha Hydrotreater Unit includes a Diene Presaturator Reactor (installed ahead of the main reactor) which will reduce bed pressure drop. The C4/C5/C6 stream recovered in Gas Recovery Unit 2 will be processed in Naphtha Hydrotreater Unit 2. A new butane product stream will be fractionated from the naphtha, H_2S will be removed by amine scrubbing and the clean butane stream will be used as product blending stock.

The Diesel Hydrotreater Unit is designed to ensure its products will:

- meet all seasonal diesel specifications
- contain less sulphur and nitrogen than in the existing plant product kerosene
- have a cetane number greater than 40

Improved product quality should result in lower NO_x and particulate emissions (from internal and external customer equipment) using this fuel.

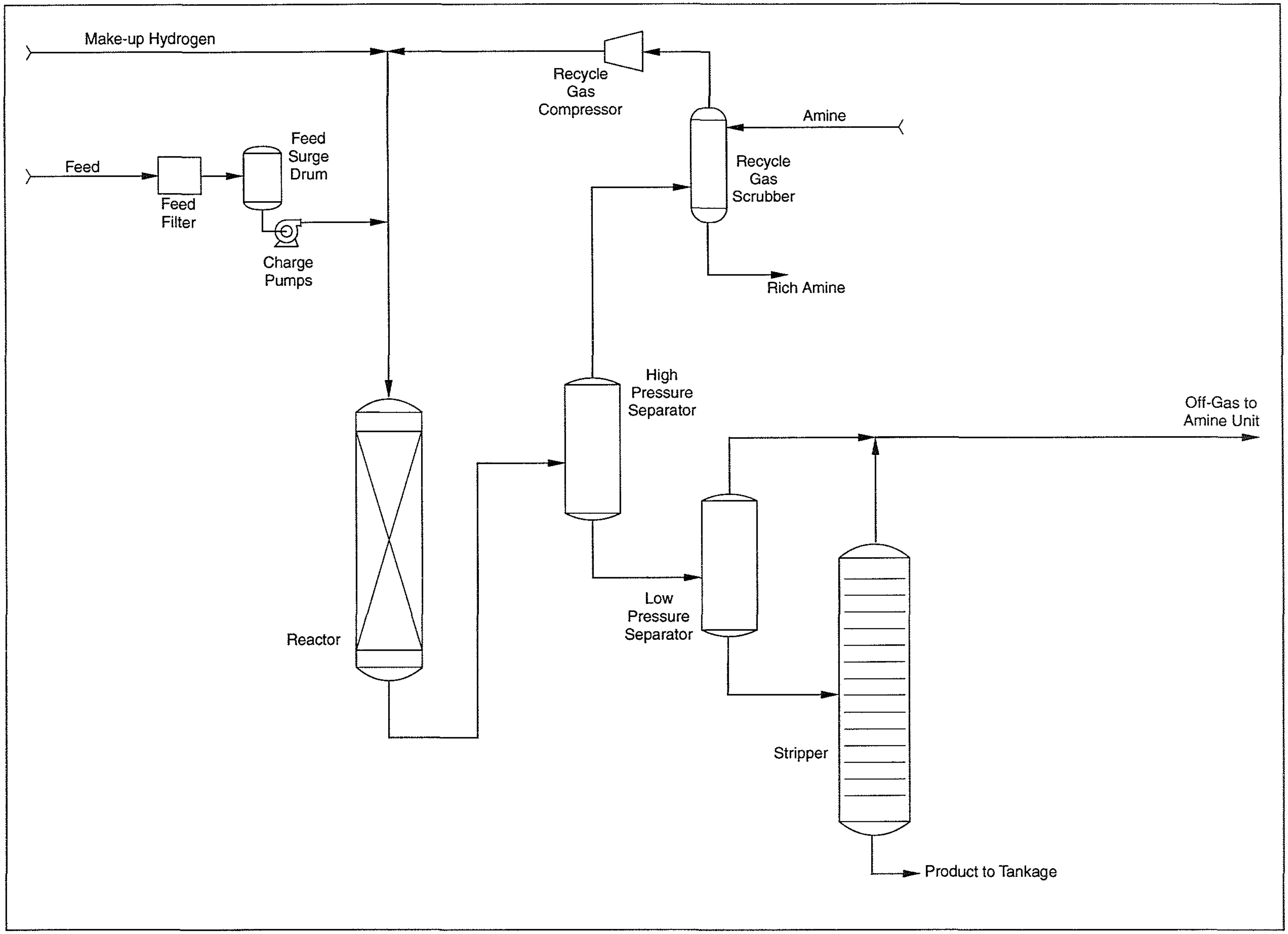


Figure C3-6 Typical Hydrotreater Process Flow Diagram

The Gas-Oil Hydrotreater Unit has incorporated improved product and water separation efficiency in its design. Its product will contain less sulphur and nitrogen than the existing plant gas-oil.

The Hydrogen Plant design (see Figure C3-7) will be based on using high pressure natural gas to eliminate the need for feed-gas compression. The design will include a current state-of-technology reforming furnace, fired on a combination of plant fuel gas and Pressure Swing Absorption Unit (which will purify hydrogen to 99.9%). Three hydrogen compressors will be installed.

C3.3.4 Sulphur Complex

The proposed sulphur complex will consist of the following units:

- Sour Water System Unit 2
- Amine Unit 2
- Sulphur Recovery Units 3 and 4
- Tail Gas Treatment Unit 2
- Thermal Oxidizer Unit 2
- Sulphur Degassing Facility

A simplified process flow diagram is shown on Figure C3-8.

The sulphur complex design operating case has been based on the acid gases resulting from all Millennium Upgrader processes and from approximately half of the Base plant's acid/tail gas.

The facility will process sour gas and sour water from various units in both the Millennium Upgrader and Base plants and will transform these sulphur components into a liquid sulphur byproduct. Sweetened fuel gas and stripped sour water will be used in the Upgrader facility. The sulphur complex will also process rich amine streams from hydrotreating units, returning lean amine back.

Sour Water System 2 (SWS-2)

In the Sour Water System 2 hydrogen sulphide (H_2S) and ammonia (NH_3) will be removed from sour water streams coming from Millennium Upgrader units. Sour water will be fed to a flash drum, where light hydrocarbons will be flashed out and recycled to Delayed Coking Unit 2. In the feed preparation tank, liquid hydrocarbons will be separated from sour water and recovered together with any hydrocarbons removed in the flash drum. This tank will be oil blanketed and have a floating roof.

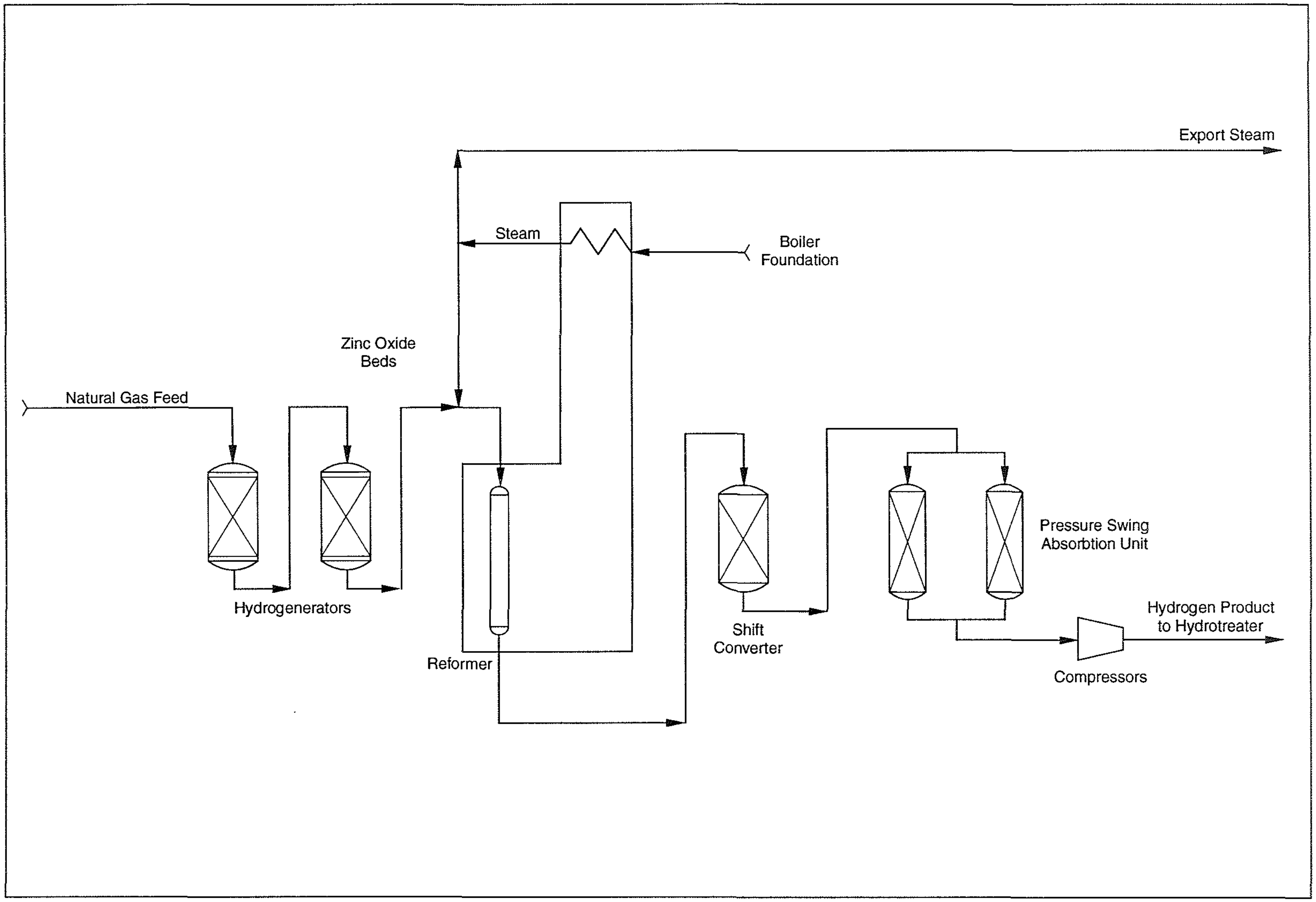


Figure C3-7 Hydrogen Plant Process Flow Diagram

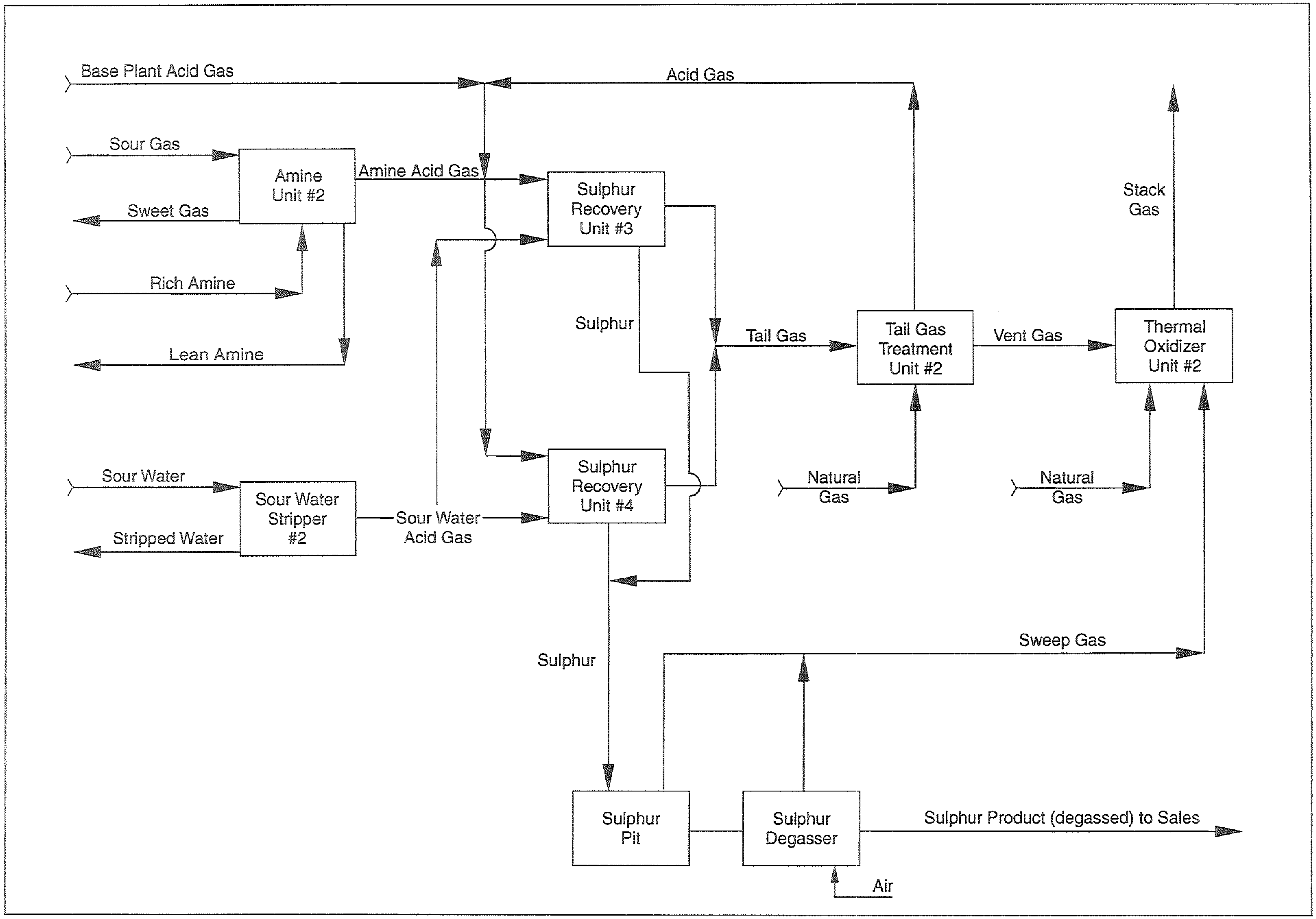


Figure C3-8 Sulphur Complex Block Flow Diagram

Sour water will then be fed to the sour water stripper, where H_2S and NH_3 will be removed. An overhead pumparound system will be used instead of the conventional overhead condenser, to minimize corrosion and to avoid exotic metallurgy. Caustic solution can be injected into the lower section of the stripper, to help release NH_3 and to also tie up organic acids present as salts. Stripped water will be cooled in the feed/bottom exchanger and sent to Delayed Coking Unit 2 and the Extraction NRU. The stripper overhead sour water acid gas will be sent to either of the two Sulphur Recovery Units. Temperature of the sour water acid gas stream will be controlled, to minimize ammonia salt deposition in the process.

Amine Unit 2

In the absorption section of Amine Unit 2, H_2S and CO_2 will be removed from the sour fuel gas streams generated in Delayed Coking Unit 2, Gas Recovery Unit 2, the hydrotreaters and potentially half of the Base plant acid gas stream. The regeneration section processes rich amine streams from the absorption section and the hydrotreating units, delivering lean amine streams back to the units.

In the absorption section, the sour fuel gas stream will be cooled in the sour gas cooler and then fed to a knockout drum, where any condensable water or hydrocarbons will be separated and sent to the slop oil system. Cooled sour gas will then be fed to a water wash tower, to remove organic acids, NH_3 and hydrogen cyanide (HCN) present in the stream. The blowdown water stream from the bottom of the column will be sent back to the Sour Water System 2.

Washed sour gas will be sweetened in the amine absorber using a diethanolamine solution. The resulting sweet gas will be fed to a knockout drum (to separate any amine carried over) and then will be sent to the fuel gas collection system for distribution. The rich amine will be sent to the three-phase separator in the regeneration section.

The three-phase separator will also receive rich amine streams coming from the absorption section, fuel gas knockout drum and hydrotreating units. A recycle stream from the nitrogen-blanketed amine sump will also be sent to the three-phase separator, where hydrocarbons and gases will be separated from the amine solution. The gas stream will be washed with lean amine and sent to the Thermal Oxidizer Unit 2, while the separated oil will be pumped to the slop oil system.

The rich amine solution will be pumped to and heated in the lean/rich exchanger before being fed to the amine regenerator. In the amine regenerator, H_2S will be removed from the amine solution by steam generated in a reboiler. The amine acid gas obtained will be sent to the Sulphur Recovery Units for further processing. The lean amine solution obtained from the bottom of the regenerator will be cooled in the lean/rich exchanger and lean amine cooler. The solution will then be pumped to the absorber and hydrotreaters for further H_2S absorption. Drains in the Amine Unit-2 area will be routed to a closed sump. Amine collected in this system will be recycled back to the process.

Sulphur Recovery Units 3 and 4

Two modified Claus process plants, each consisting of a thermal stage followed by two catalytic stages, will be used to recover elemental sulphur from H_2S.

Two separate acid gas streams will be processed in the two units:

- amine acid gas from Amine Unit 2
- sour water acid gas from Sour Water System 2, which has a significant NH_3 content

Amine acid gas will be fed to both trains, while sour water acid gas will be processed in only one train at a time. Both trains will be capable of handling the sour water acid gas stream. Each unit can be operated under pressure or flow control of the feed streams. If the feed in one unit is being flow-controlled, feed in the other unit is pressure-controlled, to absorb any flow variations.

Combustion air and acid gas will be preheated with steam in the reaction furnace, to ensure sufficient temperature for NH_3 destruction. The feed control system will maintain the proper amount of combustion air by adjusting the air flow in proportion to the amine acid gas and sour water acid gas flows. A tail gas analyzer will provide feedback correction of the air flow.

In the waste heat boiler, the high temperature of the reaction furnace effluent will be cooled to generate 4 100 kPa steam. The gases will then be fed to the first condenser, where they will be further cooled. There, liquid sulphur will be produced and sent to the sulphur pit. Low-pressure steam will be generated in the condenser. Two catalytic reactors (with preheat exchangers and sulphur condensers) will be used in series to recover sulphur.

Sulphur produced in the catalytic reactors will be condensed using low-pressure steam generation. Tail gases from both Sulphur Recovery Units will be sent to Tail Gas Treating Unit 2 for further processing.

The sulphur pits (one for each Sulphur Recovery Unit) will collect all liquid sulphur produced and pump it to a sulphur degassing unit and truck-loading facilities. Steam coils in the sulphur pits will maintain the sulphur in liquid form.

Tail Gas Treating Unit 2

Tail Gas Treating Unit 2 will consist of a hydrogenation section, which will convert the remaining sulphur compounds (those not converted in Sulphur Recovery Units 3 and 4) back into H_2S, and an amine section.

The amine section will remove the H_2S and CO_2 (using MDEA solution) and recycle them to the Sulphur Recovery Units 3 and 4. The rich amine stream will be pumped and heated before it is fed to the regenerator. There, H_2S and CO_2 will be stripped from the amine solution and sent back to the SRUs. The lean amine will be cooled in the lean/rich amine exchanger, then further cooled in the lean amine cooler, before it is returned to the absorber. The unit is sized for approximately 175% of Millennium treating requirements, to accommodate acid gases from the Base plant.

Thermal Oxidizer Unit 2

Thermal Oxidizer Unit 2 will receive feed from Tail Gas Treating Unit 2. It will also be able to process streams from:

- Sulphur Recovery Units 3 and 4:
  - when Tail Gas Treating Unit 2 is down
  - during Sulphur Recovery Unit startup and shutdown
  - during Sulphur Recovery Unit and/or Tail Gas Treating Unit upsets
- the Amine Unit 2 flash drum
- sulphur pit vents
- the sulphur degas unit

Feed streams will be combusted in the thermal oxidizer to convert all of the remaining compounds into SO_2. The process gas will then be vented to atmosphere through the 106-m thermal oxidizer stack.

Sulphur Degassing Facility

The Sulphur from Sulphur Recovery Units 3 and 4 and Tail Gas Unit 2, will be degassed. An evaluation of several process alternatives for degassing sulphur is underway. Criteria which will be used to compare the processes are:

- capital cost
- operating and maintenance cost
- commercial experience
- safety
- efficiency
- ease of operation and maintainability

A decision is expected to be made by May 1998.

C3.4 Upgrading Support Facilities

This section describes the following facilities:

- sulphur and coke handling
- wastewater treatment and disposal
- flare system
- product storage
- sewage treatment

C3.4.1 Sulphur and Coke Handling

Liquid sulphur from the Millennium Upgrader will be transported by truck south on Highway 63 to the Edmonton area. From there, it will be distributed to customers in Alberta, North America or overseas. Sulphur blocking of Millennium production is not currently planned, except for use of the emergency pad during interruptions in trucking or when out-of-specification sulphur is produced during startup, shutdown or process upsets. The current plan is to share common emergency sulphur storage facilities with the existing plant.

When coke is produced from the Millennium Upgrader, it will be stored separately from coke produced by the existing cokers. Currently plans have Energy Services preferentially burning Millennium Upgrader coke. Surplus coke will be sold as marketing opportunities are developed.

C3.4.2 Wastewater Recycle, Heat Recovery and Cooling

An important design criterion is to reduce or eliminate discharge to the Athabasca River from the Upgrading wastewater treatment system. Under normal operating conditions, wastewater discharge to the river will be significantly reduced as a result of proposed equipment and process modifications in Project Millennium. Reliance on once-through cooling will be greatly reduced due to improved heat integration and a comprehensive waste heat recovery system.

The Upgrading wastewater stream will be reused as: makeup water to Extraction process recycle water; for Utility water (e.g., coke-cutting and gland water); and makeup water to the Base Upgrading plant cooling water system. When the site operating units are processing at or near design rates, there will be a minimum outfall flow to the Athabasca River. The waste heat recovery system designed into Millennium Upgrader facilities, as well as installation of cooling towers at the freshwater pond, are expected to eliminate once-through cooling water discharge to the Athabasca River during normal operations.

Final cooling of process streams will be achieved through use of the closed treated cooling water system and air fin coolers. The treated cooling water, once heated by the process streams, will be cooled directly (in a bank of plate heat exchangers) with pond recycle water before being routed to a 4 770 m^3 surge tank. The use of a separate treated water loop avoids the requirement for spare heat exchange equipment, exotic metallurgy and frequent chemical cleaning, all of which would be required for process coolers exchanging heat directly to extraction recycle water. A second, smaller treated cooling water loop will exchange heat with extraction recycle water in winter months and will be cooled by a cooling tower. Up to 1 160 GJ/h of waste heat will be recovered in these systems, an amount approximately equivalent to heat generated by an additional coke-fired boiler.

The Millennium cooling water system process flow diagram (see Figure C3-9) illustrates the treated cooling water circuit, which is used to cool process fluids in Sulphur Recovery Units 3 and 4, Diluent Recovery Unit 3, Delayed Coking Unit 2 and Gas Recovery Unit 2. Recycle water for use in the extraction process is heated by Upgrader-treated cooling water in a bank of plate heat exchangers.

Stripped sour water will be recycled for use as coker quench and cutting water through a closed cleaning and collection system. No freshwater makeup will be required for use in the coke removal system. Stripped sour water will also be used as washwater and makeup water in the process units, reducing demand for condensate or other treated water. Internal recycling of stripped sour water will reduce the load on Extraction processing units, currently used to route this stream to the extraction recycle water system.

C3.4.3 Flare System

One of Suncor's key operating criteria is that there will be no new continuous flaring from the Millennium plant. A combined H_2S - hydrocarbon emergency flare is proposed for the Millennium Upgrader. Final flare loading will be evaluated during the detailed design stage of the project. Design considerations will include:

- monitoring, including:
  - remote flame-out indication to control room
  - a closed-circuit video-monitoring system
  - flare header temperature
- environmental issues, including:
  - continuous pilots to ensure ignition
  - steam injection for smokeless operation
  - tip velocity to ensure dispersion
  - provision for lift gas if required for dispersion

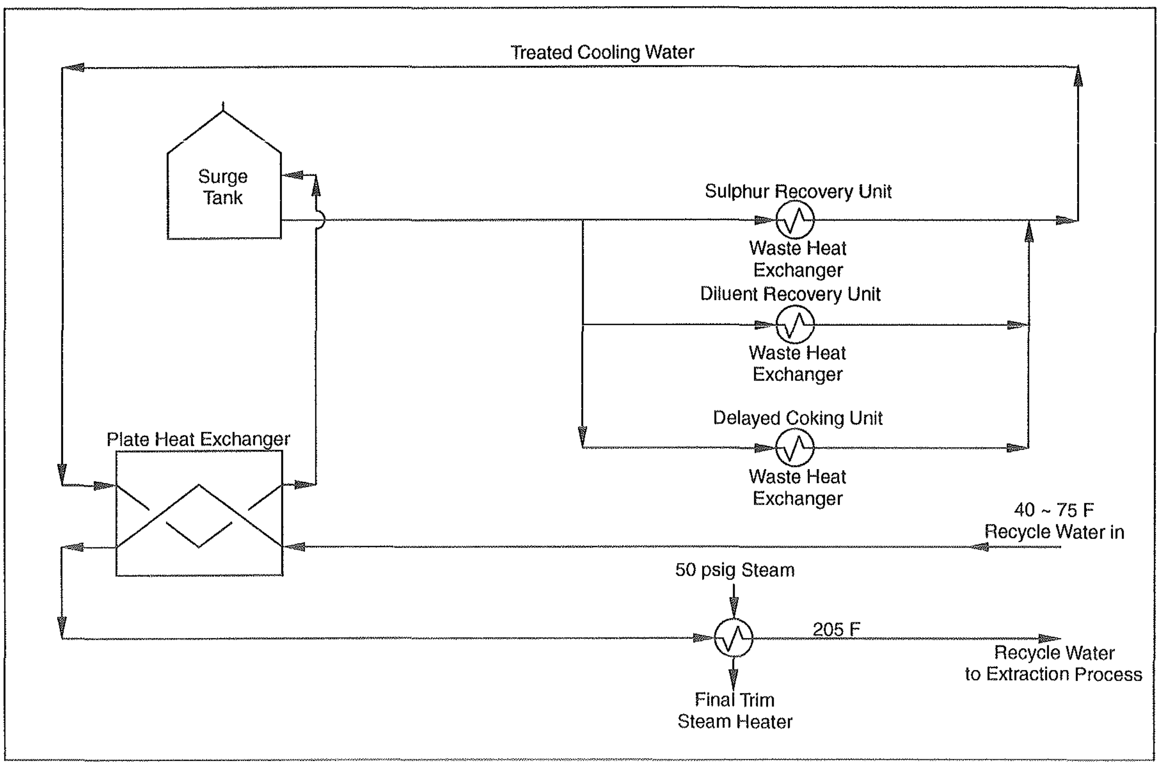


Figure C3-9 Cooling Water System Process Flow Diagram

The new flare will be located directly north of the existing flare area (see Figure C3-1). It will be designed to handle the largest vapour release on a single-risk basis (as cited in API-RP-521). The flare will be provided with flashback protection, to prevent a flame front from travelling back to the upstream piping and equipment.

C3.4.4 Bitumen and Product Storage

South Tank Farm capacity for diluent and diluted bitumen storage will be evaluated based on final plant design. Preliminary planning indicates that additional tankage may be required for either raw or diluted bitumen.

The existing Vapour Recovery Unit will be used to recover and treat vapours resulting from additional froth treatment facilities, and additional diluted bitumen tankage, if installed. The unit is currently operating reliably with sufficient excess capacity to process the anticipated increased load. Additional Vapour Recovery Unit capacity will be added, if necessary.

Seven new, 16 000 m^3 floating-roof tanks are anticipated for product storage. Floating roofs will be used where appropriate to minimize loss of hydrocarbon vapours. Five of the tanks will store intermediate product and two will store hydrotreated product. Preliminary plans are to expand the existing North Tank Farm. Other locations, including Lot 2, are also being evaluated.

Under normal conditions, all sour products will be shipped by Wild Rose Pipeline Inc.'s proposed Athabasca Pipeline (currently the subject of an application before the AEUB) from the Suncor plantsite to the Hardisty, Alberta area. There the proposed Athabasca Pipeline will interconnect with the Interprovincial Pipe Line Inc. pipeline facilities, which in turn provide access to markets in Eastern Canada and the United States.

All hydrotreated blends will normally be shipped through the existing Suncor Oil Sands Pipeline to the Edmonton area.

C3.5 Upgrading Research and Development

Suncor is currently participating in the following two CONRAD upgrading research projects:

- heater (coker and vacuum) fouling mitigation
- diesel emissions from oil sands-derived feed stocks

Suncor is a member of a number of technical associations concerned with upgrading including: National Centre for Upgrading technology, CONRAD and the Alberta Sulphur Research group.

C4 ENERGY SERVICES

This section describes:

- the guiding principles, objectives and criteria for the Energy Services portion of Project Millennium
- the technical and process options that have been evaluated
- the proposed Energy Services facilities

C4.1 Principles, Objectives and Criteria

The guiding principles of the Energy Services strategy for Project Millennium are:

- to provide all supporting utilities to the operation in an energy-efficient, environmentally-sustainable and cost-effective manner
- to maintain technical and operating flexibility and reliability
- to use technology that is the best considering cost, performance, and commercial viability factors

Energy Services facilities will be integrated with the existing plant complex, to support a maintenance turnaround philosophy allowing continuous production from either the existing Base plant or the proposed Millennium plant. This will be accomplished by using the appropriate:

- equipment-sparing and isolation criteria
- equipment material selection
- turnaround avoidance design philosophy
- optimum plant and energy integration
- efficient, proven energy-generation options

Objectives used to define the proposed Energy Services facilities include:

- optimize site-wide energy integration
- optimize power generation efficiency
- increase power production to maintain site self-sufficiency
- minimize external energy import use
- reduce energy intensity per unit of production
- minimize air emissions
- minimize freshwater use
- maximize water recycle
- minimize solid and liquid waste
- ensure safe drinking water supply
- evaluate and use safe, reliable and commercially-proven technologies

- identify regional cooperative opportunities

These objectives, related design criteria and proposed technology improvements are outlined in Table C4-1.

C4.2 Technical and Process Options

Gas turbine generators (GTG) equipped with heat recovery steam generators (HRSG) have been selected after consideration of other steam and power generation technologies, including import options. The key factors used to evaluate process alternatives include:

- commercially-proven technology
- capital cost
- operating cost
- equipment reliability and maintainability
- environmental performance
- energy intensity and efficiency
- equipment availability
- construction and procurement schedule
- technology fit with needs

Project Millennium electrical power demand (three times present-day demand) is predicted to grow more rapidly than steam demand (two times present demand). Therefore, emphasis has been placed on the capability of the technology to produce electrical power efficiently.

A discussion of considered options follows:

- Increase electrical power import from the present supplier (Alberta Power Limited). Insufficient additional power is available from the current network configuration. A third transmission line corridor would be required to satisfy Project Millennium needs and has been considered impractical.

- Purchase power and steam from an independent producer in the area. At present, Suncor is actively pursuing this option with a number of interested parties. Final evaluations are to be completed in May 1998. If selected, this option would have to satisfy Suncor's energy need and meet all regulatory requirements.

Table C4-1: Energy Services Objectives, Criteria, and Technology and Operating Improvements

Issue	Objectives	Criteria	Technology and Operating Improvements
Resource Conservation	• Optimize site-wide plant integration	• Target opportunities for maximum energy and water conservation	• Energy Services integrated with Upgrading and Extraction via waste heat loop (80% waste heat recovery) • Pond water reconfiguration will reduce river intake and discharge
Energy Efficiency	• Optimize energy integration and efficiency • Reduce energy intensity per unit of production	• Design for optimum heat recovery and minimum heat rejection to atmosphere or cooling water • Use high-efficiency equipment • Minimize energy losses • Improve power factor correction	• Optimum 80% waste heat recovery loop minimizes additional fossil fuel use • Steam balance optimized to minimize atmospheric venting and pressure-reducing station supplemental steam • TG and GTG operation near maximum rating for optimum efficiency • Design for high-efficiency burners, motors, heat tracing and insulation • Use of synchronous motors and capacitors to improve on-site power factor
	• Maximize co-generation power	• Develop co-generation facilities • Minimize off-site fuel consumption	• Closed-cycle GTG/ HRSG arrangement increases energy efficiency, reduces fuel consumption • Evaluate other on-site co-generation opportunities
Environmental Protection	• Ensure protection of environmental and public health; minimize air emissions	• Ensure safe drinking water supply by maintaining standards to existing guidelines • Control air and water emissions to lowest practical levels • Use the best commercially-proven pollution prevention and control technologies	• Dedicated potable water clarifier with once-through raw water supply • All HRSGs will meet CCME guidelines for industrial boilers • All GTGs will meet CCME guidelines for stationary combustion turbines

Issue	Objectives	Criteria	Technology and Operating Improvements
Environmental Protection (Continued)	• Minimize liquid and solid waste	• Include cost of waste handling and disposal in process selection and facility design • Continually evaluate technology opportunities and seek markets for byproducts • Use advanced technology to minimize chemical use	• Gas GTG/HRSGs produce no solid waste • Ash handling modifications direct all boiler and flyash to tailings ponds • FGD gypsum byproduct reused in CT process to enhance tailings pond reclamation • Reverse osmosis water treatment process minimizes chemical addition
	• Minimize fresh-water use • Maximize recycling and minimize discharge of process-affected water	• Use wastewater as makeup to the recycle water system • Reduce wastewater return to the Athabasca River	• Pond water flow modifications and waste heat recovery loop will reduce fresh- water intake, maximize recycle and reduce discharge to river • Use of cooling towers increases recycle and decreases freshwater makeup

- Recover additional waste heat from the existing Upgrader. While capturing thermal energy, this option does not provide additional electrical power. High capital cost as well as construtability and process risks negate this option.

- Install additional boiler and steam turbine generation capacity (current technology). This technology has been rejected because of high capital and operating costs as well as its inability to efficiently maximize power generation, creating surplus low-pressure steam. In conjunction with this option, three fuel sources have been considered:

  - Petroleum Coke: A circulating, fluidized bed boiler burning byproduct coke was evaluated. This option was rejected because of high capital and operating costs, increased air emissions and solid waste, as well as inadequate plot-space availability.
  - Liquid Fuel Product: This option was not favoured because it consumes plant product.
  - Natural Gas: While presenting an increased cost for offsite fuel, this option presents significantly lower capital costs, no solid waste disposal and limited (NO_x control only) flue gas conditioning requirements.

- Install GTG capacity. Gas turbine engines (frame and aeroderivative models) are proven, reliable technology used in a multitude of prime mover and industrial power generation applications. Numerous units of varying capacity are in worldwide use, ranging from the air transportation to power generation industries. Operating cost is relatively low, with relatively high thermal and electrical power generation efficiency in co-generation applications. Capital cost is significantly lower when compared to solid fuel boilers and steam generation turbines. Other advantages of this technology include: relatively low air emissions; absence of additional mechanisms for fuel preparation and solid waste disposal; relatively small plot-space requirement; and a short engineering design-to-commissioning time-frame. For these reasons, this is the option selected.

C4.3 Proposed Energy Services Facilities

This section describes:

- location and layout of the proposed facilities
- products and volumes
- preliminary design and operating parameters of the individual units

C4.3.1 Location and Layout

Location of the major proposed facilities is shown on Figure C4-1 and listed in Table C4-2. The proposed location of the co-generation facilities is west of the existing Administration building. Turbine enclosures will reduce noise levels to within acceptable limits, while extensive combustion monitoring and control equipment will ensure continuous safe and reliable operation consistent with all regulatory requirements for industrial power boilers.

C4.3.2 Products and Volumes

Products and projected total volumes for existing and proposed facilities include:

- 52 000 m^3/d of treated boiler feed-water
- 51 million kg/d of high-, medium- and low-pressure steam
- 250 MW of electrical power
- 775 000 m^3/d (at standard conditions) of dry, compressed air

Material balances for the proposed Energy Services facilities are provided in Volume 1, Section D.

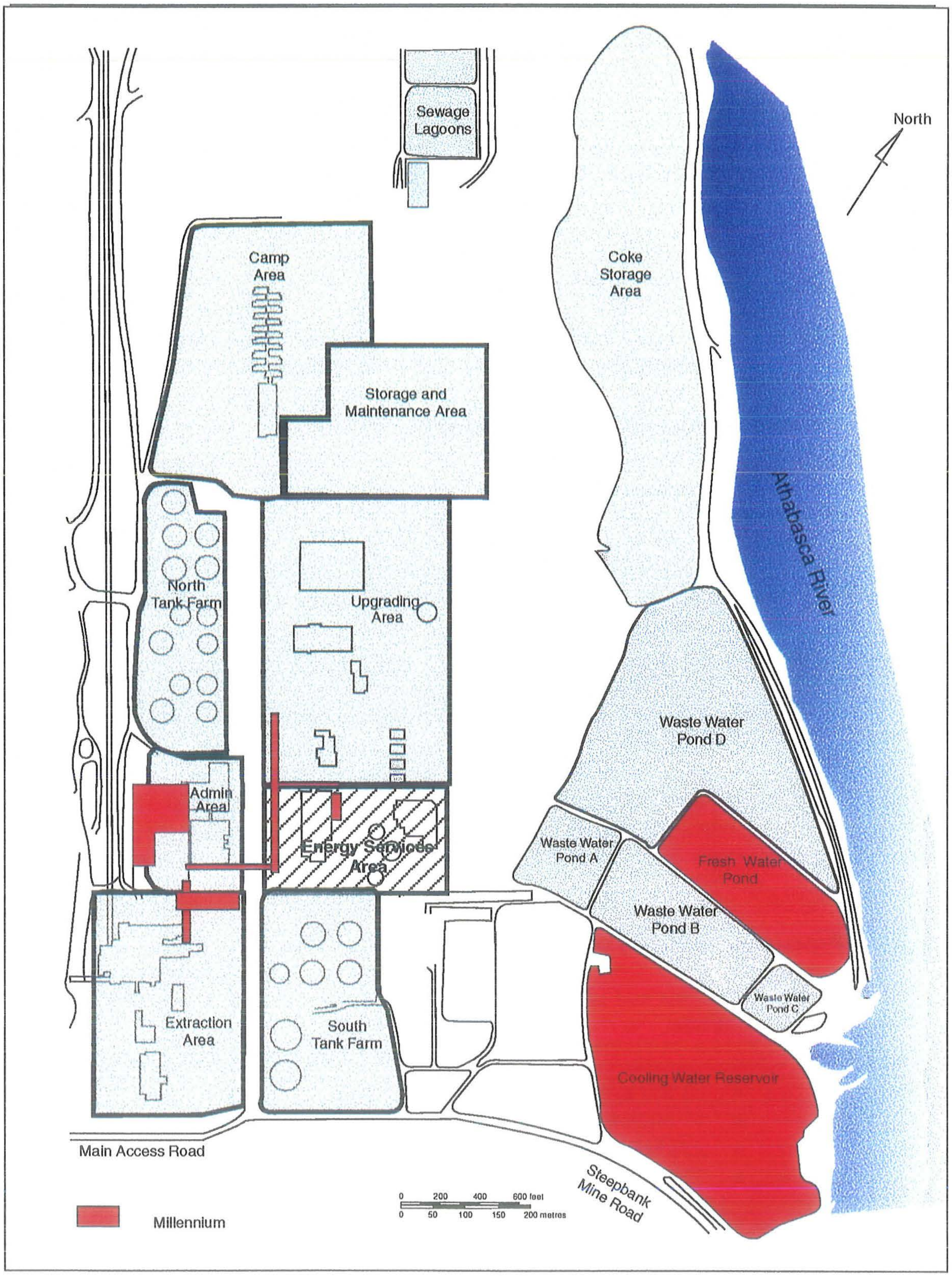


Figure C4-1 Suncor Plant Site - Proposed Millennium Energy Services Facilities

Table C4-2 Energy Services: Project Millennium Major Modifications

Plant Area	Modifications
Water System	• Reconfiguration of raw water, cooling water and wastewater ponds • One freshwater pump house • One waste heat recovery supply pump house • One waste heat recovery return pump house • Additional condensate filter (total 6) • One new condensate receiver and associated equipment • One deareator (total 4) • Additional boiler feedwater pumps and piping
Steam System	• New 5 450 kPa steam header to Upgrading • New condensate return line from Extraction to Energy Services • Waste heat recovery boiler and associated equipment on the new gas-fired turbine • Two 2.7 million kg/d natural gas-fired boilers • One sodium zeolite-brine water softening unit
Electrical System	• New gas-fired turbine (85 MW) and associated equipment
Compressed Air System	• Two air compressors and associated equipment

C4.3.3 Water Systems

The freshwater and wastewater pond systems (see Figure C4-2) will be reconfigured, to increase reliability and to reduce the average volume of wastewater discharge. Depending on operating conditions, the system will have the capability to approach zero discharge, accomplished by:

- converting the current wastewater Pond E to a once-through freshwater makeup supply reservoir dedicated to boiler feed and potable water production
- installing a new drain line from Pond C to the existing freshwater pond, which will be converted to a cooling water reservoir
- installing an additional set of freshwater supply pumps and piping from Pond E to the water treatment plant
- installing an additional set of waste heat recovery loop supply pumps

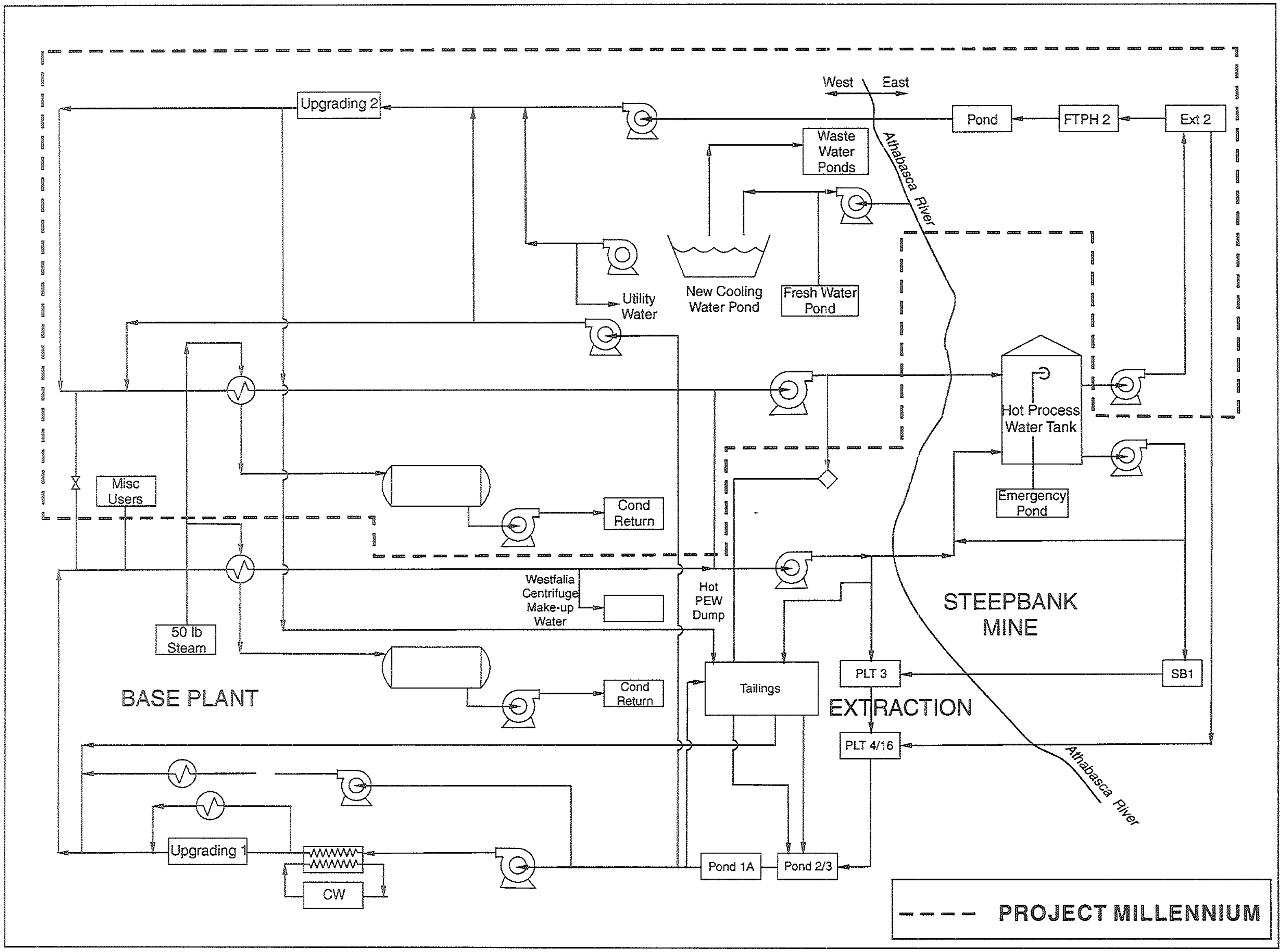


Figure C4-2 Millennium and Existing Waste Heat Recovery Process Flow Diagram

- installing an additional set of waste heat recovery loop return booster pumps

The above configuration will have several important benefits, as it will:

- allow more flexible water management
- increase plant reliability by reducing the risk of hydrocarbon contamination of the freshwater supply (as a result of routing cooling loops through the freshwater pond)
- eliminate the current Pond E discharge to the Athabasca River
- reduce the main wastewater discharge to the Athabasca River

Makeup water requirements for the waste heat recovery loop will be provided from the cooling water reservoir. Wastewater diverted from Pond C to the cooling water reservoir will supplement the recycled flows from the two returning cooling water loops (via the cooling towers) to maintain reservoir levels.

It is expected that some chemical water treatment in the cooling reservoir will be required to mitigate the concentration effects of recycling. The level of treatment will depend on final volumes withdrawn from this pond to supplement the Millennium waste heat recovery loop as described above. This optimized recycle flow arrangement is shown on Figure C4-3.

Additional equipment will be installed to further increase water systems capacities, including:

- a sixth condensate filter
- an additional condensate receiver, pumps and piping
- a fourth deaerator
- additional boiler feedwater pumps and piping

C4.3.4 Steam and Electrical Systems

Project Millennium requirements for electrical power and steam will increase for the following reasons:

- proportionally higher production rates with larger and more extensive plant and mine footprint
- preference for electrical versus steam turbine drivers in the fixed plants, for reliability and economic reasons

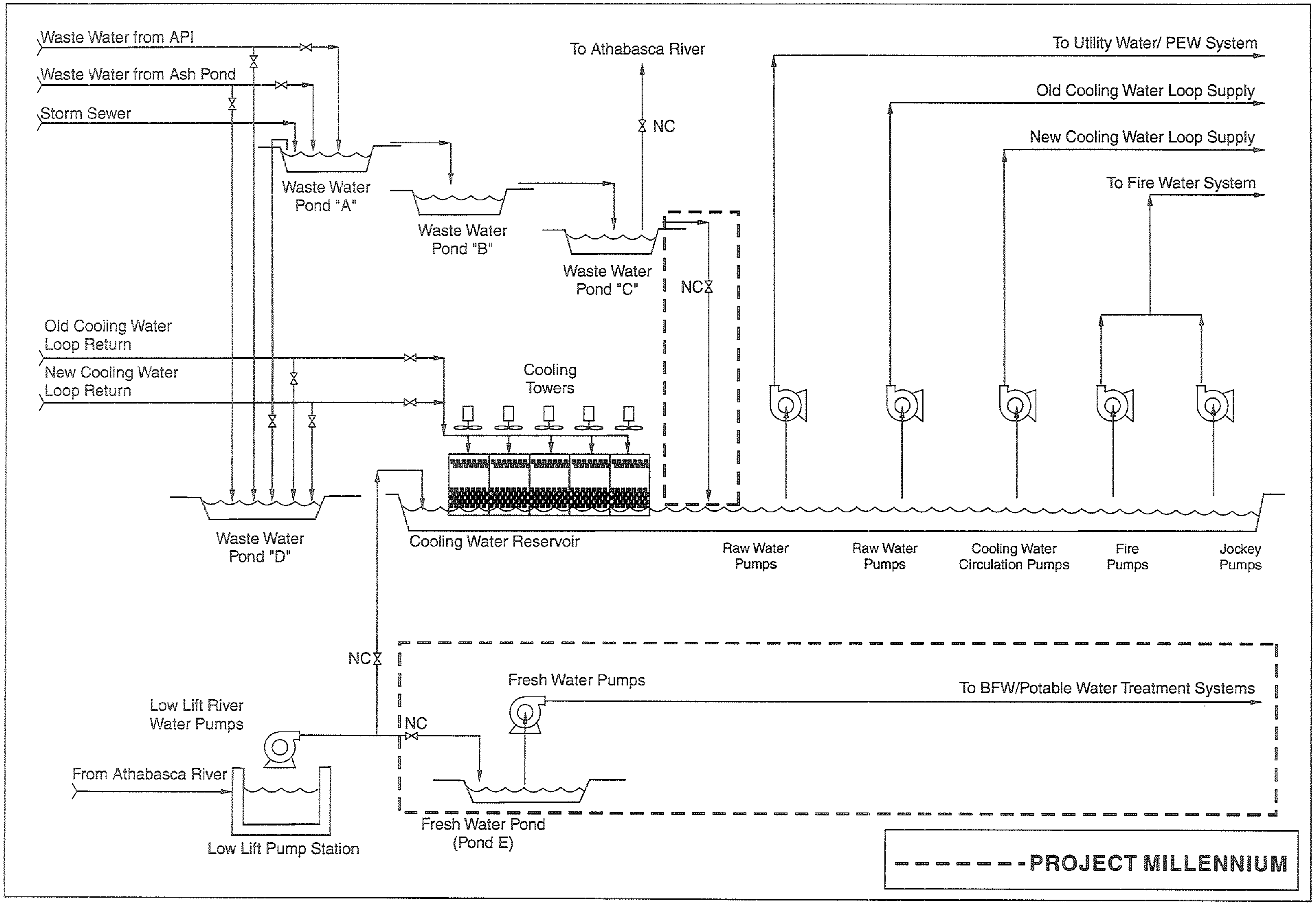


Figure C4-3 Water Distribution System Process Flow Diagram

Millennium energy demands will be met by the following:

- installing a second 85 MW gas turbine generator (GTG) equipped with a heat recovery steam generator (HRSG) and associated equipment (described in Volume 1 Section B4.2.2). The unit will be located adjacent to the PEP GTG, near the existing Administration building as illustrated on Figure C4-1.

- capturing approximately 80% of available waste heat from the Millennium Upgrader

The following equipment will be located on the east side of the Athabasca River, adjacent to the Millennium Extraction plant:

- two 2.7 million kg/d low-pressure natural gas-fired boilers and auxiliaries producing 1 000 kPa steam
- boiler feed-water and condensate tanks, piping and auxiliary equipment associated with these two field boilers
- One 4 000 m^3/d sodium zeolite-brine water softening unit

These units are required for bitumen froth steam deaeration in the Millennium Extraction plant. Suncor is currently evaluating the substitution of a mechanical froth deaeration process for the new Millennium Extraction plant. If this process is selected, these proposed new field boilers and associated equipment will not be required at the Millennium Extraction plant however, the equivalent heat demand would shift to the west side of the river.

Screening studies are in progress to evaluate the following:

- an additional 15 MW, 350 kPa steam-condensing turbine as an economic optimization
- co-generation options with an independent third-party energy producer (including use of petroleum coke as fuel)

Final selections are expected to be made by mid-1998.

C4.3.5 Waste Heat Systems

Energy Services steam demand will be significantly reduced on a unit-of-production basis for Project Millennium in comparison with the current operation. This will be due to the use of major process modifications requiring less heat and optimum heat integration for improved energy efficiency and will be accomplished in:

- Bitumen Production by:
  - operating at a lower temperature (53°C) rather than the current 68°C in the Extraction oil separation circuit

- Millennium Upgrader by:
  - incorporating waste heat recovery in all new fired heaters, either through steam generation or air preheat
  - recovering about 80% of the waste heat in the Millennium Upgrader

These energy efficiency enhancements all share the effect of significantly reducing steam requirements and resulting air emissions.

C4.3.6 Compressed Air Systems

Compressed air requirements for Project Millennium will increase significantly. Electrically-driven compressors with associated air receivers and driers supplying 325 000 m^3/d will be installed in the Millennium Upgrader area, to eliminate the large pressure drop and energy loss associated with long piping runs from the main Energy Services facilities. In addition, air distribution piping connecting Upgrading demands with the Energy Services air supply will be installed as a looped ring, to enhance system reliability. Further design optimization may alter the size of these units.

C4.3.7 Energy Services Support Facilities

A control room and maintenance facilities will be required to support additional Millennium equipment. Pending final design and economic optimization, these facilities may be shared with the Millennium Upgrader.

C5 PLANT SUPPORT INFRASTRUCTURE

C5.1 Scope

This section discusses the changes in support infrastructure that are required by Project Millennium. Present infrastructure has been described in Volume 1, Section B5.

Suncor has of necessity developed a site master plan, to resolve competing demands and to accommodate the support needs for Project Millennium in a well-considered manner. The most significant outcome is the proposed development of Fee Lot 2 for a number of purposes including:

- Administration Building
- Warehouse
- Permanent and Construction Camp
- Suncor Tank Farm
- Wild Rose Tank Farm and Pump Station (by others)
- Natural Gas Liquids Plant and Storage Facility (by others)
- Tanker truck loading and unloading facility

C5.2 Fee Lot 2 Development

C5.2.1 Access

Currently, the capacity and safety of Highway 63 is being assessed by the Regional Infrastructure Working Group (RWIG) in light its of increased use.

Other issues include the development of additional access to Highway 63 for the proposed camp.

C5.2.2 Fee Lot 2 Proposed Facilities

Figure C5-1 shows a preliminary site layout for Fee Lot 2 development. This Lot 2 is not suitable for open-pit mining and provides a convenient site for the proposed development. Suncor holds fee simple title to the land.

Administration Building

The current Administration building may be required to house Extraction and Energy Services personnel, forcing the relocation of support personnel. An administration building may be constructed on Fee Lot 2. Other options including Fort McMurray offices are being considered.

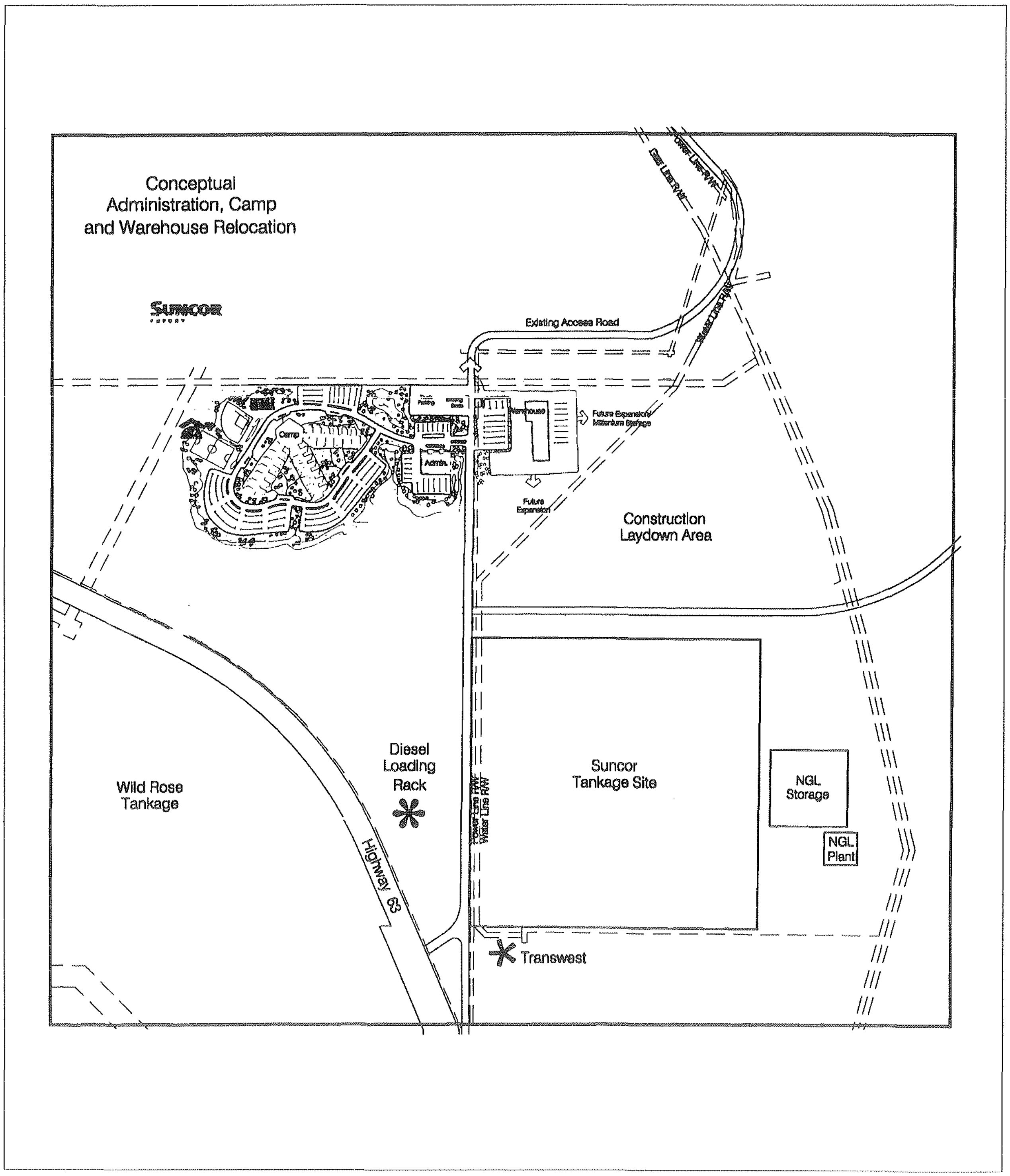


Figure C5-1 Fee Lot 2 Development Plot Plan

Warehouse

Current plans are to locate electrical generation facilities immediately west of the Administration building, affecting storage space and forcing relocation of the warehouse to Fee Lot 2.

Camp

The current camp area will be encroached upon by the new upgrading train and will need to be relocated in stages, then completely decommissioned when the Upgrader begins operation. It is probable that a portion of the Camp's permanent structure will be used for other purposes.

A 1 200 to 1 500 person permanent camp facility (complete with recreation and food services) planned for Fee Lot 2 will be required to provide accommodation for major maintenance events, ongoing projects and Project Millennium construction.

A 1 500 to 2 000 person construction camp (adjacent to the permanent camp) to support Project Millennium construction is also under consideration.

Suncor Tank Farm

Additional product storage is required for the increased production rates. The location of this storage is being evaluated; options include Fee Lot 2.

Wild Rose Pipeline Terminal

A terminal for the Athabasca Pipeline Project (comprising tankage, a pumphouse, control and office facilities) is proposed for Fee Lot 2. The facilities would be owned by others.

Natural Gas Liquids Facility

A natural gas liquids plant including an underground storage facility (to be owned, constructed and operated by others) is proposed to be located on Fee Lot 2. This plant would recover light hydrocarbon liquids from Suncor Upgrader-generated gas.

Utilities

The Fee Lot 2 development will require provision of natural gas, electricity, communications, sewer and water. Supply of these utilities is under active study.

C5.2.3 Base Plant Infrastructure

The firehall, laboratory and medical centre facilities will likely be relocated as space becomes available through the relocation of Administration and the warehouse.

C6 SCHEDULE AND IMPLEMENTATION

This section describes the proposed Project Millennium schedule, project implementation and relevant plans.

C6.1 Schedule

The overall schedule for Project Millennium (from disclosure to full production) is shown on Figure C6-1.

This schedule provides one year for regulatory review and approval. Suncor believes this is sufficient time given that:

- the project is an expansion of existing operations that are well-known and have a demonstrated performance history
- the mining component of Project Millennium is an expansion of the recently-approved Steepbank Mine
- the Millennium Upgrader is a twinning of the present upgrader, using fundamentally similar technology, but with enhancements
- the technology to be applied is fundamentally demonstrated, with enhancements to improve environmental performance, energy efficiency, reliability and cost performance
- a high level of public consultation has continued through the Steepbank Mine and Fixed Plant Expansion applications and the Project Millennium application process
- most issues are believed either to have been resolved prior to the application; or, considered to be resolvable within the regulatory timeframe

Regulatory approval by the end of first quarter 1999 or sooner is important because it would allow Suncor to take advantage of the 1999 spring and summer construction window and thus achieve the project startup date of 2002.

Project Millennium is targeted to commence production of at least 210 000 bbl/cd in early 2002, just under 3 years from regulatory approval

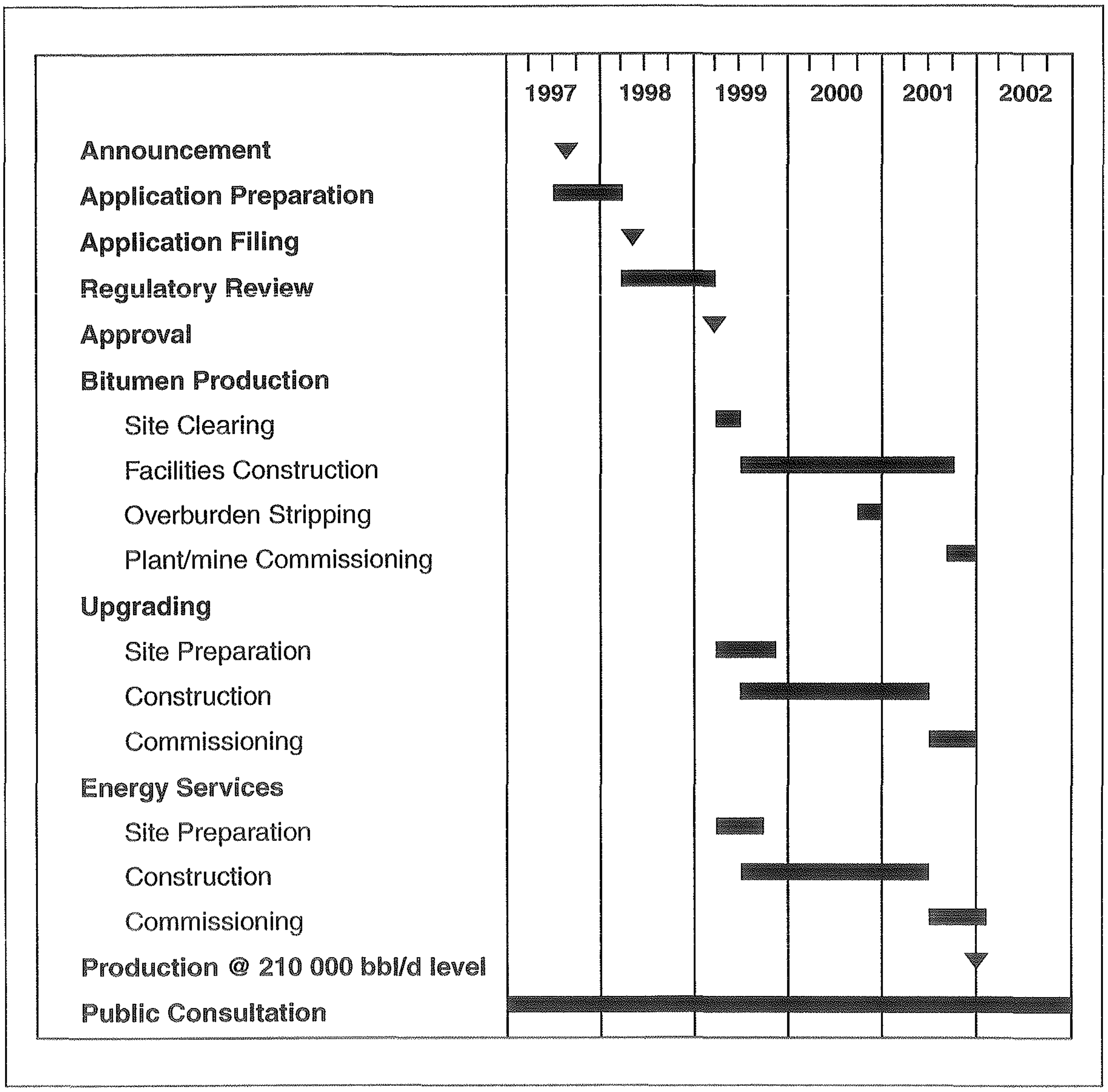


Figure C6-1 Project Schedule

and 4.5 years from project disclosure. The project implementation schedule is aggressive but of critical importance to Suncor's growth plans. By more than doubling present production, Project Millennium will reduce the cash cost per barrel by \$10/bbl to \$11/bbl. The step-increase in income combined with the step-reduction in cash costs not only returns project investment capital, it is the means to take maximum advantage of the large present investment, operating experience and know-how. It also reduces vulnerability of the operation to world oil price volatility.

Suncor's Board of Directors has given concept approval for Project Millennium and is expected to provide final approval by mid-1998, upon confirmation of project capital cost and economics.

C6.2 Project Implementation

The project implementation can be described in five broad phases:

- concept and feasibility basis
- design basis
- detailed engineering
- procurement and construction
- commissioning and operation

These are discussed in the following sections.

C6.2.1 Concept and Feasibility Phase

Initiation of a major project typically takes place in response to a strategic need and plan. Project development proceeds with more definition through stages of engineering, typically culminating in a feasibility-level design and cost estimate, which in turn provides guidance for further engineering, study and decision-making. The cost estimate is the basis of the Board of Directors' concept approval, allowing the project to proceed to the next stage.

Project Millennium has completed this phase.

C6.2.2 Design Basis Phase

This phase typically produces an engineering design basis memorandum (DBM) and a budget cost estimate. A DBM is the basis upon which detailed project engineering, procurement and ultimately construction can proceed. The cost estimate is the basis for final Board of Directors' approval.

In this phase, many of the basic decisions are made regarding project scope, technology selection, performance criteria, location decisions and environmental impact mitigation. The EIA is prepared at the same time. This is also the stage where stakeholders are consulted intensively for their input and when the greatest impact on project decisions occurs. During this period, at the point where the bulk of input has been received and most of the key design decisions are made, the project application is filed and the DBM development proceeds rapidly to completion.

Sufficient Suncor engineering and support skills in-house and through contract are available to execute this phase to a high standard.

Project Millennium is currently in this phase.

C6.2.3 Detailed Engineering Phase

This phase produces a detailed engineering plan with which procurement and construction can proceed. Typically, the engineering, procurement and construction time periods overlap to optimize the overall schedule.

It is during this stage that the bulk of detailed engineering effort is applied: to produce a safe, reliable effective and efficient design; to select and specify materials and equipment; and to produce a detailed construction and (ultimately) operating plan.

The key issue here is the sourcing of sufficient engineering skill to execute this phase expeditiously and to a high standard.

Suncor has formed an alliance with several large, prominent firms having worldwide engineering, procurement and construction skills. The Company is confident the requisite skills will be available, largely in the Canadian skill pool but globally if necessary. Suncor's stated goal is to achieve a worldwide model of excellence in project implementation for Project Millennium.

For Project Millennium, Suncor and its Alliance members are developing a Millennium-specific approach that will: take advantage of the size and competence of the organizations; a risk/reward commercial structure for all the members; a commitment to finding new ways of running projects that lead to innovation and performance breakthroughs; and having the experience of working on the project being rewarded for everyone.

C6.2.4 Procurement and Construction Phase

The product of this stage is a project ready to be commissioned for operation. This phase includes the sourcing and transportation of all equipment and materials; contracting of services; site preparation; pre-fabrication on-site and off-site; construction; and tie-ins to existing operations and utilities. Key to the success of this phase is strong project management and supervision, as well as planning and control, all with an emphasis on safety.

Procurement

Suncor intends to source materials and services locally to the largest extent possible provided cost is competitive and quality expectations can be met.

Total expenditures for Project Millennium are expected to be spent geographically in the following proportions:

- Region of Wood Buffalo - 300 to 400 million dollars
- Other Alberta - 1.0 to 1.1 billion dollars
- Other Canada - 300 to 400 million dollars
- World - 400 to 500 million dollars

At this point there are no identified material or service scarcities that would delay the project.

Construction

At the peak of construction activity in 2000/2001, it is projected that 2 500-3 000 construction workers will be required at the Suncor site.

The key issue will be construction trades availability. To understand the supply and demand for skilled labour, Suncor participated in the collaborative efforts by the Construction Owners Association, Alberta Labour, The Alberta Construction Contractors, labour organizations and Human Resources Development Canada in forecasting Alberta's construction workforce supply and demand. This analysis was concluded in May 1997 and is presently being updated.

Findings in 1997 (covering the period 1997 to 2001) indicated potential shortages for millwrights and ironworkers with some concern for the number of available plumber/pipefitters and operating engineers. It was anticipated that the market may tighten for welders, electricians and carpenters in this timeframe.

During 1997, Suncor has supported industry, labour and government initiatives to review training and development processes for skilled trades. Suncor will encourage maximum use of apprenticeship training during construction, to ensure skills are available for the project as well as future projects, and will continue to cooperate with trades and construction associations to ensure trade availability.

During Suncor's peak construction period it is expected that a number of other projects will be underway throughout Alberta. Suncor will take steps to ensure workers are attracted to its project through competitive work schedules, provision of transportation, and high-quality accommodation and food services. A new permanent camp and construction camp(s) are currently being considered.

Suncor remains confident the requisite skills will be available in the Alberta and Canadian skilled labour pools.

C6.2.5 Commissioning and Operation Phase

This phase involves the sequenced, safe startup of constructed facilities. To accomplish startup the operational workforce must be in place, trained and familiar with the new facility.

Suncor will increase its workforce from the 1998 level of 1 600 to 2 400 by 1 January 2002. This increase of employees by 800 is projected to be allocated as shown in the following table:

Table C6-1 Workforce Increase for Project Millennium

	Total
Management/Supervision	50
Engineering/Technical	64
Administration	14
Operators	386
Maintenance/Trades	286
TOTAL	**800**

To support this level of recruitment (plus normal attrition of the existing workforce) Suncor's employment strategy will be to recruit and develop the pool of successful candidates from the local region first, neighboring regions second, and then (in order), the Alberta and Canada employment markets. Suncor is working in partnership with the local communities, the education and training system, government and the project constructors to source currently-qualified individuals for direct employment and to develop individuals with the skills and competencies required for the 2002 workforce.

Through multi-stakeholder consultation, Suncor will provide the forum to have its workforce requirements understood and will jointly develop processes to source and ensure workforce diversity. In particular, this will involve considerable efforts with local aboriginal communities.

Recruitment of the additional 800-person workforce will be achieved through:

- active recruitment in the Regional Municipality of Wood Buffalo (RMWB) and extending outward as required
- development of qualified candidates through cooperative education and training initiatives with both local education systems and communities
- development of existing employees to assume additional responsibilities, thus opening entry-level opportunities for existing community resources

Suncor intents to increase the diversity of its workforce. Its target for aboriginal hiring is to reach 12% of its workforce by 2002.

Suncor will work with local communities to provide the supply of housing, transportation, recreation and other infrastructure services that are required to meet the needs of current residents as well as those of new residents relocating from external-to-the-region recruitment.

Throughout this period, Suncor will work in cooperation with other employers to address the cumulative impact of the employment growth potential.

D MATERIAL BALANCES

D1 INTRODUCTION

D1.1 Planned Expansion

Suncor plans to increase its production from its current capacity of 85 000 bbl/cd as follows:

- to 105 000 bbl/cd by late 1998 (Steepbank Mine and Fixed Plant Expansion)
- to 130 000 bbl/cd in 2001 (PEP)
- to a minimum of 210 000 bbl/cd by 2002 (Project Millennium)

D1.2 Purpose of Calculations

Suncor has developed measurement practices to support the control of its operations. Primary emphasis is given to monitoring of operating criteria in the areas of:

- Upgrader product quality
- Upgrader performance
- Extraction performance
- resource conservation
- sulphur recovery
- water management
- energy consumption
- air emissions

Systems have been developed to measure, monitor and report data that will ensure that:

- operations are effective
- Suncor meets all regulatory requirements

D1.3 Calculation Basis

Material and energy balances have been derived through use of best professional judgment and are based on process engineering models and plant operating experience. Actual operating data may differ from that presented in the balances as a result of potential inaccuracies in model assumptions, design expectations and measurements.

Three cases are presented:

- FPE case (105 000 bbl/cd)
- PEP case (130 000 bbl/cd)
- Millennium case calculated at 218 000 bbl/cd net

Project Millennium is planned to produce at a minimum average level of 210 000 bbl/cd. The material balance is calculated at 218 000 bbl/cd because that represents the best current engineering judgment of the design capability of the integrated operation and is a conservative basis for calculated emissions performance. The performance expectation may change as detailed design optimization proceeds.

The calculations account for internal plant fuel consumption. For example, while the Fixed Plant Expansion case gross production is 107 000 bbl/cd, the net production is 105 000 bbl/cd, due to internal consumption.

Material and energy balances are shown in Figures D1-1 to D1-5. These include (all in SI units except where indicated):

- hydrocarbon balance on a calendar day basis
- hydrocarbon balance on a calendar day basis (in Imperial units)
- water balance on a calendar day basis
- sulphur balance on a calendar day basis
- energy balance on a calendar day basis

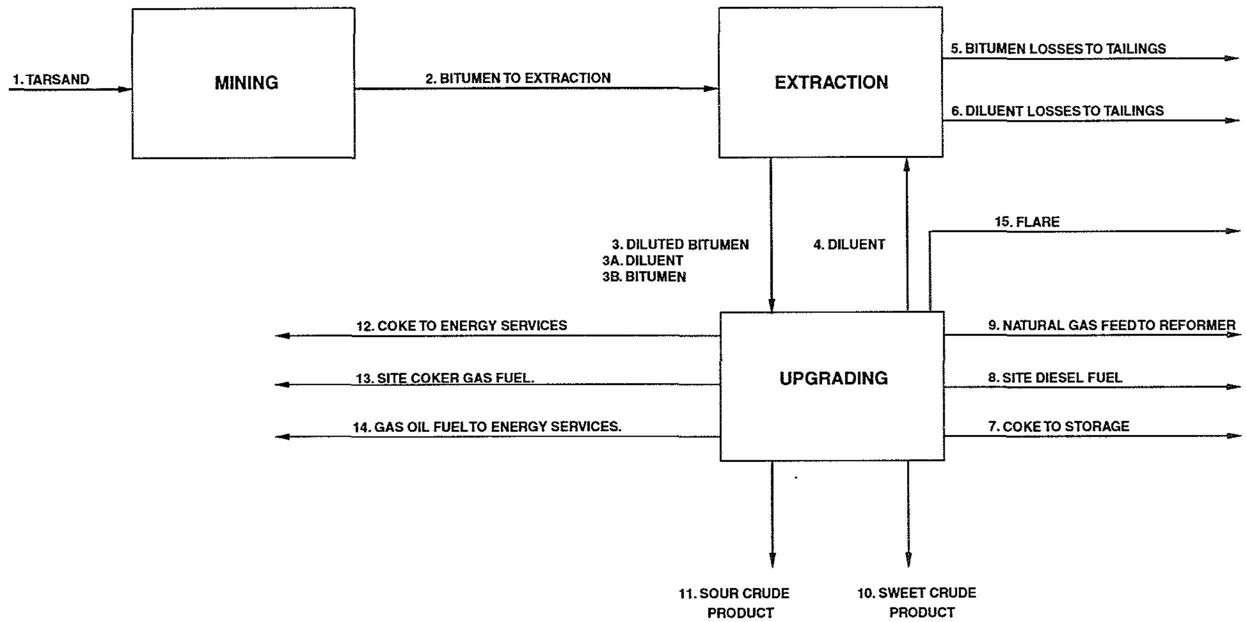
Calendar day rates are representative of average annual performance including a service factor.

D1.4 Key Assumptions

The following key assumptions are included in the three cases presented:

- bitumen in oil sand is 11.5 wt% for the FPE and PEP cases, and 11.7 wt% for the Millennium case
- extraction recovery is 92.5% of mined ore
- diluent to bitumen ratio by volume (in diluted bitumen from extraction) is 0.86 for FPE, 0.77 for PEP and 0.74 for Millennium cases
- diluent recovery is 99.3% of diluent supplied to the extraction process
- upgrading utilization factor of 93.6% for Millennium
- bitumen production utilization factor of 85% for Millennium

Figure D1-1 Hydrocarbon Balance Calendar Day Rates (SI)



IN

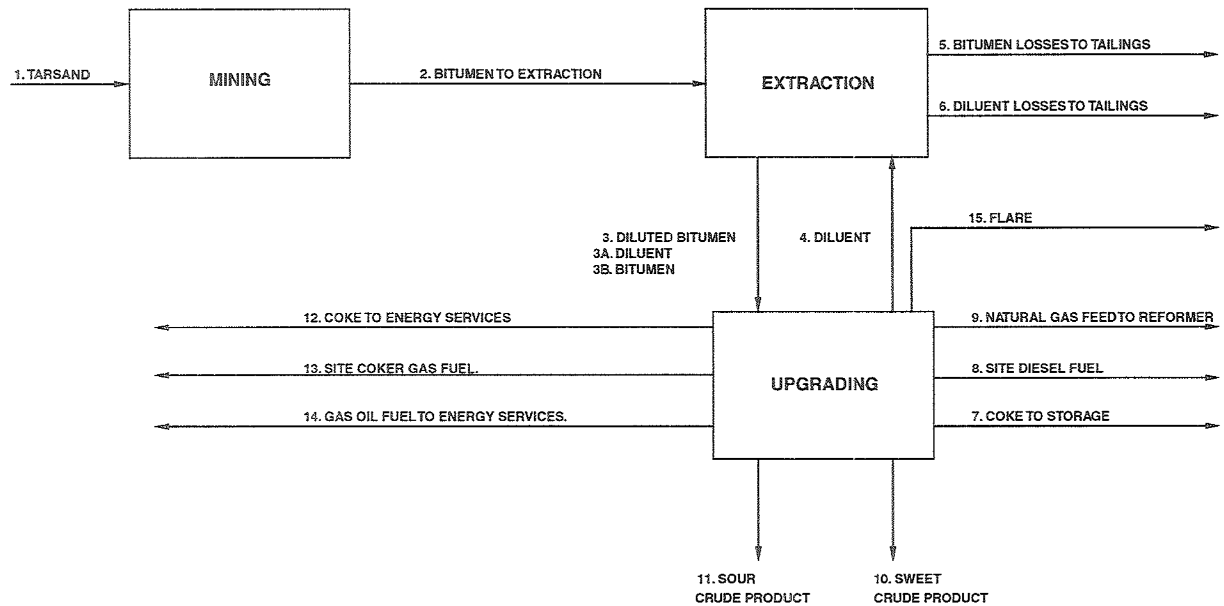
STREAM	1	9
UNITS	TONNES/ DAY	$10^6 m^3$
FPE- 1998	196,931	0.48
PEP- 2001	243,376	0.51
MILLENNIUM- 2002	403,850	1.06

INTERNAL USAGE

STREAM	2	3	3A	3B	4
UNITS	$10^3 m^3$	$10^3 m^3$	$10^3 m^3$	$10^3 m^3$	$10^3 m^3$
FPE- 1998	22.47	38.65	17.87	20.78	18.00
PEP- 2001	27.76	45.40	19.72	25.68	19.86
MILLENNIUM- 2002	46.88	75.50	32.14	43.36	32.36

OUT

STREAM	5	6	7	8	10	11	12	13	14	15
UNITS	$10^3 m^3$	$10^3 m^3$	TONNES/ DAY	$10^3 m^3$	$10^3 m^3$	$10^3 m^3$	TONNES/ DAY	$10^6 m^3$	$10^3 m^3$	$10^6 m^3$
FPE- 1998	1.69	0.13	1,686	0.19	10.65	6.04	2,357	0.92	0.03	0.09
PEP- 2001	2.09	0.14	2,378	0.25	12.08	8.59	2,618	1.32	0.00	0.08
MILLENNIUM- 2002	3.52	0.23	5,818	0.52	21.47	13.20	2,618	2.40	0.00	0.14



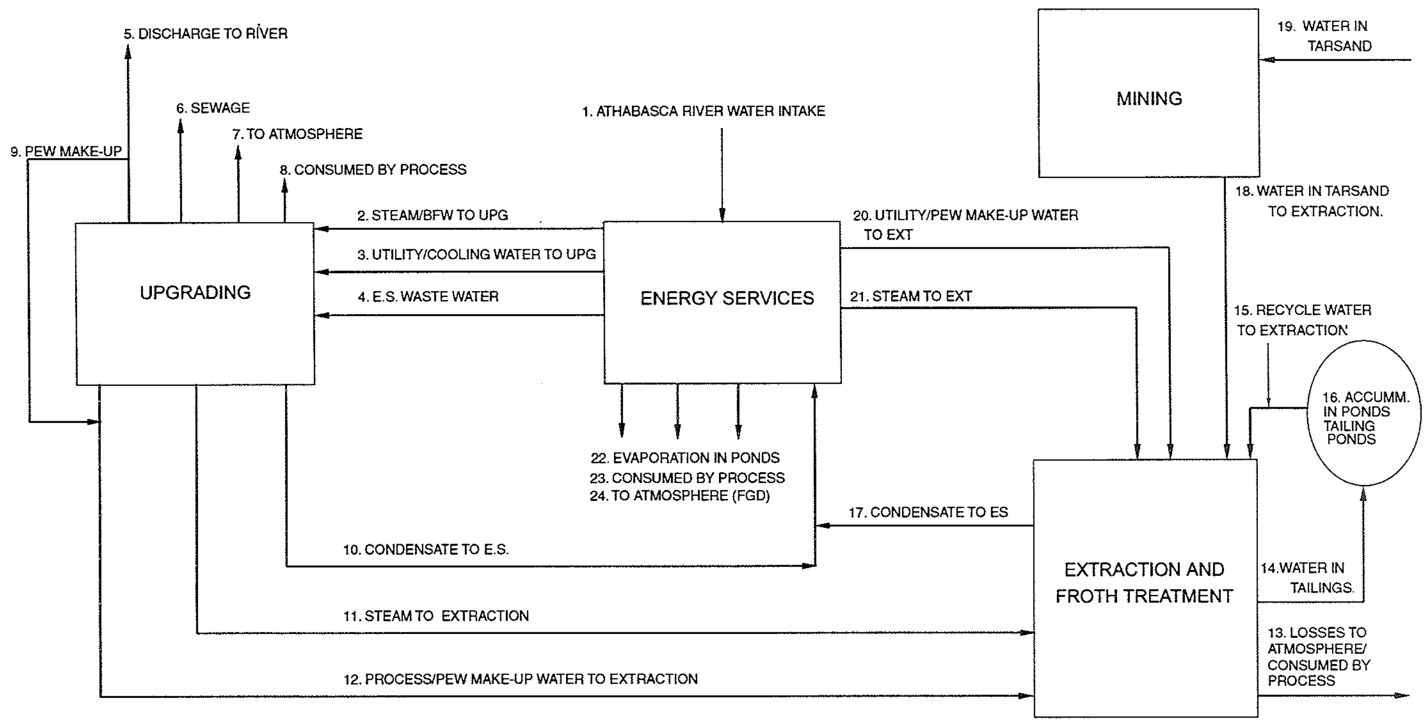
IN	STREAM	1	9
	UNITS	TONS/ DAY	MMSCFD
	FPE- 1998	217,018	17.1
	PEP- 2001	268,200	18.1
	MILLENNIUM- 2002	445,043	37.3

INTERNAL USAGE	STREAM	2	3	3A	3B	4
	UNITS	KBPD	KBPD	KBPD	KBPD	KBPD
	FPE- 1998	141.3	243.1	112.4	130.7	113.2
	PEP- 2001	174.6	285.5	124.0	161.5	124.9
	MILLENNIUM- 2002	294.8	474.8	202.1	272.7	203.5

OUT	STREAM	5	6	7	8	10	11	12	13	14	15
	UNITS	KBPD	KBPD	TONS/ DAY	KBPD	KBPD	KBPD	TONS/ DAY	MMSCFD	KBPD	MMSCFD
	FPE- 1998	10.6	0.8	1,858	1.2	67.0	38.0	2,597	32.5	0.2	3.3
	PEP- 2001	13.1	0.9	2,621	1.6	76.0	54.0	2,885	46.7	0.0	2.9
	MILLENNIUM- 2002	22.1	1.4	6,411	3.3	135.0	83.0	2,885	84.7	0.0	5.0

Figure D1-2 Hydrocarbon Balance Calendar Day Rates (Imp.)

Figure D1-3 Water Balance Calendar Day Rates (m^3/cd)

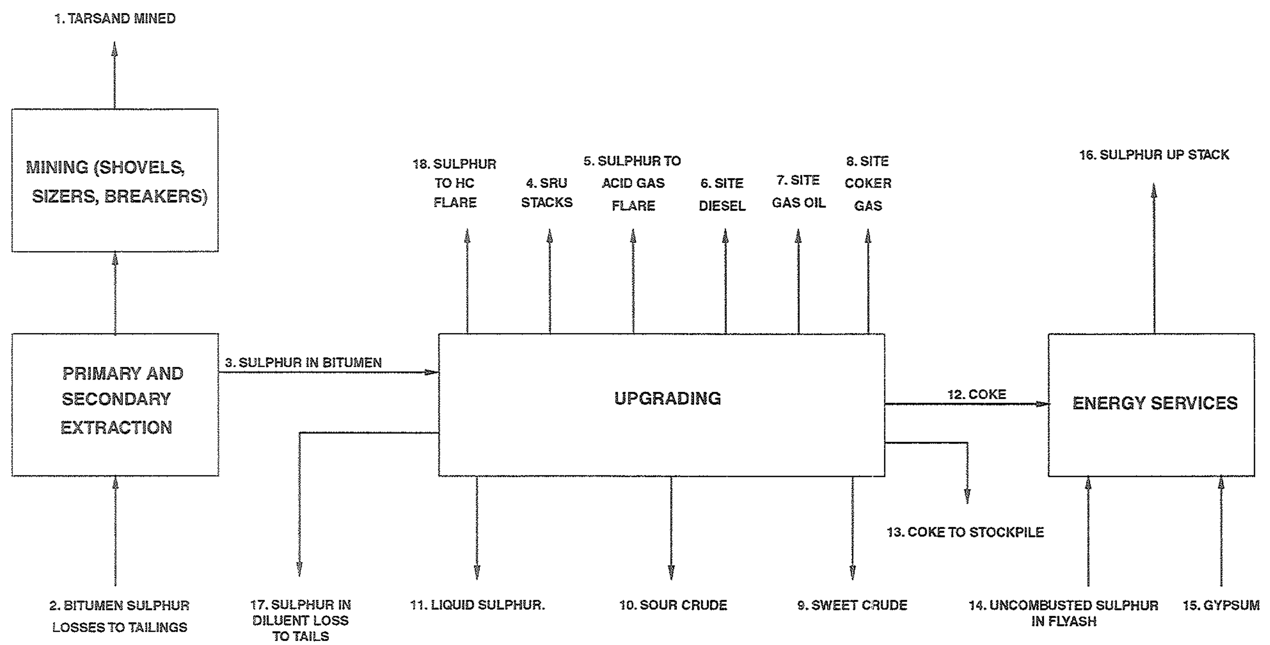


IN	STREAM	1	19	TOTAL
	UNITS	M^3/DAY	M^3/DAY	M^3/DAY
	FPE (1998)	74,808	8,177	82,985
	PEP 2001	82,903	10,084	92,987
	MILLENNIUM 2001	57,961	16,357	74,318

OUT	STREAM	5	6	7	8	13	16	22	23	24	TOTAL
	UNITS	M^3/DAY	M^3/DAY	M^3/DAY	M^3/DAY	M^3/DAY	M^3/DAY	M^3/DAY	M^3/DAY	M^3/DAY	M^3/DAY
	FPE (1998)	41,500	452	616	611	654	28,703	2,109	981	7,359	82,985
	PEP 2001	31,229	545	1,092	635	2,243	45,843	2,109	1,090	8,200	92,987
	MILLENNIUM 2001	0 (1)	545	1,305	1,512	3,761	55,795	2.109	1,090	8,200	74,318

INTERNAL USAGE	STREAM	2	3	4	9	10	11	12	14	15	17	18	20	21
	UNITS	M^3/DAY	M^3/DAY	M^3/DAY	M^3/DAY	M^3/DAY	M^3/DAY	M^3/DAY	M^3/DAY	M^3/DAY	M^3/DAY	M^3/DAY	M^3/DAY	M^3/DAY
	FPE (1998)	11,993	28,241	14,991	0	452	7,032	3,761	78,993	55,740	16,610	8,176	18,077	8,923
	PEP 2001	17,104	20,975	15,128	0	4,081	8,929	5,895	142,006	101,613	14,261	10,084	28,277	9,158
	MILLENNIUM 2001	26,247	18,530	15,264	27,287	9,830	9,773	36,273	195,178	139,384	16,812	16,354	3,097	10,871

(1) During steady operations discharge volume is expected to approach zero. Discharge may be necessary during cooling tower maintenance, extremely hot weather, extended periods of low production or other unusual circumstances.

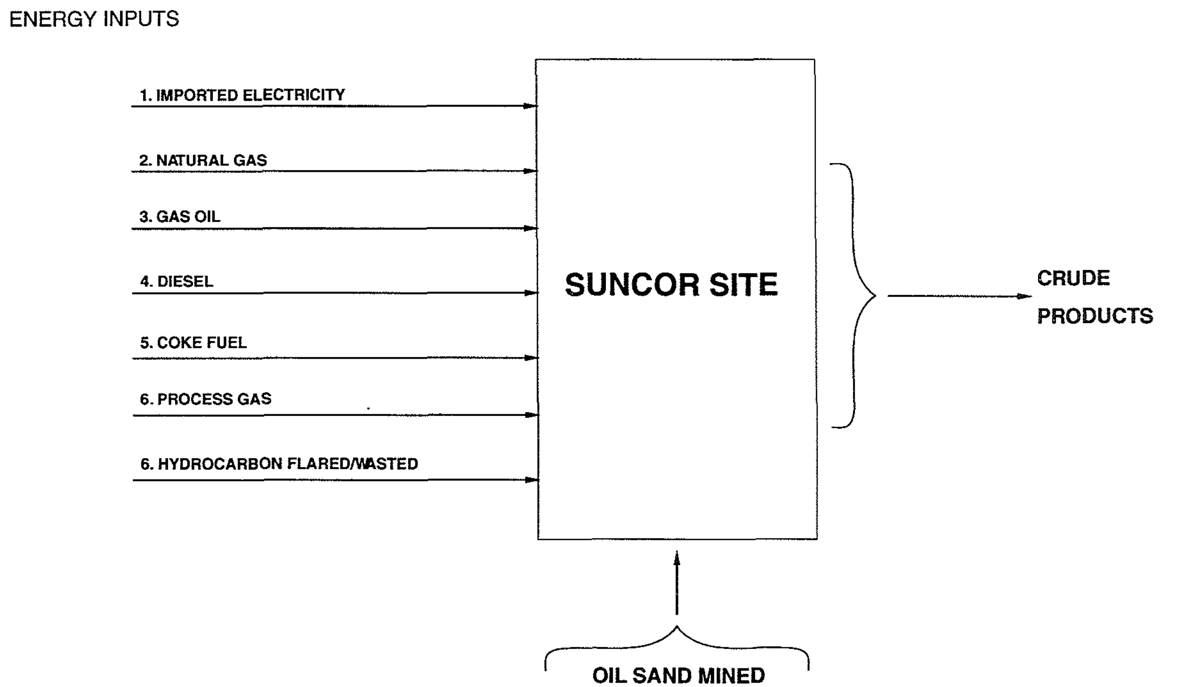


	STREAM	1	TOTAL
IN	UNITS	TONNES/ DAY	TONNES/ DAY
	FPE (1998)	1106	1106
	PEP (2001)	1358	1358
	MILLENNIUM (2002)	2292	2292

	STREAM	3	12
INTERNAL USAGE	UNITS	TONNES/ DAY	TONNES/ DAY
	FPE (1998)	1023	146
	PEP (2001)	1256	164
	MILLENNIUM (2002)	2120	164

	STREAM	2	4	5	6	7	8	9	10	11	13	14	15	16	17	18	TOTAL
OUT	UNITS	TONNES/ DAY	TONNES/ DAY	TONNES/ DAY	TONNES/ DAY	TONNES/ DAY	TONNES/ DAY	TONNES/ DAY	TONNES/ DAY	TONNES/ DAY	TONNES/ DAY	TONNES/ DAY	TONNES/ DAY	TONNES/ DAY	TONNES/ DAY	TONNES/ DAY	TONNES/ DAY
	FPE (1998)	83	9.4	1.7	0.0	0.1	1.4	18	196	542	103	0.7	136	9	1.7	3.7	1106
	PEP (2001)	102	10.9	1.9	0.0	0.0	2.0	21	278	627	148	0.8	153	10	1.9	0.7	1358
	MILLENNIUM (2002)	172	9.3	3.5	0.0	0.0	3.5	24	398	1154	360	0.8	153	10	3.1	0.7	2292

Figure D1-4 Sulphur Balance Calendar Day Rates (t/cd)



ENERGY INPUT TABLE

STREAM	1	2	3	4	5	6	7	TOTAL
UNITS	GJ/DAY	GJ/DAY	GJ/DAY	GJ/DAY	GJ/DAY	GJ/DAY	GJ/DAY	GJ/DAY
FPE 1998	5258	17760	1252	6769	82305	38231	3882	155456
PEP 2001	0.0	31127	0.0	8707	91432	54934	3411	189612
MILLENNIUM 2002	0.0	43485	0.0	18594	91432	118649	6258	278399

ENERGY INTENSITY FACTORS

INTENSITIES	FPE	PEP	MILLENNIUM
GJ/TONNE OF OIL SAND MINED	0.72	0.71	0.63
GJ/m^3 OF BITUMEN PRODUCED	7.48	7.38	6.42
GJ/NET BBLS OF CRUDE PRODUCED	9.51	9.35	8.21

Figure D1-5 EnergyIntensity (GJ/d)

D1.5 Standards for Measurement

Systems and equipment installed and used to obtain operational data for regulatory reporting are based on sound engineering practices and meet or exceed the following standards:

- regulatory specifications where applicable (e.g., CSEM calibration and survey standards)
- American Petroleum Institute Manual of Petroleum Measurement Standards (API - MPMS)
- recognized and frequently-used industrial recommended practices (e.g., API standards)

Specifications and standards apply to:

- installation
- calibration
- data collection
- data calculation and conversion

D1.6 Testing and Reconciliation

Supporting data is collected, evaluated and made available (when required) to regulatory authorities and the public, to demonstrate applicability and accuracy of measurement systems and equipment. AEUB and Suncor have developed a methodology which demonstrates the validity of the measurement of bitumen and diluent in Extraction.

Field monitoring programs include material sampling, analysis, and data verification. This is supported by field (operational) and laboratory services. Laboratory and other external services, such as meter proving, conform to recognized and certifiable standards. Monitoring programs are in place to identify deviations from expected recoveries or potential metering issues.

D1.7 Records and Reporting

The *Monthly Oil Sands Processing Plant Statement*, or the *S-23*, is the basis upon which data is reported externally. This reporting statement was developed jointly by the AEUB, Suncor and Syncrude to meet the information needs of all regulatory agencies. The *S-23* summarizes operational information based upon the defined production and processing activities and is organized by specific products and feedstocks.

D2 PLANT BALANCES

D2.1 Hydrocarbon Balance

The hydrocarbon balances are shown on:

- Figure D1-1: calendar day production rates (metric units)
- Figure D1-2: calendar rates (Imperial units)

These balances are representative of the Mine, Extraction and Upgrading configurations for each of the three cases as described previously in Volume 1, Sections B and C.

Gross liquid yield (crude oil product plus plant use as a fraction of bitumen to the Upgrader) as derived from the hydrocarbon balances is:

- FPE case 82.0%
- PEP case 82.0%
- Millennium case 81.7%

Upgraded product is a combination of virgin crude, intermediate coker product and hydrotreated product. The virgin crude and intermediate coker product are considered sour crudes, with about 3% wt% and 4.2% wt% sulphur respectively. Hydrotreated product is a sweet crude with about 0.2 wt% sulphur.

The proportion of sweet to sour products varies for the three cases as follows:

- FPE case: 36% sour; 64% sweet
- PEP case: 42% sour; 58% sweet
- Millennium case: 38% sour; 62% sweet

Petroleum coke production balance as derived from the hydrocarbon balances is shown in Table D2-1.

Table D2-1 Petroleum Coke Production and Disposition (kt/d)

Case	Coke Used for Plant Fuel	Coke to Storage or Sales	Coke Produced
FPE	2.3	1.7	4.0
PEP	2.6	2.4	5.0
Millennium	2.6	5.8	8.4

D2.2 Water Balance

The water balance for the three cases is shown on Figure D1-3.

Water intake from the Athabasca River is projected to decrease to 58 000 m^3/cd for the Millennium case from 75 000 m^3/cd for the FPE case. This represents a 23% reduction in water intake per unit of production.

In the Millennium case, wastewater discharge to the river is substantially reduced as a result of improved water recycle and process cooling water.

During steady operations near Millennium design rates, it is expected that the reconfiguration of the wastewater ponds will result in all water being recycled and therefore discharge may not be required. At other times (during maintenance on cooling towers, extended low rates in Bitumen Production, a long stretch of extremely hot weather or other unusual circumstances), discharge may be necessary. Overall average outfall rates will be much lower than today. Suncor is actively working to keep discharges to the river at the lowest rates possible without impacting tailings pond storage requirements.

For the purposes of the EIA, a conservative estimate of discharge rate of 10 900 m^3/cd has been assumed. This is the equivalent of eliminating the cooling water outfall flow and reducing the wastewater outfall flow by one-half from the Fixed Plant Application basis. Quality of the water discharged is not expected to be materially different from the current wastewater outfall stream in terms of licenced contaminant emissions.

The net accumulation of water in the tailings pond system is indicated to increase by 56 000 m^3/cd from the FPE case to the Millennium case. This water is needed to build up the operating inventory for Millennium Extraction plant. It is expected that water requirements will begin to decrease within eight to ten years as water released from Consolidated Tailings replaces river water intake.

D2.3 Sulphur Balance

Sulphur balances are shown on Figure D1-4 for calendar day production rates.

Most of the sulphur in the petroleum coke used by Energy Services is removed in the form of gypsum with FGD. Sulphur emissions from Energy Services are projected to increase slightly for the Millennium case compared to the FPE case reflecting higher coke-fired boiler utilization.

Overall tailgas sulphur is reduced from 9.4 t/d for the FPE case to 9.3 t/d for the Millennium case. Elemental sulphur production increases from 545 t/cd for the FPE case to 1 154 t/cd for the Millennium case.

D2.4 Energy Balance

The overall energy intensity for the three cases is shown on Figure D1-5.

Site-wide energy intensity (total energy consumed per unit of net product produced) for the PEP case is 2% less than for the FPE Case. Project Millennium energy intensity is 14% less than for the FPE case.

Natural gas consumption increases by 75% for the PEP case relative to the FPE case. This increase is a result of the addition of the gas turbine and waste-heat boiler in Energy Services to meet Suncor's power and steam demands at the PEP production rates. For the Millennium case, natural gas will increase by 40% over the PEP case, reflecting energy efficiencies captured in the Millennium Upgrader.

E CLOSURE PLAN

Reclamation plans for Lease 86/17 and Steepbank Mine have been discussed in the "Detailed Conservation and Reclamation Plan for Suncor's Integrated Mine Plan - Lease 86/17 Steepbank Mine and Athabasca River Valley" (Golder 1996e). The goals and endpoints for reclamation were established in that document, and have been incorporated into the planning for Project Millennium as described below. This document focuses on the reclamation process and closure plan for Suncor mining activities associated with Project Millennium, and is the basis of Suncor's request for an amendment of its approval under AEPEA Approval Regulation, Division 3. The environmental assessment of the closure plan is presented in Volume 2, Section E of this application.

E1 INTRODUCTION

E1.1 Scope

This section provides Suncor's goals for reclaimed landscapes as well as a description of the process needed to realize the goals within each step of the project life cycle. Included are:

- classification systems used to describe pre-development ecosystems and reclaimed landscape
- pre-development conditions as described in the EIA
- the conceptual plan for reconstructing landforms, drainages, surface soils, wetlands, forest lands and the end pit lake
- procedures for evaluating the acceptability of the plan

E1.2 Reclamation Goals

The goal of reclamation is to achieve maintenance-free, self-sustaining ecosystems with capability equivalent to pre-development conditions. Maintenance-free reclamation means that routine maintenance activities are not required, except for circumstances where future human activities lead to re-disturbance of areas. This does not imply a changeless state, as landforms will experience normal processes typical of the region that lead to gradual reshaping of the landscape. Self-sustaining ecosystems will evolve on reclaimed areas, from new plantings to mature systems typical of the region. Following initial re-establishment of the ecosystem, little input is required. Equivalent land capability refers to the ability of reclaimed land to support various uses similar to those existing prior to an activity being conducted on the land. These individual original and post-reclamation land uses will not necessarily be identical.

Objectives of the Suncor reclamation program can be summarized as follows:

> *Developed lands shall be reclaimed with viable ecosystems compatible with pre-development, including forested areas, wetlands and streams. The reclaimed lands will provide a range of end uses including: forestry, wildlife habitat, traditional use and recreation.*

Following are general operational and reclamation objectives which form the basis for reclamation program design:

- Structures will be geotechnically stable. Catastrophic discharge of earth materials (coarse and fine tailings, overburden storage piles), particularly to the Athabasca and Steepbank Rivers, must be controlled to achieve an extremely-low probability of occurrence.

- Earth material discharges through surface erosion processes will be controlled to rates which are typical of the region.

- Surface and seepage water discharges will be managed to ensure an acceptable level of input to the Athabasca and Steepbank Rivers, Shipyard Lake and other fish habitats.

- Ecosystems re-established on disturbed lands will be self-sustaining and capable of maturing naturally, to present suitable opportunities for the needs of resident and migratory wildlife species.

- Reclaimed lands will be maintenance-free, thereby qualifying for reclamation certification. Various end uses will be possible for the reclaimed landscape, with end-use decisions made based on input from both regional communities and recommendations in the report of the Oil Sands End Land Use Committee.

E1.3 Project Life Cycle for Conservation and Reclamation

Any mine project typically follows a life cycle consisting of four phases, in which reclamation activities are an integral component, as follows:

<table>
<tr><td>Mine Planning</td><td rowspan="4">RECLAMATION</td></tr>
<tr><td>Mine Operation</td></tr>
<tr><td>Mine Closure</td></tr>
<tr><td>Reclamation Certification and End Use</td></tr>
</table>

E1.3.1 Mine Planning Phase

During the Mine Planning Phase, pre-development conditions are assessed, then project goals, design criteria and assessment techniques are established, providing the design basis for the project. Also, technologies best suited to achieve both operating and reclamation objectives are selected. Areas are identified where further research or demonstration projects may be required. This phase includes the submission of a detailed mine operation and closure plan for regulatory and stakeholder approval.

E1.3.2 Mine Operation Phase

The Mine Operation Phase involves the following functions:

- preparation of the minesite
- salvage of muskeg soil
- construction of facilities
- mining of oil sands
- extraction of bitumen
- placement of tailings and overburden waste

The detailed design for reclamation is developed as mining progresses. This produces a design based on actual operational conditions which will facilitate inclusion of progressive improvements in reclamation technology.

Reclamation activities concurrent with active mining include:

- physical reconstruction of landforms
- surface contouring
- recovery of reclamation soil material
- soil placement and area revegetation (initially on slopes of active waste dumps and tailings ponds and later on larger top areas)
- maintenance activities

Landform reconstruction will proceed toward a predominantly dry landscape by the use of Consolidated Tailings (CT) technology, combining coarse and fine tailings to form a stable deposit. Following deposition of CT into mine pit areas, subsoil construction techniques produce a trafficable surface on the CT deposit prior to soil reconstruction and area revegetation.

Integral to the development of sustainable closure ecosystems is the establishment of water management systems for the reclaimed landscape. Mine operations will include development of drainage systems, wetlands areas and an end pit lake.

E1.3.3 Mine Closure Phase

The Mine Closure Phase begins in stages, as active mining and waste placement progress.

As early as is practical, surface contouring is completed; soil is reconstructed; and vegetation, surface drainage and wetlands systems are re-established. Implementation of the CT process will eventually allow reclamation of developed mine areas to occur more closely after mining activities.

Closure also includes:

- systematic evaluation of the biophysical resources of the area
- planning of development activities
- assessment of the probable effectiveness of the closure plan and reclamation activities

Once active reclamation is complete and vegetation has been re-established, Suncor will monitor progress toward landscape and ecosystem maturation. During this phase, Suncor will conduct any required maintenance on reclamation areas and will establish practical criteria to serve as milestones for evaluation of the maturation process of these areas.

Also included in the Mine Closure Phase are the development and evaluation of pilot-scale tests and analytical models. Suncor is actively involved in research and demonstration projects both to prove and to further develop reclamation technology. The results of these activities are used to hone the Closure Plan.

E1.3.4 Reclamation Certification and End Use

Suncor endorses the work completed by the Oil Sands End Land Use Committee, and has included the report's recommendations into the closure planning process. The basis of Suncor's closure planning incorporates the primary land uses for forestry, natural ecosystems, wildlife and traditional land uses.

Upon successful completion of mine closure activities, Suncor will apply for reclamation certification. Future large-scale demonstrations and monitoring of fully-reclaimed areas will comprise the basis for reclamation certification.

E1.4 Classification Systems

Classification systems are necessary to be able to describe components of the ecosystem prior to development and subsequent to reclamation. The major classification systems currently used by Suncor are reviewed below as an aid to understanding the description of the reclamation and closure plan. Many of these systems have only recently been described and are currently being verified through application for development and reclamation of oil sands projects. Ecosystem components for which these classification systems are applied are shown in Table E1-1.

Table E1-1 Ecosystem Classification Systems and Areas of Application

Classification System	Terrain	Soil	Vegetation	Wildlife
Ecological Land Classification	Yes	Yes	Yes	
Land Capability for Forest Ecosystems	Yes	Yes		
Wetlands Classification	Yes		Yes	
Wildlife Habitat Suitability Indices			Yes	Yes

E1.4.1 Ecological Land Classification

Pre-development areas are evaluated to determine the types of terrain, soils and vegetation communities that exist. To define the ecological land units found in the proposed development area, the following publications are used: "Alberta Vegetation Inventory Standards Manual Final Draft" (Nesby 1997); "Field Guide to Ecosites of Northern Alberta" (Beckingham and Archibald 1996); and "Alberta Wetlands Inventory Standards" (Hasley and Vitt 1996). Results from these assessments are used in part to define baseline conditions for the development area. For the purposes of the EIA, an Ecological Land Classification is used to identify major ecosystem units in the region and locally. This system incorporates the use of remote sensing and Geographical Information System (GIS) as well as the above systems.

E1.4.2 Land Capability for Forest Ecosystems

Suncor participated on an industry/government committee (Tailings Sand Reclamation Practices Working Group) that helped to develop a land capability classification system applicable to forest ecosystems in the oil sands region. This system was designed to aid in the planning of soil-handling procedures and in measuring land capabilities for forest production. Details are provided in a document released by the working group: "Land Capability Classification for Forest Ecosystems in the Oil Sands Region; Working Manual" (Leskiw 1998). The capability classification approach to the rating of reclaimed lands includes assessment of:

- Land Capability: The ability of land to support a given use, based on evaluation of the physical, chemical and biological characteristics of the land including topography, drainage, hydrology, soils and vegetation.

- Soil Capability for Forestry: The nature and degree of limitations imposed by the physical, chemical and biological characteristics of a soil unit for the development of a productive forest.

- Landscape: Comprises terrestrial, semi-aquatic and aquatic landscapes when the term is used in definitions of land capability and equivalent land capability.

As a result of the assessment process, lands are assigned capability classes based on their number of index points. Defined capability classes and their characteristics are detailed in Table E1-2.

While the developed classification system applies directly to oil sands region forest ecosystems, it does not apply directly to other ecosystem types such as grasslands and wetlands. For example, forest capability Class 3 areas are considered Low Capability (i.e., lands having limitations which, in aggregate, are severe for sustained forest production) while Class 4 areas are currently considered conditional (i.e., lands with limitations which may be surmountable in time, but which cannot be corrected with existing knowledge). However, both Class 3 and Class 4 areas may contain highly-productive wetlands systems or grassland areas suitable for raising range animals. As a result, these can be considered for use other than the production of commercial forest stands under a different management regime.

E1.4.3 Wetlands Classification System

Wetlands on the pre-development landscape are defined using three systems. The base system is the "Alberta Wetlands Inventory Standards" (Halsey and Vitt 1996), used to supplement the vegetation classification system in the "Field Guide to Ecosites of Northern Alberta" (Beckingham and Archibald 1996). This guide includes the types of vegetation found in depressional areas, but is primarily focused on upland and better-drained sites capable of supporting forest ecosystems. Neither of these two systems fully defines the functions and capabilities of the various wetlands systems that exist within the region.

Consideration of the functions of wetlands is included through application of a third system, the "Peatland Inventory of Alberta, Phase 1: Overview of Peatland Resources in the Natural Regions and Subregions of the Province" (Vitt, Halsey, Thormann and Martin 1997) as part of the wetlands classification process.

Table E1-2 Land Capability Classification for Forest Ecosystems in the Oil Sands Region (Revised Edition; Leskiw, 1998)

Capability Class	Index Points	Forest Capability - Productivity and Limitations
1	81-100	High Capability: Land having no significant limitations to sustained forest production, or only minor limitations that will be overcome with normal management practice.
2	61-80	Moderate Capability: Land having limitations which (taken together) are moderately limiting for sustained forest production. The limitations will reduce productivity or benefits, or will increase inputs to the extent that overall cost-benefit will still be attractive but appreciably inferior to that expected from Class 1 land.
3	41-60	Low Capability: Land having limitations which (taken together) are severe for sustained forest production. The limitations will reduce productivity or benefits, or increase inputs to the extent that overall advantage to be gained from the use will be low.
4	21-40	Conditionally Productive: Land having severe limitation (some of which may be surmountable through management) which cannot be corrected with existing knowledge.
5	0-20	Non-Productive: Land having limitations which appear so severe as to preclude any possibility of successful sustained forest production.

Suncor and Syncrude jointly sponsored a Wetlands Workshop (September 1997) to review the current state of knowledge relating to wetlands found within the region. Discussed during the workshop was the suitability of available wetlands classification methods in defining the functions of natural undisturbed wetlands. Following the workshop, a group was formed to evaluate the use of current knowledge in defining the steps needed to create viable wetlands through reclamation. This working group will provide draft guidelines for use in the oil sands region by November 1998.

E1.4.4 Wildlife Habitat Suitability Indices

Suitability of habitats in pre-development and post-reclamation landscapes is assessed using habitat suitability indices (HSI). This modelling procedure evaluates the specific requirements of selected wildlife species and assesses their presence or absence in the development area and associated regions. HSI models are analytical tools used to determine the relative potential of an area (its pre-development and post-reclamation capability) to act as habitat for wildlife species. Species selected for modelling are known as key indicator resources (KIR). Wildlife KIRs were selected for Project Millennium based on input from oil sands community representatives, project stakeholders and representatives of regulatory agencies.

E2 PRE-DEVELOPMENT BASELINE

An assessment of pre-development conditions including land capability for soils, vegetation, forestry, wetlands, wildlife and recreation is required to evaluate the acceptability of a mine closure plan. References to details of these assessments for the Suncor projects follow.

E2.1 Lease 86/17

Pre-development site analysis for Lease 86/17 is described in detail in "Application for Renewal of Environmental Operating Approval" (Suncor 1995).

E2.2 Steepbank Mine

Pre-development site analysis for Steepbank Mine is described in detail in "Steepbank Mine Project Application" (Suncor 1996b) and its supporting documents.

E2.3 Project Millennium

The baseline definition for areas to be developed as part of Project Millennium is fully described in Volume 2 of this application. Specifically, baselines for each of the following project considerations are found in the noted sections of Volume 2:

- Air Quality - B2
- Surface Hydrology and Hydrogeology - C2
- Surface Water Quality - C3
- Fisheries and Fish Habitat - C4
- Soils and Terrain - D2
- Vegetation and Wetlands - D3
- Ecological Land Classification - D4
- Wildlife - D5
- Human Health - F1
- Socio-Economics - F2
- Land Use and Resource Utilization - F3
- Historical Resources - F4

E2.4 Project Millennium Assessment Study Areas

Pre-development assessments include consideration of two major study areas, a Local Study Area (LSA) and a Regional Study Area (RSA). For the Project Millennium Application, the terrestrial LSA includes the full mining development area on the east side of the Athabasca River (i.e., the

Steepbank Mine and Project Millennium or "east bank mining areas" plus applicable buffers). The area runs from the McLean Creek area in the south to the Steepbank River. Details on both the LSA and RSA are provided in Section A2 of Volume 2 of this application.

The RSA generally extends from south of Fort McMurray north to the Birch Mountains area, but is variable depending on the environmental component being assessed.

E2.5 Summary of Suncor Study Areas

The following provides details on the soils and terrain, vegetation, wetlands and forests on the Suncor development areas. Some pre-development information is not currently available for Lease 86/17 because assessment systems have changed over the years. Suncor is working to redefine pre-development information for Lease 86/17 as part of a commitment made during the Oil Sands End Land Use Committee program in 1997.

E2.5.1 Soils and Terrain

Analysis of soils and terrain includes the Suncor east bank mining area.

Terrain analysis was developed by integrating data from:

- soil map units
- Alberta Vegetation Inventory (AVI) map units
- digital elevation model of the LSA with a 2-m contour interval
- composition of surficial deposits

On review and analysis of these components, the initial terrain amalgamation was derived, combining soil units with similar parent materials. A detailed description of the terrain units for the expanded Steepbank Mine is included in the "Soils and Terrain Baseline for Project Millennium" (Golder 1998k).

Broad terrain or physiographic units had to be developed due to the complexity of Suncor's development areas. These units were defined by predominant terrain unit, elevation, slope and modifying landform processes. The area of terrain units is described in Table E2-1.

Two major classes of soils are found in the Suncor development areas: those which developed in organic deposits and those which formed from mineral parent materials. Distribution of the soil series for Project Millennium is detailed in Golder (1998k) and the area of each soil series is presented in Table E2-2. The land capability of forest ecosystems in Suncor development areas is provided in Table E2-3.

Table E2-1 Area of Terrain Units in Suncor East Bank Mining Areas

Terrain Units and Other Features	Suncor Development Areas (ha)		
	Steepbank Mine	Project Millennium	Total
Bog (B)	64	223	287
Shallow Bog (Bs)	1 030	1 571	2 601
Bogs, Subtotal	**1 094**	**1 794**	2 888
Fen (N)	107	583	690
Shallow Fen (Ns)	810	1 299	2 109
Fens, Subtotal	**917**	**1 882**	**2 799**
Fluvial (F)	157	10	167
Glacio-fluvial (Fg)	239	896	1 135
Morainal/Till	341	816	1 157
Rough Broken (RB)	1 006	275	1 281
Total Area, Terrain Units	**3 754**	**5 675**	**9 429**
Disturbed Lands (AIH, AIM)[1]	14	1	15
Water (NWL)[1]	8	7	15
Total Area, Other Features	**22**	**8**	**30**
Total, All Areas	**3 776**	**5 683**	**9 459**[2]

[1] AIH, AIM and NWL are spatial features that occur within the Suncor area but are not terrain units; the abbreviations used are AVI codes.

[2] Area is 178 ha larger than the east bank mining area footprint used in the EIA. This is because of a reduction in the actual Steepbank Mine footprint due to removal of planned activities out of an area in the Athabasca River valley.

Table E2-2 Soil Series Areas in Suncor Development Areas

Soil Series [1]	Suncor Development Areas (ha)			
	Lease 86/17 [2]	Steepbank Mine	Project Millennium	Total
Bitumount	0	15	47	62
Kinosis	0	341	816	1 157
McLelland	0	917	1 882	2 799
McMurray	597	156	10	763
Mildred	713	97	36	846
Muskeg	1 002	1 095	1 795	3 892
Rough Broken	140	1 006	276	1 422
Steepbank	0	127	813	940
Disturbed Lands [3]	0	14	1	15
Water [4]	76	8	7	91
TOTAL	**2 528**	**3 776**	**5 683**	**11 987**

[1] All soil series variants are grouped together (e.g., Bitumount includes both Bitumount and peaty Bitumount variant).

[2] Taken, derived or extrapolated from Turchenek and Lindsay (1982).

[3] All disturbed lands are assumed to be permanently non-productive for forestry.

[4] All water is assumed to be permanently non-productive for forestry.

Table E2-3 Land Capability Classification for Forest Ecosystems in Suncor Development Areas (Classes from Leskiw, 1998)

Capability Class	Suncor Development Areas (ha)			
	Lease 86/17 [2]	Steepbank Mine	Project Millennium	Total
1	0	17	114	131
2	597	496	728	1 821
3	713	700	687	2 100
4	140	529	469	1 138
5[1]	1 078	2 033	3 685	6 796
TOTAL	**2 528**	**3 776**	**5 683**	**11 987**

1 All lands and waters disturbed prior to oil sands development and water areas were assumed to be permanently non-productive for forestry.
2 Taken, derived or extrapolated from Turchenek and Lindsay (1982).

E2.5.2 Vegetation

Preliminary delineation of vegetation communities was based on AVI map units that were reclassified into a hierarchical system using "The Field Guide to Ecosites of Northern Alberta" (Beckingham and Archibald 1996). Ecosite ELC units are determined from nutrient and moisture regimes (i.e., medium, mesic) while ecosite phase ELC units are determined by dominant tree species or tallest vegetation layer (i.e., trembling aspen). Subdivision of plant community types is determined from understory species composition and abundance (i.e., Canada buffalo berry).

There are eight general terrestrial vegetation types in the Project Millennium regional study area,. described fully in "Terrestrial Vegetation Baseline for Project Millennium" (Golder 1998l). The area and percent coverage of the ecosite phases for Suncor east bank mining areas is presented in Table E2-4.

E2.5.3 Wetlands

The "Alberta Wetlands Inventory Standards" (Halsey and Vitt 1996) uses variables that are distinguishable on aerial photographs and consists of classes similar to those developed by the National Wetlands Working Group (NWWG).

Wetlands represented in Suncor development areas are detailed in Table E2-5.

Table E2-4 Terrestrial Vegetation Types and Ecosite Phases in Suncor East Bank Mining Areas

Terrestrial Vegetation Types	Ecosite Phases	Steepbank Mine (ha)	Project Millennium (ha)	Total (ha)
Open Pine Lichen	Lichen - jack-pine(Pj)	1	0	1
Mixed Deciduous (Aspen-dominant)	Blueberry Aw-bearberry (Bw)	26	2	28
	Low-bush cranberry Aw	923	906	1 829
	Dogwood - balsam poplar (Pb)-Aw	28	12	40
	Blueberry - trembling aspen(Aw)	98	48	146
Mixedwood (White Spruce-dominant)	Blueberry Aw-white spruce (Sw)	57	0	57
	Low-bush cranberry Aw-Sw	60	83	143
	Dogwood Pb-Sw	16	3	19
Mixed Coniferous (White Spruce-dominant)	Low-bush cranberry Sw	212	132	344
	Dogwood Sw	25	12	37
	Labrador tea/Horsetail Sw-Sb	21	13	34
Mixed Coniferous (White Spruce-Pine dominant)	Blueberry Sw-Pj	37	12	49
	Labrador tea-mesic Pj-black spruce(Sb)	1	0	1
Mixed Coniferous (Black Spruce-Tamarack)	Black spruce- Tamarack complex	0	20	20
Mixed Coniferous (Pine-dominant)	Labrador tea-subhygric Sb-Pj	0	1	1
Shrublands	Shrubland	51	6	57
Total		1 556	1 250	2 806

Table E2-5 Alberta Wetlands Inventory in Suncor East Bank Mining Areas

Class	Subclass	Steepbank Mine (ha)	Project Millennium (ha)	Total (ha)
Shallow open water (Wonn)	Shallow open water (SW)	6	2	8
Marsh (M)	Graminoid marsh (Mong)	12	7	19
	Shrubby marsh (Mons)	22	7	29
Swamps (S)	Coniferous swamp (Stnn)	162	612	774
	Coniferous swamp (Sfnn)	51	325	376
	Deciduous swamp (Sons)	47	24	71
Subtotal	Swamps	260	961	1 221
Fens (F)	Open, non-patterned, shrubby fen (Fons)	110	215	325
	Open, non-patterned, graminoid fen (Fong)	0	3	3
	Wooded fen (trees cover >10% < 70%) (Ftnn)	1 528	2 870	4 398
	Wooded fen (trees cover >70%) (Ffnn)	262	284	546
Subtotal	Fens	1 900	3 372	5 272
Total Wetlands		**2 200**	**4 349**	**6 549**

E2.5.4 Forests

Forest types currently in pre-development areas, as well as types that will develop on reclaimed Suncor lease areas, are determined by parent material, topography and drainage of the area. An estimate has been determined by using the capability classification system discussed previously. The potential for commercial forestry in Suncor development areas has been assessed for pre-development conditions by using the AVI system. For Lease 86/17, prediction of the amount of merchantable forest was made based on information about vegetation types prior to lease development. Table E2-6 quantifies the area where merchantable forest was present prior to Suncor development.

Table E2-6 Merchantable Forest Areas in Suncor Development Areas

Merchantable Forest Types	Suncor Development Areas (ha)		
	Lease 86/17 [1]	East Bank Mining Area	Total
Aspen - balsam poplar	242	752	994
Mixedwood	497	480	977
Jack-pine	61	101	162
Spruce - Balsam fir	109	0	109
Totals	**909**	**1 333**	**2 242**

[1] From "Application for Renewal of Environmental Operating Approval" (Suncor 1995).

E3 CLOSURE AND RECLAMATION PROCESS

This section describes specific closure and reclamation criteria and guidelines for Project Millennium based on broad goals already described. Project Millennium's development plan and design are detailed in Volume 1, Section C of this application.

Development of methodologies to achieve Suncor's reclamation objectives requires an understanding of the principal processes that influence ecosystem development. The types of vegetation and soil that will develop on the Suncor lease will depend on climate, topography, parent material, drainage and time. Of these environmental factors, parent materials, topography and drainage can be modified to some extent by Suncor but they are essentially fixed, by virtue the oil sands mining and extraction methodologies. Time and climate are uncontrollable factors. Vegetation can influence surface soil and vice versa; these are controllable to some extent.

Phased Certification:

One of the objectives of Suncor's Closure Plan is to achieve phased certification of its reclaimed areas. This involves the intent to return blocks of land with sensible boundaries to the Crown as the areas are reclaimed.

The process of phased certification begins with those areas identified in the Mine Long Range Plan. It is recognized that this planning process must identify logical lease elements with natural boundaries such as roads, topographic features and drainage systems. Clearly, any parcel of land must also meet the objectives of the overall Closure Plan, including compliance with end land use goals and integration within the overall watershed and drainage plan.

Also addressed will be the timing and schedule for implementation of reclamation design measures and the setting of performance monitoring indicators. Suncor recognizes that while aspects of the reclamation process are well-tested, others (such as watershed design and long-term seepage controls) are less developed. Suncor has initiated and will be initiating, field demonstrations to test and refine these aspects.

In cooperation with Alberta Environmental Protection (AEP) and local stakeholders, Suncor will develop a checklist for assessment of the closure process to aid in the phased certification process. This checklist will describe aspects of the Closure Plan to be considered during the certification process. Agreement between AEP and Suncor on the attributes to be included in the Closure Plan checklist will facilitate progressive development of a phased certification process.

Project Millennium Closure Plan:

Suncor's Closure Plan for the mining areas on the east side of the Athabasca River has been integrated with Lease 86/17.

Figures E3-1 through E3-3 show some of the components of a closure plan which are included in an assessment process. Figure E3-1 shows parts of reclaimed landforms which are key components in determining success. Figure E3-2 provides definition of the types of landforms and drainage systems that will be developed in the mining areas. On Figure E3-3, long-term vegetation communities are shown which will develop on mining areas, based on Suncor's reclamation methodology. Additional schematics of components of the Closure Plan are provided in Volume 2, Section E of this application.

Development of a viable Closure Plan includes consideration of a number of critical inputs, which are reviewed here.

E3.1 End Land Use Planning

Suncor will reclaim developed lands to pre-development capability. This will be accomplished through undertaking of activities based on guidelines established by the Oil Sands End Land Use Committee with input from regional land users, communities and special technical working groups.

End land use goals toward which Suncor's Closure Plan is directed include the following:

- continuity of landforms and watershed systems between developed areas and undisturbed land
- location of land uses in areas or on landforms that make physical, biological, social and economic sense
- forest productivity of reclaimed landscape to be equal to or greater than pre-development conditions

Due to the length of time required for development of mature ecosystems within the Boreal Forest Ecoregion, reclamation areas must be assessed for certification long before they have fully matured. Therefore, Suncor (in association with other stakeholders), will establish criteria and monitoring programs that will clearly show progress made toward fully-mature ecosystems. Results of monitoring programs, together with performance criteria, will support Suncor's application for certification of reclamation areas.

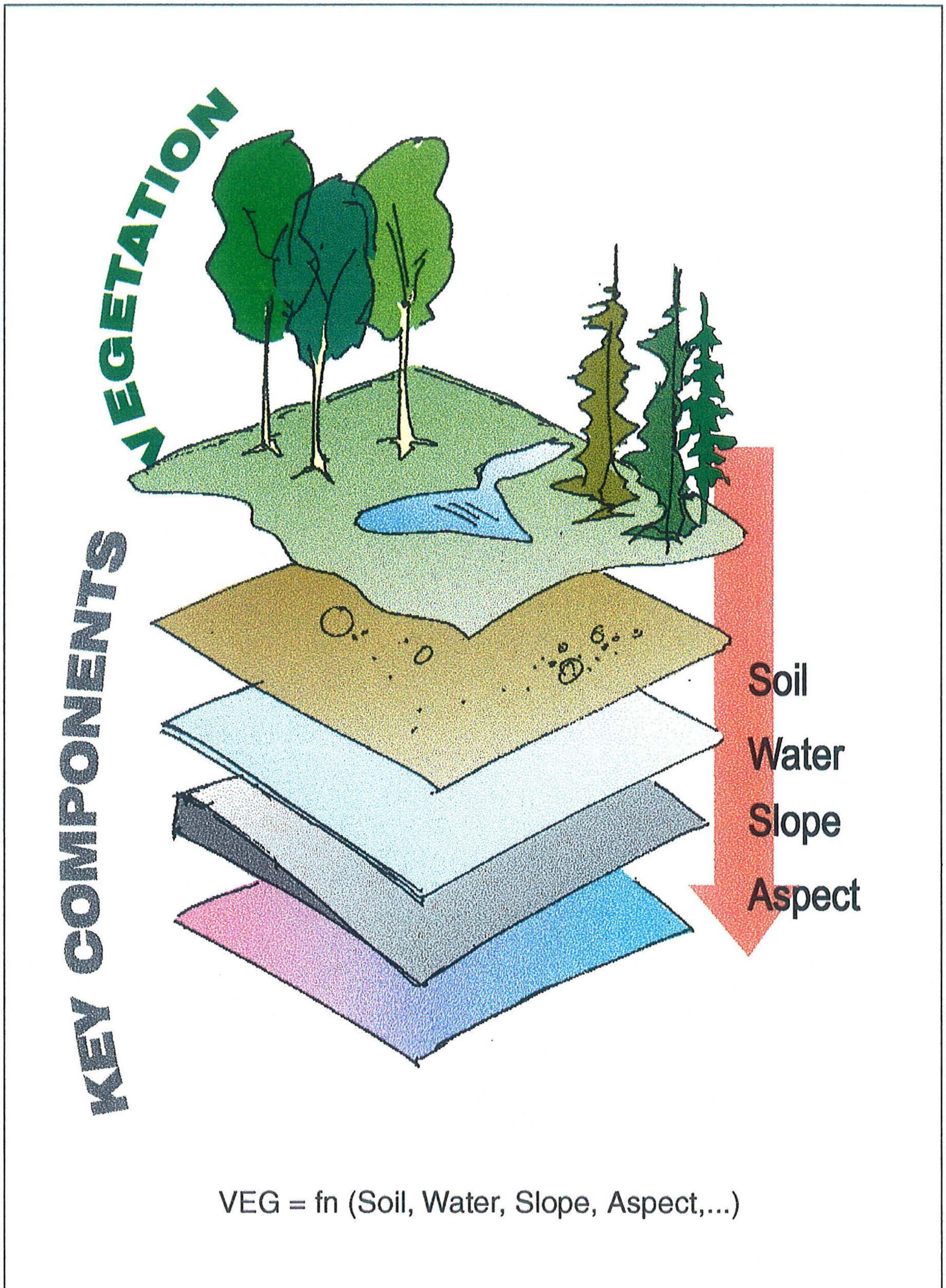


Figure E3-1 Key Components Enclosure Plan

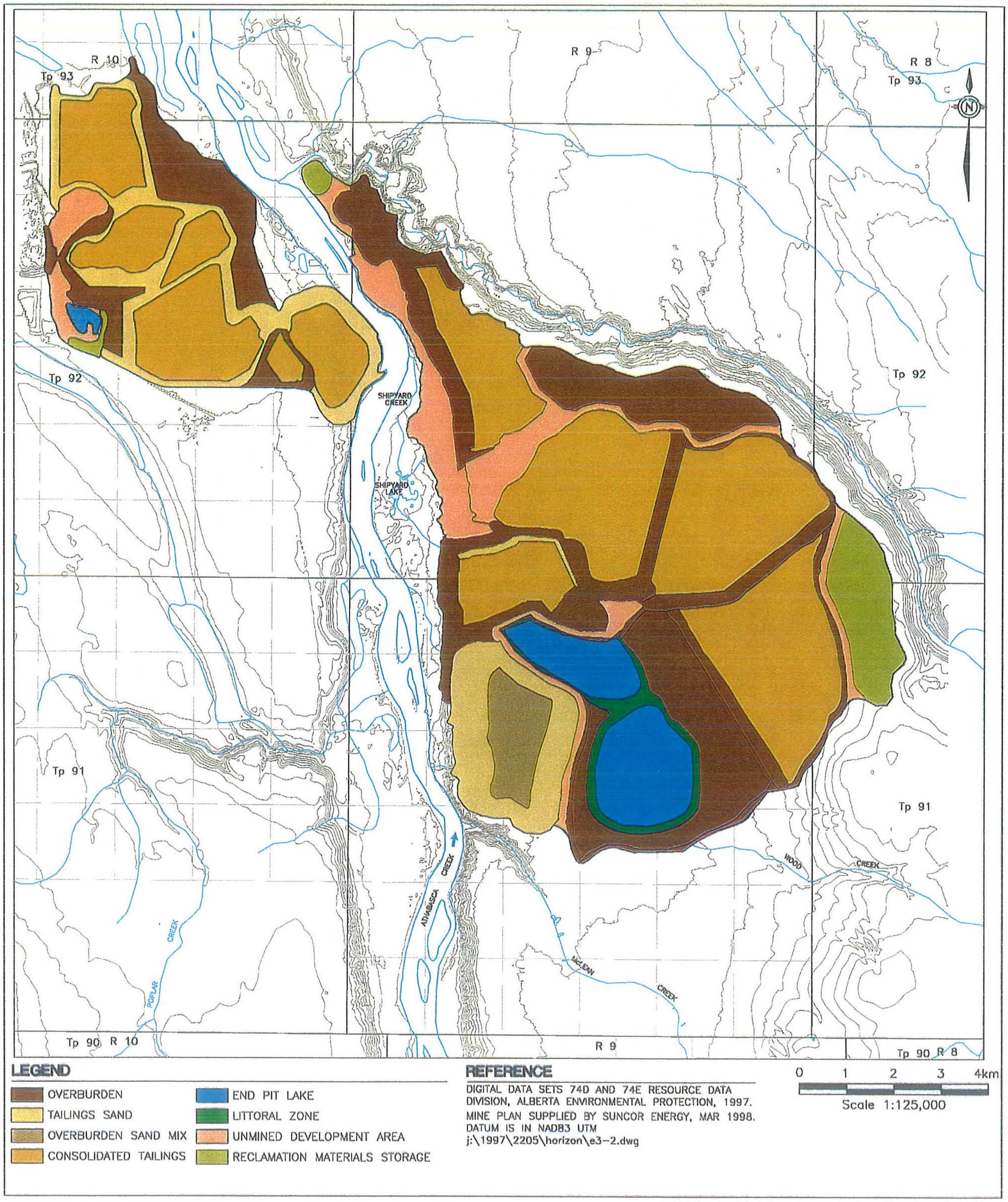


Figure E3-2 East Bank Mining Area Closure Landforms

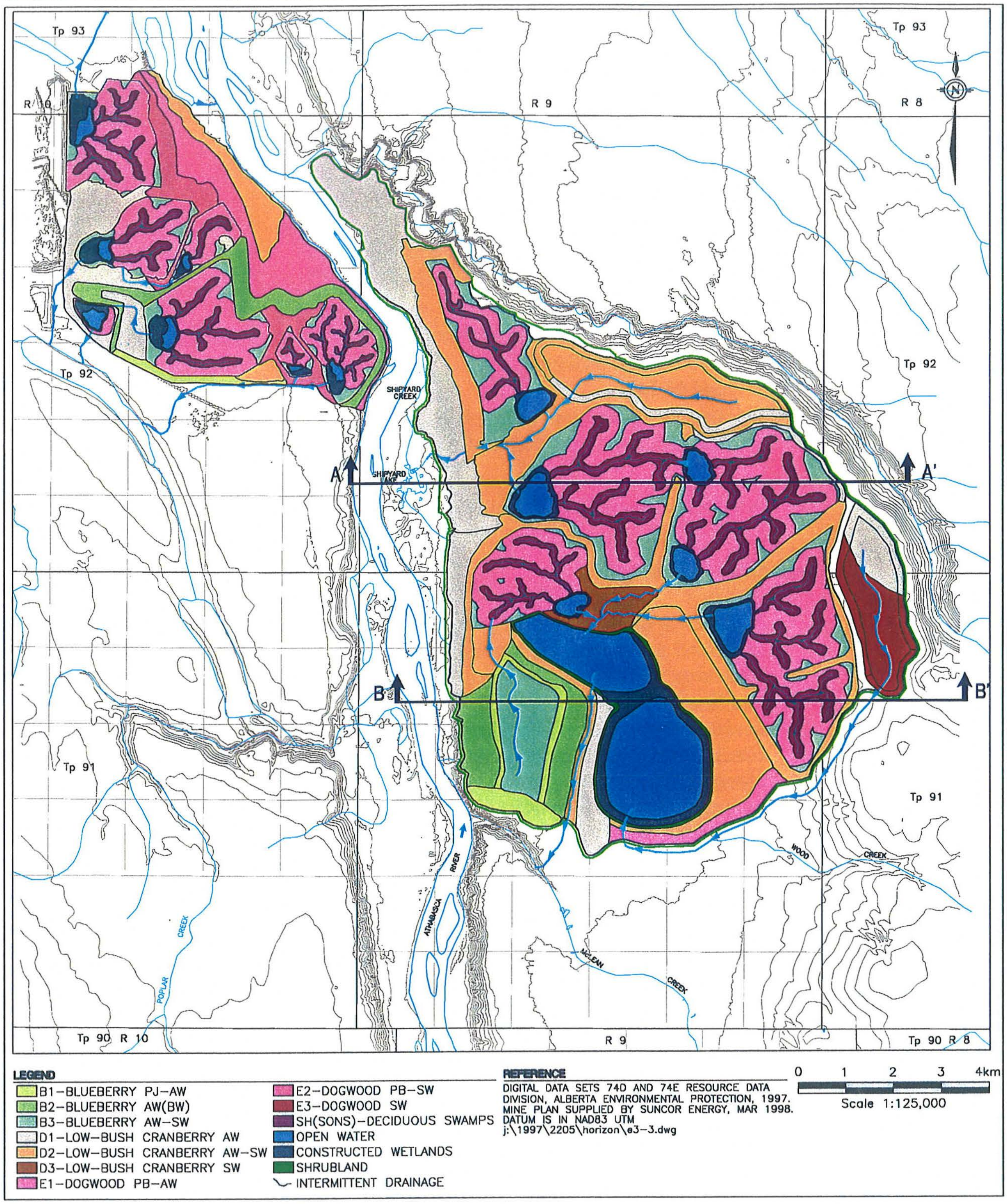


Figure E3-3 East Bank Mining Area Drainage and Vegetation Classification

E3.2 Landforms

A number of created landforms will be established through the mine development and reclamation process. These include:

- tailings sand slopes
- tailings sand plateaus
- capped Consolidated Tailings deposits
- overburden waste dumps and dykes
- capped oversize dumps
- decommissioned coke, sulphur and gypsum storage areas
- streams and wetlands
- end pit lake
- ancillary areas such as ponds and roads (fixed plant decommissioning is not included in the current Closure Plan)

A review of general design considerations for these landforms follows.

E3.2.1 Geotechnical Stability

The design of earth structures for impounding tailings during operations is described in Volume 1, Section C2.4. As part of the Closure Plan, all structures will be reclaimed so that they are "maintenance-free". Before certification, fluid-impounding structures will be transformed into landforms containing CT, producing a non-fluid infill material of soft soil consistency. Where final pitwalls are incorporated into the reclaimed topography, detailed design will take into account long-term stability, including impacts of geotechnically-weak units in the Clearwater formation. Landforms will be stable under both static and anticipated earthquake loadings.

E3.2.2 Landform Grading

Traditional design and construction practice for waste dumps and tailings retention structures results in conventional slope grading for overburden and tailings storage facilities. These forms result in:

- long, straight lines
- planar slopes, usually subdivided vertically into a series of benches
- intermediate slopes with a flat top or plateau

This traditional layout tends to:

- maximize storage of materials
- allow for optimized construction layout

- control placement and fill operations

Landform grading and certain revegetation techniques are a means of slope reclamation which may allow for more naturally appearing slopes and reduce long-term surficial erosion potential by mimicking a mature, undisturbed landscape. As well, the potential for biodiversity is increased. Suncor will proceed with field demonstrations of landform grading, to develop natural appearing structures subject to overall landform stability and integrity.

Suncor has examined several possible landform options including:

- variations of slope profile
- berm elimination
- contour grading
- specialized shaping
- varying horizon
- zoned revegetation

These landforms are briefly discussed as follows:

<u>Slope Profile</u>: The slope is regraded to an overall concave profile. This would result in some loss of storage volume and is not favoured.

<u>Berm Elimination</u>: Intermediate berms are eliminated with runoff routed directly downslope. This approach is favoured, as it should improve erosion control and should reduce negative visual impacts by eliminating one of the major linear elements.

<u>Contour Grading</u>: Contour-graded slopes consist of conventionally-graded slopes that are curvilinear in plan. Slope gradients are still unvarying and profiles are planar. Transition from one slope plane to another is rounded. Slope drainage consists of some sheet flow with concentrated flow in the resulting mild swales on the slope face.

<u>Specialized Shaping</u>: Specialized shaping attempts to replicate irregular shapes of natural, stable slopes. Specialized-graded slopes are characterized by a continuous series of concave and convex forms interspersed with mounds. In plan, the footprint or toe of the slope meanders, reflecting the non-planar slope face.

<u>Varying Horizon</u>: Varying the top of slope elevation results in breakup of the horizon, which mimics natural landforms. The undulations produced also provide runoff control by preventing sheet flow from spilling over the slope face.

Zoned Revegetation: To break up lines of sight and to introduce apparently random elements in the view, plantings of different species produce a variety of ecotypes and provide a more pleasing aspect.

Relative impacts of the different landform methods have been considered for the North Waste Dump, which is currently under construction. The dump is located adjacent to the Athabasca River at the far north end of Steepbank Mine. A major consideration in developing an aesthetically-pleasing landform is the perspective of the viewer.

As there are no public roadways in the vicinity and local air travel is primarily related to oil sand mine activity, public viewing is primarily by boaters travelling along the Athabasca River. Therefore, the highest priority for viewing should be for visual impacts seen from the river.

The following plan has been developed for the Northeast Waste Dump. First, the footprint has been adjusted, moving the toe in and out at several locations. This introduces a random element and avoids several deep muskeg deposits which could affect stability. Berms are eliminated everywhere except for the lower haul road, a location is not visible from the river. The overall cross-section slope (nominal 4 Horizontal : 1 Vertical) is sufficiently flat so that geotechnical monitoring can be accomplished using track-mounted equipment and all-terrain vehicles for a tolerable cost increase.

Suncor will proceed with the general landform plan for the Northeast Waste Dump resolving the practical aspects of construction as they are encountered. It is expected that, in the modest swales or depressions created by the intersection of planar slopes, additional design measures will be required to accommodate concentrated runoff. These measures may require local departures from normal reclamation practice and may require specification of more erosion-resistant soils and vegetation down the low point of the swale.

As the Northeast Waste Dump will require relatively rapid construction, it will serve as a demonstration of the concepts involved. It may be practical to extend these concepts to other structures fronting the Athabasca River, especially dumps. The practicalities of major modification to tailings retention structures may be challenging, but Suncor plans to make necessary adjustments consistent with optimization of storage, safety and design requirements.

E3.2.3 Dry Landscape Reclamation Technology

Principal technologies now available to achieve a dry landscape include:

- Consolidated Tailings (CT) process
- surface stabilization techniques
- options to handle treatment of reclamation waters

Suncor will eliminate permanent storage of fluid fine tailings from Suncor mining areas through utilization of the CT process. This process involves recombination of coarse and fine tailings into a stable deposit with a reclaimable surface. It will allow relatively rapid return of disturbed land to a fully-reclaimed state. Details on application of the CT process at Suncor are provided in Volume 1, Section B2.

E3.3 Water Management

Suncor's Reclamation Plan is intended to manage quality and quantity of water discharge from the reclaimed landscape. The discharge can be through surface water or groundwater flow.

E3.3.1 Reclamation Water Discharge

The Oil Sands Water Release Technical Working Group (OSWRTWG), a joint industry/government task force, was created in 1995 to address issues associated with oil sands waters. Oil sands water releases have been defined by the group as either operational or from reclamation (OSWRTWG 1996). Operational waters are discussed in Volume 1, Sections C2.4.3 and C3.4.2 of this application.

Sources of reclamation waters on reclaimed areas include surface runoff and groundwater seepage from all types of landforms. Reclamation waters will be controlled over the long term by means of systems inherent in the reclamation landscape design. These waters (which typically originate from non-point sources) may be directed through wetlands, streams or lakes prior to discharge from reclamation areas. The waters will release at slow rates over long periods of time, with seepage channelled to planned collection discharge points. Closure planning utilizes landscape designs to facilitate on-site water treatment, using systems that incorporate maintenance-free reclamation landscapes.

The OSWRTWG developed a protocol for assessment of water discharge to ensure that discharge impact on the Athabasca River is environmentally-acceptable (Figure E3-4). Suncor will apply this protocol to determine treatment requirements for all waters discharged by its operations. Suncor is committed to:

- forecasting the quality and quantity of potential closure discharges
- constructing facilities to provide required long-term controls
- monitoring the impact of these streams through the post-operation and reclamation finalization periods

These efforts form the basis for assurance that discharges from Suncor's maintenance-free closure landscape will be environmentally acceptable.

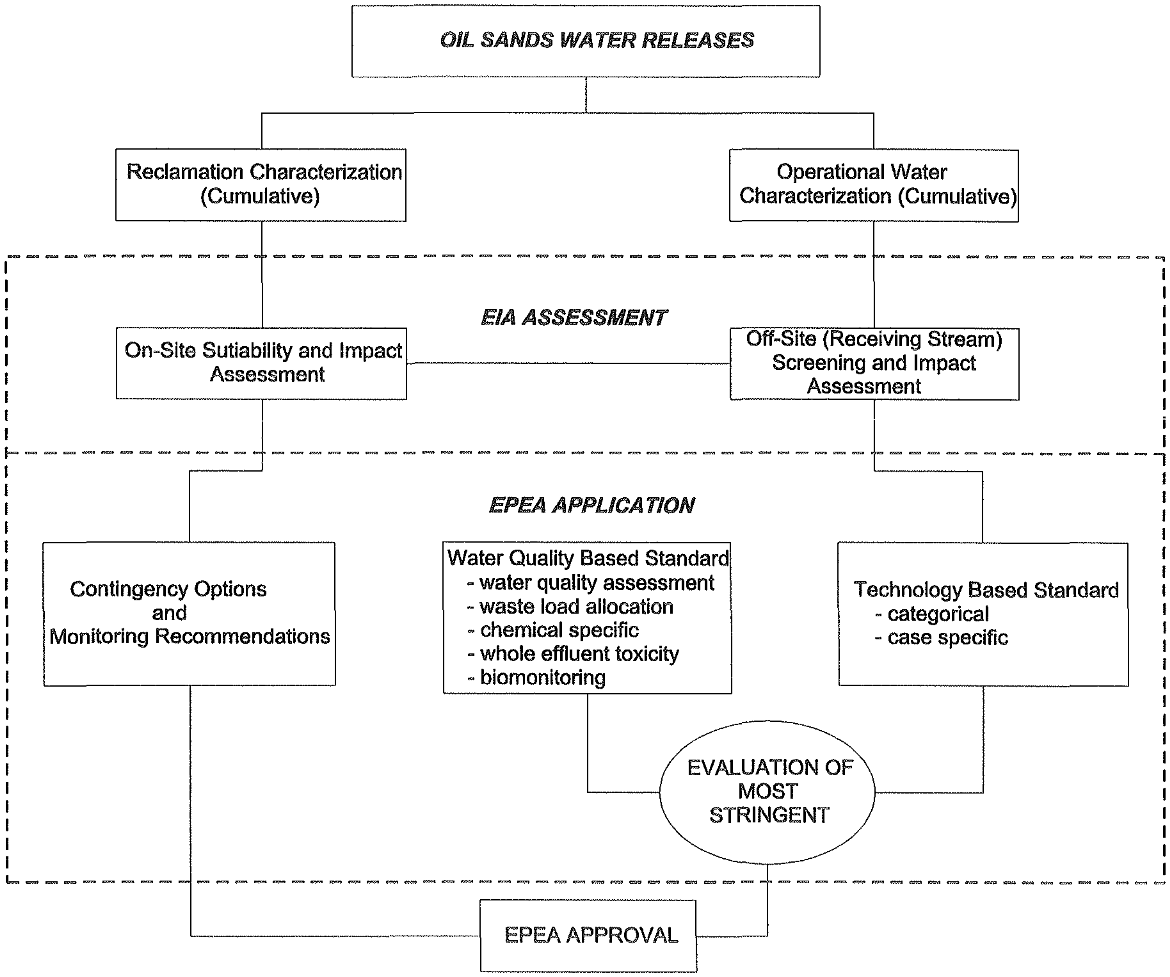


Figure E3-4 Water Release Assessment Protocol

E3.3.2 Surface Drainage

The design objective of a reclamation drainage system is to achieve the pre-development stability and productivity of natural drainage systems. System design must also provide assurance that water leaving the reclaimed area will be of a quality suitable to ensure acceptable environmental impacts on receiving waterbodies. These objectives will be accomplished through development and use of a surface drainage system patterned after natural models that are characterized by similar climate, topography and soil conditions to those in Suncor's development areas.

Although it will not be possible to implement a design that fully replicates the original drainage systems, it will be possible to replicate the stability and sturdiness of natural systems.

Historically, the approach to the design of drainage systems for reclamation has been to supply rigid, erosion-resistant drainage facilities configured to handle specific extreme events. This approach may result in uniformity of design and construction, but it does not necessarily achieve the closure objectives of erosion control and long-term sustainability. A major deficiency in conventional practice is the absence of a self-healing mechanism for drainage systems. Often, when man-made channels fail (due to overtopping, washout of erosion protection or channel degradation), the failure leads to accelerated erosion and/or channel relocation. These situations are unacceptable for Suncor's closure plan. When underlying materials are highly-erodible, a high sediment yield and potential loss of, or change to, aquatic habitats results.

The alternative to rigid systems designed for specific extreme events is a dynamic system capable of accommodating evolutionary change without accelerated erosion or unacceptable environmental impacts. Such dynamic facilities must be effective systems with several lines of defence and inherent self-healing capability.

Suncor plans to maintain the existing drainage channel of McLean Creek to direct water down the valley slope to the Athabasca River. This natural drainage system provides a degree of erosion resistance to present flow regimes and may be augmented by further armouring if necessary. Elsewhere, drainage systems will be developed using a geomorphic approach that replicates natural drainage systems. This replication reduces the risk of accelerated erosion and provides self-healing erosion control systems.

E3.3.3 Erosion Control

Erosion of slopes along the Athabasca River is a natural process which has created the Athabasca Valley and sculpted local topography. Similar processes currently occur on all reclamation structures. Small, localized movements of muskeg soil amendment (topsoil) are to be expected, but the movements must be at a sufficiently low rate to allow for self-healing of the vegetative cover. Measures to control erosion are described in "Steepbank Mine Project Application" (Suncor 1996b).

Reclamation drainage courses will alter over time as natural erosive forces occur. Every effort will be made to anticipate and accommodate such shifts, using erosion-resistant overburden to backfill critical areas (such as drainage outlets between ponds) as well as the end pit lake inlet and outlet. In addition, several lines of defence will be incorporated within drainage channels, including boulder-strewn ground and deep riprap trenches.

Other reclaimed landforms (including dump slopes and surface drainage channels) will undergo long-term erosion but at rates which will not lead to:

- catastrophic failure
- overloading of systems receiving the erosion solids
- permanent disruption of vegetative cover

E3.3.4 Groundwater Drainage

Investigation of the potential effects of Steepbank Mine expansion on groundwater included consideration of three factors:

- changes in direction of groundwater flow
- changes in rate of groundwater discharge to surface water bodies
- changes in groundwater quality

Mine operations will produce a change in direction and rate of groundwater flow in the surficial aquifers within the mine footprint. Widespread groundwater seepage along the Athabasca River, Steepbank River and Shipyard Lake from the surficial aquifers and bedrock units will be replaced by discharge from point sources into Shipyard Lake and the Athabasca River.

Groundwater quality in surficial or bedrock aquifers will not be affected by mine operations. Existing surficial aquifers in the mine footprint will be replaced with reclamation landforms and an aquatic ecosystem (as discussed in Volume 1, Section E3.4.2.

Bedrock aquifers will naturally re-establish after reclamation since CT fill materials have similar hydrogeologic and quality characteristics similar to natural formations.

During operations, spill prevention and containment measures along access corridors and in facilities areas are designed to prevent contamination of the groundwater from routine operations. Monitoring wells will be installed at appropriate locations, to evaluate the performance of these measures and to provide notice of any deteriorating water quality.

E3.4 Ecosystem Re-Establishment

Suncor employs a sequential procedure for the re-establishment of ecosystems on reclamation landforms. Establishment of both terrestrial and aquatic ecosystems are included in the reclamation program.

E3.4.1 Terrestrial Ecosystems

Soil capability is a primary factor for many of the characteristics of terrestrial ecosystems, including sustainability and biodiversity of both vegetation and wildlife. Suncor's objective is to provide equivalent (or better) soil capability (with consequent and equivalent ecosystems) as part of the reclamation program. Development of mining landforms and reclamation of those landforms means that about 78% of the reclaimed land area will be returned primarily to an upland forest ecosystem. Suncor has developed and successfully demonstrated its reclamation techniques for overburden and tailings sand deposits over the last twenty-five years. These techniques include consideration of soil management and reconstruction as well as area revegetation.

Soil Management and Reconstruction

Suncor-reconstructed soil is a mixture capable of sustaining an initial erosion-controlling plant cover. The reconstructed soil is also designed to be capable of supporting vegetation species found in adjacent forest communities. Restoration of soil capabilities to a state equal to or greater than those existing prior to development requires an understanding of reconstructed soil conditions. Design specifications have been developed to ensure that the reconstructed soil provides:

- adequate moisture supply
- adequate nutrient supply
- capability to support an erosion-resistant vegetative cover

Natural soil types have been selected as references to represent comparable pre-development capabilities for the main post-mining landforms. Physical and chemical parameters of these reference soils are used to assess the effectiveness of reconstructed soils in meeting both the above specifications and Suncor's reclamation goals.

Soils suitable for use in the reclamation program are salvaged from areas that will undergo mining activities. Soil salvage involves recovery of a muskeg soil amendment that has been stripped from areas to be mined and then either transported directly to reclamation areas (i.e., direct placement) or stockpiled. Stockpiling, which is the non-preferred option, is undertaken when there are no areas immediately available for reclamation. The muskeg soil amendment is recovered using a technique involving the overstripping of muskeg (peat) to include 25% to 50% (by volume) of mineral overburden.

Mineral soils with little to no organic material are not normally salvaged by Suncor. When used in reclamation, these shallow soils do not provide the vegetative growth performance found by the deeper muskeg soils. This is a result of natural factors found in the forested areas. Thin forest soils are difficult to salvage due to tree stumps and roots found near and at the surface. A deeper cut into the subsoil must be taken to compensate for this factor, resulting in a poor-quality reclamation soil amendment.

Soil salvage and its placement on reclamation areas is designed to follow the guidelines provided in "Land Capability Classification for Forest Ecosystems in the Oil Sands Region, Working Manual" (Leskiw 1998). Forest capability development is the primary consideration for soil reclamation. This focus is not expected to drastically alter soil salvage criteria, but it will assist in managing the placement of better-suited reclamation amendments.

Suncor reconstructs soils using the one-lift soil placement method. In this method, a muskeg soil amendment is hauled, placed on prepared subsoil and then spread to a minimum depth of 20 cm. Subsoil base materials may be either tailings sand, overburden or (in the future) capped Consolidated Tailings. Muskeg mixed with fine-textured till, clay or silt (fines), is the preferred amendment for tailings sand areas (Figure E3-5). When muskeg is mixed with coarse-textured material (sand and gravel), this mixture is primarily used to amend overburden waste dumps or dykes (Figure E3-6).

Use of one-lift soil handling methods for tailings sand and overburden allows prediction of the probable classes of resulting soil capability in reclamation areas. Suncor's methods typically result in creation of Class 3 soils. Figure E3-7 shows the relative areas of each soil capability class for Suncor's east bank pre-development and post-reclamation areas.

Some materials available for construction of reclamation landforms are less desirable as they contain high saline and sodic concentrations. Reclamation plans stipulate that no materials with a sodium absorption ratio (SAR) greater than 12 are placed within 1 m of the surface. Soil samples will be analyzed during construction to identify areas of concern, allowing for mitigative work prior to reclamation. Mine planning will include integration of this requirement to ensure good-quality subsoil materials are placed as a cap on higher-SAR materials.

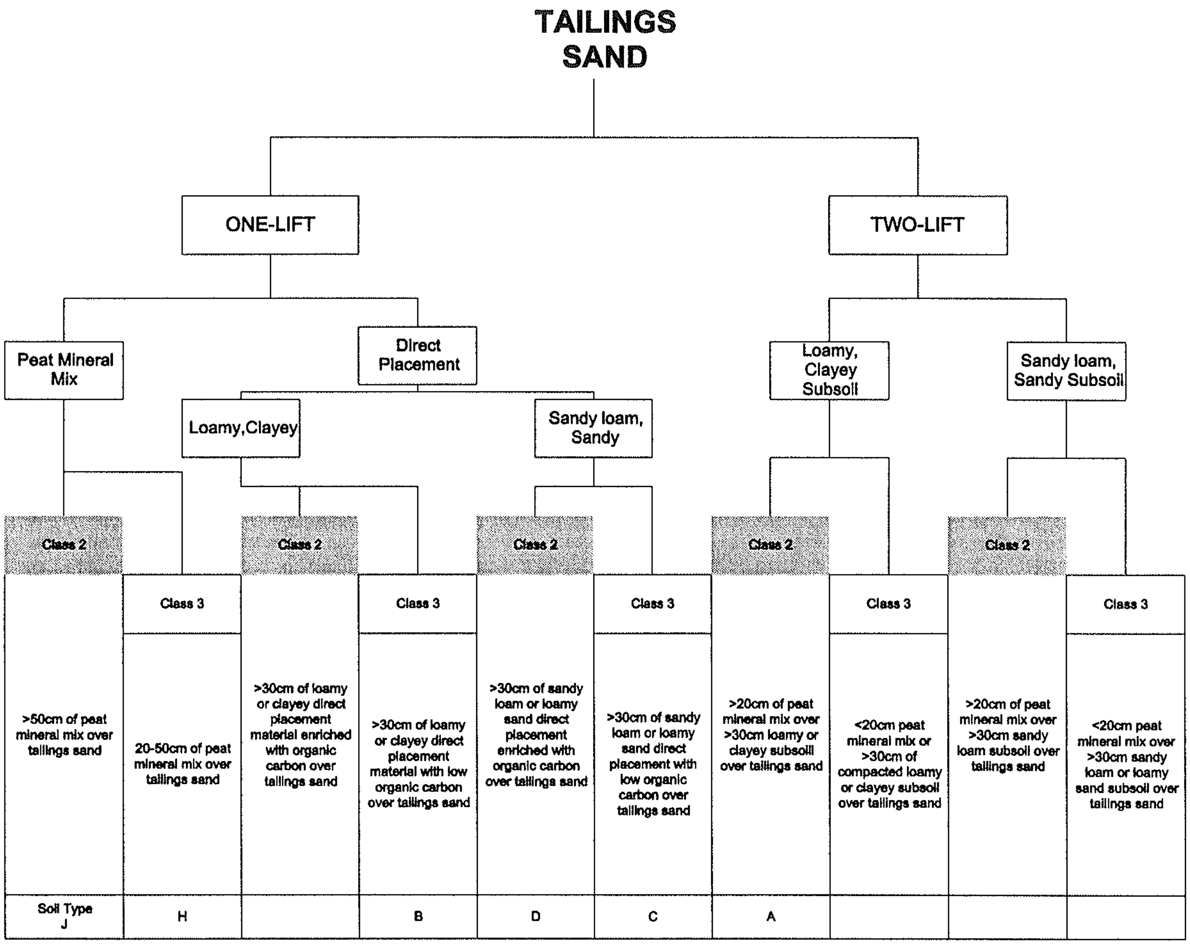


Figure E3-5 Tailings Sands Soil Handling Options

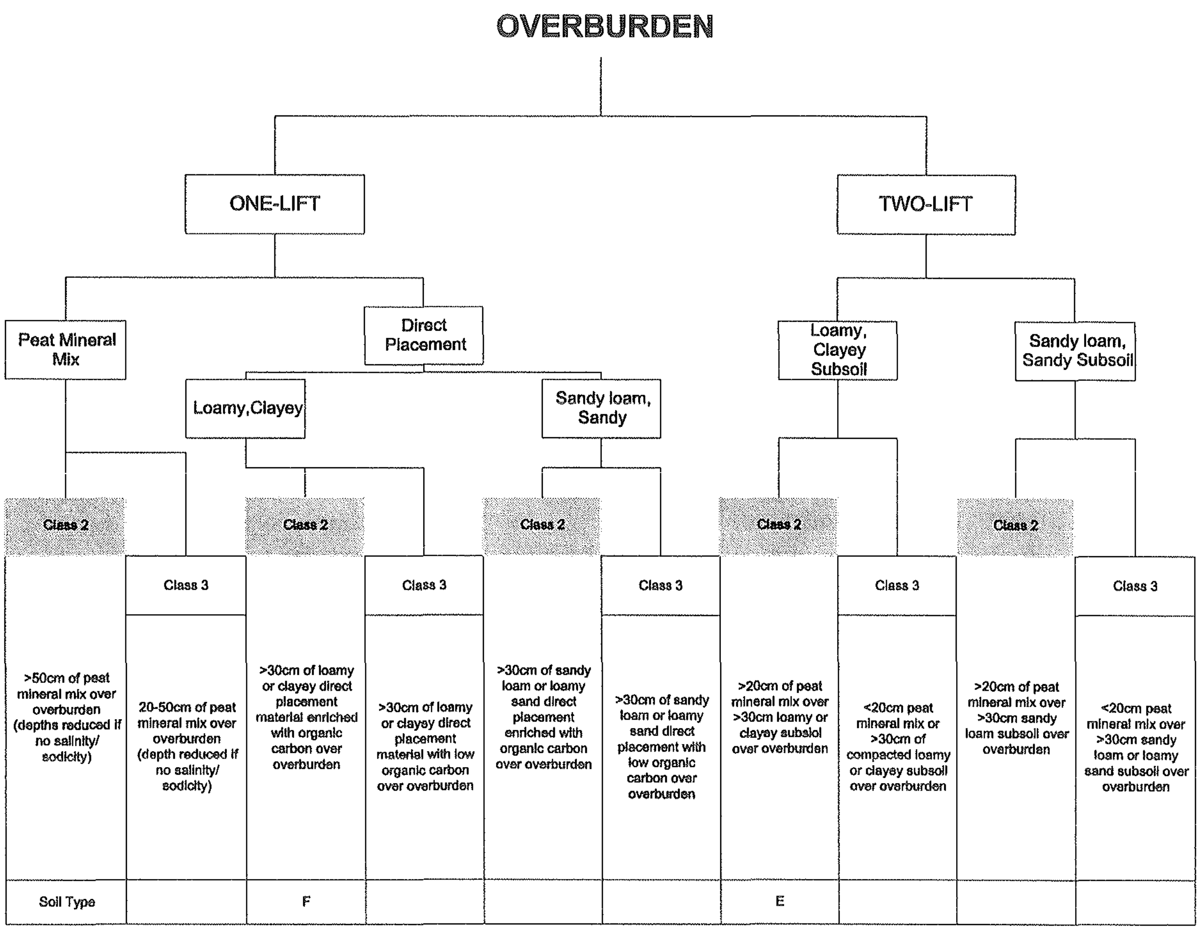


Figure E3-6 Overburden Soil Handling Options

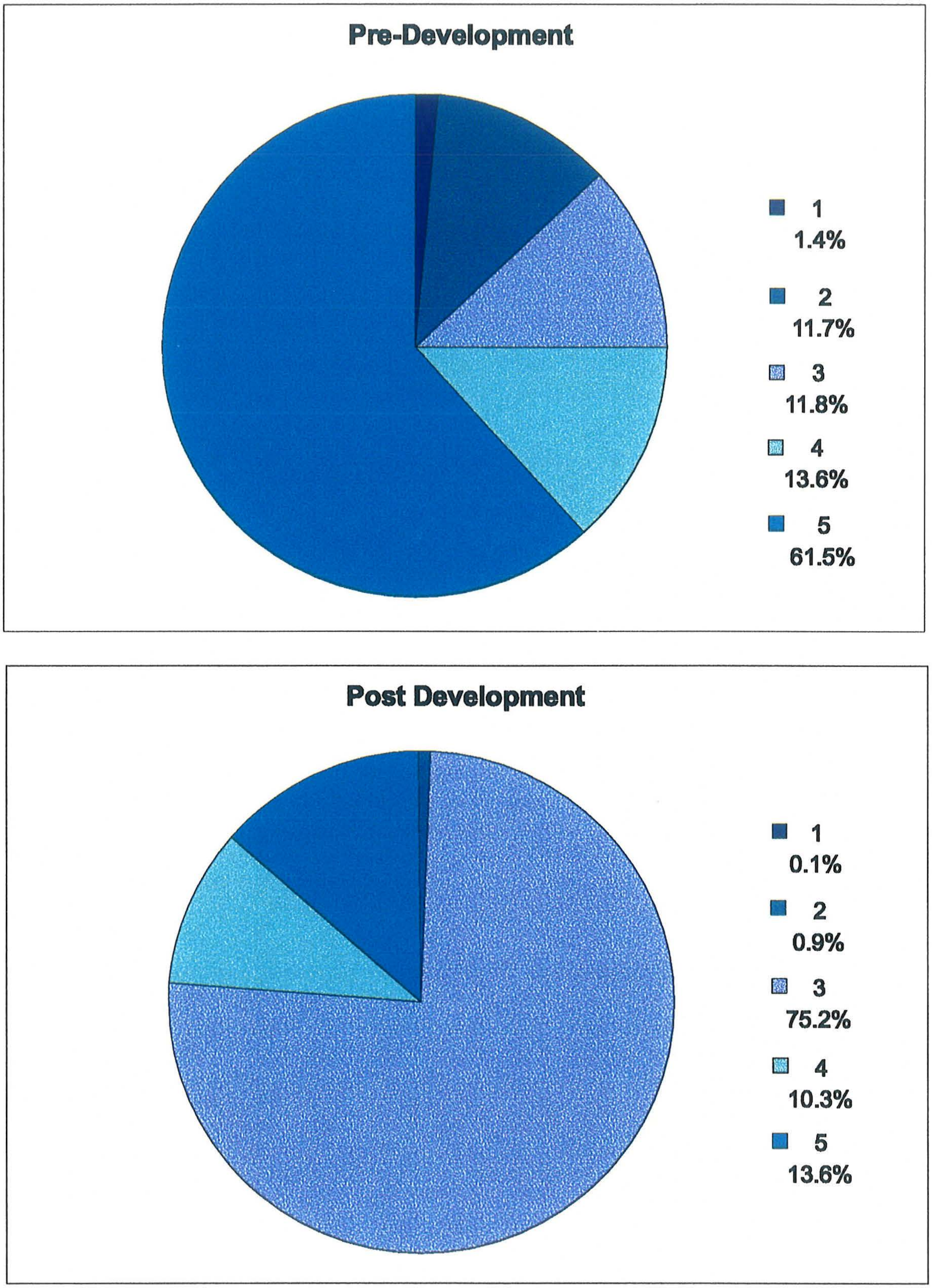


Figure E3-7 Relative Areas of Class of Forest Capability

Revegetation

Suncor will continue to follow established revegetation procedures as approved for Steepbank Mine, taking into account recent work completed by the Oil Sands Vegetation Reclamation Committee. The committee's report "Draft Guidelines for Reclamation of Terrestrial Vegetation in the Alberta Oil Sands Region" (Oil Sands Vegetation Reclamation Committee 1998) will form the basis for future revegetation activities on reclaimed sites.

The primary objectives of Suncor's revegetation program are to:

- provide an erosion-resistant plant cover on tailings dyke slopes and overburden waste dump slopes
- provide a diverse range of plant species at start of reclamation to increase the potential of reclaimed sites to evolve to bioversity values of the pre-development state
- establish a permanent, viable plant community at start of reclamation capable of developing into a self-sustaining cover of forest species suitable for traditional land uses, wildlife use and with possibilities for recreation and other end uses

These objectives match those of the "Fort McMurray-Athabasca Oil Sands Subregional Integrated Resource Plan" (AEP 1996a) for the issues of wildlife, erosion, floodplain, recreation and tourism, and ecological resource management. With its revegetation program, Suncor is committed to providing a diversity of self-sustaining vegetation communities throughout its reclaimed leases to meet objectives. Suncor will reclaim escarpment areas to establish pre-development upland ecosystem types as quickly as possible.

Using information from the "Draft Guidelines for Reclamation of Terrestrial Vegetation in the Alberta Oil Sands Region" (Oil Sands Vegetation Reclamation Committee 1998), revegetation will be followed by natural succession efforts, developing ecosystems similar to others found in this region, which comprise five primary ecosite phase communities:

1. Blueberry, Jack-Pine, Aspen: These vegetation types will be established on the edges of tailings sand plateaus and south slopes.

2. Blueberry, Aspen, White Spruce: These vegetation types will be established on the moister areas of tailings sand plateaus and Consolidated Tailings deposits. It will also be established on

overburden dykes that are used to re-establish escarpment areas within the Athabasca River Valley.

3. Low-bush Cranberry, White Spruce, Aspen, Birch: These vegetation types will be established on the overburden waste dumps and on the lower portions of the tailings dyke slopes with north-facing aspects.

4. Dogwood, Balsam Poplar, Aspen: These vegetation types will be established on capped Consolidated Tailings deposits and near-level, low-lying tailings sand areas.

5. Wetlands Closed Shrub Complex: This vegetation type will be established on poorly-drained areas of tailings sand plateaus and Consolidated Tailings deposits.

The area and percent coverage of the ecosite phases, and forested and wetlands areas for the east bank mining areas are shown on Figures E3-8 and E3-9. Merchantable timber is also shown on Figure E3-9.

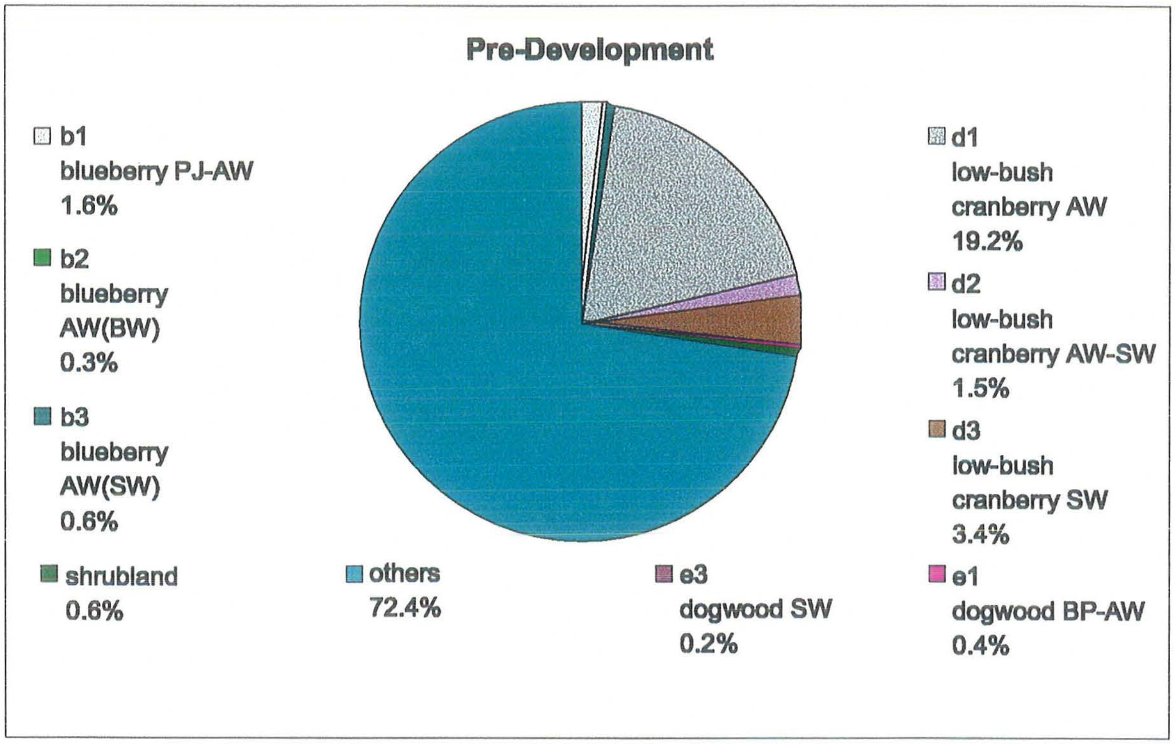
Revegetation Practices

Revegetation of reclaimed landform surfaces is dictated by the nature and type of landform structures (dykes, overburden, tailings sand, CT deposit); slope aspect; soil type (capability class); and soil drainage conditions. The type or types of vegetation community which will successfully establish and develop under various combinations of these factors has been the subject of Suncor research and monitoring programs over the last twenty-five years.

Excavation and hauling of muskeg soil amendments directly to reclamation area enhances site revegetation because dormant, in situ native seed and root fragments are transferred with the soil amendment. Spreading soil amendment on a reclamation area is completed in early spring with the usual result being the emergence of a variety of native forbs, wildflowers, grasses and woody-stemmed species.

Establishment of woody plants in reclamation areas is integral to the reclamation process. Selection of species and the proportion of each species in the supplemental planting mix are based on:

- woody-stemmed species common to the ecosites
- existing field conditions
- vegetation type or types desired for development on the site, based on end land use objectives and landscape terrain features
- expected growth of woody-stemmed species from seeds and root fragments in the soil amendment layer



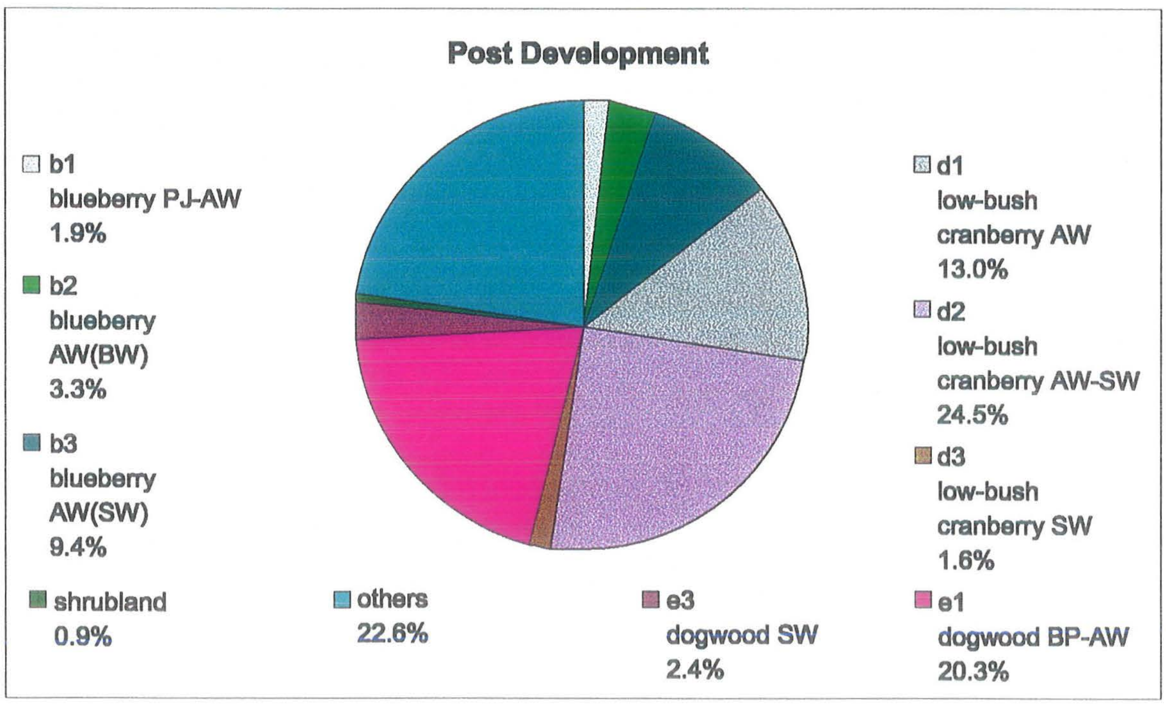
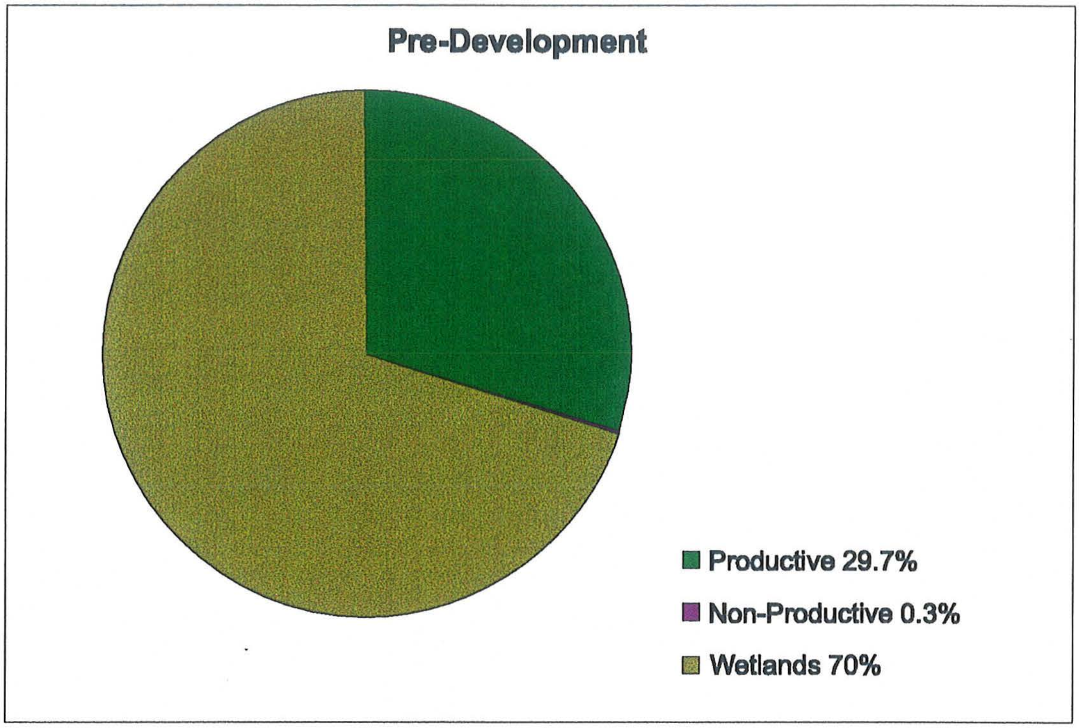


Figure E3-8 Percent Coverage of Selected Ecosite Phases for the East Bank Mining Area



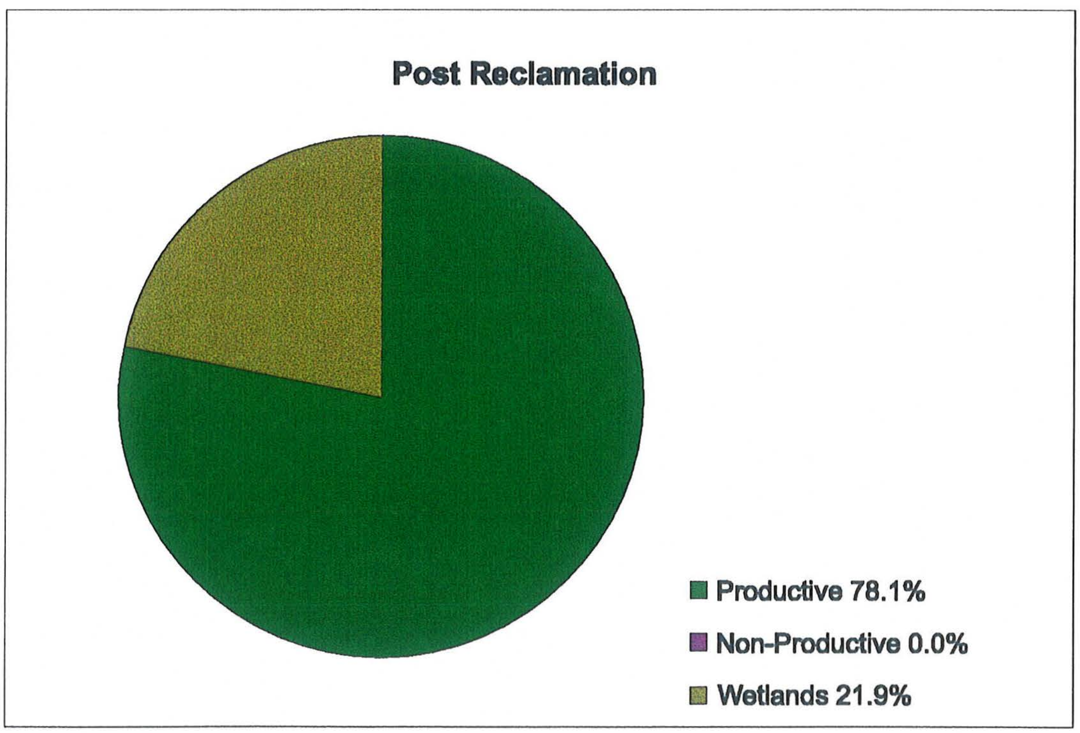


Figure E3-9 Percent Coverage of Forested and Wetlands Areas for the East Bank Mining Area

Optimum species composition is designed to accelerate the process of natural succession toward desired vegetation types. The micro-environment modifies as woody cover develops on a reclamation area and provides favourable conditions for successional and mature species. Planting programs ensures these species are present, established and able to act as seed sources for future establishment. Generally, four to six species are planted to supplement the natural processes of woody plant establishment. Table E3-1 outlines the starter woody-stemmed planting prescriptions to establish each of the ecosite phases.

Refugia

Areas of natural ecosystems located at the periphery of Suncor's development areas serve as sources of seed for native plant establishment and assist in speeding recolonization of reclaimed areas by amphibians, birds, small mammals and the invertebrates that exist in forest soils. These native habitat areas will serve to connect undeveloped areas around the extensive reclaimed areas. These connections will accelerate recolonization of reclaimed areas by wildlife and will enhance habitat interspersion.

Ecosystem Implants

Another method of increasing the rate of recolonization is to transplant patches of soil and vegetation from natural ecosystems to reclamation areas. As discussed earlier, muskeg soil amendments contain seeds and roots of many native plant species. This practice benefits natural regeneration for level sites with moist soil conditions. Establishment of native vegetation by this method has been demonstrated on Lease 86/17.

Due to drier site conditions, this practice is not likely to provide the same benefits on the slopes of overburden waste dumps and dykes along the escarpment, which have rapid drainage as well as south and west exposures. For these sites, soil material (i.e., topsoil and vegetation) will be transplanted from equivalent ecotypes. Trials are being conducted to determine if this is a more effective regeneration method. While it is not feasible to completely cover reclamation area slopes in this way, placing small patches of this material across extensive reclamation areas is expected to facilitate recovery of natural biodiversity in escarpment areas. This covering would be achieved through sequencing of mine stripping and reclamation, with material moved from new working areas to reclamation sites as the mine advances.

The same approach could be used to develop diverse, productive wetlands habitats in reclamation areas. Transplanting soils or sediments from marshes into constructed wetlands would significantly accelerate wetlands development. Existing wetlands sediments contain seeds, roots and other

Table E3-1 Planting Prescription by Ecosite Phase

Landscape Features	Soil Capability and Moisture Regime[1]	Target Ecosite Phase[2]	Tree Species (1800 - 2200 Stems/ha Total Density)	Shrub Species[3] (500 - 700 Stems/ha. Total Density)
Tailings Sand, Crests	Soil Class 4, Xeric, Subxeric	a1 lichen Pj	Jack-pine	Blueberry, Bearberry, Green Alder
Tailings Sand Slope, South Aspect	Soil Class 4-3, Subxeric, Submesic	b1 Blueberry Pj-Aw	Jack-pine Aspen White Spruce	Blueberry, Bearberry, Labrador Tea, Green Alder
Tailings Sand Slope, North Aspect	Soil Class 3-2, Subxeric, Submesic	b2 Blueberry Aw (Bw)	Aspen White Birch White Spruce	Blueberry, Bearberry, Labrador Tea, Green Alder
Tailings Sand Slope, North Aspect	Soil Class 3-2, Subxeric, Submesic	b3 Blueberry Aw-Sw	Aspen White Spruce White Birch	Blueberry, Bearberry, Labrador Tea, Green Alder
Tailings Sand Slope, North Aspect	Soil Class 3-2, Subxeric, Submesic	b4 Blueberry Sw-Pj	White Spruce Jack-pine White Birch Aspen	Blueberry, Bearberry, Labrador Tea, Green Alder
Overburden, Low Organic	Soil Class 3, Mesic, Submesic	c1 Labrador Tea-Mesic Pj-Sb	Jack-pine Black Spruce	Labrador Tea, Green Alder, Bog Cranberry, Blueberry
Overburden, South Aspect	Soil Class 3-2, Mesic	d1 Low-bush Cranberry Aw	Aspen White Spruce Balsam Poplar White Birch	Low-bush Cranberry, Canada Buffalo berry, Saskatoon, Green Alder, Rose, Raspberry
Overburden, North Aspect	Soil Class 3-2, Mesic	d2 Low-bush Cranberry Aw-Sw	Aspen White Spruce Balsam Poplar White Birch	Low-bush Cranberry, Canada Buffalo berry, Saskatoon, Green Alder, Rose, Raspberry
Overburden, North Aspect	Soil Class 3-2, Mesic, Subhygric	d3 Low-bush Cranberry Sw	White Spruce Aspen Balsam Poplar White Birch	Low-bush Cranberry, Canada buffalo berry, Saskatoon, Green Alder, Rose, Raspberry
Near Level Overburden or Tailings Sand	Soil Class 3-2, Subhygric, Mesic	e1 Dogwood Pb-Aw	Aspen Balsam Poplar White Spruce White Birch	Dogwood, Low-bush Cranberry, Raspberry, Green Alder, Rose
Near Level Overburden or Tailings Sand	Soil Class 3-2-1, Subhygric, Mesic	e2 Dogwood Pb-Sw	White Spruce Aspen Balsam Poplar White Birch	Dogwood, Low-bush Cranberry, Raspberry, Green Alder, Rose
Near Level Overburden or Tailings Sand	Soil Class 3-2-1, Subhygric, Mesic	e3 Dogwood Sw	White Spruce Aspen Balsam Poplar White Birch	Dogwood, Low-bush Cranberry, Raspberry, Green Alder, Rose
Near Level Overburden or Tailings Sand, Lower Slope Position	Soil Class 2-1, Subhygric	f1 Horsetail Pb Aw	Balsam Poplar Aspen Birch White Spruce	Rose, Green Alder, Dogwood, Raspberry, Low-bush Cranberry
Near Level Overburden or Tailings Sand, Lower Slope Position	Soil Class 2-1, Subhygric	f2 Horsetail Pb Sw	White Spruce Aspen Balsam Poplar Birch	Rose, Dogwood, Low-bush Cranberry
Near Level Overburden or Tailings Sand, Lower Slope Position	Soil Class 2-1, Subhygric	f3 Horsetail Sw	White Spruce	Rose, Low-bush Cranberry

1 Xeric = water removed very rapidly in relation to supply; soil is moist for brief periods following precipitation.
Subxeric = water removed rapidly in relation to supply; soil is moist for short periods following precipitation.
Submesic = water removed rapidly in relation to supply; water available for moderately short periods following precipitation.
Mesic = water removed somewhat slowly in relation to supply; soil may remain moist for significant but sometimes short periods of the year; available soil water reflects climatic input.
Subhygric = water removed slowly enough to keep the water table at or near the surface for most of the year; organic and gleyed mineral soils; permanent seepage less than 30 cm below the surface.

2 Target ecosite phases defined in "Draft Guidelines for Terrestrial Vegetation in the Oil Sands Region" (Oil Sands Vegetation Reclamation Committee 1998).

3 Propagation of some of the listed shrub species has not been verified to date.

plant propagules, all of which encourage rapid vegetation colonization in the new wetlands area. Additionally, these transplanted sediments introduce a wide range of invertebrates and micro-organisms that will promote establishment of a typical wetlands detrital food chain in the constructed systems.

Slash and Deadfall

Slash and deadfall will be incorporated into soil amendment materials used in Suncor's reclamation program because they provide a number of benefits. Habitat in boreal forests is provided not just by living vegetation but also by dead and decaying vegetation components. Many species depend on snags and fallen logs for cover, as nesting or denning sites, and as feeding substrates. Some of these wildlife benefits will be achieved by including logs and slash from newly-cleared mine areas with area soil used for reclamation.

This practice will result in nutrient enrichment of reclamation areas because a disproportionately large amount of the nutrients in a tree are contained in its branches, twigs and leaves (Hunter 1990). Slash will slowly decompose and enhance nutrient recycling. Decomposing woody debris also provides a moist and fertile seedbed, facilitating natural regeneration of trees and other native vegetation. The debris serves as a source of mycorrhizal fungi, which form symbiotic relationships with plants (essential for certain tree species) by assisting with nutrient resorption.

Deadfall is also an important habitat element for small mammals (such as red-backed voles) which consume the fruiting bodies of the fungi and serve as agents of dispersion for spores. On slopes, slash can also aid in erosion control.

E3.4.2 Aquatic Ecosystems

Drainage Systems

Integral to the development of a sustainable reclamation landscape is the creation of drainage systems away from the landscape which serve to channel surface runoff waters to wetlands, lakes and eventually to the Athabasca River.

A variety of engineered enhancement measures will be incorporated (where appropriate) into the drainage systems. Features such as rock weirs, riffles, log sills, deflectors and constructed cover all enhance the value of drainage systems for use as aquatic habitat.

Detailed design of reclamation drainage systems is completed as the design of a specific area is finalized and linkages with adjacent systems are better defined.

Shallow Open-Water and Wetlands

About 22% of the reclaimed landform will be shallow, open-water areas and wetlands tied to drainage systems constructed as part of the Reclamation Plan. These areas act as aquatic habitat and water treatment areas. Design parameters for reclamation wetlands will be based on the results of research conducted on constructed wetlands by Suncor since 1991, as well as on other applicable wetlands design information.

Another consideration for constructed wetlands and shallow-water areas is the linkage of these systems to similar systems located in undeveloped parts of the lease areas. An example of such a system is Shipyard Lake, to which drainage systems on the east bank mining areas will be connected as part of the Closure Plan.

One of the objectives of the reclamation program is to ensure that whenever reclamation systems are connected to natural wetlands areas, sustainable mitigation designs are in place to minimize impacts to the receiving natural system. For Shipyard Lake, this means that waters draining into the wetlands must not have a significant impact on fundamental wetlands functions (e.g., sediment type and levels, water quality and hydrology).

Suncor has developed a conceptual "Project Millennium Conceptual Plan for 'No Net Loss of Fish Habitat' " (Golder 1998i) to describe activities planned to minimize the project impact on fish habitat, as well as to describe methodologies which could enhance the aquatic habitat potential for reclamation drainage systems.

End Pit Lake

One feature of the Closure Plan is an end pit lake. This area of the landscape represents the final mining location for Suncor's east bank mining area. The end pit will be an area bounded by undisturbed land along the west and south sides, with the balance of the perimeter provided by overburden dykes. Because this is the last mining area, there will not be sufficient mining byproduct (e.g., overburden, CT or fine tailings) to fill the area to original ground level.

The end pit area will be used as a final receptacle for materials including overburden, CT, and any fine tailings remaining at the cessation of mining and extraction activities. Other fluids that will be directed to the end pit area will include:

- surface runoff from the reclaimed southern sections of the mine area
- seepage from CT deposits in mine cells located around the end pit area
- water from the headwater area of Wood Creek

- water from the Athabasca River, as required to complete filling of the end pit lake prior to completion of reclamation activities

This end pit lake will be designed to evolve into a functional, self-sustaining aquatic ecosystem. Suncor is working on development of guidelines for the end pit lake, which will include consideration of the following parameters:

- use of upslope runoff to maintain water levels after closure
- inclusion of approximately 20% of the surface area as a littoral zone, composed of wetlands or lake areas less than 1.5 m deep
- design of shorelines to minimize hazards associated with immediate sharp drop-off into deep water areas
- creation of wetlands/fish habitat areas where streams discharge into the lake (e.g., Wood Creek, drainage streams from reclaimed CT deposit areas) as well as at the end pit lake outlet where it connects with McLean Creek
- contour of shoreline areas, to enhance future potential for use of the lake as a recreational area (e.g., wildlife observation)
- design such that waters discharging from the lake meet water quality and toxicity guidelines

E3.4.3 End Use Potentials

The end use objectives for closure of Suncor development areas are to develop areas suitable for commercial forestry, wildlife, recreation and traditional land use. The potentials for recreation and traditional land use are inherent in the efforts towards establishment of forestry and wildlife areas. Capability to support forestry and wildlife indicates that re-established ecosystems are diverse and will provide the opportunities for traditional land use and recreational use.

Commercial Forests

Development of reclamation areas with suitable commercial forest potential means consideration of design criteria as detailed in the document "Draft Guidelines for Reclamation of Terrestrial Vegetation in the Alberta Oil Sands Region" (Oil Sands Vegetation Reclamation Committee 1998). A commercial forest is defined in the guidelines as:

- lands with a land capability class equal to or greater than 3 that can support sustainable forest growth
- lands stocked with native tree species such as white spruce, black spruce, jack-pine, aspen poplar, balsam poplar, white birch or tamarack
- forest stands not limited by operating requirements such as stream buffers, potential recreation lakes, stand size or accessibility

As noted previously, the target soil capability for all reclamation areas is at minimum Class 3, while the revegetation plan calls for outplanting of tree species included in the commercial forest species list. Reclamation area layouts will determine the acceptability of various areas to comply with the third component of the above commercial forest definition.

Terrestrial areas on reclaimed landscape should generally have the potential for commercial forestry. To define areas of the reclaimed development area as acceptable for commercial forestry, factors such as tree species, stand width, stand size and terrain slope will be considered.

Wildlife

Development of reclamation areas for enhancement of wildlife habitat involves consideration of habitat diversity, spatial heterogeneity and movement corridors. Habitat diversity in reclamation areas can be achieved through creation of a similar degree of landform diversity as well as through establishment of plant communities comparable to those which exist already in the area.

Suncor's reclamation methods produce ecosite phase plant communities common to those of the oil sands area. This practice will result in creation of habitat areas suitable for regional wildlife species. The biggest change between pre-development and closure ecosystems is the trend toward drier "upland-type" ecosystems. This change means that wildlife species most commonly associated with wetlands areas will be less abundant on the reclaimed landscape, while those species associated with drier, upland habitats will be more abundant.

The reclamation program involves development of habitat types suitable for use by several target wildlife species including: moose, snowshoe hare, ruffed grouse, voles and songbirds. Areas will also be suitable for habitat generalists such as black bear. Long-term development of reclamation areas will also result in development of mature ecosystems suitable for species such as fisher and great gray owl.

Reclaimed areas must be spatially diverse in order to support a high diversity of wildlife, although the degree of diversity required varies from species to species. Reclamation planning will reflect habitat requirements of species identified for Suncor development areas during wildlife surveys, conducted during Steepbank Mine and Project Millennium EIAs.

Wildlife movement corridor requirements are integrated into the mine plan. Approximately 100-m-wide areas of undisturbed native forested areas are left along the Athabasca and Steepbank River valleys, providing corridor capability during the construction and operation of the mine. Closure landscapes will not include specific corridor considerations, but will allow free range of wildlife species throughout the area.

Recreational Uses

Inherent within the design of reclamation areas suitable for wildlife habitat is the development of areas with the potential for recreational use. Target recreational uses could be consumptive (e.g., hunting, fishing, berry picking) or non-consumptive (e.g., nature observation).

Potentials for recreational uses will be defined for specific reclamation areas as design details are finalized.

E3.4.4 Biodiversity

For the purposes of assessment of the Suncor Closure Plan, the following definition of biodiversity has been adopted:

> *The variety of life and its processes, including the variety of living organisms, the genetic differences among them, the communities and ecosystems in which they occur and the ecological and evolutionary process that keep them functioning yet ever changing and adapting (Noss and Cooperrider 1994).*

Various scales of biodiversity may be included in evaluations, although most are not well-understood or defined. In addition, each scale of biodiversity can be described in terms of three levels (composition, structure and function). To aid in developing and understanding Suncor's Closure Plan, two scales will typically be examined:

- landscape (macroterrain)
- plant communities (ecosite phase, wetlands)

Composition refers to the number and abundance of each unit (e.g., ELC units, plant communities, wetlands types and species), and it can be measured using indices of richness and diversity. Structure refers to the vertical and/or horizontal layering of these units, and to the abundance and distribution of these layers; and/or to the distribution of patches across the landscape. Function refers to the climatic, geologic, hydrologic, ecological and evolutionary processes that occur within each scale.

Reclamation Planning for Biodiversity

The basis for re-establishment of biodiversity on reclamation areas has already been described in the reviews of terrain design, soil management and reconstruction, revegetation plans and drainage system establishment. It is recognized that, as the reclaimed landscape matures and evolves, it will increasingly resemble conditions found in the surrounding region. A terrain-based predictive model has been devised to forecast long-term vegetation distribution (expected to develop given the landform characteristics of the reclaimed landscape) and to examine whether or not (based on characteristics of existing local vegetation) the proposed revegetation plan is sustainable. The model is applied to the designed final reclamation surface and the vegetation classified appropriately.

Establishment of productive habitats on reclaimed areas will be assisted by planting a diverse mixture of native plant species of different life-forms (e.g., grasses, forbs, shrubs and trees). Structure and composition of the initially-established communities will be simplistic in comparison with natural undisturbed ecosystems. Newly-reclaimed communities will lack the within-habitat (alpha) diversity that characterizes natural ecosystems. Over the long term, however, other native species are expected to recolonize reclaimed areas, resulting in an increase in plant and animal diversity. It is likely to take hundreds of years before recolonization is complete and the full complement of native species is restored for relatively complex ecosystems.

E4 RECLAMATION MONITORING AND RESEARCH

The performance of reclaimed areas must be predicted well into the future. Predictions of performance are based on:

- extrapolation of data from research projects and pilot tests
- results of monitoring programs on reclaimed areas
- input of current experience in the oil sands and other northern regions

Elements considered for performance prediction include:

- landform performance
- impact of chemical constituents of the landscape
- ecosystem sustainability

Suncor has undertaken specific monitoring and research programs on mine development sites and has actively participated in joint research programs with industry, regulatory, academic and consulting partners to increase available data upon which to base its performance predictions.

Annually, Suncor produces a conservation and reclamation report that summarizes the year's activities in terms of reclamation, monitoring and research, as well as describing planned activities for the following year. This report is submitted to Alberta Environmental Protection and shared with interested stakeholders.

E4.1 Reclamation Monitoring

Suncor conducts annual monitoring programs on reclaimed areas to assess herbaceous vegetation growth, major species composition, and the physical and chemical properties of soils.

Annual assessments of tree and shrub survival and growth have been conducted in areas where known numbers of seedlings have been planted. Several other studies related to land reclamation, groundwater monitoring and fine tailings handling have been undertaken and are reported. Suncor will continue research in these areas to ensure that reclamation goals are achieved.

E4.1.1 Soil and Vegetation Monitoring of Reclaimed Land

Soil and vegetation characteristics of reclaimed areas on Suncor leases are routinely monitored by both in-house staff and external consultants. The monitoring program consists of annual soil sampling and vegetation cover assessments on areas reclaimed within the past three to four years. A detailed assessment and sampling of older reclaimed areas is completed every fifth year. This information provides input into the Geographical Information System (GIS), which is used by Suncor as a planning tool to relate the monitoring data to soil and vegetation development in the reclamation areas.

Sampling of soil and vegetation from reclaimed areas is accomplished by means of permanent transects through the areas. These transect lines are determined through review of aerial photographs of the reclaimed areas. At each location, permanent 30-m transects are positioned at mid-slope, parallel to the contour for dyke areas, and at regular intervals for level reclamation areas.

E4.1.2 Meteorology

As development of a vegetative cover is affected by meteorological conditions, amounts of precipitation, temperatures, and the seasonal variations of these factors are very important when assessing area development. The annual reclamation monitoring program has shown that normal precipitation and temperature together with a relatively-even distribution of precipitation during the growing season results in superior vegetation growth in all reclaimed areas. Suncor collects meteorological data from both on-site and off-site regional stations.

E4.1.3 Soil Sampling

Soil samples are collected in conjunction with the vegetation assessment, using the same transects. Typically, three layers are sampled per transect at most sites including: the amended layer (approximately 0 cm to 15 cm); the layer immediately below the amended layer (15 cm to 30 cm); and the 45 cm to 60 cm layer. Samples are taken from three locations (i.e., approximately the end points and the middle of each transect), then bulked to form one composite sample per layer per transect. In most cases, portions of several samples are bulked again to form one composite sample representing a specific reclamation area. Samples are then submitted for laboratory analyses. Since soil properties of the lower layers (analyzed the year the site was reclaimed) tend to change much more slowly than those at the surface, sampling of lower layers is less frequent than for surface layers.

E4.1.4 Vegetation Assessment

Data on vegetation cover and height are collected from assessment plots located on the transect lines. At each location, a permanent 30-m transect is positioned at mid-slope, parallel to the contour. Ten 0.10-m^2 quadrants are systematically placed along the transect and average vegetation height (of herbaceous species only), as well as percent of living (by individual species) and dead plant cover is estimated within each quadrant.

Species composition is recorded, and growth measurements are made for all woody-stemmed plants within each plot. Mean percentage cover for each component and mean total cover are calculated from these estimates.

E4.1.5 Tree (Woody-Stemmed Vegetation) Assessments

Suncor uses two methods for assessing woody-stemmed vegetation establishment: growth and performance. The Primary Assessment method is used for reclaimed areas three to four years after tree planting has been completed on the reclamation site. The Regeneration Survey method is conducted on all areas that have been revegetated for a period of eight or more years.

Primary Assessment

The Primary Assessment procedure is employed to monitor the success of establishing woody-stemmed vegetation on a reclamation site over the short term. Data collected is used to plan maintenance treatments for individual sites (e.g., fill-in planting and fertilization).

Challenges to establishment of commercial forests on reclamation sites include south-facing terrain aspects and the presence of a grass mat. Excessive grass growth, in conjunction with the southern exposure, may result in severe drying conditions that stress trees and can cause tree mortality.

Regeneration Survey

A second method of assessment of vegetation involves utilization of the Regeneration Survey procedure developed by Alberta Environmental Protection - Land and Forest Service (AEP-LFS). This survey must be conducted by a certified person using the AEP-LFS Regeneration Survey Manual.

Results from the Regeneration Survey method, while variable, provide an indication of the need for additional work on a reclamation area. Areas expected to develop into a merchantable forest stand are to have 1 200 stems/ha at the end of the assessment period. A survey may indicate that insufficient woody-stemmed plants have become established to meet the (AEP-LFS) Regeneration Standard. Should this occur, mitigative work such as fill-in planting is implemented. Tailings sand slopes (which are reclaimed primarily for erosion control) are also assessed although the intent is not necessarily to meet the forest stand criteria, but rather to develop the slopes into suitable wildlife habitat.

Suncor utilizes the AEP-LFS mixedwood establishment survey to help evaluate tree survival and native invasion on reclamation areas. According to the survey criteria, acceptable trees (eight years following planting) include 50+ cm spruce or 100+ cm jack-pine, tamarack, aspen, balsam poplar or birch. Once these species have reached a merchantable size, all have potential for use in lumber or pulp industries. The AEP-LFS establishment survey has been modified slightly to include the presence of other woody-stemmed plants because Suncor's reclamation focus is to develop a diverse ecosystem on the reclamation sites.

E4.1.6 Wetlands Assessments

In 1991, Suncor initiated programs to assess the utility of constructed wetlands for treatment of reclamation area seepage and runoff waters. Routine monitoring of reclamation area wetlands systems has not been initiated as no such systems are fully established. As reviewed below, research continues on wetlands.

E4.1.7 Wildlife Surveys

Suncor conducts a variety of wildlife assessment programs as components of its operational and reclamation activities. The potential interaction of wildlife (particularly birds) with operational tailings ponds has been monitored on the Suncor site since the mid-1970s. Suncor operates and maintains a bird deterrent program, to effectively minimize interactions between birds and the tailings ponds.

Monitoring the use of reclamation areas by wildlife species has typically been accomplished by using an observational approach, in which personnel who spend time working on reclamation areas report sightings of larger mammals. One exception to the observational approach has been the collection of detailed avifauna data for Lease 86/17 between 1976 and 1994, when data was collected in association with the bird deterrent program.

In 1997, Suncor initiated a systematic approach to evaluate the use of reclamation areas by wildlife with the completion of ungulate browse, pellet count and track count surveys. This survey program will be further developed in 1998 to include assessments of the presence of wildlife species on different available reclamation areas.

E4.2 Reclamation Research

Suncor participates in a variety of reclamation research programs. This research (conducted either by Suncor alone or, more commonly, by Suncor together with industry, regulatory, academia and consulting research partners) focuses on identification and resolution of issues associated with oil sands operations and reclamation of mine development areas.

Research conducted during the 1970s and 1980s led to development of the effective soil reconstruction and area revegetation approaches that are applied successfully in today's reclamation areas.

Research conducted during the 1980s and 1990s has focused on the management and reclamation of oil sands tailings materials and has led to development of Consolidated Tailings technology. As well, it has focused on waters which are released or will seep from these areas. The research includes a combination of engineering and environmental assessments to fine-tune processes and to develop an understanding of the ramifications of these processes.

Suncor has also participated in two studies to evaluate the potential impacts of seepage waters on fish. These studies, which included both fish health and fish tainting evaluations, were conducted at laboratories and used rainbow trout and walleye. Suncor will initiate a fish health and tainting study to evaluate potential impacts on fish of CT release waters.

The annual research programs associated with reclamation activities are overviewed in the annual Conservation and Reclamation Report prepared by Suncor for AEP.

Future research programs associated with Suncor's Reclamation and Closure Plan will include programs to evaluate:

- effectiveness of wetlands systems developed in association with CT reclamation areas
- effectiveness of designed reclamation drainage systems in providing fish habitat
- potential for the end pit lake to provide a viable aquatic ecosystem

Details on research programs undertaken in association with further development and refinement of CT technology are detailed in Volume 1, Section E5.2.

E5 CONSERVATION AND RECLAMATION PLAN

This section of the Closure Plan details planned reclamation activities for the Steepbank Mine expansion area to the year 2006. This time period was selected so that the conservation and reclamation approval for the expansion area would align with the existing approval for Lease 86/17 and Steepbank Mine.

This section also provides details on the following:

- an overview of solid landscape reclamation technology
- review of the fundamentals behind the move to Consolidated Tailings
- plans for a CT reclamation demonstration site
- summary overview of issues associated with continued application of CT technology

A description of CT technology and current CT operations at Suncor is provided in Volume 1, Section B2.3

E5.1 Conservation and Reclamation Plan Activities

E5.1.1 Topsoil Development and Placement

Development of reclamation soils will be strongly influenced by the nature of the reclaimed landforms. Factors which affect soil development include: slope, aspect and drainage of reclaimed landforms, vegetation and climate. Suncor uses the single-lift peat-mineral mixture as described in the "Draft Guidelines for Reclamation of Terrestrial Vegetation in the Alberta Oil Sands Region" (Oil Sands Vegetation Reclamation Committee 1998). The general application and spreading of muskeg soil materials on these landforms will follow practices previously described.

Suncor is continuing to evaluate enhancements to current techniques used in its reclamation program. Logistical constraints limit the ability to salvage shallow deposits of topsoil. Organic deposits of less than 0.6 m are not usually salvaged due to the reduced quality of the topsoil and problems associated with using large excavating equipment for this task.

A demonstration area has been set up on the north slope of the Horse Shoe Substation on Lease 86/17 to determine the benefits of salvaging shallow deposits of mineral topsoil. This demonstration site has undergone the first year of a five-year monitoring program; results to date are considered preliminary. Natural regrowth of woody-stemmed plants from shallow mineral soil was not evident after the first growing season, while native herbaceous plant species were observed. These results are in contrast to the plant growth noted resulting from the application of muskeg from a deeper source. The rate of native plant re-establishment at the site will be documented and compared to current reclamation practices, to assess the benefit of this approach.

If a significant advantage can be demonstrated, shallow mineral topsoil would be selectively removed from specific pre-disturbance areas. Areas where aspen stands are dominant would be stripped of shallow soil and placed on areas where aspen stands are expected to develop. This shallow mineral soil would be placed on reclamation sites in conjunction with standard, salvaged muskeg-mineral soil amendment to cover approximately 20% of the total reclamation area. Because of the abundance of organic soils found on the east bank mining area, lack of good quality soil building materials is not a concern.

E5.1.2 Soil Stripping Schedule and Reclamation Progression

Land capability provides the basis to describe land use options for site-specific conditions on both pre- and post-development landscapes. The land capability classification system for the oil sands region, developed by Leskiw (1998), specifies the soil amendment requirements for a desired land capability. Utilizing this classification system, as well as data gathered during assessment of the project area, a detailed soil mass balance has been completed.

Soil Stripping Schedule

Table E5-1 outlines muskeg soil salvage, requirements and cumulative surplus for the east bank mining area. Stripped soil volumes to be used for reclamation reflect areas of Muskeg and Mildred soils (i.e., Class 5). These soils are usually overstripped to an average depth of 1.4 m (i.e., 1 m peat; 0.4 m mineral overburden). To take a conservative approach for this application, volumes calculated in Table E5-1 reflect organic volumes only. Actual reclamation soil volumes are expected to be greater than indicated because overstripped mineral soil has not been included in the calculation. Volumes required for reclamation are based on spreading 20 cm of muskeg soil amendment. The table indicates a cumulative reclamation soil surplus to end of mine amounting to about 22 million bank cubic metres (BCM).

Table E5-2 provides the reclamation soil schedule for Lease 86/17 during this same operational period. As soil stripping and salvage is expected to be completed during 1998, no further opportunities for direct placement are present.

Table E5-1 Reclamation Soil Schedule for East Bank Mining Area

Year	Area Description	Area Ha	Reclamation Muskeg Required (10^3 BCM)	Annual Muskeg Salvaged (10^3 BCM)	Direct Placement (10^3 BCM)	Cummulative Surplus (10^3 BCM)
1998				732	17	1 065
1999				177	0	1 242
2000	NW DUMP -slope	61	135	195	135	1 303
2001	DYKE 11A - slopes	69	153			
	NW DUMP - surface	75	166			
	TOTAL	**144**	**319**	**664**	**319**	**1 647**
2002		0	0	614	0	2 261
2003	DYKE 11A - slopes	24	54	866	54	3 073
2004	NE DUMP - slopes	64	142	1 280	142	4 212
2005	DYKE 11	28	62			
	DYKE 11A	150	332			
	NE DUMP-slopes	39	87			
	TOTAL	**217**	**481**	**1 504**	**481**	**5 235**
2006	DYKE 10	79	175			
	DYKE 11A	113	252			
	DYLE 11c	16	34			
	NE DUMP - top & slopes	136	301			
	TOTAL	**343**	**762**	**1 789**	**762**	**6 261**
2007	DYKE 10	46	102			
	DYKE 11	71	157			
	DYKE 11A	113	252			
	TOTAL	**230**	**510**	**684**	**510**	**6 436**
2012	DYKE 11c	187	416			
	NE DUMP - slopes/top	267	592			
	TOTAL	**454**	**1 009**	**7 851**	**1 009**	**13 278**
2018	DYKE 14	112	249	4 497	249	17 526
2025	DYKE 14	31	69			
	DYKE 15	146	324			
	POND 9 - surface	761	1 690			
	TOTAL	**938**	**2 084**	**7 449**	**2 084**	**22 891**
END OF MINE	DYKE 15	70	156			
	DYKE 16	108	240			
	POND 7	404	897			
	POND 8	282	626			
	POND 8A	328	728			
	POND 10	777	1 726			
	POND 11	826	1 835			
	POND 12	1 034	2 297			
	ROAD	120	267			
	TOTAL	**3 947**	**8 771**	**8 200**	**8 200**	**22 320**
TOTAL		**6 532**	**14 516**	**36 502**	**13 961**	**22 320**

Table E5-2 Reclamation Soil Schedule for Lease 86/17

Year	Area Description	Area Ha	Reclamation Muskeg Required (10^3 BCM)	Annual Muskeg Salvaged (10^3 BCM)	Direct Placement (10^3 BCM)	Cumulative Surplus (10^3 BCM)
1998				996	64	5 256
1999						5 256
2000	DYKE 5 - slopes	11	24			5 232
2001	DYKE 7/8 - slopes	59	131			5 101
2002	POND 4 - surface	110	244			4 857
2003	POND 9 - slopes	72	159			
	MINE BTTM	119	264			
	TOTAL	**191**	**424**			**4 433**
2004	DYKE 8 - slopes	87	192			4 241
2005			0			4 241
2006			0			4 241
2007			0			4 241
2012	POND 1 - surface	242	537			3 704
2018	POND 5 - surface	255	566			
	POND 6 - surface	443	984			
	TOTAL	**698**	**1 550**			**2 154**
2025			0			2 154
END OF MINE	POND 1A	61	135			
	POND 2/3	419	930			
	TOTAL	**479**	**1 065**			**1 089**
	TOTAL - 86/17	**1 875**	**4 168**	**996**	**64**	**1 089**

Reclamation Progression

Figures E5-1 to E5-12 show: the progression (from 2000 to end of mine) of soil striping; tree clearing; incremental area available for reclamation; cumulative reclamation for the east bank mining areas; as well as areas available for reclamation and cumulative reclamation for Lease 86/17.

The reclamation progression figures show the locations of reclamation activities as well as the areas of muskeg salvage, with the direction of material flow indicated. The majority of this reclamation is via direct placement, with the remaining inventory either placed in stockpiles or discarded with overburden materials. Muskeg materials will be discarded because of the significant surplus (approximately 22 million BCM) of reclamation materials.

A discrepancy exists in surface areas between the summary of closure landscape reclamation units and Table E5-1. The table shows less area because:

- no waterbodies are included
- reclamation stockpile areas are not included
- unmined and undisturbed areas are not included
- the perimeter drainage is not included
- some areas are reclaimed, redisturbed by mining, then reclaimed a second time

E5.1.3 Revegetation Plan

Objectives

Objectives of Suncor's reclamation program, previously stated in Volume 1, Section E1.2 of this application are as follows:

> *Developed lands shall be reclaimed with viable ecosystems compatible with pre-development, including forested areas, wetlands and streams. The reclaimed lands will provide a range of end uses including: forestry, wildlife habitat, traditional use and recreation.*

The following premises underlie the overall objectives of the revegetation program:

- The composition and structure of the vegetation communities varies with terrain conditions including slope, aspect and drainage patterns.
- Terrain of the reclaimed landforms (dykes, overburden dumps and CT deposits) will provide variation in slope, aspect and drainage patterns.

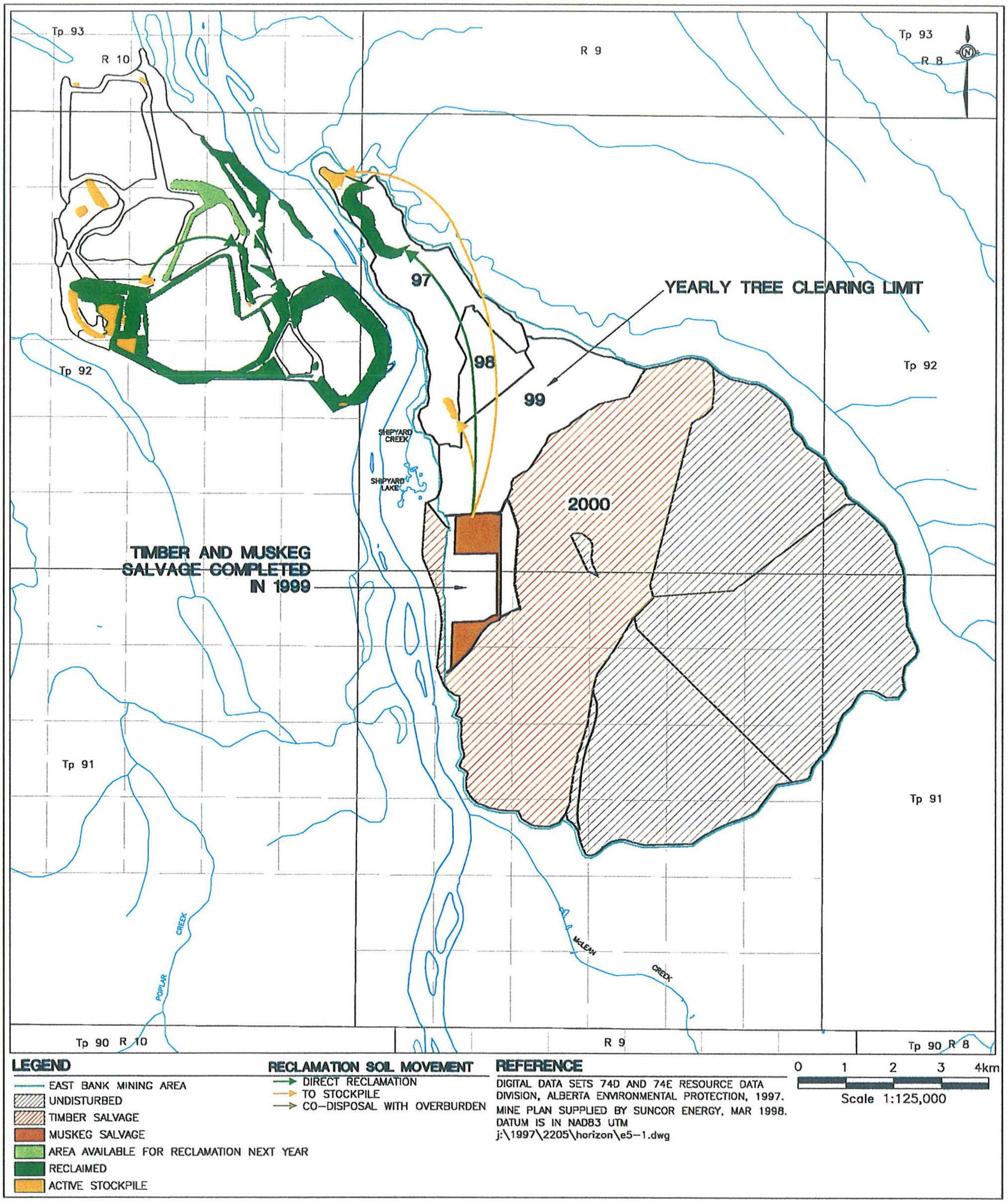


Figure E5-1 Reclamation Progression 2000

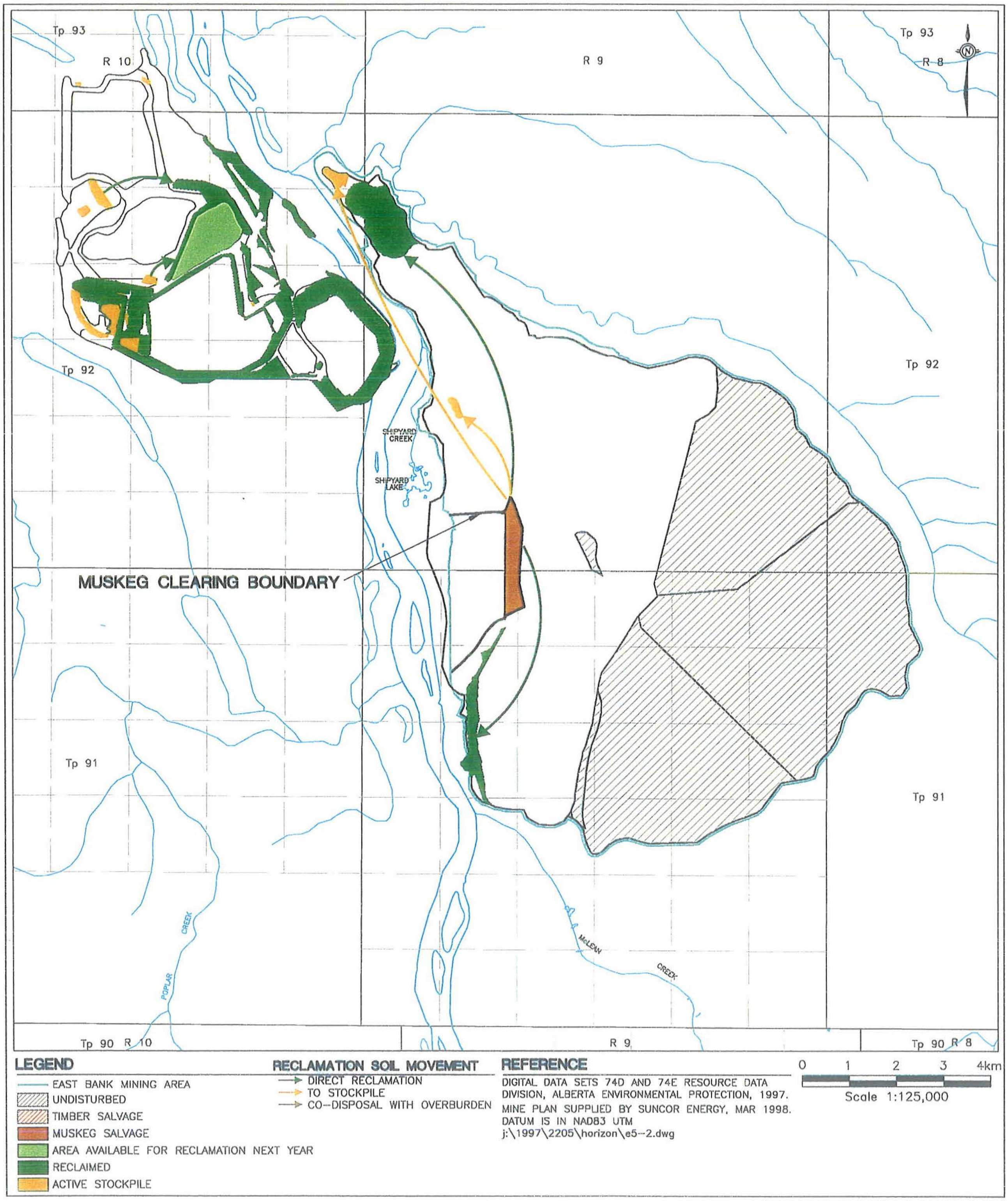


Figure E5-2 Reclamation Progression 2001

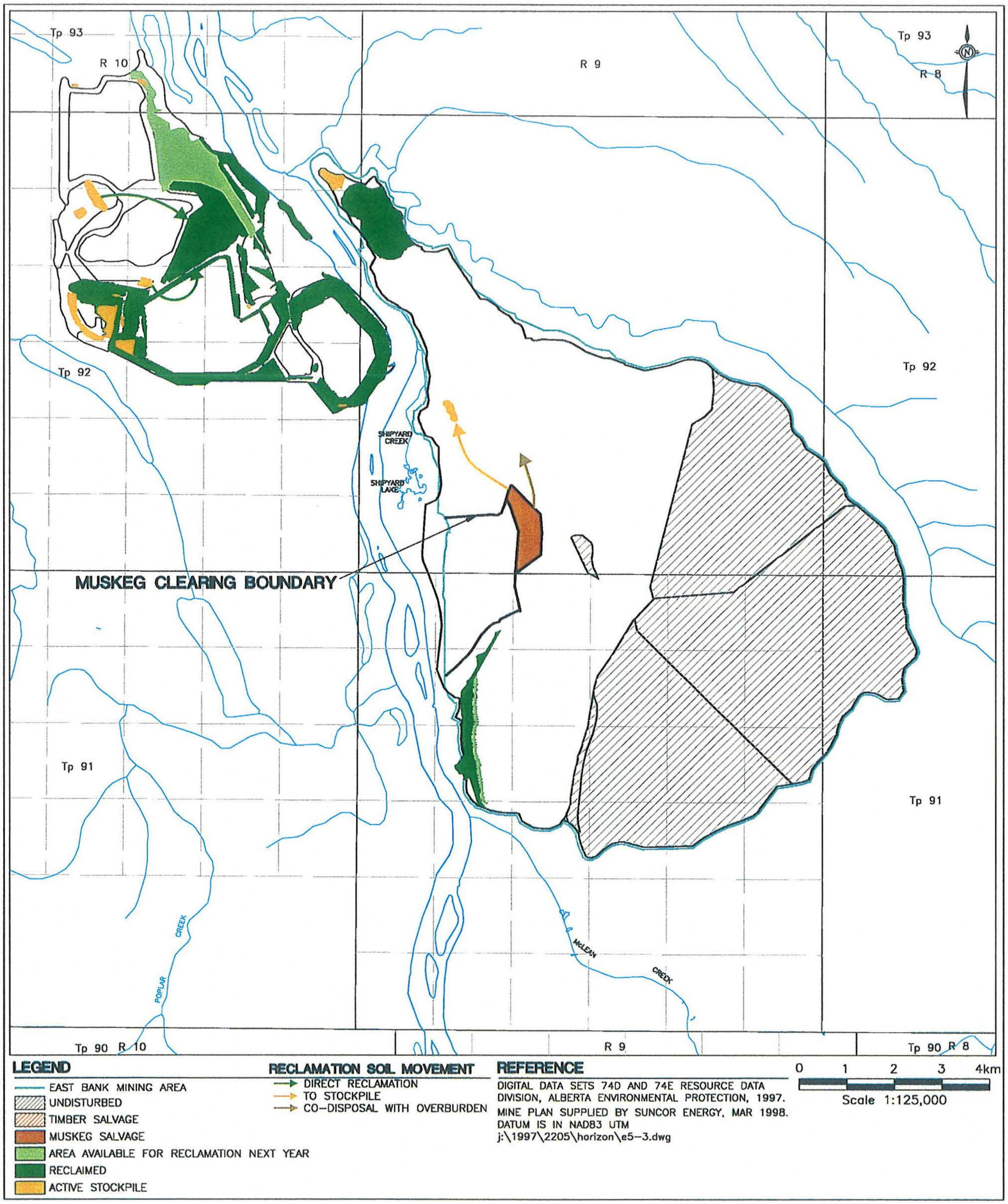


Figure E5-3 Reclamation Progression 2002

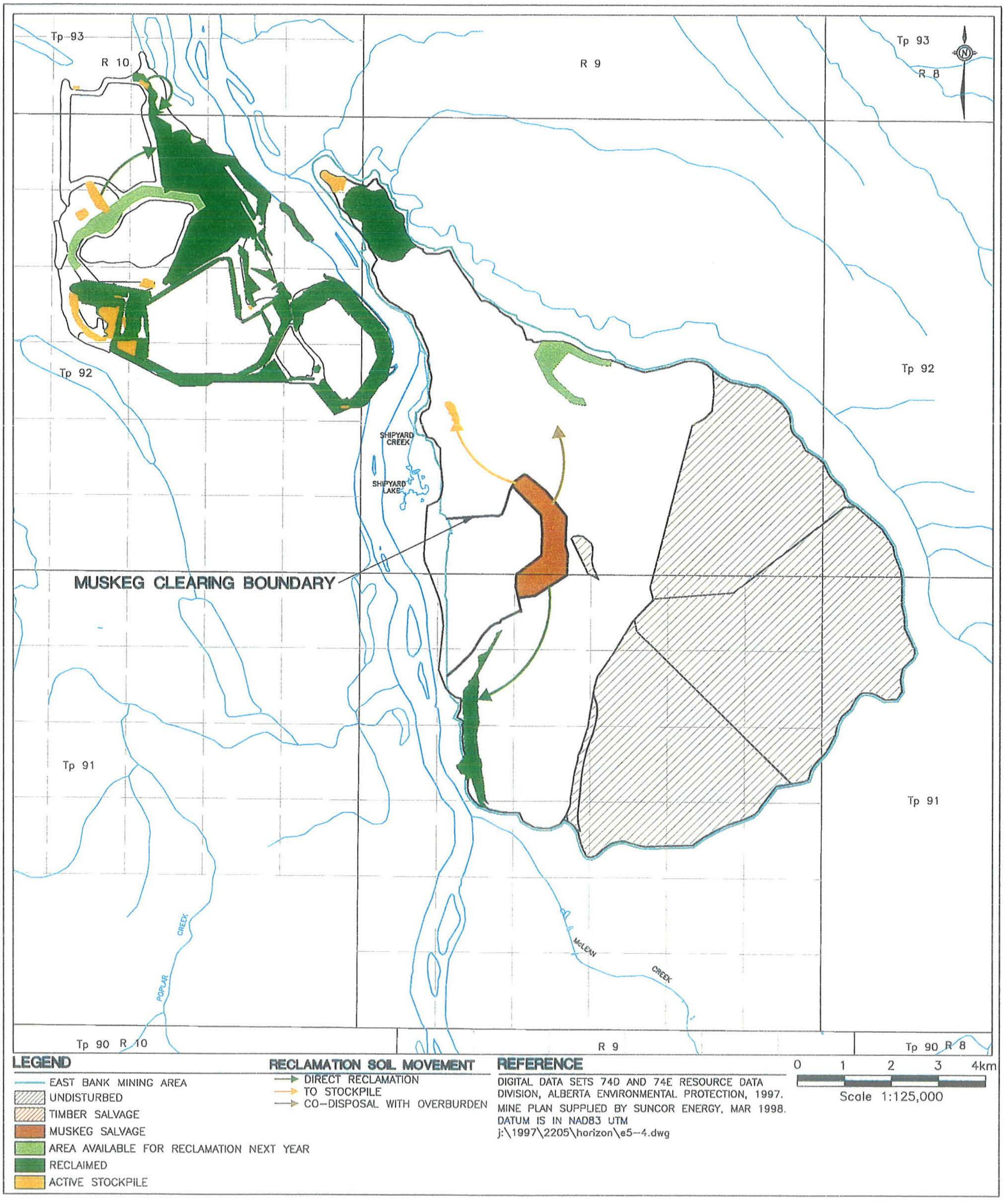


Figure E5-4 Reclamation Progression 2003

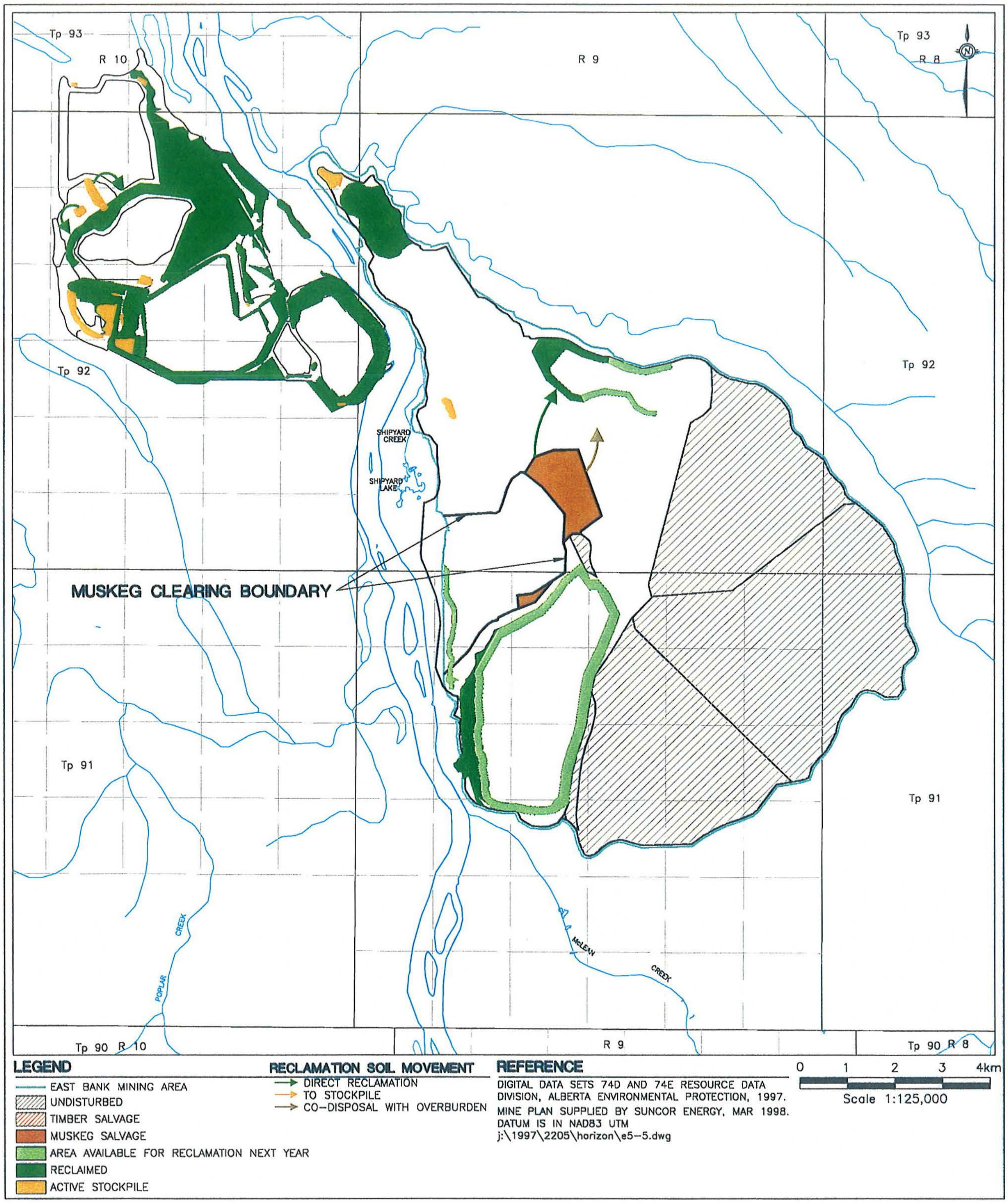


Figure E5-5 Reclamation Progression 2004

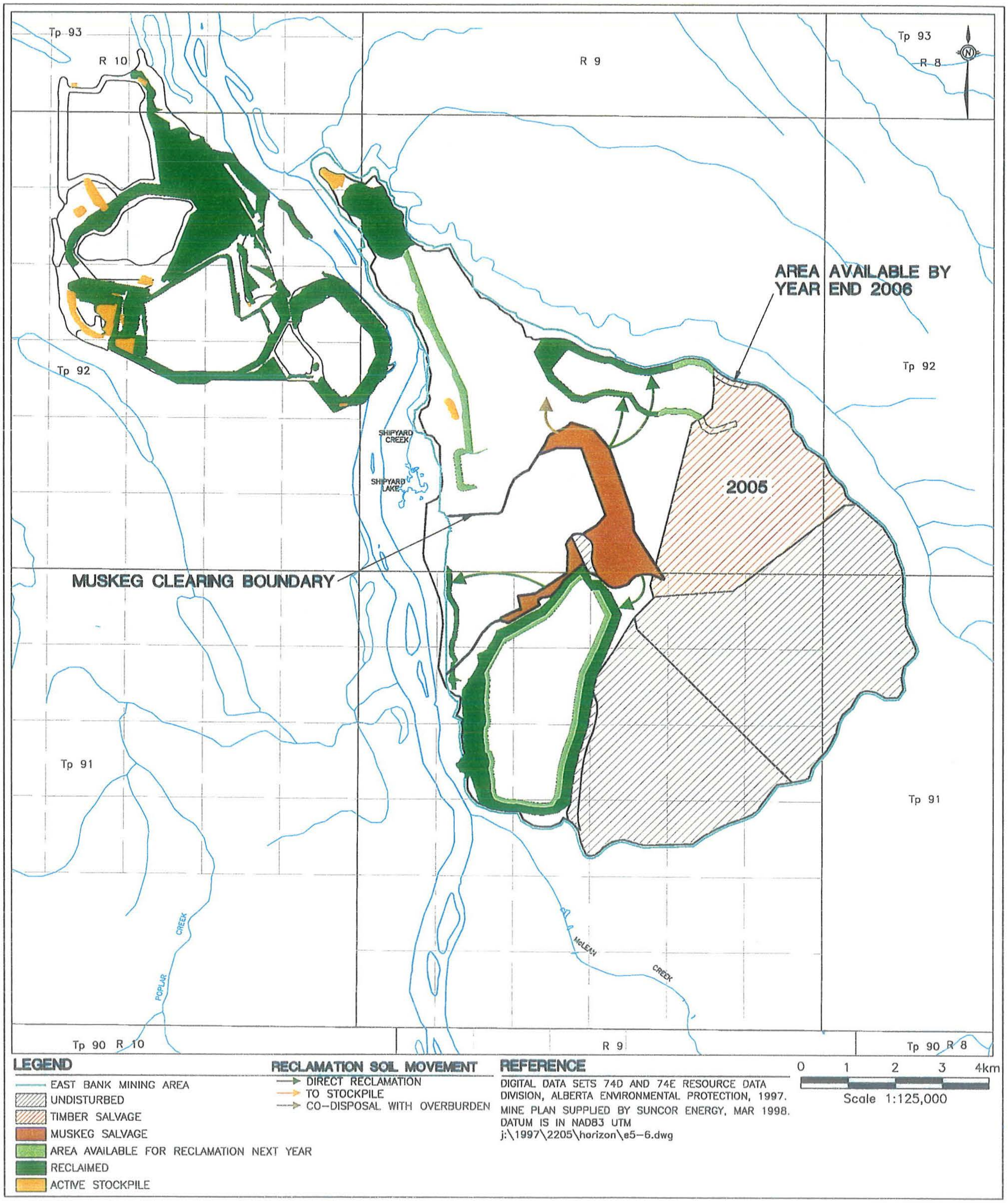


Figure E5-6 Reclamation Progression 2005

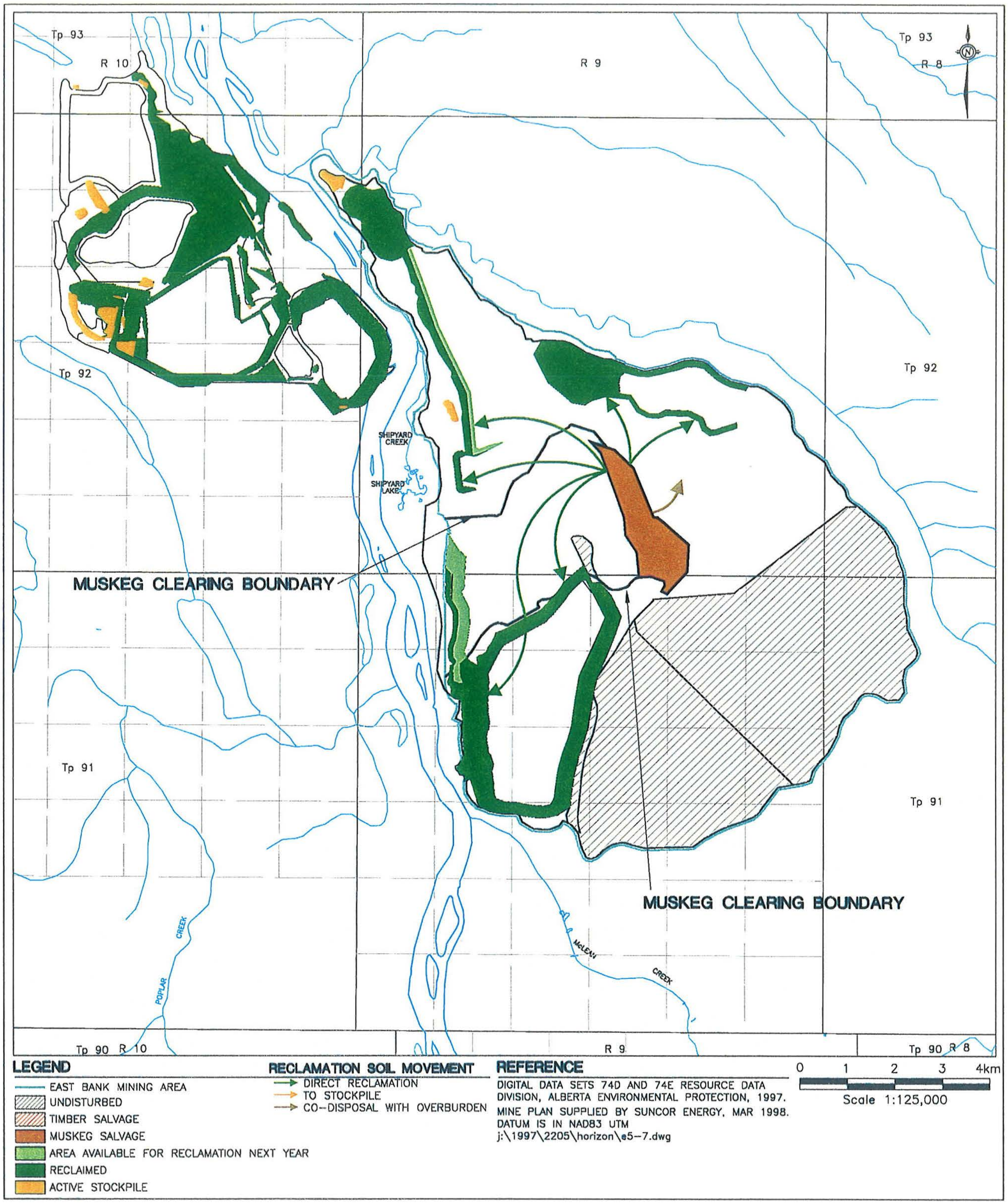


Figure E5-7 Reclamation Progression 2006

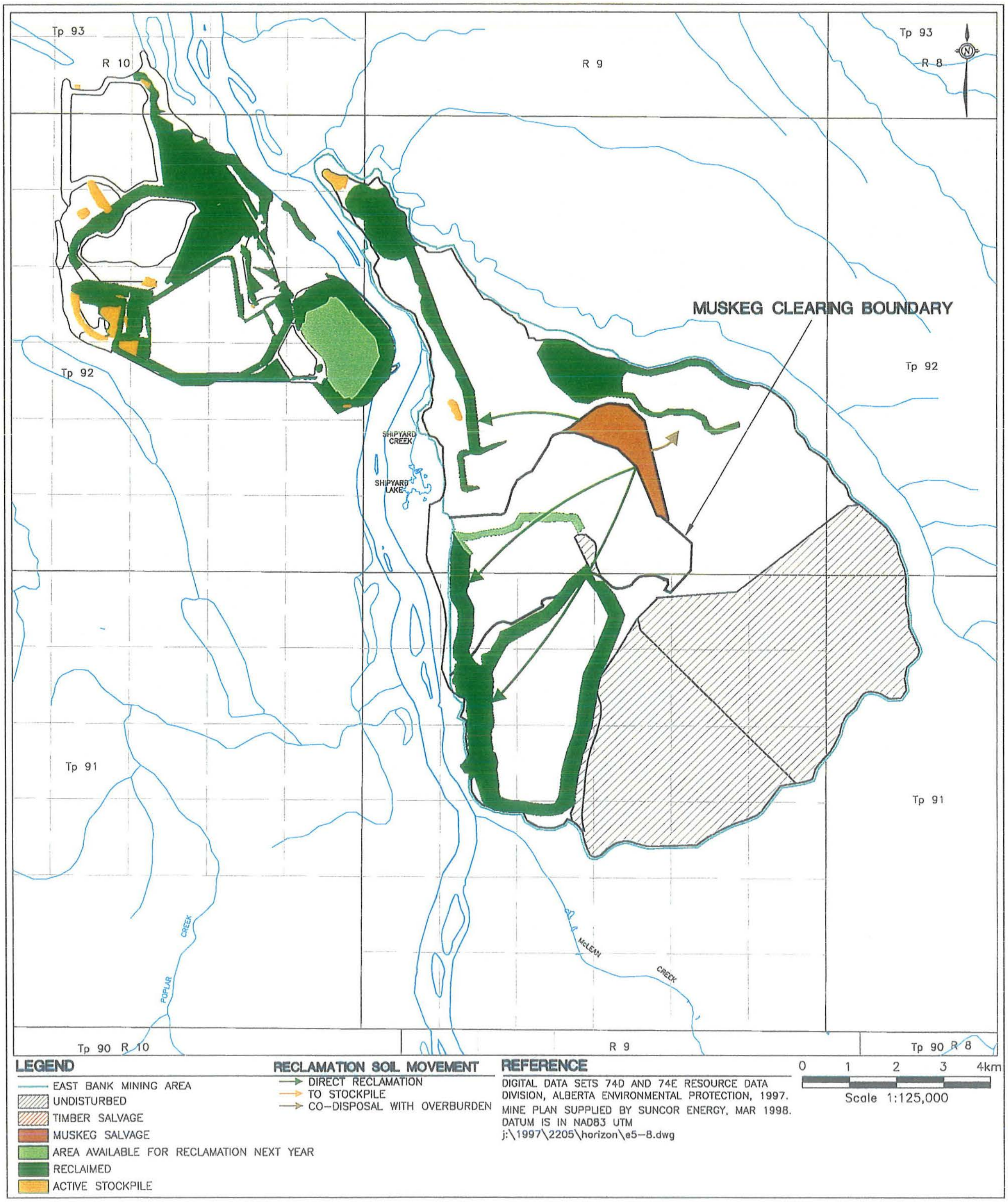


Figure E5-8 Reclamation Progression 2007

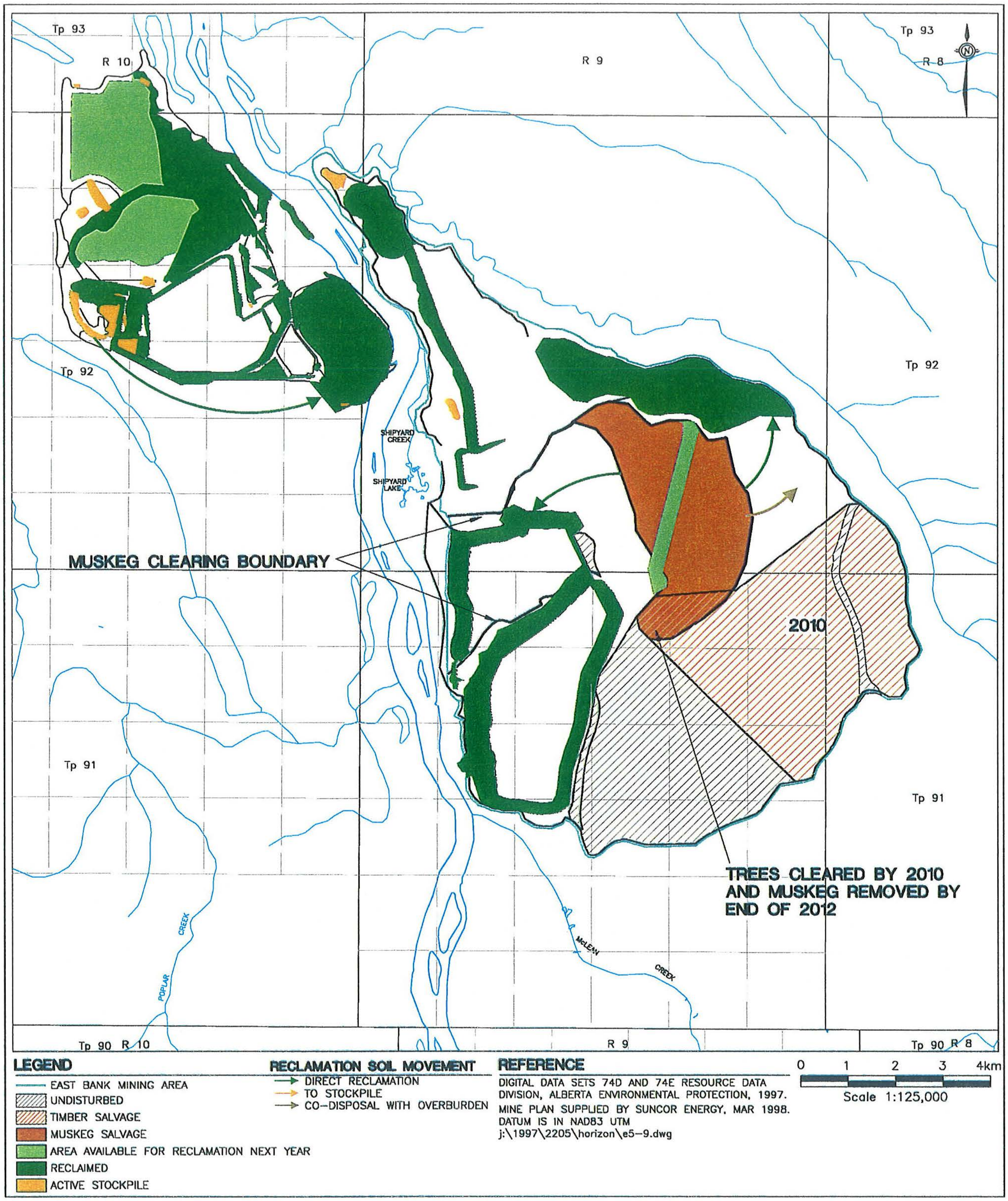


Figure E5-9 Reclamation Progression 2012

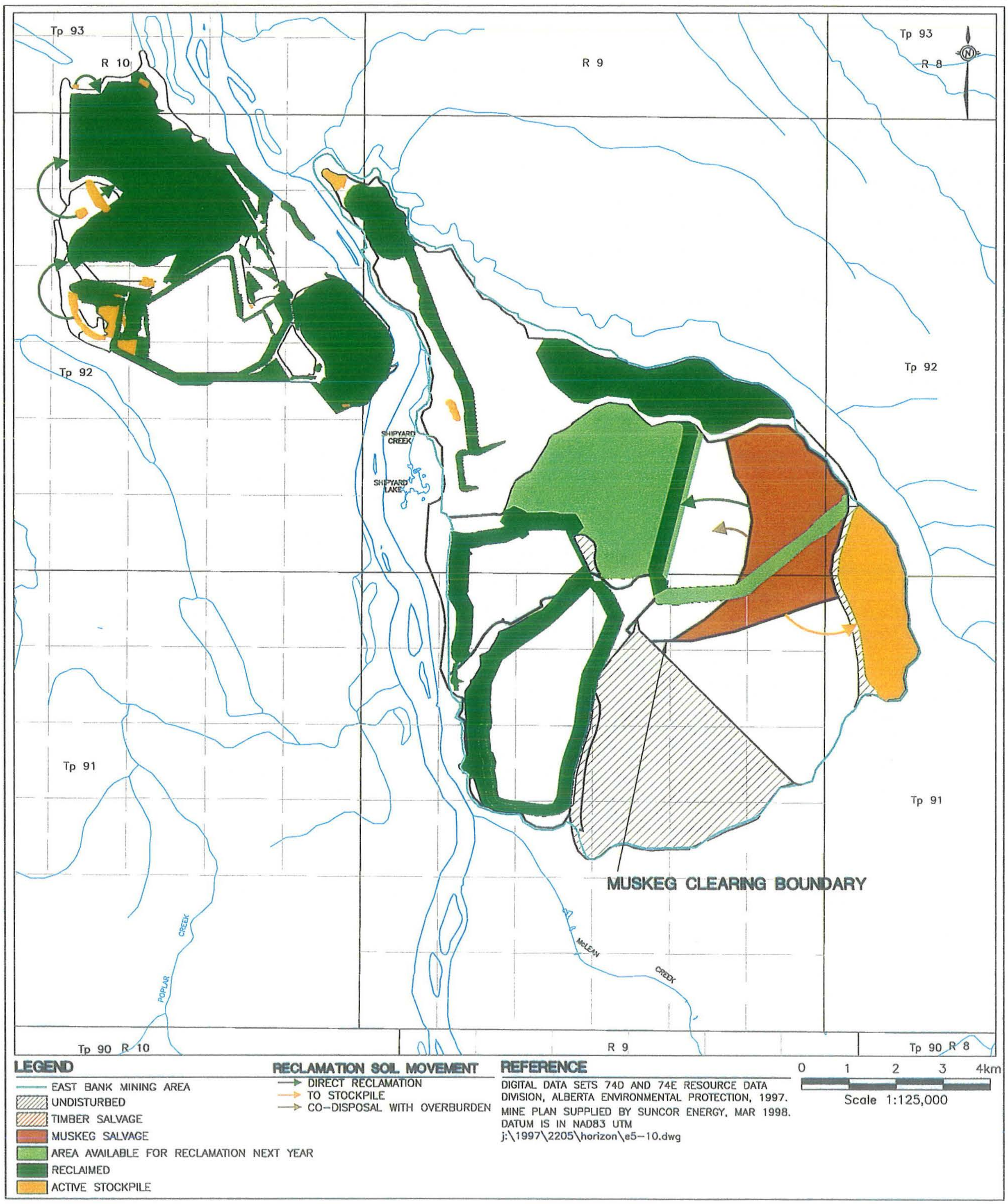


Figure E5-10 Reclamation Progression 2018

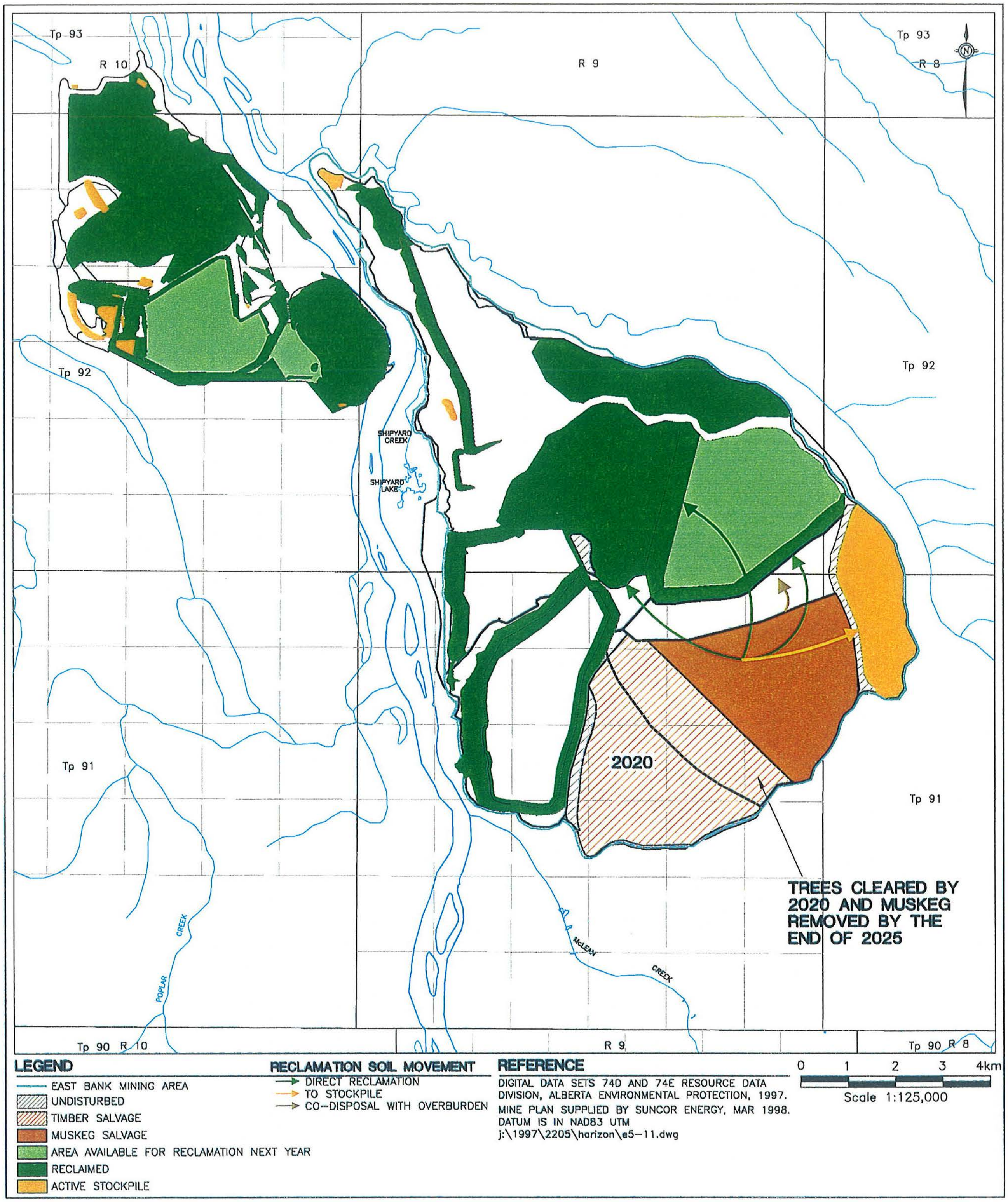


Figure E5-11 Reclamation Progression 2025

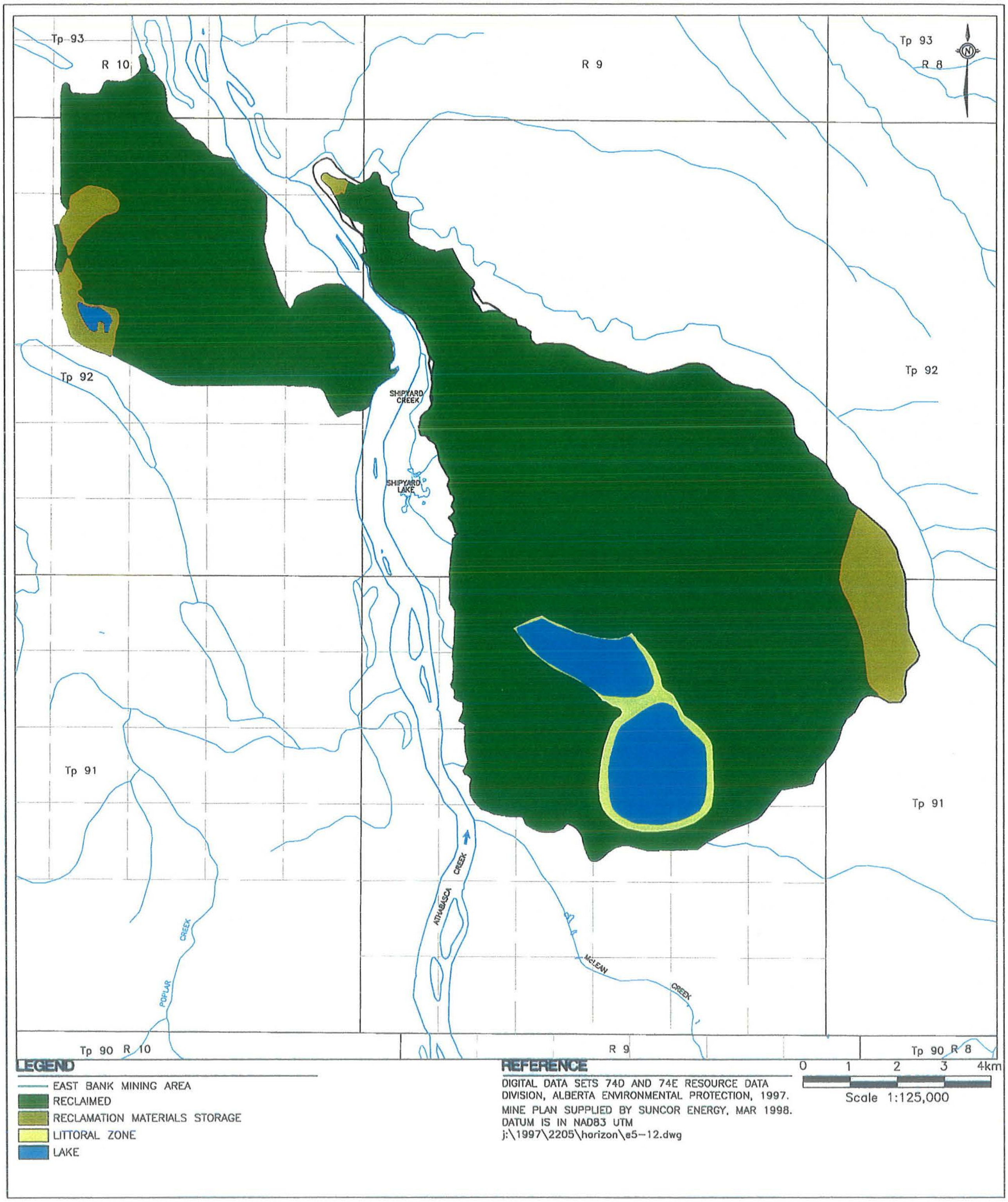


Figure E5-12 Reclamation Progression End of Mine

- Land capability will influence the types of vegetation which can be established on various reclamation landscapes.

- Land capability classes are a function of slope, aspect, drainage, depth of amendment and climate.

- Landform diversity can be provided for in the reclamation plan. This will in turn promote diversity of vegetation communities.

- Vegetation community and species diversity will be enhanced, where possible, through direct placement of muskeg soil amendment from the river valley escarpment slope to reclaimed dykes and overburden waste dump sites.

- Vegetation patch size and habitat interspersion are important components of the existing vegetation cover, and can be re-established to some extent through site-specific planning that creates a mosaic of revegetation types.

Revegetation Prescription

The aim is to provide a revegetation community mix on the reclaimed landscape which will develop into a seamless blend. This requires selecting pre-development vegetation communities as benchmarks. For example, reclamation of west-facing overburden waste dumps will be directed at establishing a vegetation cover that is as similar as possible to pre-development cover in terms of vegetation community types, patch size, interspersion and community composition.

To re-establish vegetation communities similar to pre-development conditions, species mixes have been prepared on a community-specific basis. The starter woody-stemmed planting prescriptions to establish each of the ecosite phases was presented in Table E3-1 (Volume 1, Section E3).

Figure E3-8 (Volume 1, Section E3) indicates the percent coverage of ecosite phases for the east bank mining areas. Within each of the ecosite phases there will be variations in microclimate, drainage and depth composition of soil amendment. While there will be variations is the success of establishing seedlings of woody plant species, this will increase diversity at the plant community level. It is conceivable, that in localized areas, a different ecosite phase may become established due to these variables. All of these factors will add to the diversity of the reclaimed sites.

E5.2 Solid Landscape Reclamation Technology

E5.2.1 Dry Landscape

Production and accumulation of large volumes of fine tailings from the Clark Hot Water Extraction process has been a concern to the oil sands industry since it began operations. Construction of Tar Island Dyke was carried out on a priority basis to store tailings and forestall plant closure shortly after operations began. The required containment of fine tailings produced increased operating costs which continue to be incurred to the present. In addition, the initial goal of rapid return of disturbed land to a fully-reclaimed state seemed unattainable.

A long search for solutions (over twenty years) has yielded the basis for a Solid Landscape Reclamation Plan. Principal technologies now available are:

- Consolidated Tailings (CT) process
- surface stabilization techniques
- various water treatment options to handle seepage and discharge waters

E5.2.2 Alternative Dry Landscape Reclamation Technologies:

For over twenty years, the oil sands industry has studied, tested and piloted many methods which claimed to resolve the fine tailings problem. None produced a solution which could be implemented economically. A general discussion of the range of methods evaluated is summarized by the Fine Tailings Fundamentals Consortium in "Oil Sands - Our Petroleum Future Proceedings" (FTFC 1993). Together, the FTFC and the University of Alberta focused on resolution of major problems associated with commercial implementation of calcium-based consolidation techniques. Their efforts produced the CT process described in the Consortium's Final Report: "Advances in Oil Sands Tailings Research Proceedings" (FTFC 1995).

E5.2.3 Fine Tailings Generation and Properties

The current caustic-based Clark Hot Water Extraction process and hydraulic tailings disposal technology has been used by Suncor since operations commenced in 1967. Although this process facilitates high bitumen recovery, one consequence of its use is the segregation of coarse and fine mineral particles in tailings ponds. There they form large lakes of fluid fine tailings which, if left untreated, would require containment for hundreds of years to achieve dewatering.

Suncor was a founding member of the FTFC, which operated from 1989 to 1994 and issued two summary reports (FTFC 1993 and FTFC 1995). These reports (and their many cited references) summarize current understanding of the generation, composition, stability and behaviour of oil sands fine tailings. As well, Alberta Energy maintains a comprehensive database of references on fine tailings properties. Suncor is continuing to participate in joint tailings research projects conducted through the Canadian Oil Sands Network for Research and Development (CONRAD) organization.

E5.2.4 Prediction of Fine Tailings Volumes

A semi-empirical model is used by Suncor to forecast accumulation of fine tailings. This model utilizes data on the water-holding capacity of clay minerals contained in the ore; dewatering rates of fine tailings, calculated from tailings pond measurements; and a material balance of fine minerals throughout the process. It has been calibrated for Suncor's extraction chemistry environment when applied to typical ores contained on Lease 86/17. A comparison of the model's projections with actual fine tailings accumulations is shown on Figure E5-13. The model has provided an adequate basis for tailings containment planning but it would require modification to be suitable for considerably different ore types or for changes to extraction chemistry.

E5.2.5 Techniques to Stabilize the Surface of CT Storage Areas

The CT process does not spontaneously create a deposit with a trafficable surface, but it does produce sufficient strength at depth to support a trafficable surface within a ten-year to twenty-year timeframe. A trafficable surface will be constructed using techniques outlined below. These techniques have each been tested on a field pilot scale (FTFC 1995) but an integrated demonstration of stabilization of a large CT deposit has not been conducted. Such developmental work is planned (discussed in Volume 1, Section E5.2.6).

Initial deposit surface stabilization will be accomplished during the topping-up operations described previously. Layers of progressively-higher sand:fines ratio CT will be constructed over the deposit. These layers possess relatively high permeability, thus allowing drainage of the underlying, consolidating deposit. The final deposit layer will be constructed to an elevation above the long-term design elevation to allow for future consolidation. In addition, the deposit surface will be constructed with a hummocky surface to facilitate revegetation.

Sand Stabilization

Following several years of dewatering, fresh sand tailings can be placed on the surface of CT ponds as there will be sufficient strength in the deposit to support the sand cap. A hummocky surface can be constructed using rapidly draining extraction tailings tailored to serve as a subsoil to support reclamation. After a period of further dewatering, revegetation activities can proceed as they would for other sand areas.

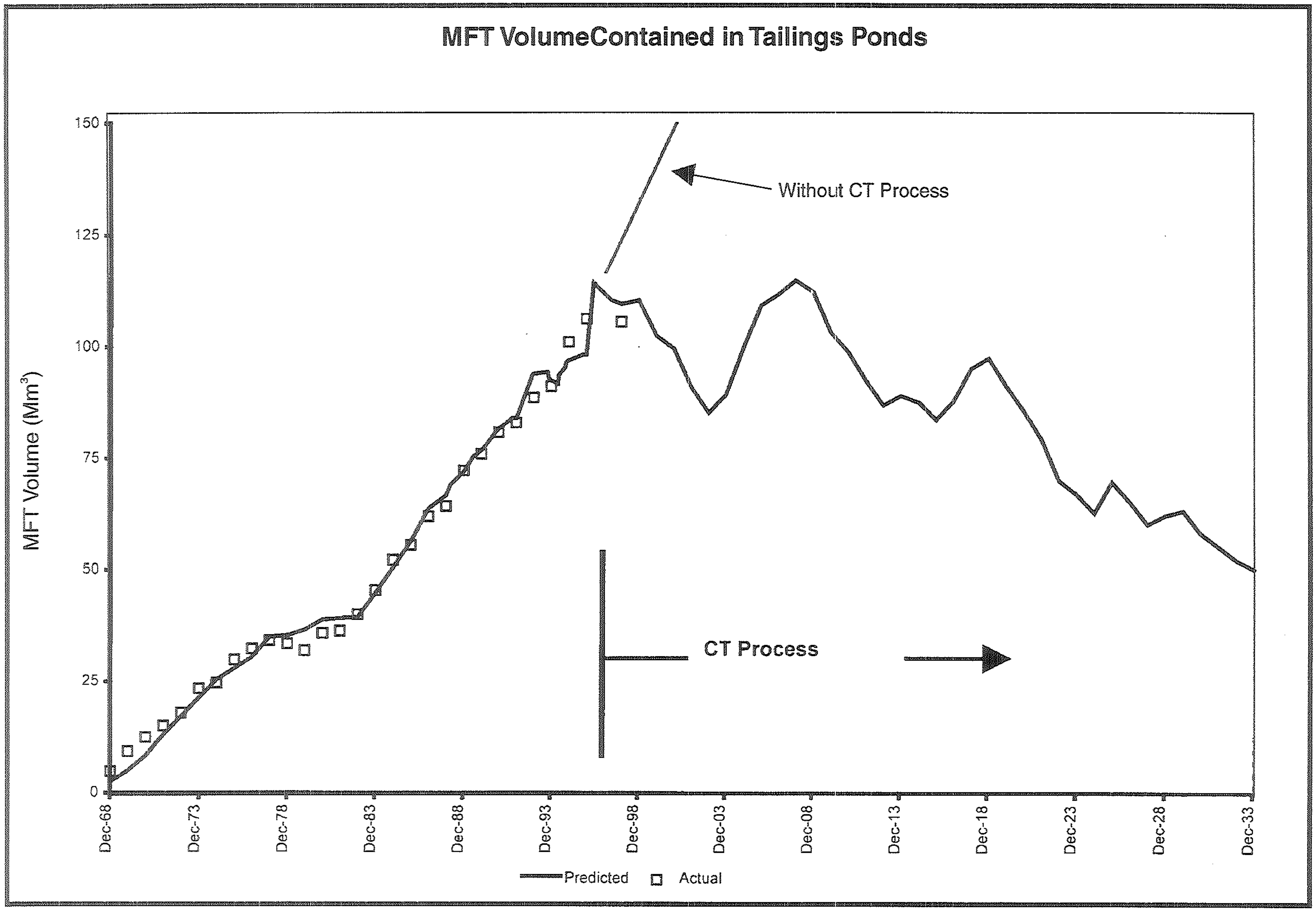


Figure E5-13 MFT Volume

Freeze/Thaw Dewatering

In pilot testing at the Suncor site, natural seasonal freeze/thaw processes acting on the surface of CT deposits have demonstrated rapid production of a stable crust from fine-grained materials. Placement of fresh materials in relatively-thin layers on the surface during the winter facilitates this process by allowing rapid frost penetration. Up to 3 m of material can be incorporated in this way each winter.

Aggressive Drainage

Once a surface cap is established its strength can be rapidly enhanced by techniques employed around the world (e.g., in Holland, river sediments are pumped across large expanses of land and in the lower mainland of British Columbia, large tracts of land are developed using sediments dredged from the Fraser River). Drainage channels are established on the deposit surface to carry away precipitation and runoff from the sediments. Water evaporates rapidly from the high ground between channels. After a year or two, vegetation is established (which accelerates dewatering by transpiration) and within five years, the land is returned to agricultural purposes.

E5.2.6 Consolidated Tailings Reclamation Demonstration - Site Preparation

Project Objectives

In 1996, Suncor initiated a project to demonstrate that CT deposits could be constructed to a stable surface and revegetated to healthy ecosystems. The general objectives of this project are as follows:

- To define the best reclamation design basis (topography, drainage, reclamation species selection) to be used for CT deposits in terms of both on-site ecosystem health and sustainability, and quality of release water to the off-site environment.

- To demonstrate this design basis at Suncor's CT Reclamation Demonstration Site. The activity consists of two steps:
  - Construction of a CT deposit including infilling and surface stabilization over a five-year period (commenced in 1996). This will include geotechnical monitoring of dewatering and consolidation/strength properties as well as release water chemistry.
  - Development of a reclamation protocol during the construction period followed by site reclamation in 2000. An extensive monitoring program will follow for several years.

The major objectives for each of the intervening years are shown on Figure E5-14 and outlined in Table E5-3.

Table E5-3 Yearly Major Objectives for the CT Project

Year	Major Objectives
1996	1. Select the site location, prepare a design, initiate construction and begin infilling the demo site. 2. Determine if exposure to CT water would lead to rapid degradation of locally-occurring, natural ecosystems by monitoring a range of plants, animals and microbes.
1997	1. Finish demo site construction and complete infilling with CT. 2. Of the various species which survived exposure to CT water in 1996, assess the potential for long-term survivability and health potential in the reclamation landscape.
1998	1. Remove surface water, freeze/thaw and air dry to form crust. 2. Select a list of plant and animal species which are likely candidates for the reclamation ecosystem. Stress testing to simulate climatic extremes.
1999	1. Top up demo site with sand over crust. Construct surface topography and drainage. 2. Final selection of demo site ecosystem components.
2000	Apply subsoil and muskeg topsoil. Reclaim the demo site.
2001+	Monitoring Phase

Deposit Surface Stabilization

Creation of a stable surface is accomplished through a series of steps. Following initial filling of the deposits in Ponds 5 through 11, release water will be removed, allowing "topping up" of the deposit with fresh CT as dewatering and consolidation continues. The surface of the final CT deposit will be strengthened by exposure to freeze/thaw and air drying followed by construction of a tailings sand cap. This will produce the "hummock" topography shown on Figure E5-15. The hummocks will be higher and "drier" areas between which "wetter" areas will channel CT release waters and precipitation runoff towards a larger wetlands area within the CT deposit surface area.

Development of a stable surface on a CT deposit has not yet been demonstrated. It is proposed to use freeze/thaw and air drying techniques (which have been used extensively in Holland to reclaim large areas of harbour dredgings) to achieve such a surface. Pilot testing at Suncor indicates that these techniques can be adapted to the CT situation, although there remain some technical challenges.

Demo Site Status

The CT Reclamation Demonstration Site is located on the southeast corner of Dyke 7. Sand containment berms around the site were constructed to final height during normal tailings operations in 1997. Although CT deposits were to start at the site in late 1997, they have been postponed until the spring of 1998 to avoid operating the site under winter conditions.

PREPARATION FOR CONSOLIDATED TAILINGS (CT) RECLAMATION DEMONSTRATION TEST SITE
MAJOR ACCOMPLISHMENTS/OBJECTIVES

Pre-1996

- Constructed wetlands systems demonstrated to have treatment capability for dyke drainage waters.
- Initial assessment of wetlands treatability of CT waters.

1996

- Select the site location, prepare a design, initiate construction and begin infilling of the CT Demo site.
- Establish an area to conduct field-scale evaluations of a CT hummock wetlands for evaluation of ecosystem impacts on aquatic and terrestrial organisms. Includes determination of the baseline ecological conditions in the study area through detailed site mapping.
- Begin determining if exposure to CT water would lead to rapid degradation of locally occurring, natural ecosystems by monitoring a range of plants, animals and microbial species.
- Develop multi-disciplinary ecosystem component investigation of onsite and offsite long term sustainability involving:

- Terrestrial
  - Plants
  - Invertebrates
  - Vertebrates
- Wetlands
  - Microbial
  - Invertebrates
  - Vertebrates
  - Amphibians
  - Plants

  Swallows & Mallards
- Site Runoff Water Quality
  Offsite Environmental Impact

1997

- Finish CT Demo site construction
- Of the various species which survived exposure to CT water in 1996, assess the potential for long-term survival/sustainability and health in the CT reclamation landscape.

1998

- Infill with CT. Remove surface water, freeze/thaw and air dry CT demo deposit to form crust.
- Select a list of plant and animal species which are likely candidates for CT reclamation ecosystems. Stress testing to simulate climatic extremes.

1999

- Top up CT demo site with lean CT over crust. Construct surface topography and drainage.
- Final selection of CT demo ecosystem components.

2000

- Apply CT Demo site subsoil and muskeg soil layers. Revegetate the CT Demo site.

2001 +

- Commence monitoring phase for CT Demo site.

Figure E5-14 Preparation For Consolidated Tailings Reclamation Demonstration

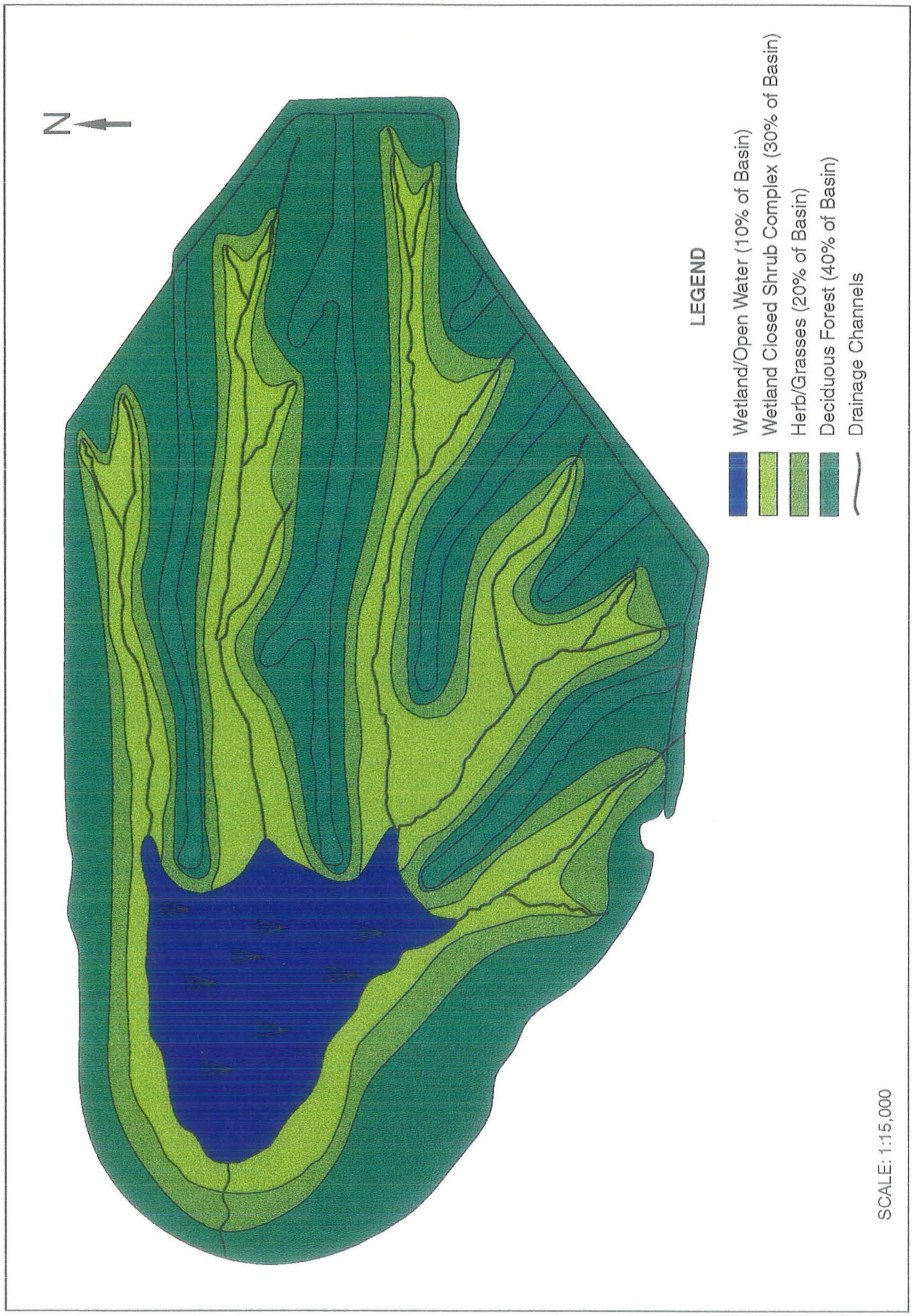


Figure E5-15 Reclamation Area 5 - Reclamation Progression 2030

Reclamation Species Selection

Successful reclamation requires that ecosystems which become re-established on the surface of CT deposits should be healthy and sustainable. Areas on both sides of the hummocks will be reclaimed to an upland forest system while the drainage channels between the hummocks will become wetlands and small shallow pools. Figure E5-15 shows the three major ecosystems involved:

- upland terrestrial systems
- on-lease water systems (wetlands, ponds and drainage channels)
- the external environment which receives site runoff water

Trees and plants growing on a CT deposit will be in contact with water which will be a mixture of varying portions of CT release water, existing dyke drainage water, seepage water and precipitation.

Work to date has focused on laboratory/greenhouse and three field test sites. CT water from Pond 5 has been introduced into Suncor's Hummock, Wetlands and Terrestrial Test Sites. These areas (located along the lease boundary just south of Dyke 2) experience a flow of dyke drainage water at the toe of Dyke 2. Both terrestrial and wetland ecosystems have redeveloped following mining operations. These sites are excellent prototypes for the topography which is expected to result on top of CT deposits. CT water was pumped from Pond 5 top water and introduced into the test sites in a ratio roughly equivalent to the mixture of CT water and dyke drainage water expected on the reclamation landscape.

The next sections detail the ecosystem components under investigation in preparation for selection of species to be monitored (following construction and reclamation) on the CT Reclamation Demonstration Test Site.

E5.2.7 Terrestrial Ecosystems

Plants

A greenhouse study has been conducted at the University of Alberta to determine the tolerance of naturally-occurring local plants to CT water. In addition, the fundamental biological mechanisms which enable various species to adapt to elevated salinity levels was determined. Some species do not tolerate CT water while others were quite tolerant.

A field study conducted in test plots on the top of the corner of Dyke 2 investigated the survival of projected reclamation species in various potential reclamation soil types including Plant 4 tailings, Plant 3 tailings and CT tailings. The focus was on plant survivability and their uptake of metals from topsoil materials. Although somewhat elevated metal levels were found, most of the plants survived two growing seasons. The issue of any impact on animals that eat these plants will be explored in the future.

Suncor's Hummock and Wetlands Test Sites were subjected to the addition of CT water. A survey of terrestrial species, conducted to identify the diversity and density of species present, will form the basis for evaluation of the long-term impact of this water. CT water has partially infiltrated into the root zone for a portion of the terrestrial plants without significant short-term impact.

Invertebrates

Work in this area will be undertaken in the future.

Vertebrates

Although a formal wildlife survey was not conducted for the CT demonstration site, observations of wildlife were recorded while conducting other field programs.

E5.2.8 Wetlands Ecosystems

To date, the major result obtained indicates that CT water did not lead to rapid degradation of Suncor's Natural Wetlands and Hummock Test Site. However, changes in community composition and diversity appear to be taking place, varying with the concentration of sulphate. This site was chosen because it is an analogue to the topography expected on the top of CT deposits. It has recovered with minimal intervention from Suncor's reclamation activities and contains a range of naturally-occurring species. A detailed listing of species present and estimated population density were compiled in order to document the types of species present in the region as well as to form the baseline for establishing the impact of CT water. A map was prepared showing the spatial concentration distribution in a plume of CT water throughout the site. This will permit estimates of the concentration of CT water to which species are exposed at different locations on the site.

Microbial

The microbial population is rapidly affected by CT water intrusion and therefore represents an early measure of its impact. Protocols for evaluating microbes have been developed and preliminary results are being compiled.

Plants

Natural Wetlands Test Site

Several test plots were established to monitor the survival of plants as CT water was introduced in the Test Site. There was no rapid degradation of the number and density of species in the test plots, although CT water was present in both the water column and the bottom sediments in the root zone. Long-term survivability can only be determined by further monitoring.

Invertebrates

About 125 different species of invertebrates were identified in the wetlands water column and bottom sediments. This list will provide a reference for further monitoring.

Vertebrates

A large number of waterfowl species inhabit the Natural Wetlands Test Site, lay eggs and produce young which migrate in the fall. Swallow boxes installed in 1995 continue to be fully occupied with a high rate of full development of young.

E5.2.9 Application of CT Technology

Long-Term Water Quality

Tailings planning aspects of the application of CT technology to future operations have been covered elsewhere in this application. The resulting water chemistry relates to the quality of recycle water used for the extraction process and stored within the final earth structures (although some seeps to the surface and into the environment). Currently, the chemical and toxicological composition of CT waters is summarized in "1997 Synthesis of Environmental Information on Consolidated/Composite Tails (CT)" (Golder 1998a). This section summarizes the predictions of water chemistry for the integrated Lease 86/17 and east bank mining areas.

The addition of a gypsum stream recovered as a byproduct from the FGD operation represents a new input to the water system. This stream contains both gypsum crystals and slurry water which has the signature of the FGD process. Rate of accumulation for various species in the recycle water depends on:

- The rate of gypsum addition to the process. This addition rate is determined to be a function primarily of the required level of treatment of the clay content in the CT mixture.
- The volume of new water imported from the Athabasca River.

- The volume of water lost from the process to final storage in tailings deposits. This is primarily a function of transient dewatering rates and final water content in the deposits.

- The sinks for chemical species within the tailings system. A sink for calcium is its relatively slow precipitation as calcite when absorption of CO_2 from the atmosphere occurs. The rate of calcium loss has been determined from actual Pond 5 operating experience. In addition, stripping of calcium and magnesium by reaction with clay minerals has also be shown to be significant. Sinks for sulphate are likely present through microbial activity, but since the rates are as yet undefined, this sink has not been included in this analysis.

Based on the water management plan prepared as part of the tailings feasibility study, it is possible to estimate recycle water chemistry during operation. However, as the feasibility study is refined during the design stages, and oil sand core data are more fully developed, it should be anticipated that predictions of water quality will also change. The following table provides concentrations of some of the major chemical species likely to be experienced during operation.

Table E5-4 Predicted Concentration of Selected Chemicals in Recycle Water

Constituent	Typical Value (ppm)	Estimated Range (ppm)
Cations:		
Calcium	15	± 10
Magnesium	10	± 5
Sodium	500	± 100
Anions		
Chloride	60	± 10
Sulphate	1500	± 500

F ENVIRONMENTAL MANAGEMENT

F1 INTRODUCTION

F1.1 Purpose

This section, along with associated sections of this application, constitutes Suncor's request for AEPEA approval for the construction, operation and reclamation of Project Millennium, a major expansion which comprises the following:

- expansion of Steepbank Mine
- Millennium Extraction plant (a second primary separation plant) producing raw bitumen located on east side of Athabasca River
- raw bitumen pipeline system to the existing Base Extraction plant
- modifications to Base Extraction plant to clean raw bitumen and produce diluted bitumen product
- a second Upgrader train, to produce slate of upgraded crude oil products
- modifications and additions to steam and power generation, as well as other infrastructure to facilitate increased production level

Included are integrated management plans for all tailings produced by both Extraction plants and an integrated reclamation plan for current and future tailings ponds. Management, control and mitigation of environmental impacts during construction and operation of both mine and plant facilities as well as mine reclamation is inherent in the project scope.

In this section is information on or references for each of the regulated divisions covering current operations, effects of Project Millennium and proposed control plans and practices. Specifically, this section will request amendments to the current Environmental Operating Approval in the regulated divisions of Waste, Substance Release, Conservation and Reclamation, Pesticides and Potable Water.

Suncor's environmental policy and practice is described in Volume 1, Section B6.

F1.2 AEPEA Approval Chronology

On 25 June 1996, Alberta Environmental Protection (AEP) issued a consolidated, ten-year operating approval (Approval No. 94-01-00) for Suncor's Oil Sands operation. Then on 15 August 1996, AEP issued an amendment approving the construction and operation of the Fixed Plant Expansion project. Subsequently (on 24 January 1997), a further amendment approved the construction, operation and reclamation of Steepbank Mine. A number of small amendments have since been issued. The chronology and purpose of the amendments to the operating approval are listed in Table F1-1.

On 17 December 1997 (Volume 1, Appendix I), Suncor advised AEP that it would be seeking further amendments to allow construction and operation of a number of modifications which comprise the Production Enhancement Phase (PEP) and which will allow the operation to reach a level of 130 000 bbl/cd in 2001. Project Millennium, the subject of this application, will increase production to a minimum of 210 000 bbl/cd by 2002.

All approval documents are available for examination through Suncor's office.

Table F1-1 Chronology of Amendments to AEP Approval No. 94-01-00

Amendment Number	Effective Date	Summary
94-01-01	15 August 1996	Construction and operation of Fixed Plant Expansion, including conditions pertaining to: flare gas recovery, upgrades to Boilers 1 and 3, interstage froth tank and freshwater clarifier
94-01-02	24 January 1997	Construction, operation and reclamation of Steepbank Mine, including conditions pertaining to hydrotransport facilities, Consolidated Tailings (CT), waste management, and, groundwater monitoring
94-01-03	10 March 1997	Construction and operation of Plant 35 Package Boilers
94-01-04	5 May 5 1997	Proposed cyclo-feeders at Steepbank Ore Preparation plant replaced by rotary drum breakers
94-01-05	5 September 1997	Extension of period during which freshwater pond dredging may be conducted
94-01-06	16 September 1997	Construction and operation of hot process water surge tank at Steepbank Ore Preparation plant
94-01-07	16 September 1997	Installation, operating and reporting requirements for ambient air monitoring stations operated by Wood Buffalo Environmental Association
94-01-08	26 September 1997	Construction of cooling tower at freshwater pond and extension of potable water turbidity limit
94-01-09	22 December 1997	Change in method by which 365-d rolling average of plant's total SO_2 emission is calculated
94-01-10	4 March 1998	Approval to receive off-site non-hazardous wastes from facilities owned and controlled by Suncor
94-01-11	8 April 1998	Inclusion of Fee Lot No. 2 activities under Approval No. 94-01-00

F2 WASTE

F2.1 Waste Management

F2.1.1 Waste and Byproduct Management Philosophy

Suncor's waste management systems have been based on the belief that effective waste control is achieved by considering waste at both its generation and disposal stages (life cycle approach). This waste management process is documented in Suncor's Annual Waste Report.

Reduction at source is part of Suncor's Chemical Product Approval System, which is implemented to manage both use and disposal of chemical products. All products used at the plantsite must first be approved by Suncor's Health, Safety and Environment department. Products under consideration are reviewed to ensure that they do not contain any banned substances, that they are handled only by certified employees and (if required) that they are used only in specified areas.

Products approved for use at Suncor's site (over 2 000) are each assigned a unique identifier number and entered into a database, which also includes the chemical ingredients in each product. Users are also provided with information on approved disposal practices and reportable release quantities in the event of a spill. As well, Suncor has completed detailed waste inventories that identify, classify and quantify process and chemical waste streams generated in each operating unit. These inventories provide baseline information which is used to establish priorities and to track waste reduction, reuse and recycling.

Suncor has five primary systems for handling its waste streams:

- Class II Industrial Landfill
- Hazardous Waste Storage Yard
- Tailings Pond Liquid Waste Disposal Site
- Upgrading Hydrocarbon Recovery Basin
- Approved Off-Site Disposal and Recycling Facilities

Current practice for these systems is discussed in detail in the "Application for Renewal of Environmental Operating Approval" (Suncor 1995) and in the "Fixed Plant Expansion Project Application" (Suncor 1996a).

There are three byproduct streams which require handling and storage:

- Petroleum Coke
- Sulphur
- Gypsum

All sulphur is sold and shipped off-site, a practice that will continue for Project Millennium. Coke is used by Suncor to generate steam and power, with excess coke currently marketed for sale. Suncor's objective is to sell as much excess coke as possible but amounts in excess of sales will be stored in an acceptable manner. Part of the gypsum produced by the FGD process is used to produce Consolidated Tailings (CT) with the remainder stored in a dedicated tailings facility. All gypsum will likely be consumed in CT production at Millennium production rates.

F2.2 AEPEA Specific Approvals

Solid and liquid wastes generated from Millennium activities and processes will be similar to those from the current operation so present waste management practices will be applied. It is anticipated no new waste management conditions will have to be added to the current approval.

Suncor expects to submit a separate application in 1998 requesting approval for relocation (due to Millennium site requirements) of the hazardous waste storage yard on Lease 86/17.

The gypsum slurry stream has been sampled weekly since 1996 and Suncor requests the sampling frequency be reduced to semi-annualy. Suncor suggests the following wording:

4.3.9 The approval holder shall monitor the gypsum slurry to Pond 4G by collecting a semi-annual grab sample, separated by a period of six months, of the gypsum slurry stream and the recycle water stream, which shall be analyzed for metals (including Nickel and Vanadium), unless otherwise authorized in writing by the Director of Air and Water Approvals.

F2.3 Waste Management Systems

F2.3.1 Waste Management Systems

All solid, non-hazardous industrial waste generated by Millennium activities will be collected in dumpsters and transported to the industrial landfill on Lease 86/17. Other wastes will be directed (as appropriate) to on-site facilities or to approved off-site disposal and recycling facilities.

F2.3.2 Industrial Landfill

Suncor currently maintains a Class II industrial landfill at its operations on Lease 86/17, in a containment area south of Pond 4. The industrial landfill is operated in accordance with requirements of the current AEP

Environmental Operating Approval (Part 6: Hazardous and Solid Wastes). Suncor does not dispose of liquid waste or hazardous waste into its landfill.

The industrial landfill is periodically patrolled five days per week. Although access to the landfill is not controlled, primary utilization of the site occurs during the controlled hours. Landfill operations are audited internally by Suncor staff and externally by AEP inspectors.

Suncor will submit a separate application for a new or expanded industrial landfill site on Lease 86/17 before the existing site reaches its capacity.

F2.3.3 Hazardous Waste Storage Yard

The hazardous waste storage yard is used for interim storage of waste that is either unsuitable for on-site disposal or targeted for recycling. Due to site requirements for the Millennium Upgrader, the current yard will be relocated. A preliminary site north of the Millennium Upgrader site has been proposed and it will be the subject of a separate application to be submitted to AEP in 1998. The new yard will be a larger version of the current facility, with an underground yard liner, runoff collection sump, containment berms, fences and a storage building. This yard will continue to be operated in accordance with standards set out in the Waste Control Regulation of AEPEA and Suncor's Operating Approval.

An accumulation or staging area will be designated at Steepbank Mine for temporary, short-term storage of drums of waste pending their transport to the hazardous waste storage yard. Bulk volumes of liquid waste will be moved by tanker trucks as they are generated, for disposal (at the tailings pond liquid disposal site), for recycling (at the Upgrader hydrocarbon recovery basin) or for off-site disposal or recycling. Hazardous waste drum inventory at the staging site will be limited to sixteen drums. Provision for secondary containment will be made in this staging area.

All drums of hazardous material to be moved across the Athabasca River will be packed into heavy-gauge, oversize drums prior to loading for transport, providing each drum with its own secondary containment. Drums will be secured onto trucks for transport across the river. Trucks moving hazardous waste will be equipped with hazardous material spill containment and response supplies.

F2.3.4 Tailings Pond Liquid Waste Disposal Site

Tailings ponds (currently Pond 2/3) are used for disposal of selected bulk liquid waste streams from tanker trucks in addition to routine inputs of extraction tailings, dyke seepage waters and mine pit drainage waters. Disposal criteria as well as systems to control and monitor disposal are established by a Suncor internal standard. Volumes of liquid wastes are reported annually to AEP. These practices will continue for Project Millennium.

F2.3.5 Upgrading Hydrocarbon Recovery Basin

Selected bulk hydrocarbon waste streams are currently deposited into the hydrocarbon recovery basin, then the material is routed through the upgrading process. These streams include gear and hydraulic oils from the mine equipment maintenance area as well as any other recyclable heavy hydrocarbon waste. This practice will continue for Project Millennium.

Waste oil and waste glycol generated at Steepbank Mine will be segregated at source and will be transported across the Athabasca River in secure containers. Waste oil will be recycled internally while waste glycol may either be used internally or recycled externally.

Suncor is currently in the process of applying to become a registered collector/transporter/processor with the Alberta Used Oil Management Association in order to recover the handling charges paid up-front for lube oil materials used on-site.

F2.3.6 Approved Off-Site Disposal and Recycling Facilities

Consistent with its waste management philosophies, Suncor routes various streams off-site for external reuse and recycle including:

- recycling:
  - waste paper
  - waste toner cartridges
  - steam traps

- regenerating:
  - waste glycol solutions
  - waste varsol solutions
  - waste diethanolamine solution from the Upgrading Gas Sweetening plant
  - spent hydrotreater catalyst

- metals reclaiming:
  - salvaged scrap metal
  - spent hydrotreater catalyst
  - waste lead acid batteries
  - waste nickel-cadmium batteries
  - lube oil filters
  - spent hydrogen plant catalyst

- reuse:
  - used tires
  - conveyor belting

Suncor will continue to aggressively pursue environmentally sound recycling practices for those streams which cannot be reduced completely at source.

F2.4 Byproduct Management Systems

F2.4.1 Gypsum

Gypsum (in the form of a slurry) is generated as a byproduct of the Flue Gas Desulphurization (FGD) process. A portion of the gypsum production is used in the Consolidated Tailings (CT) process while the remainder is pumped to Pond 4G, where it settles rapidly. In an effort to characterize this stream, Suncor has been monitoring the slurry line to Pond 4G weekly since the startup of the FGD plant. As this eighteen months of sampling has enabled detailed quantification of gypsum's chemical makeup, Suncor proposes to reduce the sampling frequency from weekly to semi-annually.

With Project Millennium, increased quantities of gypsum will be required for the Consolidated Tailings (CT) process, while the amount of available gypsum production will remain the same. Gypsum storage requirements will decrease or be eliminated depending on the gypsum dosage required for Consolidated Tailings. Suncor expects to be able to provide sufficient storage (if required) within the current tailings system.

F2.4.2 Petroleum Coke

As part of its AEP Operating Approval, Suncor is required to submit a plan for disposition of its existing coke stockpile and of all future coke production. On 20 February 1998, Suncor requested authorization to begin storage of excess coke in Pond 4 beginning April 1998. It is recognized that at least a portion of the coke so deposited will not be economically retrievable.

Current Status

Currently, the status of coke production and storage at Suncor is as follows:

- Suncor's petroleum coke production is in excess of Energy Services' combustion needs.

  - At Fixed Plant Expansion rates, Suncor will produce about 40 kt/cd of coke, while consumption in the coke-fired boilers will require about 2.3 kt/cd.
  - At PEP rates, coke production will increase to about 5.0 kt/cd and consumption will rise to about 2.6 kt/cd.
  - At Project Millennium production levels, coke production will increase further, to 8.4 kt/cd, while consumption will remain unchanged at about 2.6 kt/cd, as Project Millennium does not include additional coke-fired boilers.

- The existing stockpile contains about six million tonnes of coke and will approach its capacity by mid-1998.

- Suncor began selling coke from the current stockpile in May 1997. To date, 195 kt have been sold.

- Quality of coke production is expected to change when the Fixed Plant Expansion becomes operational in April/May 1998. The current upgrading train will then incorporate a vacuum unit upstream of the delayed coking units, resulting in heavier coker feed. This will likely lead to production of a hard coke or "shot" coke. The new coke will probably not be usable as fuel in the coke-fired boilers and must be segregated from the currently-produced "sponge" coke. Suncor will evaluate the shot coke to determine its suitability as a boiler fuel.

Short-Term Plan

Suncor will continue to use the present coke stockpile as fuel for its coke-fired boilers, reducing the stockpile about 65% by 2002. Additional coke sales will continue to be pursued.

Suncor plans to segregate shot coke and truck all coke produced during the next one to three years for storage in Pond 4. Currently part of the extraction tailings system, Pond 4 contains tailings sand, oversize reject, fine tails and process water. However, this containment volume is not essential to the tailings plan because it is relatively small compared to tailings production rates. Pond 4 is also a reasonable haul distance from the cokers. Suncor is in the process of obtaining authorization to store coke in Pond 4. If approved, only coke and oversize reject will be placed in Pond 4 until it reaches capacity.

Previously, Suncor indicated that Pond 4 would be used for gypsum storage, but at Millennium production rates, Suncor expects that most gypsum produced from the FGD plant will be required for Consolidated

Tailings. If there is any requirement for gypsum storage, Suncor will provide for it within its current tailings system.

When Pond 4 capacity is reached, the coke will be covered with oversize reject that will in turn be capped with material such as tailings sand, to meet reclamation requirements. The cap is intended to address long-term coke combustion issues and to minimize infiltration. During placement, fires will be controlled by spreading and crushing coke with heavy equipment, as is the current practice.

Long-Term Plan

Suncor will complete a full assessment of long-term coke handling requirements by August 1998. So far, it appears that a slurry transportation system is the most cost-effective method of moving coke in excess of consumption and projected sales.

Objectives of the plan include:

- favourable economics and resource utilization
- satisfactory control of surface water and groundwater flow
- adequate mitigation of dust and fires
- acceptable impact on recycle water and the CT process (for CT pond disposal)

F2.4.3 Sulphur

Liquid sulphur produced from the Upgrader is currently trucked directly to market.

At PEP production levels, about 625 t/cd of liquid sulphur will be produced. This volume will grow to about 1 150 t/cd at Project Millennium production levels. The practice of direct trucking to market will continue and no on-site blocking of solid sulphur is planned.

The existing sulphur-handling infrastructure will be modified by relocating both the emergency sulphur storage pad and the sulphur loading racks as well as installing a liquid sulphur storage tank. Upgrader Millennium sulphur will be degassed prior to shipment.

F3 SUBSTANCE RELEASE

F3.1 Air Emissions

F3.1.1 Scope

Suncor's oil sands operations generate a number of air emissions from a variety of sources. These emissions are documented in Suncor's Annual Air Reports. This section of the application describes and quantifies the changes in these emissions as a result of Project Millennium; discusses emission control and monitoring plans; and requests specific changes to AEPEA Operating Approval No. 94-01-00 (as amended). The impacts of these emissions (including cumulative impacts) on human health and terrestrial resources are discussed in the EIA.

The important air emissions include:

- Sulphur Dioxide (SO_2) emissions from combustion of petroleum coke and upgrading operations. These result in acid deposition and potential impacts on human health and the biophysical environment.

- Oxides of Nitrogen (NO_x) emissions from the mine fleet and combustion sources in Energy Services and Upgrading. These emissions can result in ambient air quality changes, deposition of acidifying emissions and photochemical production of ozone, which in turn may have an impact on both human health and vegetation.

- Volatile Organic Compounds (VOCs) and other hydrocarbon emissions from mine fleet exhaust, the mine pit area, extraction operations and tailings ponds. These emissions can result in ambient air quality changes, the photochemical production of ground-level ozone and can have potential impact on human health.

- Greenhouse gases (mainly carbon dioxide (CO_2) from combustion sources) are of concern because of their possible impact on global environment and in view of Canada's international commitments toward their reduction.

- Fugitive emissions, including total reduced sulphur and H_2S from the extraction and upgrading operations and tailings ponds. These have the potential to cause off-site odours.

- Particulate matter (PM) emissions from site clearing, mining activities, combustion sources as well as coke handling and storage. PM and associated polycyclic aromatic hydrocarbons (PAHs) can have adverse impacts on human health and aquatic life.

F3.1.2 Specific AEPEA Approval Requests

As Project Millennium activities will result in a number of additional air emission points, Suncor requests that these be approved emission points. In addition, Suncor requests a change to its site-wide SO_2 limit due to increased production. As the entity which carries out ambient air monitoring in the Wood Buffalo Region has changed its name, Suncor would also like this reflected in its approval.

To cover these changes, Suncor suggests the following wording changes to clauses in its Operating Approval No. 94-01-00:

4.1.1 The approval holder shall not emit effluent streams to the atmosphere except from the following sources:

a) to ii) (as per existing Approval)
jj) Millennium ore preparation plant vents associated with the hydrotransport slurry preparation facilities (rotary drum breakers and pump boxes, and agitation/surge tank vents, Millennium froth deaerator stacks)
kk) Millennium diluent heaters (52F-0101A/B)
ll) Millennium coker charge heaters (52F-0300/0301)
mm) Millennium gas-oil charge heater (55F-0300)
nn) Millennium gas-oil fractionator heater (55F-0301)
oo) Millennium hydrogen plant deaerator (54C-0109)
pp) Millennium naphtha charge heater (55F-0100)
qq) Millennium naphtha stabilizer reboiler (55F-0101)
rr) Millennium diesel charge heater (55F-0200)
ss) Millennium diesel stripper reboiler (55F-0201)
tt) Millennium thermal oxidizer (53F-0610)
uu) Millennium H_2S/HC flare (59F-0001)
vv) Millennium SWS flare stack (52F-0612)
ww) Millennium hydrogen reformer stack (54F-0101)
xx) Millennium hydrogen flare
yy) Millennium tank farm

4.2.5 Coincident with Millennium Upgrader startup (defined as operating at 80% of design capacity for a sustained period of 60 days), the combined emission rate of sulphur dioxide from all sources at the plant to the atmosphere shall not exceed 79 t/d based on a 365-d rolling average.

4.3.3 The approval holder shall conduct (or shall cause to be operated and maintained) ambient air monitoring in the following manner:

a) prior to completion of construction of the Wood Buffalo Zone ambient air monitoring network, the approval holder shall conduct ambient air monitoring in accordance with Table 4-4 (in the approval).

b) upon completion of the construction of the Wood Buffalo Zone ambient air monitoring network, the approval holder shall:

(i) cause to be operated and maintained an ambient air quality monitoring program, through participation in the Wood Buffalo Zone ambient air monitoring network, and

(ii) operate and maintain one continuous ambient air quality monitoring station for determining on a continuous basis concentrations of sulphur dioxide, and wind speed and direction, unless otherwise authorized in writing by the Director.

4.4.2 Commencing 24 months after Millennium Upgrader startup as specified in Clause 4.2.5, .in the event that the combined emission rate of sulphur dioxide to the atmosphere from all sources at the plant is higher than an average of 71 t/d during any calendar year, the approval holder shall submit a detailed written report on sulphur dioxide emissions to the Director of Air and Water Approvals on or before 31 January of the following year. The report shall be in a level of detail acceptable to the Director and shall include:

a) a description of the events and circumstances that led to the combined emissions being higher than an average of 71 t/d, which was one of the design performance criteria for Suncor's Project Millennium;

b) an outline of the steps or procedures which were taken to minimize emissions during the events and circumstances described above; and

c) a description of any long-term measures or actions that are required to prevent or minimize such occurrences in the future and a schedule of implementation for these measures or actions.

F3.1.3 Sulphur Dioxide (SO_2)

Suncor's emissions of SO_2 have been reduced by installation of the Flue Gas Desulphurization unit (FGD), improvements in the Upgrader sulphur plant and overall operation reliability. SO_2 emissions are summarized in Table F3-1 and are presented on Figure F3-1. The figure also indicates what SO_2 emissions would be without Suncor mitigation initiatives to reduce emissions.

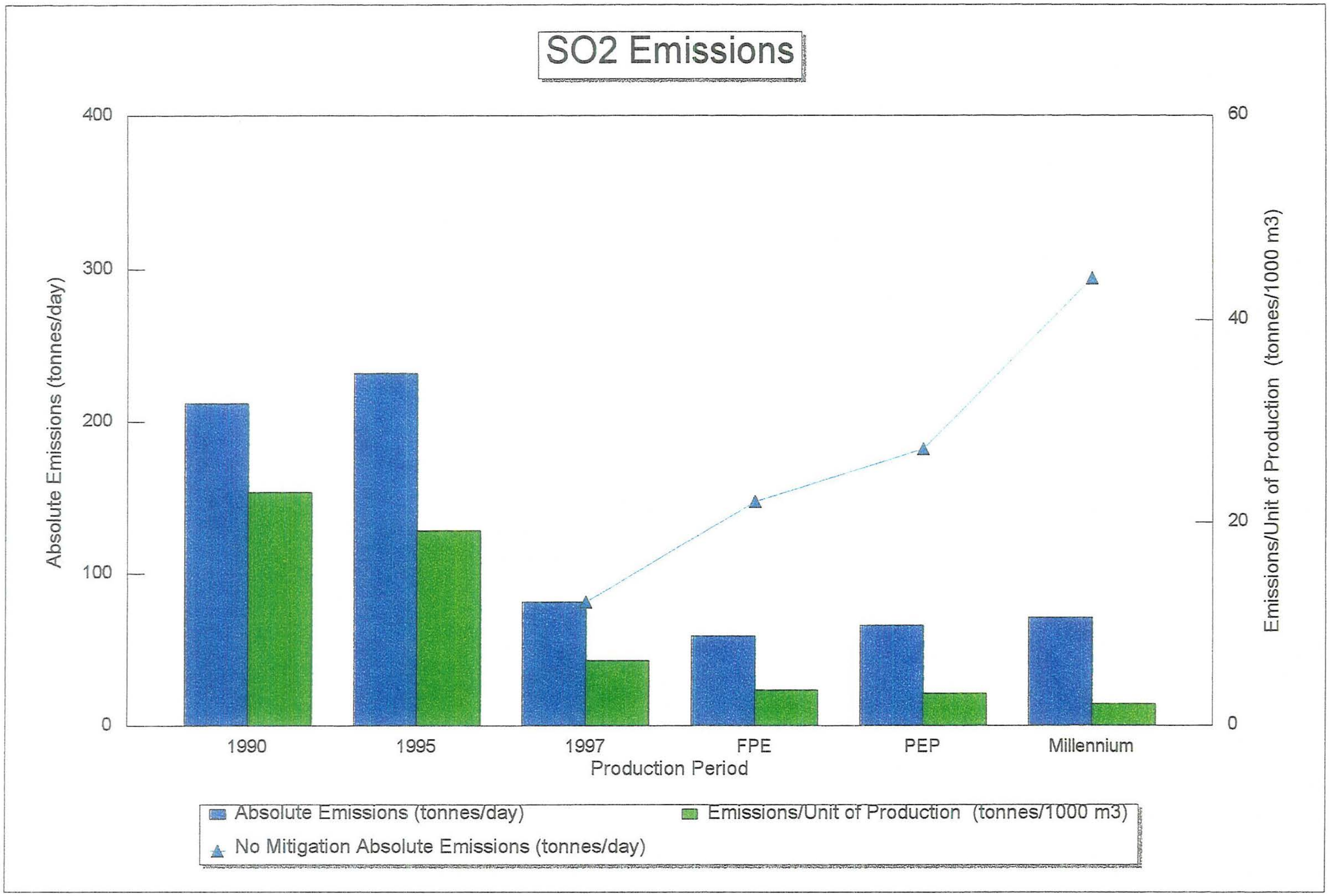


Figure F3-1 Sulphur Dioxide Emissions

Table F3-1 SO_2 Emissions

Period	Yearly Average Production (bbl/cd)	Yearly Average Production (m3/cd)	Normal Operations[1], No Maintenance: Average SO_2 (t/cd)	Annual Total[2]: Average SO_2 (t/cd)	Annual Total: Unit of Production SO_2 (t/ 1000 m^3)
1990	58 000	9 221	212.0	212.3	23.0
1997	79 400	12 624	78.0	81.2	6.4
FPE	105 000	16 694	51.0	59.0	3.5
PEP	130 000	20 668	51.0	66.0	3.2
Millennium	210 000	33 387	51.0	71.0	2.1

1. Normal operations does not include FGD maintenance and emergency flaring.
2. Annual total includes all operating and maintenance activities and emergency flaring

1997 was a transition year for SO_2 at Suncor as the FGD plant was being fully commissioned. As a result, the average yearly SO_2 emission does not reflect the actual emissions after FGD was fully online (less than 51 t/day).

Main sources of SO_2 emissions are Energy Services coke-fired boilers, and various sources in the Upgrader, including the Sulphur plant incinerator stack and flaring.

Total predicted emissions are higher than those contained in the Fixed Plant Expansion Application. This is due to a number of previously unquantified sources of SO_2 which were measured after the application filing. These "newly quantified sources" of SO_2 include continuous flaring and mercaptans in the fuel gas. They are not included in Suncor's site-wide rolling average calculation because Suncor has committed to capture the majority of these emissions by installing the flare gas recovery project, scheduled for completion in 1999.

Energy Services

Suncor's FGD unit began commissioning in September 1996 and is now fully-operational. This unit is expected to be operational 95% of the time, during which it will recover about 95% of the SO_2 from coke-fired boiler combustion products. For the remaining 5% of the time (when the unit is off-line) SO_2 emissions could approach the current licensed level from the old powerhouse stack of 259 t/d .

Energy Services' configuration to supply thermal and electrical energy demand for Project Millennium is described in Volume 1, Section C4 of this application. SO_2 emissions from Energy Services will be held to an increase of about 3 t/d from 1997 levels on an absolute basis primarily by meeting additional energy needs for Project Millennium by waste heat capture from the Millennium Upgrader, and by natural gas fired gas turbine generators with heat recovery steam generators attached.

Upgrader

The existing sulphur plant (with the addition of a SUPERCLAUS™ stage in 1994 and subsequent reliability improvements) achieves 98% recovery, and will continue to serve the current Upgrader. Gases currently being continuously flared will be recompressed for treatment and use in Upgrading as part of the flare gas recovery project.

Project Millennium's Upgrader is described in Volume 1, Section C3 of this application. The Millennium Upgrader sulphur plant facilities will include two Claus sulphur recovery trains with a downstream tail gas treating unit.

There will be no new, continuous-flaring sources in the Millennium Upgrader. As well, Suncor will ensure plant facilities will be operated and maintained such that emergency flaring per unit of production will not increase as a result of either Project Millennium or the production increase in the intervening period.

SO_2 Reduction Strategies

Suncor has spent considerable effort in understanding projected SO_2 emissions associated with both the Base plant and Project Millennium. The company has developed a plan for SO_2 management. The objectives are:

1. Suncor's SO_2 emissions will not result in any ground level concentration (GLC) exceedences.
2. Suncor will reduce site-wide increases in SO_2 emissions as much as practical while recognizing that production will double.

Although these two objectives are reasonably clear, there is uncertainty associated with projected emission estimates and therefore no unique solution is currently proposed. Suncor has adopted the following strategy to achieve these two objectives.

Suncor expects that, with the operation of its new vacuum tower (scheduled for startup in April 1998), gas flow to the Sulphur plant may be reduced. SO_2 emissions from the incinerator stack may also be reduced. Based on pilot plant data for the vacuum tower, current projections for SO_2 emissions from the existing Sulphur plant at PEP production rates show emissions that may result in an increase of GLC exceedences in the Suncor plant area. However, there is potential that predicted gas flows to the Sulphur plant will be lower than pilot plant data indicates (due the scale up factor from pilot to commercial scale), which will eliminate any increases in predicted GLC exceedences as well as reduce site-wide SO_2 emissions.

Suncor has evaluated several alternative means to achieve these objectives including:

- additional SO_2 reduction from Energy Services
- increasing the height of the incinerator stack
- reduction of mercaptans in fuel gas through natural gas liquids extraction with Novagas Canada
- increasing capacity of the Millennium Sulphur plant and Tail Gas Treatment Unit (TGTU) to accommodate partial flows from the existing sulphur trains

The latter option is currently favoured as the optimum choice to:

- eliminate GLC exceedences
- reduce site-wide SO_2 emissions

Suncor will further evaluate requirements for implementing additional sulphur recovery once the vacuum tower is fully operational.

As part of Suncor's Environmental Operating Approval, the current stewardship target for site-wide SO_2 emissions is 51 t/d on a 365-d rolling average basis. If emissions exceed 51 t/d but are less than 59 t/d (the approval limit), Suncor must explain the variance above the 51 t/d target.

At Project Millennium production rates (double the FPE rates), Suncor will continue to hold site-wide SO_2 emissions during normal operations (no FGD maintenance and no emergency flaring) consistent with the current stewardship target of 51 t/d on a 365-d rolling average basis.

Concurrent with the production increase associated with Project Millennium, Suncor requests a new site-wide SO_2 emission reporting target of 71 t/d (including FGD maintenance periods, which account for about 13 t/d when annualized; the "newly quantified sources" and emergency flaring) on a 365-d rolling average basis. Suncor also requests a new approval limit of 79 t/d . This is an increase of about 34% over the existing limit and reflects uncertainties in operation of the new Millennium Upgrader as well as operation of the Base plant at PEP rates.

Short-Term SO_2 Issues

Although there appear to be several options for reducing SO_2 once Project Millennium is operational, there may be an interim period (1999-2001) when SO_2 emissions will be near or exceed the current approval limit of 59 t/d. Depending on gas flow from the vacuum tower, this may result in occasional exceedences of the emission limit for the Base plant incinerator stack. Suncor has initiated discussions with AEP regarding this issue and will continue this dialogue outside of this application process.

While recognizing that SO_2 emissions will rise over the next few years, Suncor will attempt to minimize those increases by:

- making every effort to carry out scheduled maintenance at opportune times, such as the recent burner replacement in the SUPERCLAUS™ unit which was carried out during coker heater de-cokes
- continuing implementation of the flare gas recovery project
- operating the plant in a manner that minimizes upsets and irregular operations
- continuing to evaluate additional strategies for SO_2 reduction

F3.1.4 Oxides of Nitrogen

Suncor's actual and forecast oxides of nitrogen (NO_x) are presented in Table F3-2 and on Figure F3-2. The figure also indicates the result of Suncor initiatives to reduce NO_x emissions since 1995. NO_x refers to emissions of nitric oxide (NO_x), nitrogen dioxide (NO_2) and trace quantities of other species generated during combustion.

Major contributors of NO_x emissions are the mine fleet and Energy Services.

Table F3-2 NO_x Emissions

Period	Yearly Average Production (bbl/cd)	Yearly Average Production (m3/cd)	Yearly Average NO_x (t/cd)	Unit of Production NO_x (t/1000 m^3)
1990	58 000	9 221	36.3	3.94
1997	79 400	12 624	32.1	2.54
FPE	105 000	16 694	47.6	2.85
PEP	130 000	20 668	56.6	2.74
Millennium	210 000	33 387	67.7	2.03

Mine Fleet NO_x

Significantly increased oil sands mining activity taking place for Project Millennium will generate more NO_x from greater numbers of mining equipment which utilize diesel engines. In selection of mining equipment, Suncor will utilize the best engine technology available considering capital cost, operating cost, fuel efficiency and emissions performance. Suncor will initiate discussions with mining equipment suppliers to make low-NO_x a priority in their design. Additionally, the quality of diesel produced by Millennium Upgrader will be improved, which will have a positive impact on NO_x generation.

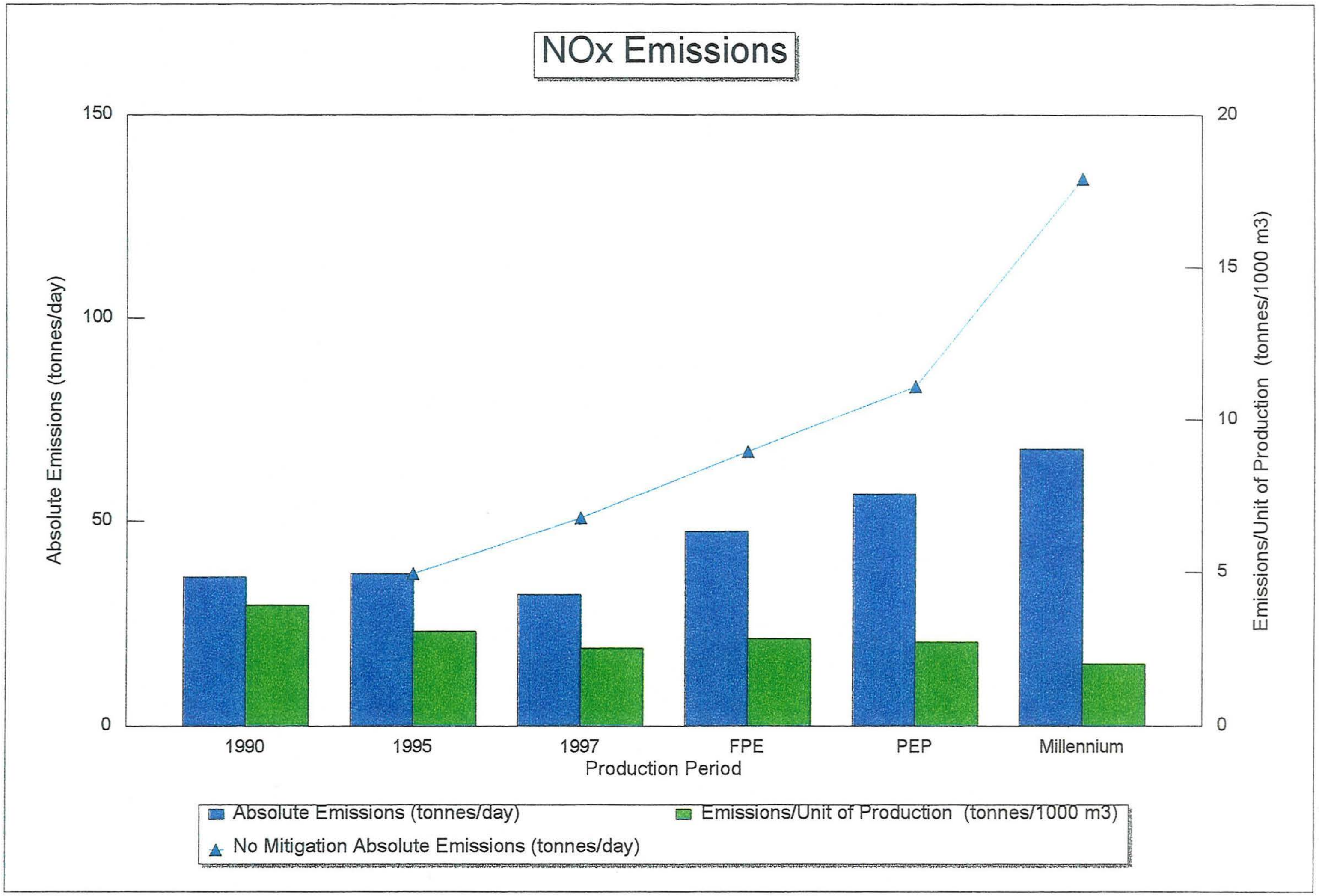


Figure F3-2 Oxides of Nitrogen Emissions

Energy Services and Upgrader

Suncor will select commercially-proven technology that can be safely and reliably used to limit production of NO_x from all new Millennium combustion equipment. All new furnaces installed for Project Millennium will have low-NO_x burners and meet Canadian Council of Ministers of the Environment (CCME) guidelines for gas-fired boilers and furnaces. Suncor will develop a site-wide NO_x management plan, which will include a comprehensive survey of emissions from fired heaters, and will develop strategic actions which may include burner modifications to reduce emissions.

Replacement of burners to low-NO_x ones in existing heaters undergoing major revamping will be considered on a case-by-case basis, considering cost, safety, reliability and emissions.

Suncor will work with regional stakeholders and other industry partners to monitor and model ground level ozone.

In 1995, Suncor conducted a study of commercially-available technologies to control NO_x formation in its three coke-fired boilers. The study concluded that (based on boiler design and space limitations) overfired air was the best practical control technology, with a predicted reduction of 15% to 20%. Coke-fired Boiler No. 2 has since been retrofitted with overfired air. NO_x testing on Boiler No. 2 is currently underway and results will be available in second quarter 1998. Coke-fired Boilers No. 1 and No. 3 are scheduled to be retrofitted in 1998/99, following NO_x testing of Boiler No. 2.

Although Project Millennium production will be 3.6 times 1990 levels, Suncor's NO_x reduction initiatives will hold NO_x increases to only 1.9 times 1990 levels.

F3.1.5 Volatile Organic Compounds (VOCs)

Figure F3-3 and Table F3-3 present estimates of past, current and projected VOC emissions. The figure also indicates what VOC emissions would be without Suncor mitigation initiatives to reduce emissions. Two different approaches are used to estimate VOC emissions. One approach assumes that tailings pond emissions will be consistent with the basis used in the Steepbank Mine application (as Suncor will soon reconfigure the pond recycle system to an operational mode similar to when this data was collected). The other approach takes a worst-case basis, where all diluent to tailings is assumed to vaporize. Under this worst case approach, pond emissions associated with diluent in tailings are the primary source of VOCs emitted from Suncor's operations.

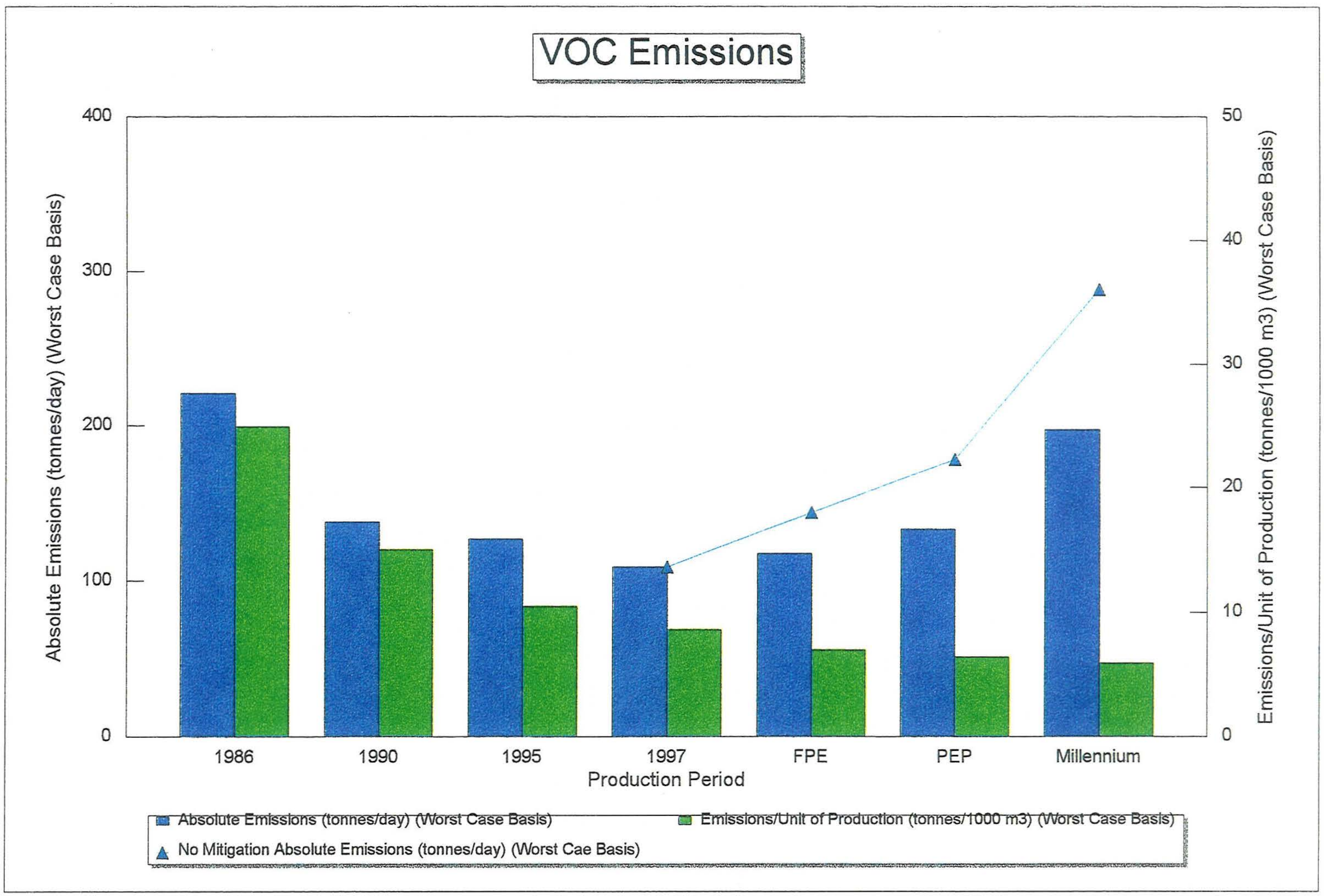


Figure F3-3 Volatile Organic Compounds Emissions

Table F3-3 VOC Emissions

Period	Yearly Average Production (bbl/cd)	Yearly Average Production (m3/cd)	Steepbank Basis Yearly Average VOC (t/cd)	Worst-Case Yearly Average VOC (t/cd)	Steepbank Basis Unit of Production VOC (t/ 1000 m^3)	Worst-Case Unit of Production VOC (t/1000 m^3)
1990	58 000	9 221	33	138	3.6	15.0
1997	79 400	12 624	36	109	2.9	8.6
FPE	105 000	16 694	30	117	1.8	7.0
PEP	130 000	20 668	28	133	1.3	6.4
Millennium	210 000	33 387	34	198	1.0	5.9

Tailings Ponds

Experimental VOC emission data were collected from the tailings ponds in 1992, twice in 1995 (spring and fall) and again in 1997. Data from 1992 and the fall of 1995 showed similar emission rates. Data from the spring of 1995 showed an increase in emission rates, although at the time there was no clear understanding of why this data set differed from the previous two. The production-prorated 1992 data formed the basis of VOC predictions in the Fixed Plant and Steepbank Mine Applications.

Another pond survey followed in 1997, which yielded results consistent with the spring 1995 data. This was immediately followed up with a detailed review of all the data collected through the years with the objective of identifying the physical mechanisms that control the way organics are emitted from Pond 1. This detailed review has shown that pond emissions are the result of a complex series of mechanisms, which are still not yet completely understood.

The estimates in Table F3-3 reflect the conservative assumptions identified in the last study. To define an assumed worst-case scenario, it has been assumed that all of the diluent sent to the ponds does vapourize.

Pond 1 currently dominates the tailings pond emissions. An estimated breakdown of Pond 1 VOC's are as follows:

- 7 % CH_4
- 1 % thiophenes
- 7 % BTEX (benzene, toluene, xylene)
- 85 % paraffins excluding CH_4

Table F3-4 provides a breakdown of the VOC emission estimate by source for Project Millennium conditions. The table also compares the Steepbank basis estimate (as Suncor will reconfigure the pond recycle system by 1999, so that it operates in a similar mode as when this data was collected) with the worst case estimate. As already mentioned, the worst-case emissions are significantly higher than the Steepbank Mine Application basis because of the assumption that all diluent sent to the pond volatilizes into the air. Bacterial action, diluent mixing with bitumen, pond recycle reconfiguration and/or accumulation all could decrease these emissions to the air, but the extent to which this will happen is uncertain at this time.

Suncor is committed to improve its understanding of pond emissions of VOCs in order to identify and understand the pond emission phenomena and take appropriate mitigative actions. Currently, Suncor has initiated a task force to understand and establish an action plan for this issue. In addition, Suncor is involved with Syncrude, Shell and the University of Alberta in a research program which is attempting to better understand the biological mechanisms that generate methane and sulphur compounds from bitumen and diluent present in the ponds.

Table F3-4 Comparison of Millennium Estimates of VOC Emissions

		Millennium (ponds consistent with Steepbank approach)	Millennium (ponds based on worst-case approach)
Oil Production	m3/cd	33 400	33 400
Tailings Ponds[1]	t/cd	9.6	173.3
Upgrading [2]	t/cd	13.7	13.7
Extraction[3]	t/cd	5.7	5.7
Tank Storage[4]	t/cd	4.0	4.0
Mine Fleet	t/cd	0.8	0.8
TOTAL	t/cd	33.8	197.5
Per unit of production	t/1000 m3	1.0	5.9

1 Primarily Pond 1
2 Fugitive Sources
3 Primary Extraction and Secondary Extraction plants
4 North and South Tank Farms

Upgrading

Upgrading losses estimated in Table F3-4 are those due to fugitive VOC emissions (FVE). Suncor is currently implementing a plant-wide campaign to measure FVE's using the protocol recommended by the Canadian Council of Ministers of Environment "Environmental Code of Practice for the Measurement and Control of Fugitive Emissions from Equipment Leaks". Currently Suncor is conducting a comprehensive fugitive emissions study in the upgrading area. Results to date have been encouraging and indicate those emissions to be less than Suncor estimates.

Primary Extraction (Bitumen Separation)

Hydrocarbon losses from the ore conditioning, separation circuit and raw bitumen storage facilities are expected to decrease from current levels because the hydrotransport system that will be used for Steepbank Mine will eliminate the need for the existing conditioning drums, and the process temperature will be lower than the current practice. FVE may occur from the froth treatment and naphtha recovery unit; these will be quantified as part of the plant-wide FVE program.

Tank Storage

As required, any new tanks in the South Tank Farm which store diluted bitumen and diluent will be fully insulated and tied into the vapour recovery unit. Any new product tanks will have floating roofs installed or will contain liquids which have a sufficiently low vapour pressure to enable storage in fixed roof tanks.

Vapour Recovery Unit

In 1995 Suncor installed a vapour recovery unit (VRU) to condense and recover emissions from secondary extraction (Plant 4) vents, the Naphtha Recovery Unit (NRU) and diluted bitumen storage. Following a period of commissioning during which extensive modifications were made to the original design, the VRU is now operational and is capturing about 94% of the vapours from the sources it serves. Plans are in place to improve the recovery further. Based on the current projections of vapour emissions at Project Millennium rates, the current VRU has sufficient capacity for the increased load. If it is determined that the increased flows will exceed the capacity of the current unit, Suncor will install the necessary equipment to ensure these emissions are collected.

Diluent Losses to Tailings

The froth treatment plant requires the addition of light hydrocarbon diluent to the bitumen to reduce viscosity to enable final removal of fine, predominately clay particles from raw bitumen. Froth treatment tailings may contain up to 0.4 wt% diluent. These tailings are treated in the NRU to recover a high proportion of the diluent.

As part of the Steepbank Mine application, Suncor requested approval for construction and use of an inclined plate separator (IPS) in its froth treatment plant. The first IPS unit is currently under construction and an additional IPS unit is planned. Use of this technology will allow a reduction in the amount of diluent used in the diluted bitumen which will also reduce losses of diluent to tailings .

The NRU will be upgraded to handle PEP and Millennium rates by installing a new larger vacuum column and upgrading the capacity of the overhead circuit. The existing NRU column will be maintained as a stand-by unit to be operated when maintenance is planned on the new larger column. NRU outages will be coordinated primarily with scheduled upgrader maintenance periods at which times the production level will be roughly halved and within the capacity of the existing unit. Suncor will ensure that the recovery of diluent used in the extraction process is maintained at a minimum of 99.3%. Diluent recovery for current operations is about 99.4%. Suncor will target to increase diluent recovery to between 99.4 and 99.5%.

The diluent produced by the Millennium Upgrader for use in secondary extraction will be modified to improve recovery in the NRU (and hence losses to the tailings ponds) and reduce VOC emissions from diluent which is sent to the ponds. This diluent will be a "heart cut" diluent which has a narrower boiling point range with less benzene and light ends. Suncor is currently evaluating the exact makeup of this diluent to ensure it will provide the required production benefit while reducing environmental impacts.

Consolidated Tailings

It is possible that CT could be a source of odours, particularly during the reclamation of Pond 1. A test in 1997 on Pond 5 showed that no appreciable odours were generated as a result of CT operation. Monitoring will take place during the production of CT with fine tails from Pond 1.

In the longer term, anaerobic production of vapours or volatilization of hydrocarbons from the CT deposits might occur. Suncor anticipates that this will contribute an insignificant impact to the environment.

F3.1.6 Greenhouse Gas (GHG) Emissions

Carbon dioxide (CO_2) is the most significant greenhouse gas (GHG) emitted by Suncor, representing over 97% of total greenhouse gas emissions on a CO_2-equivalent basis. Suncor's forecast of direct greenhouse emissions is shown in Table F3-5 and on Figure F3-4. Also indicated on the figure is the result of Suncor's initiatives to reduce GHG emissions.

Table F3-5 Greenhouse Gas Emissions

Period	Yearly Average Production (bbl/cd)	Yearly Average Production (m3/cd)	Yearly Average GHG (t/cd)	Unit of Production GHG (t/m^3)
1990	58 000	9 221	9 410	1.02
1997	79 400	12 624	10 100	0.80
FPE	105 000	16 694	13 350	0.80
PEP	130 000	20 668	15 440	0.75
Millennium	210 000	33 387	20 640	0.62

Greenhouse Gas Management

Suncor is committed to leadership and action in seven areas that address the risk of climate change:

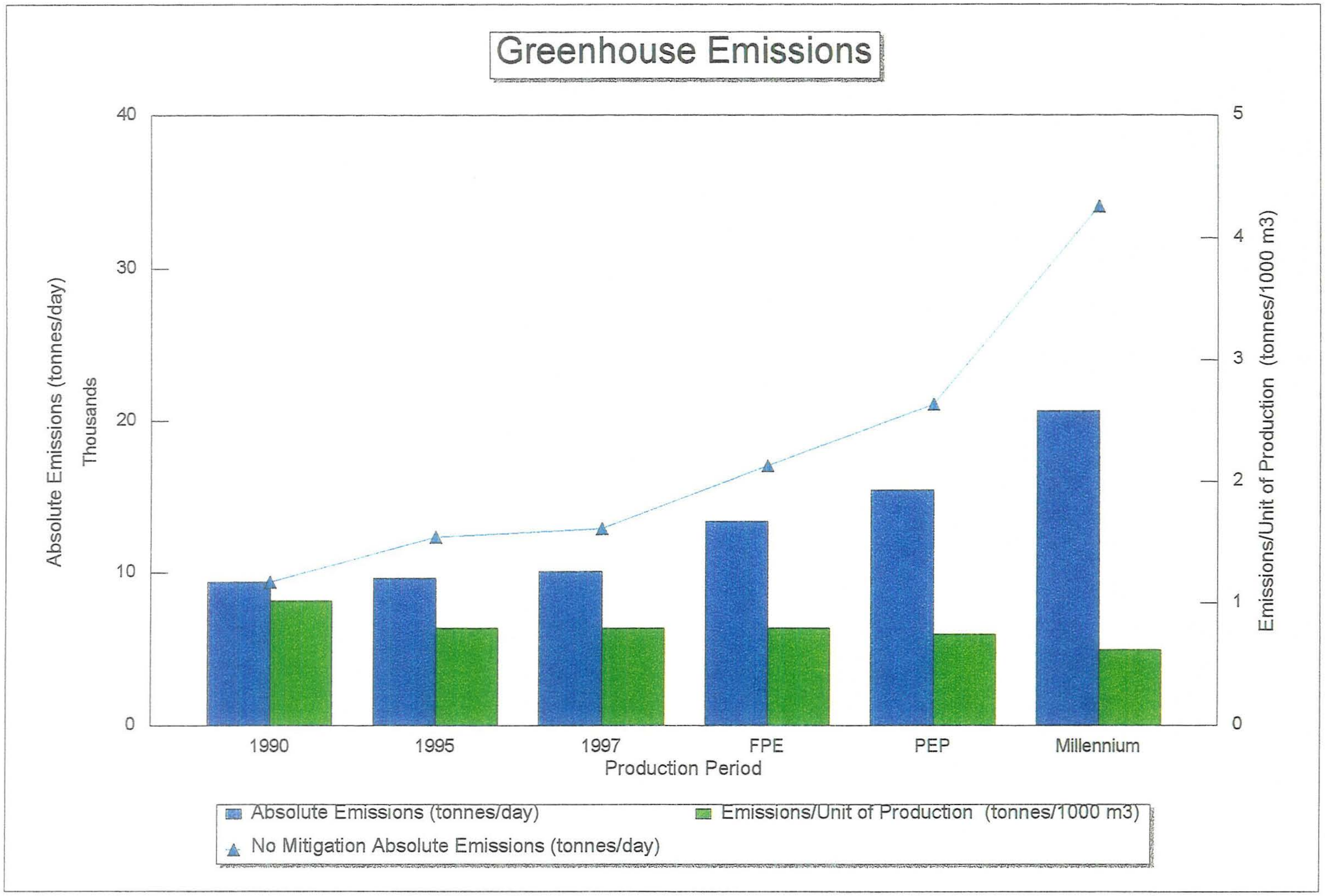


Figure F3-4 Greenhouse Gas Emissions

1. Managing the company's own GHG emissions and their impact: Suncor has produced a progressive GHG management plan as part of its participation in Canada's Climate Change Voluntary Challenge and Registry Program.

2. Developing alternative and renewable sources of energy: Suncor has formed an alternate energy team, to pursue alternative sources of energy as part of its portfolio of business opportunities.

3. Supporting environmental and economic research: Suncor is working with research institutions to develop more advanced production and processing technology for conventional, synthetic and heavy crude oil production that will reduce GHG emissions. Suncor is also working with industry associations and governments on selected research projects to address environmental and economic policy aspects of climate change.

4. Pursuing domestic and international offsets: Offsets are GHG emission reductions that are achieved through actions that either reduce, prevent or absorb the emission of GHGs to offset a company's own emissions. This can include investment in forest conservation projects, technology transfer to developing countries, energy efficiency investments, co-generation, alternate energy and improving energy infrastructure.

5. Providing constructive public policy input in support of sustainable solutions: Suncor is engaged with its communities and various stakeholder organizations to address climate change policy at provincial, national and international levels.

6. Educating and engaging the company's employees, customers and communities on the issue of global climate change: Suncor supports education about climate change on a community level with a number of organizations and plans to further fund global climate change education initiatives.

7. Measuring and reporting on the company's progress: Suncor takes a thorough and open approach to measuring its environment, health and safety performance, and this includes measurement of its progress in reducing GHG emissions.

Suncor published its third Annual Progress Report to Canada's Climate Change Voluntary Challenge and Registry Program in August 1997. That report provided a total company performance review; it outlined significant improvements in actual and forecast GHG emissions performance for the period 1990 to 2000. While production volumes are projected to increase by 64% in the period 1990 to 2000, GHG emissions are projected to increase significantly less, only by 12%. GHG emissions per unit of production will be reduced by 32%. Suncor's plan was rated fifth among nearly 600 plans by the Pembina Institute for Appropriate Development, and Suncor has been recognized by the federal government for leadership in this area.

Significant corporate initiatives include:

- Investment in a pilot project in Belize which entails acquiring and managing 7 700 ha of endangered forested land that would otherwise be burned and converted to farmland. Suncor's participation in this conservation project will result in the prevention of at least 400 000 t of CO_2 from being released into the atmosphere.

- An agreement to fund the generation of up to 350 000 kWh/y of electricity from wind turbines in Alberta, resulting in a modest but important reduction in air emissions.

- An agreement to make an initial purchase of 100 000 t of GHG emission reductions from the Niagara Mohawk Power Co., a United States power generating company. The agreement is designed to help Suncor Energy achieve its voluntary emission reduction targets, while providing Niagara Mohawk with funding for new projects to further reduce GHG emissions.

Suncor Energy integrates GHG issues into everyday management process in each of its operating business units through:

- commitment and leadership of senior management
- employee education and involvement
- stakeholder and public involvement
- life cycle value analysis

Suncor Oil Sands: 1990 to 2000

Suncor Oil Sands has established as a key goal the stabilization of GHG emissions from its operations at or below 1990 levels by 2001. This position was developed jointly with the Oil Sands Environmental Coalition, which consists of representatives of environmental interest groups and the community.

In the period 1990 to 2000, oil production volumes are projected to increase 81% (from 58 000 bbl/cd to 105 000 bbl/cd). Without the voluntary reduction plan, GHG emissions could be expected to increase in the same proportion as oil production to 17 000 t/cd in 2000, an increase of 7 600 t/cd over the 1990 level. The 7 600 t/cd thus represents a reduction target.

By the end of 1997, 38% of the reduction target has been achieved through initiatives to improve reliability, sustain consistently high production rates, and reduce net energy demand per unit of production.

In the period 1998 to 2000, Suncor Oil Sands plans to achieve the remainder of its GHG emission reduction target through initiatives largely in three categories:

1. New Technologies: The new technologies that will be employed in all areas of the operation in 2000 are inherently more energy-efficient than in the past. These include, for example: hydrotransport of mined oil sands; lower primary extraction temperatures; and diversion of a significant portion of bitumen around the energy-intensive coking operation in the Upgrader (through vacuum distillation).

2. Energy-Efficiency Projects: Both the Fixed Plant expansion and Steepbank Mine provide opportunities to implement a series of energy-efficiency initiatives. The more significant of these opportunities (totalling a reduction of 2630 t/cd) include:

   - heat recovery in new Upgrader units
   - heat recovery from existing Upgrader units
   - catacarb system regenerator vent condenser
   - recovery of gas presently going to the flare system
   - hot diluent to extraction
   - hot water surge tank for extraction

3. New Upgrader Products: At present a large portion of Upgrading CO_2 emissions results from the production of hydrogen from natural gas. Hydrogen is used in a process that removes sulphur from the presently-produced sour crude oil. Any increase in production by the year 2000 will be a sour crude that does not require removal of its contained sulphur The net effect of increased production of sour crude oil will be a transfer of some 1 200 t/cd of GHG emissions to the customer refineries. (This points to the need for life cycle analysis and determination of offsets in calculating emissions).

Suncor Oil Sands: Project Millennium

Project Millennium represents a production increase of 3.6 times 1990 levels or 2 times FPE levels. With this very large increase in production, it will not be possible to maintain GHG emissions from the Suncor oil sands facilities at 1990 levels beyond 2002, when Project Millennium comes on-stream.

Suncor will manage its GHG emissions on a corporate basis following the seven-step plan described previously.

Improvements in energy intensity with corresponding reductions in GHG emissions are inherent in the design of Project Millennium. Some of the more significant improvements in GHG emissions stem from:

- recovery of waste heat from Upgrading for use in Extraction
- full application of new technologies already installed
- scale effects of doubling production
- use of gas turbogenerators for additional electricity supply

As a result, while Suncor's oil production volume will be 360% of 1990 levels, GHG emissions are projected to increase only 92% or less. Further, Suncor will continue to pursue GHG emission offset opportunities.

F3.1.7 Fugitive Emissions and Hydrogen Sulphide (H_2S)

Typical fugitive emission sources (which may include H_2S) include leaks from valves, flanges, sampling lines, drains and seals as well as previously-discussed VOC emissions.

Suncor applies the CCME "Environmental Code of Practice for the Measurement and Control of Fugitive Emissions from Equipment Leaks". Currently Suncor is conducting a comprehensive fugitive emissions study in the upgrading area. Results to date have been encouraging and indicate those emissions to be less than either industry benchmarks and Suncor estimates. A similar program has been developed for the secondary Extraction plant, with field measurements scheduled for summer 1998. The mechanical design of Project Millennium will include enhanced control of fugitive emissions.

Hourly average hydrogen sulphide (H_2S) concentration exceedences (Alberta Ambient Air Quality Guidelines) at ambient air monitoring stations (see description below) have decreased by 94% since 1990. Continuous reliability improvement (to reduce plant upset events) and control of fugitive emissions are the main reasons for the decrease in these emissions.

Suncor has carried out extensive studies to identify and quantify odours resulting from its operations. These odours are believed to emanate from pond emissions, fugitive emissions and plant upset conditions. Odour complaint information collected as part of a regional odour complaint protocol indicates a significant reduction in complaints since 1991.

The improved characteristics of diluent proposed for Project Millennium, along with enhanced fugitive emission control, improved reliability and reduction of continuous flaring should contribute to the continued reduction of off-site odours.

F3.1.8 Particulates

Particulate emissions result from windblown fine particles and combustion sources; Mine operations and Energy Services are the major contributors of these emissions.

Current and forecast particulate emissions from combustion sources are shown in Table F3-6 and on Figure F3-5. The result of Suncor's mitigation initiatives is also indicated on the figure.

Table F3-6 Particulate Emissions[1] - t/cd

Period	Yearly Average Production (bbl/cd)	Yearly Average Production (m3/cd)	Yearly Average Particulates (t/cd)	Unit of Production Particulates (t/1000 m^3)
1990	58 000	9 221	6.2	0.67
1997	79 400	12 624	1.6	0.13
FPE	105 000	16 694	1.5	0.09
PEP	130 000	20 668	1.8	0.09
Millennium	210 000	33 387	2.2	0.07

1 From combustion sources only

Mine Operations

Both vehicle traffic on roads and haul roads as well as wind erosion on cleared areas scatter particles of silica dust into the surrounding environment. To minimize this dust, roads are watered and overburden stripping operations precede mine operations by about six months, limiting the area exposed.

At Steepbank Mine, dykes will be predominantly constructed of overburden materials and will be revegetated promptly, to reduce erosion. Consolidated Tailings (CT) will be placed underwater, reducing dust concerns at beach areas.

Energy Services

Particulates are generated by combustion of coke in Energy Services. Ninety-eight percent of these are removed by electrostatic precipitators with 85% of the remainder removed by the Flue Gas Desulphurization (FGD) process.

The majority of incremental energy needed for Project Millennium will be from Gas firing and waste heat capture, thereby minimizing future particulate emissions.

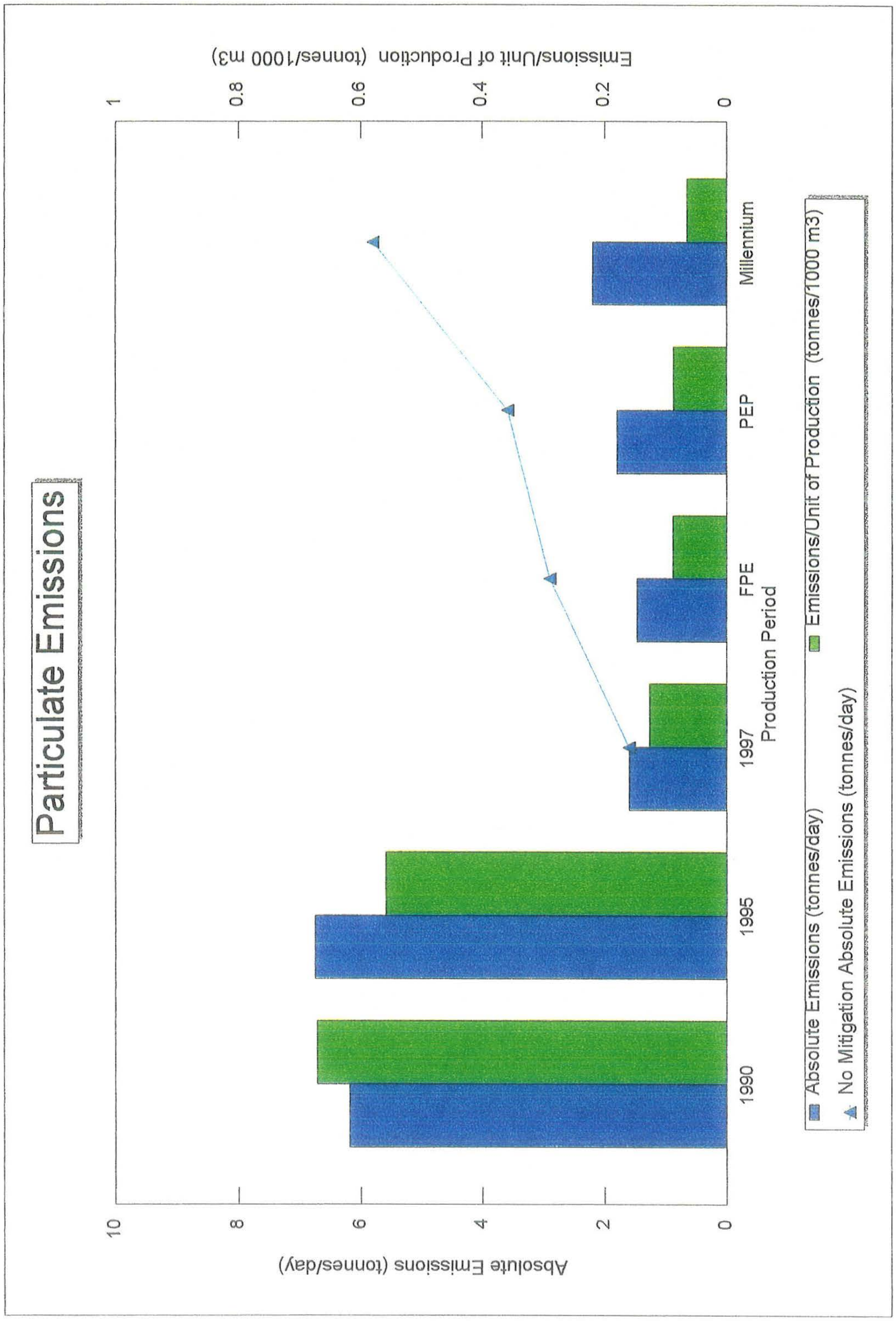


Figure F3-5 Particulate Emissions

Coke Pile

Temporary vegetative cover on the coke pile is used as part of routine dust suppression activities. During the summer months, a sprinkler system is used to control dust on operating areas of the pile. As discussed earlier, Suncor is evaluating options for future coke handling and storage to accommodate current and Project Millennium excess production.

F3.1.9 Monitoring Design

Air Quality Monitoring

An enhanced air quality monitoring network (the Air Monitoring System) has been recently installed in the Athabasca Oil Sands Region. Operated by the Wood Buffalo Environmental Association (WBEA), the initiative combines the expertise and leadership of government, health and community organizations, and industry. Operation of the system is directed by the Regional Air Quality Coordinating Committee (RAQCC). It is expected that the mandate for the WBEA will eventually encompass all aspects of environmental monitoring, from air and water quality to ecosystem health.

Data collected at these air monitoring stations will help government and industry make critical decisions to protect human health, vegetation and wildlife, as well as to minimize odours and to examine soil and water acidification. Seven air monitoring stations are currently set up in the region: four around the oil sands plants, one at Fort McKay, two in Fort McMurray (one in Timberlea and one on MacDonald Drive). These stations continually monitor the following:

- SO_2
- H_2S
- total hydrocarbons
- ozone
- oxides of nitrogen
- total reduced sulphur
- wind speed
- relative humidity
- particulates to 2.5 microns
- particulates to 10.0 microns

The stations also intermittently monitor Volatile Organic Compounds (VOCs), Polycyclic Aromatic Hydrocarbons (PAHs) and metals. This suite of parameters is significantly more extensive than that for monitoring in the region previously and will provide considerably more information on health effects than was previously possible. An eighth station will be set up at Fort Chipewyan, to provide residents with air quality data and to provide comparison data on air unaffected by industrial or urban activity. Figure F3-6 shows the location of the Wood Buffalo Environmental Association Air Monitoring System stations.

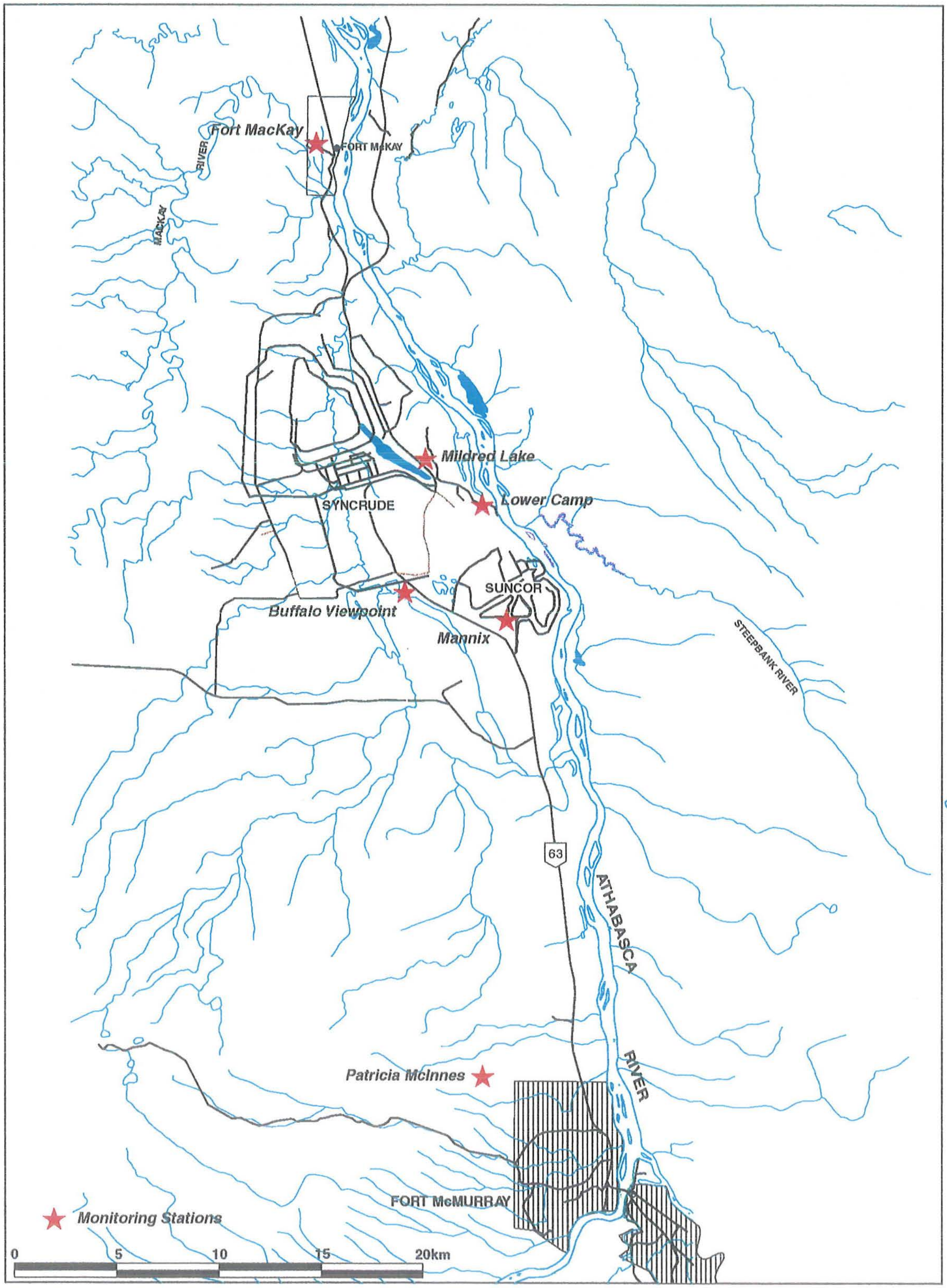


Figure F3-6 Wood Buffalo Zone Air Quality Monitoring Network

An extensive passive monitoring program is planned to coincide with the Community Exposure and Heath Effects Program now being conducted in the region.

A telephone hotline has been set up to provide community residents with reports of current air quality in the region. Information on the hotline is available in English, French, Cree and Chipewyan. In addition, the WBEA operates an Internet web site (http://www.wbea.org), which contains all current air quality information at each of the monitoring stations.

The Wood Buffalo Environmental Association air monitoring program is endorsed by the Clean Air Strategic Alliance (CASA). Currently, the following RAQCC members are in the process of becoming formal members of the WBEA:

- Fort McKay First Nation
- Fort McMurray Environmental Association
- Alberta Environmental Protection
- Northern Lights Regional Health Authority
- Regional Municipality of Wood Buffalo
- Northland Forest Products Ltd.
- Athabasca Chipewyan First Nation
- Syncrude Canada Ltd.
- Suncor

Suncor still operates the Fina Air Quality Monitoring station, located within the Steepbank Mine area, in order to quantify the benefits of Flue Gas Desulphurization (FGD). Once the effects of SO_2 reduction achieved by FGD have been confirmed, this station will likely be dismantled.

Environmental Effects Monitoring

Biological observation in the region has been undertaken in the past by government agencies as well as by oil sands operators and the Alberta Oil Sands Environmental Research Program (AOSERP). These efforts are being continued by the Terrestrial Environmental Effects Monitoring Committee (TEEM), a subcommittee of the Regional Air Quality Coordinating Committee (RAQCC). Typical projects either completed or continuing to date include:

- infrared photography (vegetative stress)
- visible foliage studies (trees in the region)
- berry studies
- soil acidification studies

The bio-monitoring program focuses on a number of selected boreal forest plots, analyzing changes in vegetation and soils over time. Observation of selected parameters is being carried out to detect any changes or trends in the plots followed by relating these changes or trends to changes in regional air quality.

F3.2 Water Emissions

F3.2.1 Scope

This section discusses current water emissions that result from Suncor's oil sands operations: quantifying and characterizing them, then requesting specific AEP approvals. Water emission data from Suncor's operation can be found in Suncor's Annual Wastewater Report.

Water is discharged to the Athabasca River via four separate systems:

- surface drainage system
- wastewater treatment system
- cooling water system
- sewage effluent

A potential future discharge resulting from Suncor's oil sands activities is Consolidated Tailings (CT) release water.

F3.2.2 Specific Approval Requests

AEPEA Approval Requests

Suncor requests the following:

- approval to modify the wastewater treatment/cooling water systems to allow for reuse/recycling of current wastewater streams

- approval to use the Pond C outfall on an "as needed" basis and to monitor the outfall only when it is operating

Suncor suggests the following wording changes to clauses in its Operating Approval to reflect the above:

5.1.2 The approval holder shall manage the industrial runoff from the plant developed area as described in the Project Millennium application, or authorized under this approval, or as further authorized in writing by the Director of Air and Water Approvals.

5.1.3 The continuous pH and flow measurement devices on Pond C outfall weir shall operate for at least ninety percent of the time during periods when the outfall is being utilized.

5.3.1 The approval holder shall monitor the release of industrial wastewater from the Pond C Outfall Weir during periods where the outfall is operating as specified in Table 5-3 (in the Approval).

Water Resources Act Approval Requests

Suncor requests the following:

- an increase in surface and groundwater diversion to 17 790 000 m^3 per year for the integrated Lease 86/17 and east bank mining areas. (The details of these diversions are discussed in Section C2.4.4)

- an increase in the net depletion (i.e. intake minus discharge) from the Athabasca River to 21 170 000 m^3 per year from the currently approved 12 700 000 m^3 per year (licence No. 10400)

F3.2.3 Surface Drainage

Lease 86/17

The "Application for Renewal of Environmental Operating Approval" (Suncor 1995) describes water management on Lease 86/17. In 1996, in conjunction with the "Steepbank Mine Project Application" (Suncor 1996b), Suncor applied for separate approval under the Water Resources Act Volume 1, Section 11(1)(a)(iv) and was subsequently granted approval (File: 27551, 27549). The Steepbank Mine application quantifies diversion volumes and presents a "fenceline" or perimeter for water diversion on Lease 86/17. Current practice is to discharge all natural runoff and shallow groundwater to the Athabasca River, while all runoff that has been exposed to oil sand is contained. Discharge to the Athabasca River occurs at three points: North Mine Outfall, Mid-Plant Outfall and South Mine Outfall.

Project Millennium will have no impact on the conditions of the Lease 86/17 approval.

Steepbank Mine

Steepbank Mine water diversion plan was presented in the "Steepbank Mine Project Application" (Suncor 1996b). Suncor holds Approval (File: 27551, 27549) under the *Water Resources Act* to 24 June 2006. The application provided a fenceline and quantified water diversion volumes. A key feature of the plan is to ensure sufficient flow to maintain wetlands in Shipyard Lake. Impact of Project Millennium on this plan is discussed next.

Project Millennium

Project Millennium proposes an expansion of Steepbank Mine by accelerating the opening and mining of Pit 2. Suncor is committed to maintain the viability of the Shipyard Lake wetlands ecosystem. The mine drainage and water diversion plan for this expansion is discussed in detail in Volume 1, Section C of this application.

Suncor is requesting approval under the *Water Resources Act* for all mine intercept water as described in Volume 1, Section C2.4.3 of this application.

In addition to a change to its surface and groundwater diversion volumes for the east bank mining area, Suncor is requesting approval under the *Water Resources Act* for an increase in net depletion from the Athabasca River. The increase is primarily required as part of the startup of the Project Millennium tailings facilities (which will likely continue for 8-10 years) as well as the planned reduction in wastewater discharge. Suncor will continue to explore opportunities to reduce this water draw.

F3.2.4 Wastewater and Cooling Water

Current Practice

The wastewater treatment system collects water from Upgrading and Energy Services as well as collecting runoff from the Administration area, sulphur pad and coke storage area. Current practice is detailed in the "Application for Approval of the Fixed Plant Expansion Project" (Suncor 1996a).

Included in the wastewater treatment system are the following:

- primary treatment facilities:
  - API separators
  - retention ponds
  - ash pond
  - flare pond

- secondary treatment facilities: Ponds A, B and C

Other components of the wastewater treatment facility include an outfall weir pond and Emergency Pond D.

An additional pond (Pond E) receives once-through process cooling water from Upgrading and discharges water to the Athabasca River through an outfall weir that is separate from the wastewater treatment system's weir.

Project Millennium

The proposed configuration and operating practice for the wastewater system that integrates the current Upgrader and the Project Millennium Upgrader is discussed in Volume 1, Section C of this application.

Proposed is a substantial reduction of water discharge from the wastewater system to the Athabasca River and an elimination of discharge of once-through cooling water via Pond E. The proposal is to convert Pond E into a freshwater settling pond that will supply water for potable water and boiler feed-water. Current wastewater system Ponds A, B, and C will be connected in series with the current freshwater pond for both cooling and recycling of all wastewater from the process area. Additional makeup water required for Project Millennium's primary extraction will be introduced at the current freshwater pond. Pond D will continue service as an emergency pond.

Table F3-7 summarizes the impact on Athabasca River water diversion from the proposed Project Millennium reconfiguration. Net water retained for the most part appears in tailings and ultimately in the interstitial water in Consolidated Tailings (CT). Figure F3-7 presents the results of Suncor initiatives to reduce fresh water draw from the Athabasca River.

Table F3-7 Water Diversion from Athabasca River (1000 m^3/y)

	1997	PEP	Project Millennium
Oil Production (m^3/cd)	12 700	20 700	33 400
Water Intake	47 400	30 260	21 170
Water Discharge:			
- Wastewater System	13 140	11 400	0[1]
- Cooling Water	24 600	2 880	0[1]
Total Discharge	**37 740**	**14 280**	**0[1]**
Net Water Retained	9 660	15 890	21 170

1 During steady operations for Project Millennium, discharge volume is expected to approach zero. Discharge may be necessary during cooling tower maintenance, extremely hot weather, extended periods of low production or other unusual circumstances.

Suncor's target is to enable zero discharge of cooling and wastewater streams during normal operations. This may be achieved by recycling and reusing all streams currently discharged. However, there may be periods when certain operations which reuse or recycle wastewater are non-operational for maintenance; during those times, streams would be discharged. Suncor will monitor outfall discharge quality using existing practices during periods when the wastewater outfall is active.

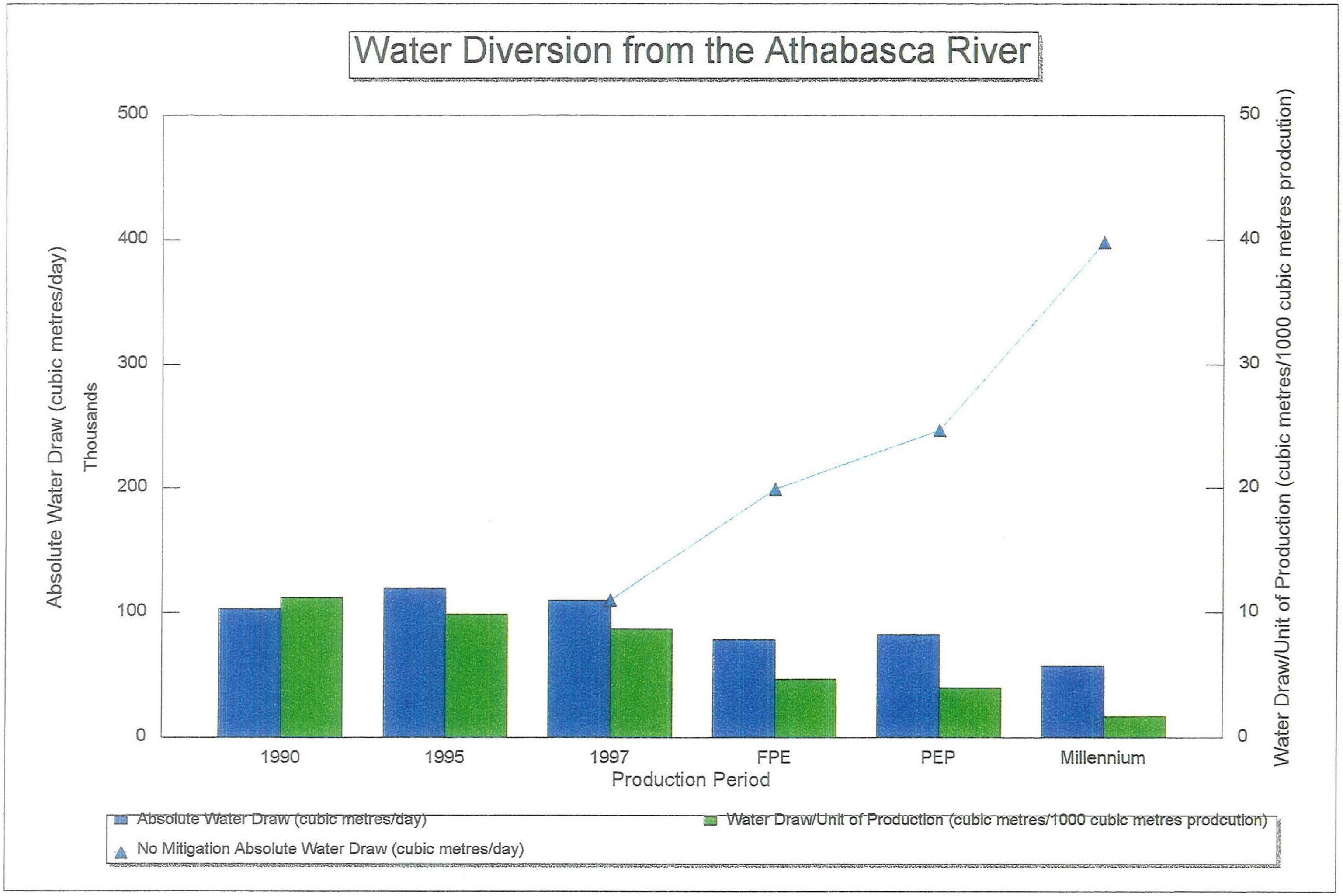


Figure F3-7 Water Diversion from Athabasca River

F3.2.5 Sewage

Lease 86/17

Suncor upgraded its sewage treatment system in 1995. Plantsite wastes are collected in a sanitary sewage system which discharges to an anaerobic pond, then in series through two mechanically-aerated ponds, and finally to a polishing pond before being discharged into the Athabasca River. Treatment in these ponds occurs through passive retention, natural biodegradation and aerobic degradation. Discharge from the treatment system occurs at the mid-plant drainage outfall ditch. This upgraded sewage system meets all AEP treated sewage discharge standards on a year-round basis. The system serves the current plant population, including a 1 400-person camp.

The current system will have sufficient capacity to handle the demands of Project Millennium. Relocation of the camp to Fee Lot 2 is currently under consideration.

Steepbank Mine

In the "Steepbank Mine Project Application" (Suncor 1996b), Suncor indicated that a sewage treatment plant such as a Rotary Biological Contactor would be used to treat sewage from Steepbank Mine facilities. It has now been determined that a package sewage treatment plant will provide the necessary sewage treatment. Suncor will be applying for approval to install this unit in 1998.

It is anticipated that sewage treatment for the expanded Steepbank Mine will be accomplished by expanding or twinning the package unit currently under consideration.

Fee Lot 2

Volume 1, Section C5 of this application described anticipated development on Fee Lot 2 including:

- new, 3 500-person permanent and construction camp
- new administration and warehouse complex
- Suncor tank farm
- Wild Rose pipeline terminal operation
- natural gas liquids facility

Options for sewage treatment for the Fee Lot 2 development include either utilization of the Lease 86/17 facility or construction of a new facility. The options are being evaluated and a separate application will be made for sewage treatment facilities at the appropriate time.

F3.2.6 Consolidated Tailings (CT) Release Water

In the "Steepbank Mine Project Application" (Suncor 1996b), Suncor contemplated the potential necessity of discharging CT water to the environment. Current water management projections (Volume 1, Section E of this application) indicate that the impact of Project Millennium may be to negate the need for release of CT water. These predictions need to be confirmed through additional modelling and monitoring. Current studies show that if Consolidated Tailings (CT) release is required, it will not occur until beyond 2006.

F3.2.7 Water Quality and Aquatic Effects Monitoring

By the terms of its Operating Approval, Suncor is committed to conduct an Athabasca River monitoring survey to monitor: the impacts on Athabasca River from Steepbank Mine; existing discharges from Lease 86/17; the wastewater treatment system; the sanitary sewage outfall; coke pile seepage; and Tar Island Dyke (TID) seepage.

In 1997, Suncor submitted a proposal for conducting a Regional Aquatics Monitoring Program (RAMP) to satisfy the terms of its Operating Approval. Recognizing that aquatics issues are regional in nature and that all oil sands developers have the potential to make an impact, Suncor has invited both Syncrude and Shell to join this initiative.

Objectives of RAMP are as follows:

- design and execute a program which satisfies aquatic monitoring requirements in environmental operating approvals
- monitor aquatic environments in the oil sands region to allow assessment of regional trends and cumulative effects
- provide data against which impact assessment predictions for water quality and aquatic resources will be verified

The 1997 RAMP included sampling for water quality and sediment quality, as well as of benthic invertebrates, fish and wetlands vegetation. Radio transmitters were implanted in two Athabasca River fish species. This radiotelemetry study was initiated to follow the movements and to identify overwintering and spawning sites of walleye and lake whitefish.

It is the intention of RAMP participants (Suncor, Syncrude, and Shell) that (in future years) the program will include a multi-stakeholder committee which will provide direction for future initiatives. This will likely follow the format of Regional Air Quality Coordinating Committee (RAQCC), to ensure that the program meets the needs of all groups, the operators and regional stakeholders.

Figure F3-8 shows sampling subjects and locations.

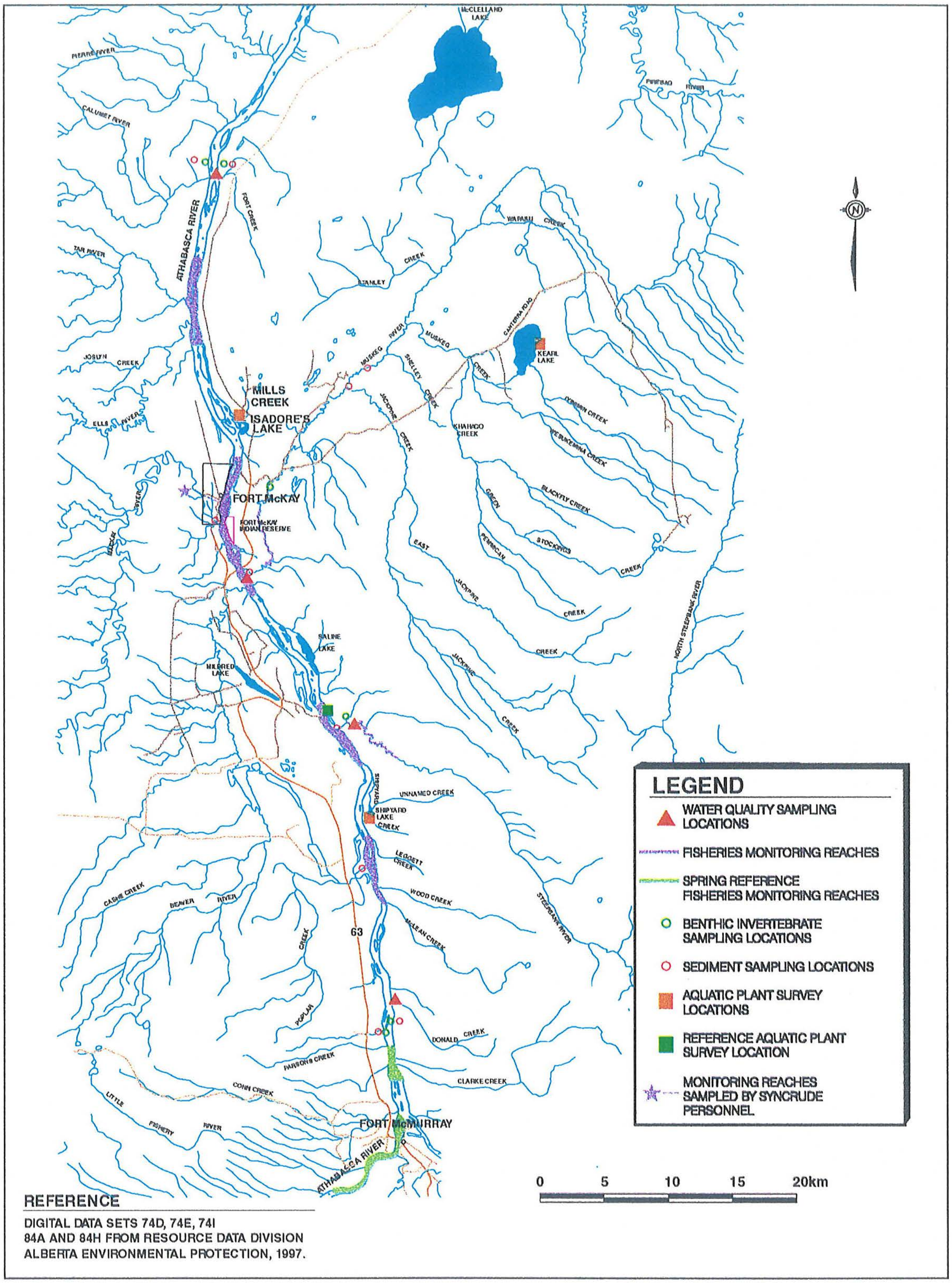


Figure F3-8 RAMP 1997 Monitoring Locations

F3.3 Groundwater

F3.3.1 Scope

The primary objective of Suncor's groundwater monitoring program is to detect contaminants in groundwater flows in a timely manner, so that Suncor can effectively mitigate against potential environmental impacts. (A previous major objective was the management of underground storage tanks, registered by the Petroleum Tank Manufacturers Association of Alberta (PTMAA), to ensure their operating integrity, Suncor no longer has any such tanks installed).

Over the years (beginning in the mid-1970s) Suncor has developed an extensive monitoring network through ongoing modifications and enhancements to its groundwater monitoring program. Detailed description of Suncor's ground water monitoring can be found in the "Application for Renewal of Environmental Operating Approval" (Suncor 1995) and "Steepbank Mine Project Application" (Suncor 1996b).

Regional water quality in both shallow deposits and deep groundwater on Suncor's leases is poor, as defined by the "Canadian Water Quality Guidelines". Regional waters typically exhibit particularly high sodium, chlorine, total dissolved solids, iron and manganese concentrations. Suncor's groundwater monitoring has concentrated largely on assessing potential impacts from its operation on shallow groundwater and on surface water quality adjacent to its operating leases.

Currently, Suncor is continuing with the implementation of a five-year plan, developed in 1993 and modified in 1996 to include Steepbank Mine. A new five-year plan was submitted 31 March 1998, under the terms of Suncor's AEP approval, and it includes proposed monitoring for Project Millennium. Suncor submits annual reports to AEP showing the results of the previous year's monitoring program.

F3.3.2 Specific AEPEA Approval Requests

Suncor requests that (pending regulatory approval) the five-year groundwater plan submitted 31 March 1998, be the reference document for Suncor's groundwater monitoring program. Suncor will submit a new five-year monitoring plan in 2003, in conjunction with its 2002 Annual Report.

Suncor suggests the following changes to clauses in its Operating Approval to reflect the above:

7.1.1 The approval holder shall implement the groundwater monitoring program for the plant as indicated in "Hydrogeology Baseline Report for Suncor's Project Millennium" (Klohn-

Crippen1998a) and "Hydrology Baseline Report for Suncor's Project Millennium" (Klohn-Crippen 1998b) unless otherwise authorized or directed in writing by the Director.

7.1.6 The approval holder shall submit a new five-year groundwater monitoring proposal by 31 March 2003, in conjunction with the 2002 annual groundwater monitoring summary report.

F3.3.3 Discussion

Groundwater management issues for Suncor's operations, including the proposed Project Millennium, are discussed in Volume 1, Section C2 of this application.

In the Project Millennium area, there are three major aquifers: shallow surface aquifers, a basal sand aquifer and the Devonian limestone. The basal aquifer and the Devonian limestone may be hydraulically connected.

Locally, most groundwater flows towards the Athabasca River with a minor component toward the Steepbank River. Total groundwater discharge to surface streams represents less than 0.01% of the low-flow of the Athabasca River and about 0.1% of Steepbank River low-flow.

Surface aquifers in the Project Millennium area will be mined out as part of the operation. The flow in basal and Devonian aquifers will be altered by mining activity, but it will likely return to pre-mining conditions following infilling and reclamation of the mine pits. There are no groundwater users in the area of the Suncor site.

F4 CONSERVATION AND RECLAMATION

F4.1 Scope

Suncor is committed to progressively reclaim its disturbed lands to a certifiable state and capability equivalent to pre-disturbance conditions.

The currently-approved Conservation and Reclamation (C & R) plan has been detailed in the "Steepbank Mine Project Application" (Suncor 1996b) Volume 1, Section D3.0. There Suncor explained its vision for reclaimed landscapes; described the strategy to realize that vision within each step of the full-project life cycle; and demonstrated the means by which the project would diligently meet the criteria for environmental acceptability and regulatory requirements. As well, Suncor submitted a detailed Conservation and Reclamation (C & R) plan in July 1996 for the Athabasca River Valley portion of its Steepbank Mine development. The Conservation and Reclamation (C & R) plan is updated on the basis of current information and to include the proposed Project Millennium in Volume 1, Section E of this application.

F4.2 Specific AEPEA Approval Requests

As Project Millennium increases the area of disturbance, and that disturbed area has a different composition of pre-disturbance land capabilities, Suncor requests that reclamation requirements be altered to reflect that difference. In addition, the ratio of commercial to non-commercial forest on the side of the Athabasca River will be changed from that in the Steepbank Mine application.

To reflect these changes, Suncor suggests the following wording changes to its operating approval:

12.3.1 The approval holder shall return disturbed land to achieve the land capability classes summarized in the table below, or as otherwise authorized in writing by the Director of Land Reclamation:

Land Capabilities Class	Post-Disturbance Area (Hectares)
1	108
2	879
3	7 986
4	1 458
5	1 849
TOTAL AREA	12 510[1]

[1] includes 230 ha classified as infrastructure on Lease 86/17

12.3.9 The approval holder shall return disturbed land east of the Athabasca River to a revegetated condition compatible with the surrounding area including:

(a) forest ecosystem on 78% of the disturbed land, containing an equivalent predisturbance area of commercial forest having equivalent productivity as determined by site indices outlined in the *Alberta Vegetation Inventory Standards Manual*;

(b) non-commercial forest on the remaining 22% of the disturbed land;

(c) re-establishment of equivalent wildlife habitat; or

(d) alternative land use as otherwise authorized in writing by the Director of Land Reclamation.

F4.3 Discussion

Volume 1, Section E of this application presents an integrated Conservation and Reclamation (C & R) plan to include the proposed Project Millennium.

Central to this plan is the continuation of Consolidated Tailings (CT) technology to achieve a dry landscape reclamation. Suncor will continue to monitor the CT operation and conduct research to optimize the operating parameters. No discharge of CT release water to the Athabasca River is indicated within the current operating approval window. Suncor is committed to continuation of research on the quality of operational and reclamation CT release water, as is required under its existing environmental approval.

Suncor is also committed to reducing the disturbance-to-reclamation time-span. The company will implement Consolidated Technology (CT) technology at the Steepbank Mine expansion (Pit 2) as soon as is practical, to optimize site reclamation. Suncor's commitment to Pond 1 remains unchanged: withdrawal of mature fine tailings (MFT) will be complete by 2006 and infilling will be accomplished by 2010, at which time surface revegetation will commence.

Disturbed land will be progressively reclaimed by Suncor in a manner compatible with both approval requirements and end use needs. Reclaimed land will be geotechnically secure and should sustain minimal possible soil erosion. Final reclamation structures will be contoured to present a more natural-appearing landscape, by means including introducing surface irregularities on pond area surfaces, and dyke and dump slopes. Surface drainage integrated with that of adjacent undisturbed areas will be established. In particular, ecological integrity of the Shipyard Lake wetland will continue to be protected.

Land west of the Athabasca River will be returned to a revegetated condition compatible with its surrounding area, including commercial forest on 60% of the disturbed land and non-commercial forest on the remaining 40% of disturbed land; or alternative land use as authorized by AEP.

Disturbed land east of the Athabasca River will be returned to a revegetated condition compatible with the surrounding area, including a forest ecosystem on 78% of the disturbed land (containing an equivalent-to-predisturbance amount of commercial forest area and productivity) and non-commercial forest on the remainder; or an alternative land use as authorized by AEP. Equivalent wildlife habitat will be re-established as well.

Further, disturbed land within the river valley east of the Athabasca River will be reclaimed, taking into consideration the values outlined in the "Fort McMurray - Athabasca Oil Sands Subregional Integrated Resource Plan". The Athabasca River escarpment will be "rebuilt" in the Pit 1 area by 2005 and in the Pit 2 area by 2008.

The current reclamation plan indicates an end pit lake area would be left at the conclusion of operations at Steepbank Mine, some thirty-five years hence. If such a lake does materialize, Suncor will ensure that it will meet appropriate geotechnical criteria, can sustain a healthy aquatic system and can be filled in a reasonable (about ten years) timeframe.

F5 PESTICIDES

F5.1 Discussion

Suncor seldom uses pesticides on its plantsite. When it becomes necessary to use controlled pesticides, the work is contracted to a licenced firm that employs certified applicators.

F6 POTABLE WATER

F6.1 Scope

Suncor's potable water system is configured to and operated to a standard prescribed by AEP, to ensure provision of safe water to the plant population, including camp residents.

Potable water requirements include those at the Base plant Administration building and Camp on Lease 86/17, Steepbank Mine, including the Project Millennium expansion and Fee Lot 2 development.

F6.2 Specific AEPEA Approval Requests

Suncor will apply separately for: approval for a Steepbank potable water system; and for an extension to the system as required to meet Project Millennium needs.

F6.3 Discussion

F6.3.1 Lease 86/17

On Lease 87/17, Suncor operates a potable water system to serve the plant and camp population. The system is operated to AEP-prescribed standards and includes the following:

- surface water supply from Athabasca River
- raw water retention/settling pond
- water treatment, consisting of flocculation, clarification (with provision to add sodium hypochlorite into or prior to the clarifier) filtration and disinfection
- two treated-water reservoirs
- water distribution network within the Suncor plantsite

The system was recently upgraded and is capable of handling increased population due to Project Millennium. The water supply will be altered (to Pond E) as described in Volume 1, Section F3.2.4.

F6.3.2 Steepbank Mine

In the "Steepbank Mine Project Application" (Suncor 1996b), potable water for Steepbank Mine facilities was to be supplied from a groundwater source in the area of the mine complex. Investigations for this supply are currently underway. All required approvals will be obtained prior to implementation of the potable water system.

F6.3.3 Fee Lot 2 Development

It is anticipated that the development of Fee Lot 2 (including administration, warehousing, camp and other facilities) will require provision of potable water. Current options include: use of groundwater or adjacent surface water; a new treatment system, using Athabasca River water; and connection to the current Lease 86/17 potable water system. Suncor will make a separate application at the appropriate time.

APPENDIX I

PEP Amendment Application

SUNCOR ENERGY

OIL SANDS

Suncor Energy Inc.
Oil Sands
P.O. Box 4001
Fort McMurray, Alberta T9H 3E3
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December 9, 1997

COPY VIA FACSIMILE
ORIGINAL VIA COURIER

ATT: Dr. Richard Houlihan
Mine Development Resources Division
Alberta Energy & Utilities Board
640 - 5th Avenue SW
Calgary, AB T2P 3G4

Dear Dr. Houlihan

RE: Approval NO. 8101 : Production Enhancement Phase of Suncor's growth plans

This letter is written to describe, to the Alberta Energy and Utilities Board (EUB), the Production Enhancement Phase of Suncor's growth plans. The purpose in providing this information is to demonstrate that the alterations are compatible with the description of the operation in Approval NO. 8101 and that operating criteria conditions set out in that approval will be met.

1.0 Suncor's Growth Plans

In July of 1997 Suncor announced plans to increase its daily production of oil from its oil sands facility to 210,000 barrels by 2002. This production increase will be achieved in stages and is a combination of projects currently approved (Steepbank Mine and Fixed Plant Expansion), initiatives to enhance existing equipment (Production Enhancement Phase) and plans to twin the existing facilities (Project Millennium).

At year end 1997 the production rate at the oil sand facility will be 85,000 (net) barrels of oil per day. The facilities under construction for the Steepbank Mine and the Fixed Plant Expansion will be completed during 1998 bringing daily production by year end to 105,000 (net) barrels of oil.

The Production Enhancement Phase, to raise production to 130,000 (net) barrels of oil daily, begins in 1998 and is targeted for mid-2001 completion. This stage of growth consists of changes to existing plant processes and those currently under construction.

Increased production through the construction of a second production train is planned as Project Millennium. This project will be the subject of an integrated application to be filed with the EUB and AEP early in 1998.

2.0 Production Enhancement Phase

The production enhancement phase encompasses a number of small independent projects designed to improve reliability, reduce or eliminate small production restrictions and increase capacity in some instances. Together, these projects, when taken as a complete package will enable the daily rate to increase to 130,000 barrels of oil by mid-2001. Production increases will occur in steps between now and then as the various modifications are completed.

The projects included in the scope of the Production Enhancement Phase are listed in Table 1 (attached). This table also provides construction start dates. Table 2 (attached) lists projects that may be implemented, pending additional engineering.

Bitumen Production: The objective of the Bitumen Production projects is to make the requisite changes to the Steepbank and Lease 86 facilities to enable 160,000 barrels of bitumen production, while maintaining overall bitumen recovery of 92.5%. The bitumen production process flow will remain unchanged from the Steepbank Mine configuration.

Additional mining equipment will be added to meet the increased demand for oil sand feed. It is currently planned to continue with 240-ton size haulage trucks. However, if the development and use of larger trucks becomes feasible during this period, larger units may be employed.

To maintain operating reliability at higher rates it will be necessary to install a third hydrotransport line from the ore preparation plant to the primary extraction plant. The inclusion of this pipeline was included in the bridge design, therefore no bridge modifications are required. Increased pumping capacity and lines in both the final tailings pumphouse and the Bitumen Recovery From Tailings Plant will be added to handle the additional tailings produced. Our tailings management strategy, utilizing the consolidated tailings process is not affected by the increased volume of material.

In the extraction process, throughput capacity and bitumen recovery are closely linked. Alterations to the process will be made to handle the increased throughput while still achieving the required bitumen recovery. Performance testing of the modifications currently underway will be required to finalize equipment selection and sizing.

For the primary extraction process the slurry distributor will be modified such that all separation cells will be connected, allowing for higher throughput and flexibility. In the froth cleaning process the remaining Bird centrifuges will be modified and the number and size of inclined plate separation units will be finalized, though it is anticipated that one additional large unit will be needed.

For diluent recovery from tailings, a new tower will be constructed, approximately 16 feet in diameter, to meet the recovery criteria of 99.3% at the higher throughput. A number of alternatives were examined including a new tower, modifying the existing unit and twinning the existing tower. The construction of a new, larger tower was selected, sized to meet future requirements anticipated from Project Millennium.

Upgrading: Through engineering studies it was determined that an increase in daily production to 130,000 barrels was achievable utilizing the existing plant equipment and configuration following the completion of the Fixed Plant Expansion Project. The alterations planned in Upgrading will increase the daily throughput while maintaining the operating standards defined in previous applications. Sulphur recovery of 98.0% will be maintained as will the net liquid yield increase as predicted in the Fixed Plant Expansion application. The incremental production through the upgrading unit will primarily be non-hydrotreated product.

In the first stage of the upgrading process alterations are needed in both the diluent recovery units and the vacuum unit to process the higher volumes. The modifications in the diluent recovery units will be balanced between the two units, the option of increasing one unit while leaving the other unchanged was found to be unfeasible. There will be pumping and exchanger modifications and a new hot oil heater may be required pending additional engineering work. The vacuum unit is currently under construction and a number of modifications to the piping, trays, packing and pumps have already been incorporated into the design.

Coke drum cycles will become shorter with increased plant throughput and the change in coke characteristics anticipated once the vacuum unit comes on stream in 1998. To accommodate the shorter cycles a second steam-out system will be required. An additional wet gas compressor will also be required, the optimum size has not been finalized. Performance testing, in mid 1998, of the cokers with the vacuum unit will be required to finalize equipment selection and specification in the delayed coking units.

The addition of a flare gas recovery system, as indicated in the Fixed Plant supplemental responses is included in this group of projects, tie-ins were completed during the 1997 maintenance turnaround. Sulphur emissions will be reduced by capturing approximately 90% of the continually flared streams for reprocessing.

Energy Services: The goal for Energy Services is to provide all necessary commodities to support the daily production of 130,000 barrels of product. This includes the supply of steam, power, water and instrument air.

To meet the higher production requirements additional power and steam are required. The power will be met through a combination of additional electrical import from the Alberta power grid, and increasing onsite power generation capability. On site steam generation capability with the existing facilities is sufficient to meet the higher demands.

Onsite power generation will be increased by upgrading the two existing turbogenerators by 13 megawatts each and the construction of a new gas-fired turbine capable of producing about 40 to 45 megawatts. A temporary gas/diesel turbine will be required for

1998 to bridge the gap between off-site power supply and onsite generation until the planned modifications and new unit are operational.

To increase energy efficiency, there is potential for the addition of a waste heat recovery boiler with the new gas-fired turbine. The need and justification for this unit will be defined over the next few months as the steam demands are finalized.

Modifications to existing equipment will also be required in the delivery of other commodities such as water and air.

3.0 Construction and Implementation Schedule

The listing of modifications in Table 1 includes the planned construction period for each item. Some of the modifications, as indicated, have been incorporated in the current construction activities for the Steepbank Mine and the Fixed Plant Expansion. The remaining items will be constructed over the period of 1998 to 2001. A planned maintenance turnaround in 2001 is necessary to complete some of the construction activities.

Production capability will increase in a series of small steps over the period of 1999 to 2001 as the various projects come on stream, reaching the planned level of 130,000 barrels of production following the planned maintenance turnaround in mid-2001.

4.0 Resource Conservation

The modifications under the Production Enhancement Phase are to the existing configuration of the plant following completion of the Fixed Plant Expansion and Steepbank Projects. There are no new processes being added, only changes to handle the increased throughput while meeting the operating criteria as defined in the EUB Approval.

5.0 Environmental Protection and Management

The plant modifications for the Production Enhancement Phase have been designed considering our existing operating approval under the Alberta Environmental Protection and Enhancement Act. As such, Suncor will keep emissions (air and water) within the existing approval limits. Adjustments to management systems and processes will be made as required. There are no incremental land disturbances associated with this project, but disturbances will be accelerated as the mining rate increases.

A. Air Emissions:

SO_2 - No increase in SO_2 emissions above the approval limit of 59 tonnes/day, however an increase in hourly emissions from the incinerator stack, above 1.2 tonnes, is likely.

NO_x - It is anticipated that a modest increase in NO_x emissions will result from the production increase. This impact is lessened through the use of low NO_x burners on all new heaters and boilers.

VOCs - It is anticipated that a modest increase in VOC emissions will result due to fugitives from the fixed plants and tailings ponds as a result of the increased production.

CO_2 - Suncor is actively pursuing options to reduce overall greenhouse gas emissions through our Voluntary Climate Change Reduction program. This includes additions to the pond water effluent loop to capture waste heat from upgrading, site wide reductions in energy demand per unit of production, and CO_2 offset initiatives.

Flaring - Streams routed to the flares on a continuous basis will be greatly reduced by the planned flare gas recovery system, and the flaring of coker gas will also be reduced with the installation of a second wet gas compressor unit.

B. Water Management:

There are no changes predicted for the water imported nor the quality or quantity of water discharged to the Athabasca River as a result of the production increase.

Suncor recognizes that amendments to our current Environmental Operating Approval will be required for the construction and operation of several components included in the Production Enhancement Phase. These include: the new naphtha recovery unit, the additional inclined plate separator, the wet gas compressor, new fired heaters, and the flare gas recovery system.

An environmental impact assessment is currently underway as required for Project Millennium. This assessment will consider the impacts of the integrated facility operating at Project Millennium production rates, this assessment will therefore include the modifications made to equipment during the production enhancement phase.

6.0 Stakeholder Consultation

Suncor has reviewed its growth plans, including this Production Enhancement Phase, with the general public and specific stakeholder groups. Recent consultation meetings with First Nation and Metis organizations in the region, The Municipality of Wood Buffalo and the Oil Sand Environmental Coalition have included Suncor's plans for growth, showing this phase of growth. Public consultation will continue specifically on Project Millennium, other Suncor initiatives, and day to day operations.

In conclusion, we request that the Alberta Energy and Utilities board confirm our interpretation of the conditions under Approval NO. 8101, specifically, that a separate approval is not necessary under the Oil Sands Conservation Act for Suncor to proceed with the construction and operation of the Production Enhancement Phase plant modifications. Suncor will obtain the necessary amendment changes to our operating approval under the Alberta Environmental Protection and Enhancement Act prior to construction. Your response to this request would be appreciated.

Please do not hesitate to contact the undersigned if you require any additional information.

Sincerely

SUNCOR ENERGY INC.

for Mark Shaw
Director
Sustainable Development

Attachments

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Table 1 : Projects included in Production Enhancement Phase

Plant Area	Modification	Construction Start
BITUMEN PRODUCTION		
Oil Sand production	• four new 240-ton trucks, one new shovel to increase haulage capacity	operating Sept 98
Ore Preparation Plant (Steepbank)	• additional hydrotransport pipeline (to make total of three) to increase production capacity from Steepbank Mine.	Feb 1998
Primary Extraction (Plant 3)	• install froth recycle on Line 6 deaerator;	Mar 1998
	• tie-in remaining separation cell to slurry pipeline distributor to handle ore from Steepbank Mine	Mar 1998
Secondary Extraction (Plant 4)	• add IPS unit for increased capacity;	Apr 1998
	• converting the scroll mechanism and feed arrangement in remaining nine Bird centrifuges for increased capacity	Apr 1998
Naphtha Recovery	• replace existing tower with larger diameter (approx. 16 foot) unit to maintain recovery criteria	July 1998
Bitumen Recovery from Tailings	• one additional pump train (total of four);	Mar 1998
	• upgrade pumps on existing lines	Mar 1998
Tailings Pumphouse	• one additional tailings line (total of seven);	Mar 1998
Pond Water Recycle	• install one additional siphon from Pond 2 to Pond 1A (total of two) for increased capacity	Apr 1998
Consolidated Tailings	• replace barge pumps and twin existing line for increased capacity	Apr 1998

Table 1 : Projects included in Production Enhancement Phase

Plant Area	Modification	Construction Start
UPGRADING		
Diluent Recovery Unit	• additional fired heater (50 million Btu/hr);	Aug 1999
	• exchanger conversions for higher steam duty and addition to pond effluent water cooling loop;	Aug 1999
	• diluent pumping modifications including new charge pump, larger discharge header and existing pump modifications	Aug 1999
Vacuum Tower	• modifications to piping, packing, trays and pumps during construction;	underway
	• additional cooling	
Delayed Coking Units	• additional steam-out system including parallel header, steam out drum and cooler to accommodate shorter coke drum cycles;	Sep 1998
	• parallel wet gas compressor;	Sep 1998
	• additional pre-saturated lean oil cooler;	Sep 1998
	• additional overhead coolers; and	Sep 1998
	• coker top head removal system	Sep 1998
Amine and Sulphur Plants	• new supply of 90% pure oxygen (by others) for capacity	Apr 1998
	• additional blower into Superclaus unit	Apr 1998
Hydrotreating and Hydrogen Plant	• additional small-capacity hydrogen compressor	2000
	• modifications to hydrotreators to improve reliability and sustainable production rates including exchangers and piping metallurgy upgrades	2001 during outage

Table 1 : Projects included in Production Enhancement Phase

Plant Area	Modification	Construction Start
Flaring	• flare gas recovery system including: compressor, suction scrubber, discharge knock-out drum, after cooler and sour water pumps, to reduce sulphur emissions due to continuous flaring	Sep 1998
ENERGY SERVICES		
Steam Supply	• new 709 psig steam header to Upgrading	Apr 1998
		late 98/early 99
Condensate System	• install new return line from Extraction to Energy Services;	late 98/early 99
	• additional condensate filter (total of five)	
Power Supply	• upgrade existing turbogenerators, increasing capacity by 13 MW each;	TG1 - Jul 1998 TG2 - Jan 1999
	• install new gas-fired turbine (40-45MW) for increased power supply;	late 98
	• remote gas/diesel turbine generator to provide additional electrical power (temporary unit until above new turbine online)	spring 1998

Table 2 : Modifications that may be added, pending additional Engineering

Plant Area	Modification
BITUMEN PRODUCTION	• additions or modifications to the flotation cells in the Bitumen Recovery from Tailings plant
UPGRADING	• wash tower in the delayed coking unit
ENERGY SERVICES	• waste heat recovery boiler on the new gas-fired turbine

SUNCOR ENERGY

OIL SANDS

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December 17, 1997

ATT: David Spink
Director, Air & Water Approvals
Alberta Environmental Protection
4th Floor Oxbridge Place
9820 - 106 Street
Edmonton AB
T5K 2J6

Dear Mr. Spink

RE: Suncor's Production Enhancement Phase and Environmental Operating Approval 94-00-00 (as amended)

As you are aware Suncor has announced plans to increase production beyond current rates. The production increase will be made in a series of steps, the first of which is to a daily production rate of 130,000 barrels - the Production Enhancement Phase. The second phase is Project Millennium which will take daily production to 210,000 barrels by 2002.

On December 9, 1997 Suncor submitted a letter to the Alberta Energy and Utilities Board describing the planned modifications. A copy of that letter is attached for your review. The Production Enhancement Phase is a series of smaller projects which enhance the existing plant configuration to increase production capability. The plant processes are not changed by the modifications. The Environmental Impact Assessment currently underway for Project Millennium will consider the impacts of the integrated facility operating at Project Millennium production rates, and will therefore include modifications made during the Production Enhancement Phase.

We have made an initial assessment to determine which modifications will require an amendment to our existing environmental operating approval. These items are tabulated below, and are grouped into a series of potential amendment applications.

Group		Modification	Construction Start	Comments
1	•	Hourly sulphur dioxide emission from sulphur plant incinerator stack	N/A	Amendment filing January 1998
2	•	New tower and facilities for Naptha Recovery from tailings	April 1998	
3	•	Additional Inclined Plate Separator	April 1998	Will combine with application for second Fixed Plant IPS unit as identified in FPE application
4	•	Gas fired turbine (40-45 meg) and temporary remote turbine generator	April 1998	
5	•	Flare Gas Recovery	Sept 1998	
	•	Delayed coker modifications including steam out system, wet gas compressor and coolers	Sept 1998	Will require some initial results from the facility when the vacuum unit is in operation
	•	Blower into Superclaus unit	Sept 1998	
6	•	Hydrotreators, fired heater for diluent recovery unit	Spring 1999	Will require some results from modifications planned for 1998

We request that you review the information provided and confirm the list of modifications that will require an amendment to our Environmental Operating Approval. We will be pleased to answer any questions that you have regarding the proposed plant modifications.

Please do not hesitate to contact the undersigned if you require any additional information.

Yours truly
SUNCOR ENERGY INC.

Mark Shaw
Director, Sustainable Development

/sl
Attachment

cc. R. Houlihan, AEUB

APPENDIX II

List of Suncor's Environmental Activities and Initiatives Since 1990

Appendix II: List of Suncor's Environmental Initiatives 1990 to 1997

Project Summary		Value ($k)
AIR EMISSIONS	Odour Abatement 1	3 200
	Odour Abatement 2	16 735
	Superclaus	15 000
	Supplementary Emission Control	750
	Lichen Study	50
	Extraction Recovery Improvements	125
	NRU Improvements	250
	Reduction of SO_2 Emissions	2 500
	Flue Gas Desulphurization Plant	190 000
	Plant 35 Coker Gas Utilization	60
	Electrostatic Precipitator Reliability Upgrade	80
	Air Conditioner Coolant Changeover	160
	Boiler Upgrades	49 500
	Ecological Effects Monitoring Programs	500
	Total Expenditure on Air Activities and Initiatives:	**278 910**
WATER EMISSIONS	Wastewater System Upgrades	553
	Wastewater Characterization Study	150
	Toxicity Reduction Plan Development	10
	Tar Island Dyke Seepage Assessment Project	195
	Groundwater Monitoring Program	800
	Continuous Boiler Blowdown	214
	Sewage Treatment System Assessment	50
	Dyke Drainage Control Systems	3 000
	Pond 5 Liner	700
	Westfalia Recycle Water	150
	Dyke Seepage Water	500
	Seepage and Drainage System Telemetry	60
	Ring Dam Water Project	150
	Sewage Treatment System Upgrade	2 045
	Regional Groundwater Model	8
	TID Seepage Collection System Enhancement	860
	Mine Drainage System - Control Structure Upgrade	30
	Pond 5 Seepage Study	85
	Fish Health and Tainting Study	130
	Total Expenditure on Water Activities and Initiatives:	**9 690**
WATER TREATMENT AND POTABLE WATER	Upgrade of Potable Water Plant	2 716
	Clarified Water to Water Treatment Facility	53
	Reverse Osmosis	11 000
	Emergency Water Supply	400
	Fire-water System	8 000
	Waste Oil Tank Replacement	62
	Mine Drainage Improvements	100
	Pond I Seepage Collection System Upgrade	100
	Coke Storage Assessments	80
	Regional Aquatics Monitoring Program	80
	Total Expenditure on Water Treatment and Potable Water Activities and Initiatives:	**22 591**

Project Summary		Value ($k)
ENVIRONMENTAL DILIGENCE	Environmental Auditing	329
	Community Consultation	100
	Environmental Impact Assessment Projects	6 654
	Total Expenditure on Environmental Diligence Activities and Initiatives:	7 083
WASTE MANAGEMENT	Hazardous Waste Storage Building	175
	Waste Inventory Work	50
	Metals Reclaiming - Spent Catalysts	100
	Compressor Seal Oil Recovery	55
	Hydrocarbon Recovery Basin	50
	Total Expenditure on Waste Management Activities and Initiatives:	**430**
RECLAMATION	Land Reclamation Activities	3 343
	Sulphur Pit Reclamation	1 332
	Coke Pile Modifications	200
	Fine Tailings Transfer	7 391
	Pond 1 Reclamation	780
	Wildlife Monitoring Programs and Raptor Enhancement Program	50
	Research - Wetlands Research: • Sustainable Lake Research • Environmental Implications of Dry Landscape Technologies • Reclamation Landscape Model	3 088
	Oil Sands Reclamation Performance Assessment Protocol	260
	Freeze-Thaw Treatment of Fine Tailings Project and Non-Segregating Tailings Field Assessment Projects	5 970
	Reclamation Rooting Study	15
	Erosional Resistance of Tailings Sand Dykes	175
	Ecological Sustainability of Revegetated Areas of Tailings Sand Dykes	75
	TID Toe Berm Erosion Assessment	47
	Consolidated Tailings Commercial Trial	5 000
	Consolidated Tailings Research	750
	Total Expenditure on Reclamation Activities and Initiatives:	**28 476**
Total Expenditure on Environmental Activities and Initiatives		**347 180**

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
AIR EMISSIONS				
Odour Abatement 1	1991	3 200	Diluted bitumen/diluent sour oil streams removed	Rerouted sour naphtha and other sour oils which previously went to diluted bitumen and diluent pool
Odour Abatement 2	1993 to 1995	1 500	Added water boot to diluent accumulator	Less water to remove in South Tank Farm diluent tanks and less oil in water routed to Extraction
		500	Added spare pump for sour water stripper (10C2) reflux	Stripper effluent H_2S on spec during overhead pump outages - reduced odours
		1 000	Added piping to send stripped sour water and slop tank pump-outs to Extraction Naphtha Recovery Unit	Stripper sour waters sent to vacuum stripper and cooled by tailings before release to Tailings Pond 1 - reduced odours
		10 700	Added vent collection and treatment system for South Tank Farm, Extraction Plant 4 and Naphtha Recovery Unit (NRU). (Vapour Recovery Project)	Reduced odours from vent releases to atmosphere
		10	NRU modifications made to improve NRU recovery rates	Diluent losses to tailings reduced; NRU recovery improved from 65% to 68%
		25	Environmental line implemented	Plant 4 controlled to minimize tails losses
		3 000	Upgrade API and Slop Tank Systems	Segregation and treatment of API, South Tank Farm and Flare waters separately, to reduce oil loss and odours

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
AIR EMISSIONS				
Superclaus	1994	15 000	Addition of a common fourth stage Superclaus converter and coalescer to Sulphur plant	Reduction of SO_2 emissions
Supplementary Emission Control	1993	750	Upgrade of air monitoring stations, including real-time alarm systems; Installation of a computer program to predict and correlate SO_2 concentrations	Programs to allow Suncor to mitigate effects related to SO_2 emissions
Lichen Study	1993	50	Study to assess the potential build-up of contaminants in lichens	Provided Suncor with information necessary for assessment of impacts associated with air emissions
Extraction Recovery Improvements	1989	25	Implementation of Optimal Predictive Control of the separation cells	Reduction in losses of bitumen to tailings ponds
	1989 to 1994	100	Separation cell feed well modified to improve plant performance; operating procedures modified to improve plant performance (both continuing)	
NRU Improvements	1994	250	Relocation of Plant 16 steam sparge nozzle below liquid level, to enhance NRU recovery rates	Estimated recovery improvements of 5% (from 68% to 73%)
Reduction of SO_2 Emissions	1994 to 1995	2 500	Burning of natural gas rather than coke; purchase of power	Reduction of SO_2 emissions from Power House to ensure compliance with 90-d rolling average

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
AIR EMISSIONS				
Flue Gas Desulphurization (FGD) Plant	1994	190 000	FGD plantsite assessment and preparation; initiation of plant construction	Commencement of construction of new plant to reduce Utilities SO_2 emissions
Plant 35 Coker Gas Utilization	1993	60	Provision of piping control changes and combustion control changes on Plant 35 boilers to allow combustion of additional coker gas from Upgrader	Energy conservation through improvement to coker gas usage, reduction in usage of imported natural gas and reduction in instances where coker gas must be flared
Electrostatic Precipitator (ESP) Reliability Upgrade	1993 to 1994	80	Installation of new rappers, rapper control system and field control cabinets	Improvement in reliability and capability of ESPs; improved ESP performance in capturing flyash emissions
Air Conditioner Coolant Changeover	1995	160	Replacement of ozone-depleting substances in mine equipment air-conditioning units	Part of Suncor's program to eliminate regulated ozone-depleting substances
Boiler 12 & 13	1995	10 000	Replace Boilers 8, 9, 10, 11	• low-NO_x burners • more reliable gas boilers for supplementary emission control
Boiler 14 & 15	1997	7 500	Additional gas boilers	• ultra-low NO_x burners meeting December 1996, CCME limits • more gas-fired capacity for supplementary emission control
Boiler Upgrades	1997	32 000	Upgrade reliability, capacity	• NO_x reduction • boiler efficiency improvement (80-85%)

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
AIR EMISSIONS				
Ecological Effects Monitoring Program	1996 to 1997	500	Examine the effects of air emissions on terrestrial resources	Better understanding of long-term environmental impacts from air emissions
Total Expenditures on Air Activities and Initiatives:		**153 910**		

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
WATER EMISSIONS				
Wastewater System Upgrades	1992	150	Installation of new outfall weir	Accurate, continuous logging of outfall flow, temperature and pH
		3	Upgrade of Slops Handling System	Improved oily-water handling
	1995	110	Installation of rotary drum skimmer on API cell	Improved oil recovery
		260	Pond D - clearing and dredging activities	Increased holding capacity
		30	Dredging of the Flare Pond	Increased holding capacity
Wastewater Characterization Study	1993	150	Detailed determination of current performance of wastewater treatment system	Allows Suncor to set maintenance and engineering upgrade priorities
Toxicity Reduction Plan Development	1993	10	Develop plan to determine potential sources of acute toxicity recorded in wastewater system	Implementation of plan allows Suncor to determine sources of toxicity and to implement mitigative actions
Tar Island Dyke Seepage Assessment Project	1993 to 1995	195	Assessment of seepage from Tar Island Dyke, efficiency of the dyke seepage collection system, and potential impact of seepage on Athabasca River	Allows Suncor and reviewing Regulators to assess potential impact of any seepage from Tar Island Dyke to Athabasca River
Groundwater Monitoring Program	1990 to 1995	800	Development and monitoring of network of groundwater monitoring wells	Allows for detection of potential impacts to groundwater from oil sands development activities

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
WATER EMISSIONS				
Continuous Boiler Blowdown	1993 to 1994	214	Project to route continuous boiler blowdown waters to Extraction	Energy and water conservation
Sewage Treatment System Assessment	1994	50	Evaluation of a variety of sewage treatment concepts	Selection of best applicable technology for upgrading Suncor's sewage treatment system
Dyke Drainage Control Systems	1991 to 1994	3 000	Dyke drainage collection systems installed for Ponds 2/3 and 4, including coke filters, piping networks and water return systems	Dyke drainage controlled and returned to tailings ponds
Pond 5 Liner	1994	700	Low-permeability liner placed on floor of future Pond 5	Minimization of potential for groundwater contamination
Westfalia (Disc Centrifuge) Recycle Water	1993	150	Conversion to Hot Process Water for Westfalia makeup water, to improve centrifuge performance	Improved separation in Westfalia centrifuges, improved product quality and better recycle water control; eliminated use of fresh river-water in Extraction
Dyke Seepage Water	1991	500	Installation of system to allow use of dyke seepage water to replace gland seal water	Flow of freshwater for use as seal-water reduced; system had to be abandoned because of bacterial contamination
Seepage and Drainage System Telemetry	1994	60	Alarms located in dispatch office for monitoring drainage and dyke seepage systems	Allows for rapid response to potential problems in drainage systems which may potentially have an impact on the environment
Ring Dam Water Project	1993 to 1994	150	Elimination of freshwater addition to disc centrifuge process	Improved recovery and water conservation

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
WATER EMISSIONS				
Sewage Treatment System Upgrade	1995	2 045	Improvements to Suncor Sewage Treatment System	Enhancement of control and treatment of sewage wastes
Regional Groundwater Model	1995	8	Development of integrated Suncor/Syncrude regional groundwater model	Allows greater understanding of regional groundwater situation
TID Seepage Collection System Enhancement	1995	860	Upgrading of seepage interceptor system at toe of TID	Reduced seepage to Athabasca River
Mine Drainage System - Control Structure Upgrade	1995	30	Initiation of work to enhance the mine drainage systems, to allow continuous monitoring and to install improved sampling points	Improved control of mine drainage system discharges
Pond 5 Seepage Study	1995	85	Assessment of the potential for seepage from Pond 5	Allows Suncor to assess impacts and mitigative opportunities associated with potential seepage from Pond 5
Fish Health and Tainting Study	1995	130	Evaluation of potential effects of TID seepage and wastewater treatment system waters on health of fish and other aquatic biota	Allows Suncor and reviewing Regulators to assess potential impact of seepage and wastewater discharge on health of fish and other aquatic biota
Total Expenditures on Water Activities and Initiatives:		**9 690**		

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
WATER TREATMENT AND POTABLE WATER				
Upgrade of Potable Water Plant	1993 to 1995	2 716	Improvements to filtration and chlorination systems, system automation and distribution system	Improvement in consistency of potable water quality
Clarified Water to Water Treatment Facility	1994	53	Installation of piping and control systems to redirect clarifier overflow (approximately 4 900 m^3/d) to water treatment reverse osmosis units, with reject stream directed to plant utility water system	Resulted in net reduction of water to wastewater system for seven months of the year (of approximately 3 270 m^3/d) while achieving better clarifier stability and pH/turbidity control
Installation of Reverse Osmosis Unit	1995	11 000	Construction of reverse osmosis unit, to improve water feed quality	Improvement in consistency of water treatment product; minimization of waste streams produced by enhanced water treatment
Emergency Water Supply System	1995	400	Development of system to assure water supply when standard system is non-operational; replacement of old diesel pump system with electric pumps	Improvement in assurance of water supply, with minimization of potential environmental impacts when bypass system is in use
Fire-water System	1995	8 000	Upgrading of Suncor's fire-water system - improved provision of water supply for emergencies	Improvement in Suncor's capability to address emergencies
Waste Oil Tank Replacement	1996	62	Replace underground waste oil tank with above ground tank	Reduced potential for soil/groundwater contamination
Mine Drainage Improvements	1996	100	Replacement of Mine Drainage Outfalls	Improved monitoring capabilities at approved discharge locations

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
WATER TREATMENT AND POTABLE WATER				
Pond 1 Seepage Collecting system Upgrade	1997	100	Upgrade Seepage Water Return Pump	Improved collection and return of seepage water to Pond 1
Coke Storage Assessment	1997	80	Review coke storage options	Long-term plan for coke storage and reclamation
Regional Aquatics Monitoring Program (RAMP)	1997	80	Aquatic monitoring of Athabasca River and tributaries	Initial survey of long-term aquatic monitoring program
Total Expenditures on Water Treatment and Potable Water Activities and Initiatives:		**22 591**		

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
ENVIRONMENTAL DILIGENCE				
Environmental Auditing	1993 to 1995	329	Completion of environmental auditing training program and environmental audits of Business Units	Assessment of environmental management and compliance activities; follow-up actions to effect improvements
Community Consultation	1995	100	Increased communication of environmental issues and initiatives with Suncor's community; includes workshops, trade fairs, and distribution of information documents	Improved understanding by Suncor of information requirements of its community. Improved understanding by community of Suncor, its current and planned activities
Environmental Impact Assessment (EIA) Projects	1995 to 1997	161	Assessment of biophysical conditions (soils, vegetation and terrain) on Local Study Area (i.e., Leases 86/17, 23, 97 and fee lots)	Improved understanding and definition of environmental conditions in area of Suncor operation
		271	Assessment of hydrological and hydrogeological conditions associated with Local Study Area	
		88	Assessment of environmental conditions associated with air emissions from Suncor operation	
		134	Environmental and human health risk assessment (cumulative impact assessment) associated with current and proposed Suncor operations	
		6 000	Steepbank Mine and Project Millennium EIA	
Total Expenditures on Environmental Diligence Activities and Initiatives		**7 083**		

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
WASTE MANAGEMENT				
Hazardous Waste Storage Building	1992 to 1993	175	30 m x 15 m storage building constructed in Hazardous Waste Storage Yard; coating of building floor	Improved protection of hazardous waste materials being held in Hazardous Waste Storage Yard pending disposal or recycling at approved off-site locations
Waste Inventory Work	1993 to 1995	50	Identification and quantification of hazardous waste streams	Improved disposal practices and identification of reduction/reuse/recycle opportunities
Metals Reclaiming - Spent Catalysts	1994	100	Catalyst sent to reclaimers for recovery of metals	Elimination of mobile heavy metals from Industrial Landfill
Compressor Seal Oil Recovery	1994	55	Used seal oil sent through Upgrading for recovery of resource	Diversion of waste oils from tailings ponds
Hydrocarbon Recovery Basin	1994	50	Contaminated hydrocarbons processed through Upgrading for recovery of resource	Diversion of hydrocarbons from tailings ponds
Total Waste Management Activities and Initiatives:		**430**		

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
RECLAMATION				
Land Reclamation Activities	1990 to 1994	3 343	Land reclamation involves placement of topsoil on reclamation areas, fertilization, revegetation and tree planting; performance of reclaimed sites is assessed on an annual basis, to ensure site development is consistent with undisturbed reference sites	Creating self-sustaining vegetative cover on lands disturbed by mining
Sulphur Pit Reclamation	1993	1 332	Reclamation of former sulphur storage area	Removal of contaminant with potential for causing environmental impact; disposal of recovered sulphur and sulphur/soils within approved sulphur deposition pit
Coke Pile Modifications	1994 to 1995	250	Modifications to coke stockpile through slope flattening, vegetating slopes and improvements in coke stockpile drainage collection system; also includes installation of irrigation system	Reduction of dust emissions from coke stockpile; reduction of fugitive sulphur emissions and minimization of risk of contaminated water reaching river
Fine Tailings Transfer	1990 to 1995	7 391	Construction of facilities for transfer of fine tailings from Ponds 1A and 2/3; includes transfer activities from Ponds 1 and 1A	Lowers mud-line in Pond 1A to maintain cleaner Extraction recycle water quality
Pond 1 Reclamation	1993 to 1995	780	Research and development for final reclamation plan and long-term stability of Tar Island Dyke (TID)	All fluids to be removed from Tailings Pond 1 and preparation for infilling of Pond 1 such that a dry, reclaimable surface is obtained within a geotechnically-secure structure

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
RECLAMATION				
Wetlands Research	1991 to 1995	3 088	Evaluation of potential for employment of constructed wetlands for treatment of wastewaters from oil sand reclamation projects	Employment of constructed wetlands for treatment of waters from oil sands reclamation schemes would mean that cost-effective, self-sustaining, productive ecosystem would function as treatment system
Sustainable Lake Research	1992 to 1994		Evaluation of sustainment of water-capped fine tailings ponds	Reclamation of fine tailings through placement under capping layer of water may provide cost-effective, environmentally-sound reclamation method for volumes of fine tailings
Environmental Implications of Dry Landscape Technologies	1991 to 1995		Evaluation of leachates from various oil sands materials which will be employed in lease reclamation scenarios	Knowledge of potential leachates from various materials which will be employed in reclamation scenarios contributes to reclamation planning activities
			Evaluation of toxicological impacts and impacts to plant productivity from various oil sands reclamation materials and material mixes	Knowledge of potential impacts from various reclamation materials contributes to reclamation planning activities
Reclamation Landscape Model	1991 to 1995		Development of model to track movement of water-borne constituents throughout reclamation landscape and from reclaimed lease to external environment	Development of model which allows tracking and evaluation of various oil sands constituents which will move between reclaimed landscape units and from reclaimed lease; also has predictive capabilities

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
RECLAMATION				
Oil Sands Reclamation Performance Assessment Protocol	1993 to 1995	260	Development of performance assessment protocol to evaluate geotechnical and environmental components of reclaimed oil sands lease	This risk assessment protocol will be employed as part of risk management program; it also allows users to predict future performance of reclamation areas
Wildlife Monitoring Programs and Raptor Enhancement Program	1991 to 1995	50	Assessment of wildlife (bird and mammal) interactions on developed oil sands lease	Allows assessment of impact of oil sands development on lease (and lease area) populations of birds and mammals
Freeze-Thaw Treatment of Fine Tailings Project	1991 to 1994	5 970	Assessment of technique to enhance removal of water from fine tailings	Potential reduction of volumes of fluid tailings; this will result in increase in dry landscape areas
Non-Segregating Tailings Field Assessment Project	1993 to 1994		Assessment of technique which results in tailings mixture with little entrapped water	Potential reduction of volumes of fluid tailings; this will result in increase in dry landscape areas
Reclamation Rooting Study	1993 to 1994	15	Assessment of rooting patterns of trees growing on Suncor reclamation areas and adjacent non-disturbed areas	Review of rooting patterns for reclamation area trees allows assessment of capability of these trees to resist blowdown and to function effectively for erosion control
Erosional Resistance of Tailings Sand Dykes	1995	175	Assessment of rates of erosion on reclaimed tailings sand dyke areas (TID), including area subjected to simulated forest fire	Provision of information to allow calculation of normal rates of erosion to be expected on reclaimed tailings sand dykes; this information will allow evaluation of sustainability of these reclamation areas

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
RECLAMATION				
Ecological Sustainment of Revegetated Areas on Tailings Sand Dykes	1995	75	Assessment of ecological development of revegetated areas of Tar Island Dyke, including assessment of soil depths	Provision of information to allow evaluation of sustainment of revegetated oil sands lease areas
TID Toe Berm Erosion Assessment	1995	47	Assessment of erosional resistance of toe berm area of TID	Identification of requirement or potential requirement for enhancement of erosional resistance of lease/river interface adjacent at TID
Consolidated Tailings Commercial Trial	1995	5 000	Initiation of project to assess full implementation of Consolidated Tailings (CT) technology	Elimination of fine tailings
Consolidated Tailings Research	1996 to 1997	750	Research into Consolidated Tailings (CT) behavior and reclamation alternatives	Better definition of long-term Consolidated Tailings (CT) reclamation
Total Expenditures on Reclamation Activities and Initiatives:		**28 476**		

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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.