SUNCOR INC.,

OIL SANDS GROUP

STEEPBANK MINE

PROJECT APPLICATION

APRIL 1996

APPLICATIONS FOR APPROVAL

Suncor Inc., Oil Sands Group (Suncor) applies to the Alberta Energy and Utilities Board (EUB), pursuant to Section 14 of the *Oil Sands Conservation Act* (OSCA), to amend Approval No. 7632, as amended by Approval No. 7632A, and as may be further amended by the EUB pursuant to Application No. 960369 (the Fixed Plant Expansion Project Application), to include:

- approval to construct and operate the proposed Steepbank Mine and related modifications in access, ore transport, extraction and tailings handling to the existing approved scheme to sustain an increase in production to 6,209,000 m^3 of synthetic crude oil and other oil sands products in each calendar year;

- approval to operate the proposed Steepbank Mine based on a twenty-year mine plan; and

- approval of the integrated conceptual reclamation plan for Lease 86/17 within the area of the existing approved scheme and the proposed Steepbank Mine.

Suncor also applies to the EUB pursuant to the *Hydro and Electric Energy Act* (HEEA) for approval for the construction, operation and connection of a power supply line and pursuant to the *Pipeline Act* (PLA) for approval for the construction and operation of hydrotransport, hot water, natural gas, diesel, tailings and recycled water pipelines, all related to the proposed Steepbank Mine.

Suncor also submits the Steepbank Mine Environmental Impact Assessment 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* (EPEA) and for a decision, in due course, by the Director that the Report is complete pursuant to Section 51 of EPEA.

Suncor also seeks approval from Alberta Environmental Protection to modify the existing Fort McMurray oil sands plant for the manufacture of petroleum products as proposed in the attached application. Accordingly, Suncor applies as follows:

- pursuant to Sections 64 and 67 of EPEA, for an amendment to the consolidated approval, currently the subject of several applications, including Applications No. 017-95 (the Fixed Plant Expansion Project Application) and expected to be approved by the Director in May 1996; and

- pursuant to Section 11 of the *Water Resources Act* (WRA), for a licence to divert water courses in the course of mine development and operation and wastewater management of both the proposed Steepbank Mine and Lease 86/17 within the existing Fort McMurray oil sands plant.

If the consolidated approval is not issued by June 25, 1996 then Suncor applies, pursuant to Sections 64 and 67 of EPEA, for amendments to the existing approvals under EPEA, namely:

- Air Licence No. 92-AL-359, as amended;
- Water Licence No. 92-WL-147, as amended;
- Reclamation Approval No. OS-1-79, as amended.

This joint application has been developed to combine all information under the OSCA, the HEEA, the PLA, the EPEA and the WRA into one document to facilitate and expedite the regulatory review of the proposed Steepbank Mine project. Section A5.4 contains a checklist of the information requirements for the amendment to the approvals under OSCA and EPEA and the approved Terms of Reference for the Environmental Impact Assessment. The pertinent information for the WRA application is found in Section C3.4, for the HEAA in Sections C4.1 to C7.5, inclusive, and the PLA in Section C4.1.

All communications on these applications should be directed to:

Mr. T.J. Bachynski
Director, Project Approvals
Suncor Inc., Oil Sands Group
P.O. Box 4001
Fort McMurray, Alberta
T9H 3E3

Telephone:	(403) 743-6892
Fax:	(403) 791-8344
E-mail:	kwoods.sunosg26@ccinet.ab.ca

Dated April 29, 1996 at Fort McMurray, Alberta

T.J. Bachynski
Director, Project Approvals
Suncor Inc., Oil Sands Group

SUNCOR INC., OIL SANDS GROUP
STEEPBANK MINE PROJECT APPLICATION
TABLE OF CONTENTS

D AEPEA APPROVAL REQUIREMENTS

E ENVIRONMENTAL IMPACT ASSESSMENT

APPENDICES

REFERENCES

GLOSSARY

LIST OF ABBREVIATIONS

"	Inch
<	Less than
>	More than
%	Percent
°C	Temperature in degrees Celsius
°F	Temperature in degrees Fahrenheit
$k	Thousand dollars
µg/L	Micrograms per litre
$\mu g/m^3$	Micrograms per cubic metre
ABDC	Aboriginal Business Development Committee
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
Al-Pac	Alberta Pacific Ltd.
AOSERP	Alberta Oil Sands Environmental Research Program
AOSTRA	Alberta Oil Sands Technical Research Authority
API	American Petroleum Institute
APL	Alberta Power Limited
ARC	Alberta Research Council
asl or ASL	Above sea level
ATP	AOSTRA Taciuk Process
avg.	Average
bbl	Barrel, petroleum (42 U.S. gallons)
bpcd	Barrels per calendar day
BCM	Bank cubic metres
BCY	Bank cubic yards
BOD	Biological oxygen demand
C	Carbon
C&R	Conservation and Reclamation
Ca	Calcium
$CaCO_3$	Calcium carbonate
$CaSO_4$	Calcium sulphate
CANMET	Canada Centre for Mineral and Energy Technology
cd	Calendar day
CEC	Cation exchange capacity
CEPA	Canadian Environmental Protection Act
ch	Calendar hour
CHWE	Clark Hot Water Extraction
CLI	Canadian Land Inventory
cm	Centimetre
cm^2	Square centimetre
cm/s	Centimetres per second
CO_2	Carbon dioxide
COD	Chemical oxygen demand
COH	Co-efficient of haze
Conif.	Coniferous

CONRAD	Canadian Oil Sands Network for Research and Development
Consortium	Fine Tailings Fundamentals Consortium
CSEM	Continuous Stack Emissions Monitor
CT	Consolidated Tailings
d	Day
DCU	Delayed Coking Unit
Decid.	Deciduous
DO	Dissolved oxygen
DRU	Diluent Recovery Unit
EAPS	Extraction Auxiliary Production System
e.g.	For example
EIA	Environmental Impact Assessment
ELC	Ecological Land Classification
elev	Elevation
EPA	Environmental Protection Agency
ESPs	Electrostatic Precipitators
FEM	Finite Element Modelling
FGD	Flue Gas Desulphurization
ft	Feet
ft^3	Cubic feet
FTPH	Final Tailings Pump House
g	Grams
g/cc	Grams per cubic centimetre
GCOS	Great Canadian Oil Sands
GDP	Gross Domestic Product
GJ	Giga-joules
GLC	Ground Level Concentration
h	Hour
ha	Hectares
H_2S	Hydrogen sulphide
ibid.	In the same place
i.e.	That Is
IC	Inhibiting concentration
IRP	Integrated Resource Plan
k or K	Thousand
kg	Kilogram
kg/d	Kilograms per day
kg/ha	Kilograms per hectare
kg/hr	Kilograms per hour
km	Kilometre
k m^3	Thousand cubic metres
KV	Kilovolt
L or l	Litre
LGHR	Low grade heat recovery
lb/hr	Pounds per hour
LC	Lethal concentration
m	Metre
M	Million
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/hr	Cubic metres per hour
m^3/s	Cubic metres per second
Mm^3	Million cubic metres
meq	Milli-equivalents
mg	Milligrams
mg/L	Milligrams per litre
MJ	Megajoule
MLA	Member of the Legislative Assembly
mm	Millimetre
MP	Member of Parliament
MVA	Mega volt amperes
MW	Mega watt
N	Nitrogen
N/A	Not applicable
N.D.	No data
No.	Number
No_x	Oxides of nitrogen
NRU	Naphtha Recovery Unit
OSEC	Oil Sands Environmental Coalition
OSG	Suncor Inc., Oil Sands Group
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
PANH	Polycyclic aromatic nitrogen heterocycle
PASH	Polycyclic aromatic sulphur heterocycles
PMF	Probable maximum flood
ppb	Parts per billion
ppm	Parts per million
psig	Pounds per square inch
Q	Quarter (i.e., 3 months of a year)
RA	Reclamation Area
RAQCC	Regional Air Quality Coordinating Committee
RRTAC	Reclamation Research Technical Advisory Committee
s	Second
S	Sulphur
SAGD	Steam Assisted Gravity Drainage
SAR	Sodium absorption ratio
scf/d	Standard cubic feet per day
SCO	Synthetic crude oil
SEC	Supplementary Emission Control
sep cell	Separation cell
SFR	Sand to fines ratio
SLC	Screening level criteria
SO_2	Sulphur dioxide
Sox	Sulphur oxides
SO_4	Sulphate
spp	Species

Suncor	Suncor Inc., Oil Sands Group
Syncrude	Syncrude Canada Ltd.
t	Tonne
t/d	Tonnes per day
TDS	Total dissolved solids
TEH	Total extractable hydrocarbons
THC	Total hydrocarbons
TID	Tar Island Dyke
TIRA	Tar Island Reclamation Area
TIE	Toxicity identification evaluation
TOC	Total organic carbon
Ton	2000 pounds
Tonne	2205 pounds
t /hr	Tonnes per hour
t/cd	Tonnes per calendar day
t/h	Tonnes per hour
TSS	Total suspended solids
TV/BIP	Ratio of total volume removed to total volume of bitumen in place
Twp	Township
UTF	Underground test facility
USgpm	U.S. gallons per minutes
VEC	Valued Ecosystem Component
VOC	Volatile organic compound
Vol.	Volume
VRU	Vapour Recovery Unit
vs	Versus
WA	Waste Area
wt%	Weight percentage
y	Year

TABLE OF CONTENTS

SECTION A **PAGE**

LIST OF TABLES AND FIGURES

A INTRODUCTION

Suncor Inc. is applying for regulatory approval to proceed with the development of the proposed Steepbank Mine, to be located across the Athabasca River from its current operations near Fort McMurray in the Regional Municipality of Wood Buffalo in northeastern Alberta. In April 1995 a disclosure document was released for the proposed mine. Since then, a comprehensive public and regulatory consultation and communication program and an environmental impact assessment have been underway in parallel with engineering feasibility studies.

This document comprises the Application for Approval of Steepbank Mine and serves to meet the requirements under the Alberta Oil Sands Conservation Act, the Alberta Environmental Protection and Enhancement Act and the Alberta Water Resources Act. It also includes the Environmental Impact Assessment.

1.0 CORPORATE OVERVIEW

In 1992 Suncor Inc. 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 was intended to make its oil sands business economically viable and environmentally responsible, and to ensure its oil sands operations could be sustained well into the twenty-first century.

It took Suncor three years and $300 million to accomplish the business renewal strategy and to fulfill its commitment to ensure the long-term economic viability of its oil sands business. By the end of 1995 this strategy had achieved operating costs which averaged $13.75 a barrel – nearly $6 less than in 1992. Additional properties were acquired to ensure that oil sands ore will be available for at least fifty years. Shareholder confidence grew and the increase in cash flow facilitated the investment required to improve the plant's environmental performance, production capability and operational reliability.

In late 1994, Suncor announced its intention to open a new oil sands mine. Located on the east side of the Athabasca River, the site now proposed as Steepbank Mine was selected because of its proximity to Suncor's existing plant facilities and because core hole drilling during the winters of

1993 and 1994 confirmed the presence of a high-quality ore body. Close proximity to current operations provides environmental benefits by allowing Suncor to reduce energy use and to integrate reclamation plans for its current site and Steepbank Mine.

In developing the Steepbank Mine proposal, Suncor used the experience and technical know-how it has gained since the early 1960s to plan a mine that is cost-effective, technologically advanced, environmentally sound and will ensure high, reliable rates of production. By participating in a comprehensive consultation program Suncor is providing residents of the region with continuing opportunities to ensure the best decisions are made in the mine's design and that economic benefits are balanced with environmental responsibility. This commitment to addressing the needs of all community interests will result in a mine design which will reduce emissions, conserve energy, improve recovery rates, decrease water use and establish a new reclamation plan which eliminates the long-term storage of liquid fine tailings.

Estimated to cost $336 million, Steepbank Mine is designed to operate for twenty years at a rate which will supply bitumen to produce 107 kbpcd of upgraded crude oil. In addition to maintaining Suncor's current workforce of 1400 full-time employees and 300 contractors, Steepbank Mine will create 1040 person-years of construction employment during the project's development. Incremental operation expenditures over the mine life are estimated at 6.4 billion dollars ($1995). Suncor's desire to acquire goods and services from locally-owned businesses is expected to generate substantial growth opportunities for both the Regional Municipality of Wood Buffalo and the Province of Alberta.

After obtaining necessary regulatory approvals, Suncor will commence construction of Steepbank Mine in 1997 with commissioning in 2000.

1.1 SUNCOR INC.

Suncor Inc., a growing Canadian integrated oil and gas company with assets of $2.4 billion, includes three operating groups and employs 2350 people.

The Oil Sands Group (based near Fort McMurray, Alberta) mines and upgrades oil sands and markets high-quality light, sweet crude oil and custom blends. The Resources Group (based in Calgary, Alberta) is involved in exploration and production of natural gas and conventional crude oil. The

Sunoco Group refines and markets transportation fuels, petrochemicals and heating oils in Ontario and Quebec.

Suncor is a publicly-traded company; its shares are traded on all Canadian stock exchanges and the American Stock Exchange.

1.2 SUNCOR INC., OIL SANDS GROUP

Suncor pioneered the commercial development of the Athabasca oil sands in 1962 as Great Canadian Oil Sands Ltd. (GCOS). When its plant came on-stream in 1967, it was the first commercial-scale oil sands venture in the world. In 1979, GCOS merged with other companies held by Sun Oil Company to form Suncor Inc.

Suncor's Oil Sands Group (OSG) is located within the Athabasca oil sands deposit, from which a viscous, tar-like substance called bitumen is extracted. At OSG 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 the mine ore enters the Extraction process, where bitumen is separated from sand. In the Upgrading plant bitumen is heated and cracked into three petroleum distillates, namely naphtha, kerosene and gas oil. These components are custom-blended into a variety of products ranging from light, sweet crude oil to diesel fuel. Energy for the operation is provided mostly by the Utilities plant. Fired mainly by coke produced in Upgrading, its boilers generate electricity, steam and process water for the entire site.

Alberta's oil sands represent one of the world's largest known petroleum resources. More than 300 billion barrels are ultimately recoverable - an amount similar in size to the proven reserves of Saudi Arabia and enough to supply all of Canada's oil needs for over two hundred years. Comprised of four major deposits located in northern Alberta (Athabasca, Wabasca, Cold Lake and Peace River), the oil sands cover about 77 000 sq km.

Throughout its history in the Fort McMurray area, Suncor has been in the forefront of innovative and practical technologies to develop the potential of the Athabasca oil sand deposit. Amid engineering challenges, fluctuating oil markets and turbulent economic events, Suncor has remained committed to developing the oil sands, which represent an abundant and increasingly important source of energy for Canada's future.

Suncor's commitment extends to the people who live in the Athabasca region. 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: the company supports regional initiatives such as local health, welfare, educational, cultural and environmental activities.

1.3 ECONOMIC VIABILITY

Suncor's objective in 1992 was to undertake a series of initiatives to improve the long-term profitability of OSG, becoming competitive with Canada's top producers of conventional crude oil. The strategy included a change in mining technology; plant improvements; acquisition of additional leases; enhancement of revenues through product mix and custom blends; and improvements in environmental performance.

Three years after announcing its strategic plan, Suncor realized the following results:

- Cash costs per barrel were reduced from $19.50 in 1992 to $13.75 in 1995.
- Production was increased from 60 kbpcd of upgraded crude oil in 1992 to 79 kbpcd by the end of 1995.
- Revenues were increased.
- Additional oil sands properties were acquired, securing oil sand resources for seventy years.

When Steepbank Mine is fully commissioned by 2001, its higher rates of production and the introduction of new technology are forecast to provide OSG with additional improvement in the cost structure per barrel and therefore further improvements in economic viability.

1.4 ENVIRONMENTAL PROTECTION

Suncor Inc. is committed to excellence in implementation of standards of care for the environment which not only comply with legislated requirements but which also respond to the expectations of its communities, customers, government and the public, within the limits of technology and the company's ability to fund. Suncor has developed a "We Care" environmental policy which is incorporated into all aspects of its activities. OSG's environmental management involves continuous improvement through planning and disciplined implementation at all levels to eliminate, minimize or mitigate (as appropriate) the impacts associated with its operations. Environmental conservation is an integral part of the operation.

Since 1992, when Suncor announced its intention to continue its oil sands business well into the twenty-first century, the company has undertaken the following environmental improvements:

- In 1994, an upgrade to the sulphur plant (at a cost of $15 million) was completed, increasing sulphur recovery from 96% to 98%.

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

- Further reductions of sulphur dioxide (SO_2) emissions will be achieved in 1996 with the start-up of a $190 million facility to treat Utilities plant stack emissions. When combined with improvements in the sulphur plant this project will reduce overall plant-wide SO_2 emissions by approximately 75% from 1995 levels.

- Energy efficiency improvements have reduced greenhouse gas (GHG) emissions per unit of output by 13% over the period 1990 to 1994. Current plans include further improvements. While production will increase by 80% between 1990 and 2000, GHG emissions will increase by only 5%. In its submission to the federal government's "Canadian Climate Change Voluntary Challenge and Registry Program" Suncor states that it expects to further reduce GHG emissions to 1990 levels by 2005. Suncor is confident this will be achieved as soon as 2001 by measures developed through implementing a comprehensive GHG reduction management strategy (see Subsection C8.1.2).

- The application of new technology to consolidate tailings (produced by the Extraction process) commenced in late 1995. This technology, developed by Suncor, will produce tailings which can be reclaimed to a dry state.

2.0 PROJECT OVERVIEW

2.1 PROJECT SCOPE

Located across the Athabasca River from Suncor's current operations, the proposed Steepbank Mine is 35 km north of the City of Fort McMurray, Alberta and 27 km south of the community of Fort MacKay (see location map Figure A2.0-1). Although the mine is projected to open by 2000, Suncor expects it will take at least one year before the operation will support a production level of 107 kbpcd of upgraded crude oil.

The scope of the project includes all the activities required to construct and operate the new mine; to transport the ore; to modify current Extraction facilities (from 87 kbpcd to 107 kbpcd); and to produce a diluted bitumen product which will be transferred to the Suncor Upgrading facility for use in the production of upgraded crude oil. Also included are the management plan for all tailings produced by the Extraction plant and the ultimate reclamation plan for current and future tailings ponds.

2.2 NEED FOR THE STEEPBANK MINE

The currently-active Suncor lease (i.e., Lease 86/17) is expected to be depleted of oil sands ore by the end of 2001. In order to sustain its operation Suncor will require a replacement source of bitumen.

Suncor's business plan calls for an increase in production capacity in its upgrader to 107 kbpcd by 1998 (105 kbpcd marketable product after internal uses) from the current capacity of 79.5 kbpcd, to be achieved by modifications to the Upgrading and Utilities plants. Also included is expansion of Extraction capacity to 87 kbpcd. This expansion in fixed plant capacity, at a cost of $309 million, will improve the environmental performance of the plant, increase plant reliability and efficiency, and will increase the production of marketable products.

Suncor's existing bitumen production operation is closely integrated with its Upgrader and Utilities plant. The Utilities complex generates electricity, steam and hot water which are used to significant advantage in the mining-extraction operation. Suncor has examined the options to support an expanded fixed plant capacity including acquisition of external supplies of bitumen. While Suncor may be receptive to competitively-priced external sources (particularly in the period 1998 to 2001) its base strategy is for self-sufficiency for the majority of its bitumen requirements. To do otherwise would dissipate Suncor's unique energy integration advantages, its investment in Extraction and mining facilities, its technology, and the know-how and experience vested in its work force.

Steepbank Mine will contribute to the orderly development of the oil sands and to Canada's economy. In spring 1995 the Alberta Chamber of Resources National Task Force on Oil Sands Strategies published a report (Alberta Chamber of Resources, Spring 1995. The Oil Sands: A New Energy Vision for Canada) which determined that further development of the oil sands industry would have a positive impact on Canada's economy and that the industry's growth could be accomplished by a series of orderly, incremental expansions.

According to the report issued by the Task Force:

- There is an enduring market for oil sands bitumen and upgraded crude oil. Fossil fuels are expected to continue to provide transportation fuels and chemical feed stocks well into the next century for a rapidly-expanding human population.

- Markets for bitumen and upgraded crude are expanding in Canadian and United States refineries. Oil sands bitumen and upgraded crude can successfully replace and displace other sources. In particular, upgraded crude blends can now be customized to suit specific refinery needs.

- The oil sands industry is viable in an environment of low commodity prices. Existing operations are viable because infrastructure is in place and because continuous improvements have lowered production costs. Continuing application of science and technology provides opportunities for further reductions in operating and capital costs.

- The oil sands industry is one of Canada's most successful knowledge-driven industries. With reliable funding and strong, focused industry collaboration technological development will be the mainstay of risk and supply cost reduction.

- Development of the oil sands-based industry is an integral part of Canada's energy future. Bitumen and upgraded crude oil now account for 21% of Canada's total oil production.

- A significant emphasis on research is continuing 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.

The Steepbank Mine project affirms the Task Force's conclusions. Detailed planning and a comprehensive consultation program for the Steepbank Mine project have ensured the mine will be developed as a logical, orderly extension to Suncor's existing operation. New technologies will improve energy efficiencies and consolidated tailings will improve OSG's land reclamation strategy. An improved operating cost structure will provide economic stability despite fluctuating oil prices. Market analysis has ensured that customer demand for OSG's oil products is diverse and secure. And the $336 million investment, along with operational benefits associated with running a twenty-year mine, will benefit Canada's economy.

2.3 OVERVIEW OF THE STEEPBANK MINE PROCESS

Prior to any construction or mining activities land will be cleared and prepared and commercial trees will be salvaged. Wet areas will be drained, and muskeg and topsoil removed and stored for reclamation purposes. Initial access (across the Athabasca River) for early activities in 1997 and 1998 will be via ice bridges in the winter and by barge in the summer. A bridge (dedicated to this project) to carry personnel, materials, heavy equipment, utilities and pipelines is expected to be available by mid-1999.

Facilities including a truck dump, crusher, hydrotransport and utility installations, and office and maintenance shops will be complete by 2000.

Pre-stripping of overburden will begin in 2000 using truck and shovel methods. The overburden will be hauled to dump areas or to construct dykes. Later in 2000 mining of ore will begin, using the same excavation methods. Mining will occur on both sides of the river until Lease 86/17 is exhausted (at the end of 2001). Thereafter, the new Steepbank Mine will be capable of sustaining the Suncor oil sands operation at 107 kbpcd of upgraded crude oil.

Suncor is currently seeking opportunities to accelerate the bridge construction in order to advance mine start-up. This strategy would allow sooner utilization of plant capacity and realize other economic and environmental benefits.

Figure A2.0-2 depicts a simplified flow diagram for Steepbank ore. The oil sand will be removed in two to three benches (each 15 m in height) and will be hauled to truck dumps located on the pit boundary. There it will be sized to less than 400 mm and conveyed to a surge bin, which provides about 45 min of surge capacity. The oil sand is removed from the surge bin by apron feeders and is conveyed to the cyclofeeder, which mixes the oil sand in warm water to an appropriate density. Cyclofeeder outflow is screened to less than 50 mm and is then transferred to high-capacity pumps for pipelining to the Extraction plant. A rejects circuit at the cyclofeeder crushes screened material. Any larger than 50 mm is sent to rejects for disposal while the remainder is sent to the slurry pumps.

The ore slurry is pumped to the Extraction plant (a distance of about 2.5 km) in a transit time of about ten minutes. Because the ore receives sufficient conditioning in the pipeline it can now be transferred directly to separation cells (by-passing existing Extraction conditioning drums). Bitumen froth is recovered from the separation cells and transferred to secondary Extraction (where upgrader diluent is added) and the froth is cleaned of fine minerals and residual water. The product is then piped to diluted bitumen storage.

Inputs to the bitumen production process include electricity, steam and hot water from Suncor's Utilities plant and diesel fuel and diluent from Upgrading.

Tailings (coarse sand, fine minerals, water and some hydrocarbon) from the separation cells are piped to the tailings pump house for conversion to consolidated tailings and then disposed in ponds in mined-out areas. Included in the consolidated tailings will be mature fine tailings recovered from existing ponds; thus, the existing inventory of fine tailings will be converted into consolidated tailings. Water released from the consolidating tailings is recycled for re-use in the Extraction process. Consolidated tailings from Steepbank Mine will be placed in available space on the current Lease 86/17 for the first eight years of operation and then in mined areas of Steepbank Mine.

Surface reclamation occurs as areas become available. Reclamation objectives are to re-establish forest vegetation common to the area. The final landscape will be capable of developing into a self-sustaining cover of forest vegetation which will provide a range of end uses.

Steepbank Mine will produce bitumen from a large ore body that has been identified east of the Suncor operation, across the Athabasca River. A twenty-year mine strategy has been prepared which outlines development of the ore body south of the Steepbank River, taking ore from Pit 1 (Lease 97, Lot 1 and Lease 25) for the first eight years followed by ore from Pit 2 (Lease 25, Lot 3, and Lease 19) (the mining sequence is illustrated in Figure C1.0-5). The area north of the Steepbank River and the remainder of Leases 25 and 19 are available for future mining and represent resource potential for fifty or more years at 107 kbpcd.

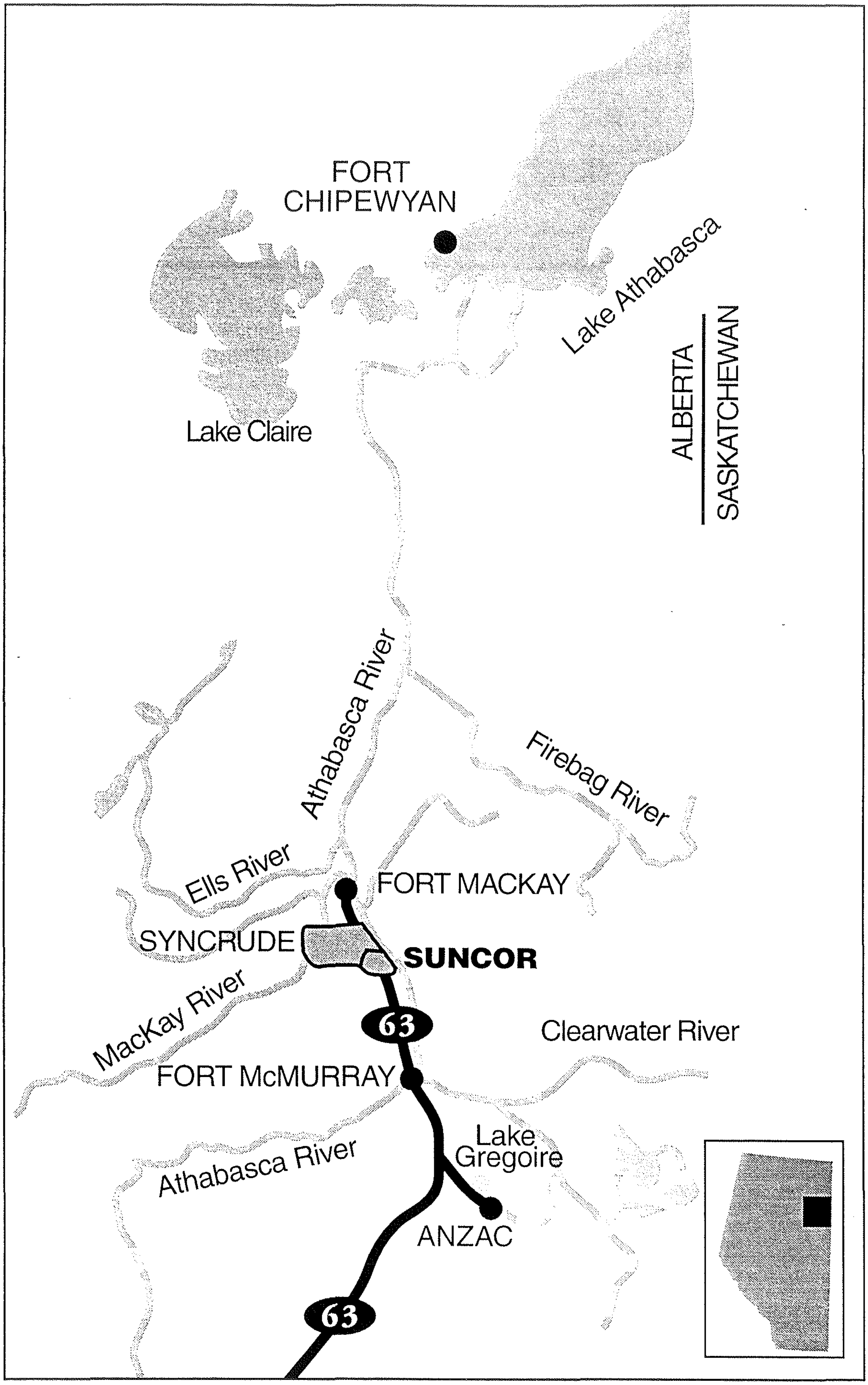
Suncor's Steepbank Mine plan recognizes the environmental sensitivity to disturbance of the areas surrounding the Steepbank and Athabasca Rivers. On the south side of the Steepbank River an undisturbed 100-m setback is maintained from the top of the escarpment. For the Athabasca River the mine plan removes 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 that the undisturbed setback from the Athabasca River exceeds 500 m along the length of Steepbank Mine, with the exception of a 2000-m length encountered in the third year of mining on Lease 97. In this area a minimum 70-m setback will be maintained. By 2009 the escarpment will be "rebuilt" with a dyke constructed from suitable overburden materials to an elevation approximately equivalent to the top of the current escarpment. The area will then be reclaimed. In the bridge access area a wildlife corridor will be provided under the bridge.

The strategy specified in this Application is the basis for the proposed mine approval. Detailed mine planning (based on substantially more core hole drilling and other information including consultation input) will optimize the strategy over the life of the mine.

Artist's renderings of Steepbank Mine for the years 2000, 2009, 2015 and 2030 are presented in Figures A2.0-3 to A2.0-6. These renderings are realistic representations of the mine strategy discussed above. Continuing revegetation and progression of waste dumps and dykes, infilling of ponds with consolidated tailings and advances of the mine and overburden faces are depicted in these figures. As well, relocation of facilities out of the river valley by 2030 is shown.

FIGURES SECTION A2.0

FIGURES



Location Map

Figure A2.0-1

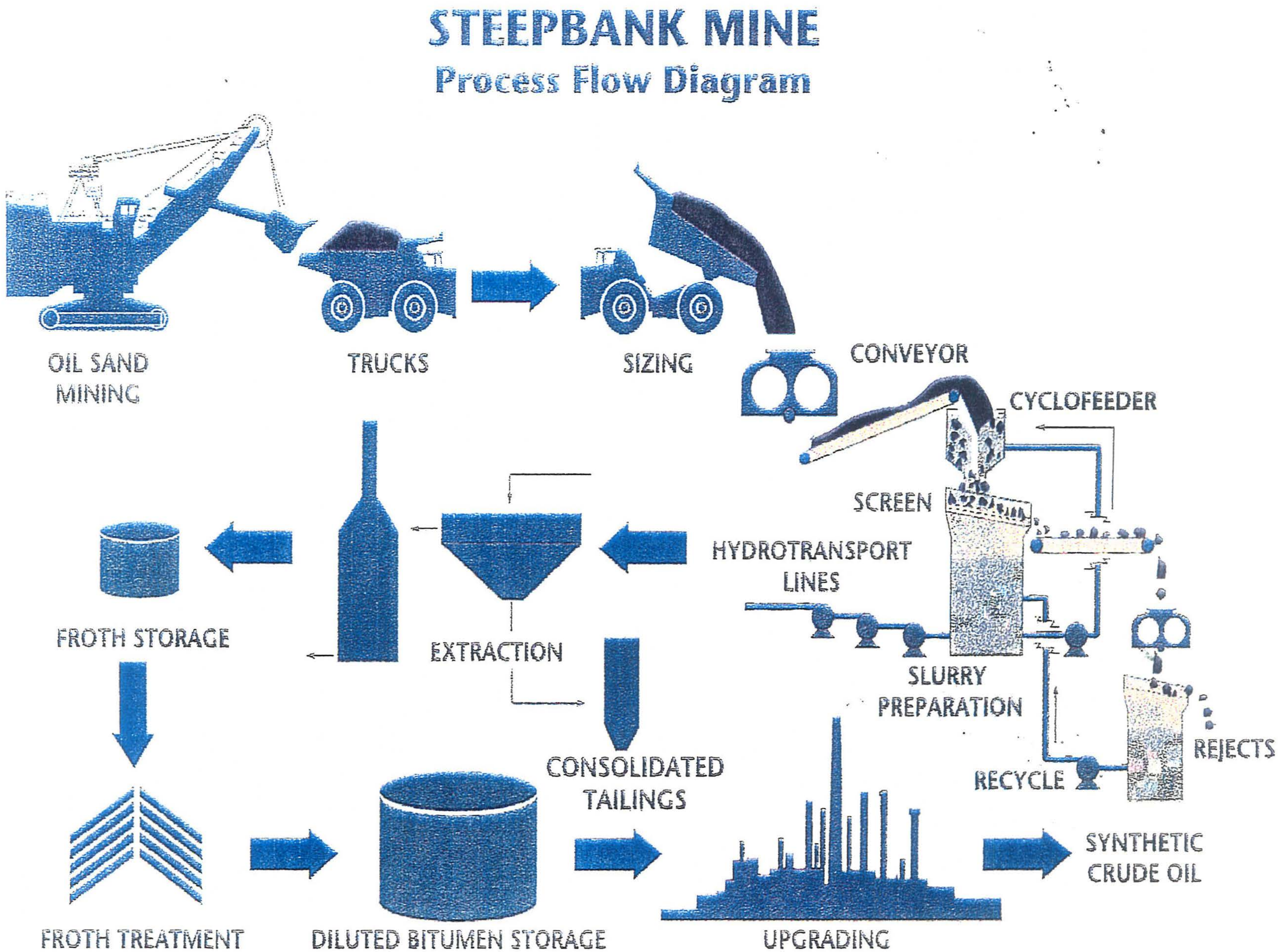

STEEPBANK MINE
Process Flow Diagram
OIL SAND MINING
TRUCKS
SIZING
CONVEYOR
CYCLOFEEDER
SCREEN
HYDROTRANSPORT LINES
SLURRY PREPARATION
REJECTS
RECYCLE
EXTRACTION
FROTH STORAGE
CONSOLIDATED TAILINGS
FROTH TREATMENT
DILUTED BITUMEN STORAGE
UPGRADING
SYNTHETIC CRUDE OIL

Figure A2.0-2

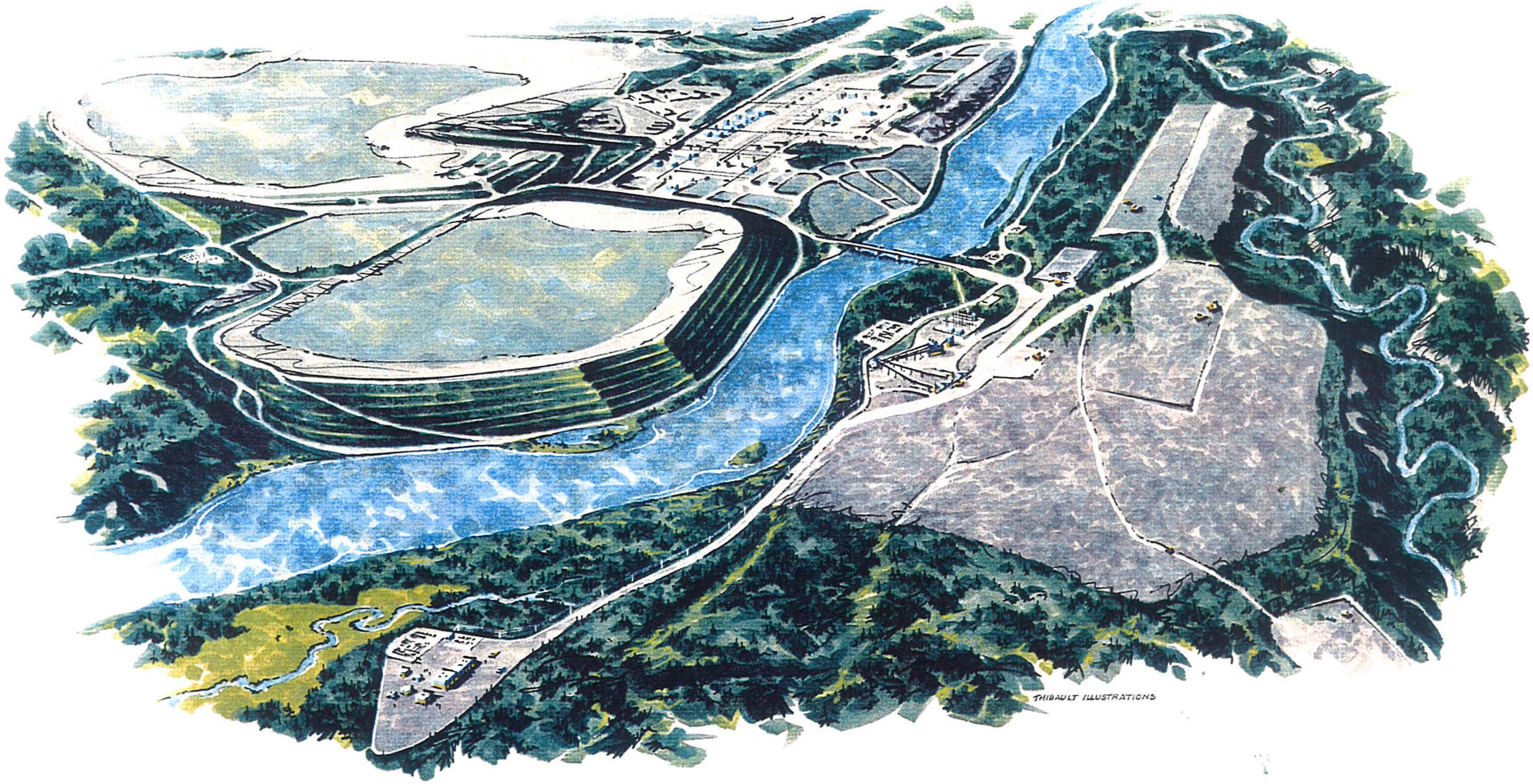


Figure A2.0-3 Steepbank Mine in Year 2000 (From South)

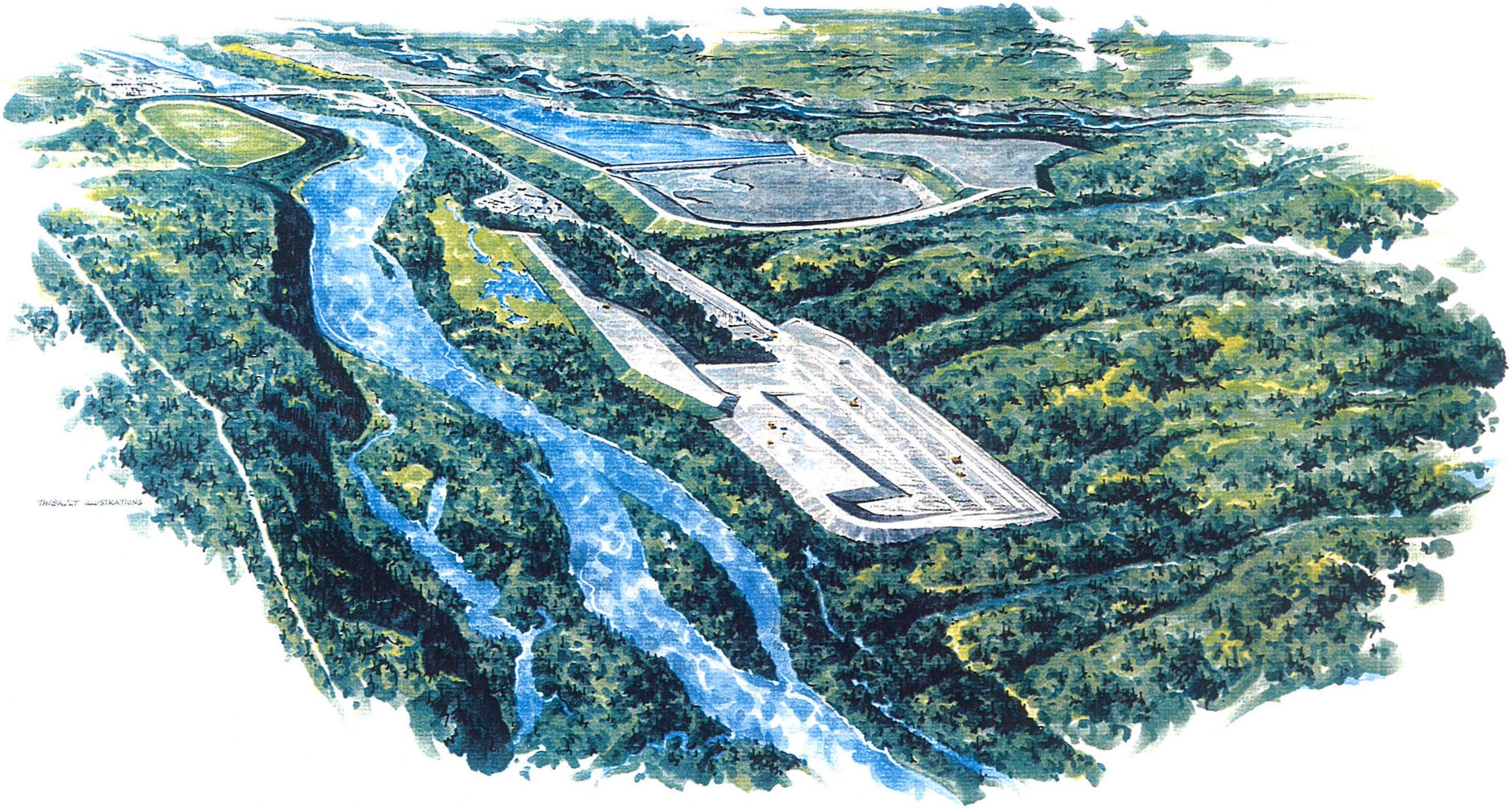


Figure A2.0-4   Steepbank Mine in Year 2009

Figure A2.0-5 Steepbank Mine in Year 2015

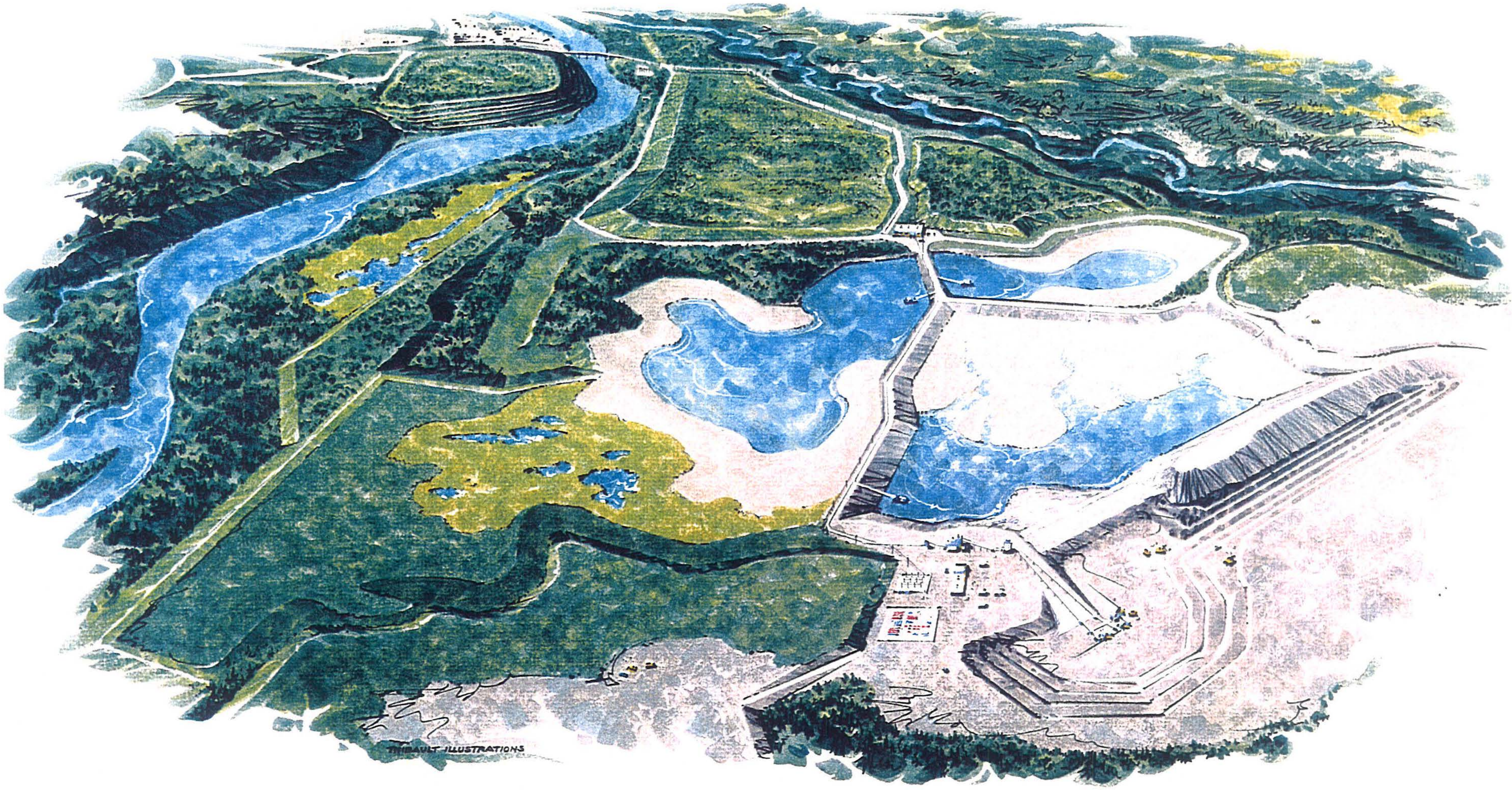


Figure A2.0-6 Steepbank Mine in Year 2030

3.0 PUBLIC CONSULTATION PROGRAM

3.1 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 individual development;
- government regulators;
- company shareholders;
- employees; and
- business associates.

The aboriginal communities in the region, as represented by First Nations and Metis governments, are essential to 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 so their needs and concerns can be reflected in how Suncor manages, plans and develops its business.*

This means that Suncor involves regional communities on an ongoing basis in discussions relating to 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's objective is to have those affected by its activities agree that the best business decisions are made after their input has been fairly considered.

3.2 DESCRIPTION OF PROGRAM

In 1994, Suncor surveyed employees, community residents, public interest groups, government, business associates and the media to assess their level of satisfaction with existing channels of communication. These groups helped establish a process for consultation on matters relating to future oil sands development.

Suncor learned that interested parties wanted more interaction with the company, especially direct access to senior decision-makers regarding the company's strategic plans. Suncor responded by expanding the responsibility of its Vice-President of Human Resources to include community affairs.

Further, it was clear that these communities did not want to be over-consulted. They wanted an effective, efficient process given the surge in public participation programs generally. Suncor adopted a menu approach, ensuring that all information was available to interested parties on all aspects of its oil sands development. Each interested community selected its areas and level of interest and a three-pronged approach to consultation was developed based on:

- informative consultation,
- continuous consultation, and
- project consultation.

- <u>Informative Consultation</u>

  To better inform the general public Suncor has held community forums, delivered twice yearly reports on future plans to 15 000 households in the region, and issued public disclosure documents outlining plans for the development of the Steepbank Mine project and the Fixed Plant Expansion project. Media releases and advertising has informed everyone concerned of Suncor's plans and how to get involved. Names and telephone numbers of contact people were provided in case more information was required. Copies of Suncor's materials are also available at the Fort McMurray Public Library and the Oil Sands Interpretive Centre.

- <u>Continuous Consultation</u>

  Several communities wanted to be more involved in Suncor's day-to-day business and strategic development. Several meetings with representatives from these communities were held to exchange information and provide input on Suncor's activities. In response to their continued interest, Suncor formed a Community Relations Committee, reporting to Vice-President, Human Resource Support and Community Affairs. This committee is responsible, on an ongoing basis, for Suncor's consultation effort with a focus on environmental performance, socio-economic matters, and health and safety.

- Project Consultation

  Project-specific relationships were developed with those communities that indicated a desire to participate in future development.

  Suncor made an early decision in a project-specific consultation to share information freely and in draft form with the widest audience possible. This would allow interested parties the maximum opportunity to provide their ideas and input for consideration by Suncor. Improvements could then be incorporated into the project. Communities have appreciated this approach and have agreed to review draft information for this purpose, knowing it may change as the project progresses. Through this process the parties have worked towards 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 to maximize the benefits for all concerned. When this Application for Approval is filed, no issue should be unresolved because of a lack of understanding of the project and of all parties needs.

For the Steepbank Mine project Suncor developed a framework which integrates community input into the Environment Impact Assessment process of project development; this framework is described in Section E1.0. Project consultation has progressed through a series of phases (from pre-feasibility to Application filing) as follows:

i. Disclosure and project concept;
ii. EIA terms of reference development;
iii. project feasibility updates and EIA issues and methods review; and
iv. EIA results and documentation.

Table A3.0-1 lists the public consultation events to mid April 1996 and indicates the individuals or groups involved in each event. This list includes activities associated with Fixed Plant Expansion Project because many of the issues were common to both projects and the EIA must address cumulative impact. Numerous other meetings were held (particularly with regulators) as part of doing business. All three forms of consultation described above are included in the table.

3.3 RESULTS OF CONSULTATION

3.3.1 Interested Groups and Communities

Suncor's prime interested groups and communities are:

- residents and leaders of the Regional Municipality of Wood Buffalo;
- residents and leaders of Fort McKay First Nation and Metis Local 122;
- residents and leaders of the community of Fort Chipewyan;

- local and provincial environmental groups, represented by the Oil Sands Environmental Coalition (OSEC) which includes:
  - The Pembina Institute for Appropriate Development,
  - Fort McMurray Environmental Association,
  - the Toxic Watch Society, and
  - the Environmental Resource Centre.

- regulatory agencies.

3.3.2 Agreements with Interested Communities

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

- Signed a Memorandum of Understanding with the Fort Chipewyan community which demonstrates the parties' commitment to developing a long-term relationship, addressing ongoing consultation, mutual respect, business development and social and cultural support.

- Developed a Memorandum of Understanding with the Fort McKay community which is not, at the time of filing this application, signed by the parties. It is hoped that this agreement will be finalized soon.

- Entered into a consultation agreement on a fee-for-service basis with the Pembina Institute for Appropriate Development to provide advice to Suncor in connection with the February 1995 application to renew Suncor's environmental operating approval under the Alberta Environmental Protection and Enhancement Act.

- Entered into consultation agreement with OSEC which defines the roles and responsibilities of each party in the pre-filing phase of the project-specific consultation process relating to the Expansion Project and the Steepbank Mine project. The agreement provides OSEC with financial support to effectively participate in this process. The objective of this agreement is to:
  - increase respective understanding,
  - improve the projects, and
  - ensure an effective, efficient regulatory review of the projects.

- Signed a two-year agreement in February 1995 with representatives of Fort McKay First Nation to provide funds for an environmental director staff position. The director is employed by Fort McKay First Nation and is a resident of the community. The director works closely with Suncor staff to review approval applications, assess environmental impacts, and ensure that Fort Mckay's needs are identified.

Suncor hopes that these agreements will lay the foundation for long-term, open, mutually beneficial relationships.

Suncor does not want its consultation relating to this project to result in economic costs to others. However, Suncor will not fund duplication. All agreements with interested parties for participation in a consultation process will be public. Suncor believes it is in everyone's best interest 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; and
- clearly define, and, if possible, resolve concerns before filing an application for approval.

3.3.3 Issues Management Database

Early in the consultation process, Suncor developed an issues management database to record questions, opportunities and concerns raised by others and to track resolution of these matters.

Issues lists were used both internally and externally to promote detailed discussion on various aspects of the proposed project and to incorporate opportunities for improvement into the final design. Many of these questions and concerns have been pursued and resolved, in large measure because of everyone's willingness to share and review draft information and participate in a constructive manner in the pre-filing consultation. Access to the Suncor database for the status of any specific issue is available on request.

To manage the large number of questions and issues raised, the database was sorted into four main areas: Human Impacts, Suncor Business Development, Environmental Impact, and Technology.

Within each grouping a list of key issues was developed. A key issue is defined as one which has a high degree of concern or interest (or both) for the community. The key issues (arranged by area) are as follows:

<u>Human Impacts</u>

- impacts on human health, primarily air and water emissions;
- opportunities for First Nation and Metis communities (employment, business development);
- development of local economic opportunities (Regional Municipality of Wood Buffalo); and
- cumulative impact on infrastructure and community services due to a number of projects underway (Suncor, Syncrude, Solv-Ex).

<u>Suncor Business Development</u>

- long-terms plans beyond Steepbank Mine; and
- alternative bitumen sources, e.g., in situ recovery.

<u>Environmental Impact</u>

- development in the river valley;
- air quality, emission level; and
- Athabasca and Steepbank Rivers ecosystem health.

Technology

- reclamation planning, particularly end land use;
- consolidated tailings technology;
- Athabasca River Bridge design and uses; and
- safety concerns regarding pipelines crossing the river.

These issues were addressed by various means: at the time raised, by follow-up, through project redesign and in the EIA.

3.4 OTHER RELATED CONSULTATION INITIATIVES

Suncor's Aboriginal Affairs staff is responsible for maintaining regular communication with aboriginal communities in the region to jointly pursue:

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

Suncor's Aboriginal Business Development Committee identifies business opportunities and works with Aboriginal communities to maximize the associated benefits for the communities.

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 an active participant on the Regional Stakeholder's Committee, chaired by Mayor Boutilier, which addresses the region's response to reduced sources of funding from external sources, particularly government. The mandate is to preserve or enhance services and programs to citizens in times of dwindling resources.

Suncor staff are currently working with regulators on the flue gas desulphurization project, operating licence renewals and the Fixed Plant Expansion Project regulatory approvals.

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

3.5 ON GOING PLANS

Suncor will continue with its open approach to public consultation. This approach has been successful, as indicated by the:

- willing participation of interested communities;
- number of requests for more detailed information;
- strong public attendance at community forums; and
- high number of opportunities and concerns identified, adopted or resolved before this application was filed.

Suncor will continue to:

- distribute the *Report to the Community* newsletter;
- hold community forums;
- meet with interested parties, both on a project-specific and continuous consultation basis,
- meet with the local MLA, MP and Chamber of Commerce; and
- host community events to explain business opportunities to the people of the region, including aboriginal businesses.

The events planned following the filing of this application are listed in Table A3.0-2. Suncor will continue to take a proactive approach to sharing information with, and seeking input from, all interested parties. Specific to the Steepbank Mine project, consultation will continue through the Application review process, mine construction and operation to ensure that the best ideas are explored and incorporated into the project.

Suncor will continue to meet with government agencies to contribute to improvements in the regulatory approval process, ensuring that the community can benefit in a meaningful way from Suncor's business success.

This integrated approval represents a new approach to regulatory approvals in Alberta. Suncor will facilitate a process which preserves the integrity of the regulatory approval regime and engages all interested parties in an effective, efficient regulatory review.

TABLE A3.0-1
PUBLIC CONSULTATION FOR STEEPBANK MINE PROJECT

Event Date	Community	Activities
December 1994	Whole Community	Survey on public consultation design
December 1994	Community of Fort McKay	General consultation
1 March 1995	Regional Municipality of Wood Buffalo	Meeting with Mayor Guy Boutilier to update him on OSG's projects
9 March 1995	AEUB/AEP	Meeting with regulators to discuss various OSG applications and Strategic Growth Opportunities
10 March 1995	Adam Germain - MLA	Meeting to update MLA on the OSG projects
16 March 1995	Chamber of Commerce	Address to the Chamber of Commerce on the status of the OSG projects
20 March 1995	Fort McKay First Nation and Metis Leaders	General consultation regarding the process groups wished to follow for further consultation and update on OSG projects
22 March 1995	OSEC	General consultation regarding the process to be used for future consultation and update on OSG projects
28 March 1995	Fort Chipewyan Community Leaders	General consultation regarding the process the group wished to follow for future consultation and a general update of OSG projects
April 1995	Whole Community	Steepbank Mine Disclosure Document issued
1 April 1995	Dave Chatters - MP	Meeting to update MP on OSG projects
6 April 1995	AEP	Meeting with Al Schulz regarding the approvals process
13 April 1995	Fort McKay First Nation and Metis Leaders	Meeting with the leaders to begin discussions on the Memorandum of Understanding
27 April 1995	Conklin Community	Meeting with community leaders to provide an update on OSG projects
28 April 1995	General Public - Fort McMurray	Open house for all OSG projects with focus on Steepbank Mine and EIA design
2 May 1995	Fort McKay First Nation and Metis Leaders	General consultation/discussion regarding the principles of consultation and reimbursement guidelines
11 May 1995	AEP/AEUB	Meeting with the regulators to discuss expansion and Steepbank Mine applications

TABLE A3.0-1
PUBLIC CONSULTATION FOR STEEPBANK MINE PROJECT

Event Date	Community	Activities
15 May 1995	Federal and Provincial Regulators	Workshop on methodology and approach for the EIA
15 May 1995	Syncrude Canada Ltd.	Meeting with Syncrude management to discuss Application items common to both companies
5 June 1995	Adam Germain - MLA	Meeting with the local MLA to update him on OSG projects
13 June 1995	Fort McKay First Nation and Metis Leaders	Continuing discussion on the Memorandum of Understanding
13 June 1995	AEP/Provincial Government Representatives	Meeting including the Energy Minister, the Environment Minister and 25 MLAs from the Standing Policy Committee to update on OSG projects and business plans
14 June 1995	OSEC	General quarterly consultation meeting and update on OSG projects
28 June 1995	Fort Chipewyan Community Leaders	General consultation discussion and final Memorandum of Understanding review
10 July 1995	Fort Chipewyan Community Leaders	Meeting with the Chiefs and Metis Leader to sign the Memorandum of Understanding between Suncor and the Community
12 July 1995	Fort Chipewyan Community Leaders	Tour of the dyke area and the mine plus a general consultation update discussion
19 July 1995	Syncrude/ Suncor	Approval Applications co-ordination
24 August 1995	Adam Germain - MLA	Meeting with Adam Germain, Grant Mitchell, Debbie Carolson, Terry Kirkland, Mike Percy and MLAs from the Liberal Party to update them on the status of the OSG projects
13 September 1995	Pembina Institute	Meeting with Rob Macintosh and Rob Hornung on environmentalists' goals, mission, views on oil sands development; definition of sustainable development and eco-efficiency; and global warming. This preceded a presentation by Pembina on Reduction of Greenhouse Gases

TABLE A3.0-1
PUBLIC CONSULTATION FOR STEEPBANK MINE PROJECT

Event Date	Community	Activities
19 September 1995	Adam Germain - MLA	Meeting to update MLA on OSG projects and business plans
3 October 1995	General Public - Fort McMurray	Public Forum (update on Steepbank Mine, expansion concept and EIA status)
15 November 1995	AEP/AEUB/ Syncrude	Senior management of each group met to discuss items of common interest in various applications from the companies
17 November 1995	Dave Chatters - MP	Meeting to update MP on OSG projects
23 November 1995	Anzac and Gregoire Lake (20 People)	Public Forum at Anzac Community Hall
1 December 1995	Fort Chipewyan	Quarterly communication meeting held with representatives from the Mikisew Cree Band, the Chipewyan Band and the Metis
11 December 1995	Fort McKay Elders First Nation	Meeting with the Elders of Fort McKay to initiate the consultation process
13 December 1995	Oil Sands Environmental Coalition (OSEC)	Update on Operating Approval, Steepbank Mine and Fixed Plant Expansion. Consultation schedule prepared together
4 January 1996	Fort McKay - Pete Ladoucer	Meeting to provide an update on projects and plan consultation schedule with Fort McKay
10 January 1996	Fort McKay - Pete Ladoucer	Planning meeting for a project description meeting and a community presentation of the projects
16 January 1996	Regulators OSEC	Project description meeting held in Edmonton
24 January 1996	Dave Chatters - MP	Meeting to review Disclosure Document and update MP on project consultation strategy
24 January 1996	Regional Municipality of Wood Buffalo	Meeting with Mayor Guy Boutilier to update both projects and schedules and to discuss consultation strategy
24 January 1996	Fort McKay First Nation	Project Description of the Fixed Plant Expansion; discussion of level of technical review desired

TABLE A3.0-1
PUBLIC CONSULTATION FOR STEEPBANK MINE PROJECT

Event Date	Community	Activities
30 January 1996	Regulators OSEC	Technical Workshops to discuss and resolve issues arising from the Fixed Plant Expansion Project prior to filing the Application
30 January 1996	Fort Chipewyan	Meeting in Fort Chipewyan with all communities to plan community presentations
6 February 1996	Environmental Resource Committee	Meeting in Fort McMurray to discuss projects with Directors of Alberta Environmental Protection and their staff
8 February 1996	Fort McKay First Nation	Community Forum for the residents of Fort MacKay to discuss the projects with Suncor people
12 February 1996	Regional Municipality of Wood Buffalo	Joint presentation with Syncrude to the "Citizens' Committee on Oil Sands Development"
13 February 1996	Fort Chipewyan	Community forum for the residents of all communities in Fort Chipewyan
14 February 1996	Regulators and OSEC	Review first draft of EIA results on Terrestrial and Valley Development
15 February 1996	Regional Municipality of Wood Buffalo	Review first draft of EIA results on socio-economic impacts
20 February 1996	Regional Municipality of Wood Buffalo	Presentation to the Regional Council to overview projects and schedule
22 February 1996	Regulators and OSEC	Review of first draft of EIA results on Eco-Health and Aquatics
26 February 1996	General Public - Fort McMurray	Review of first draft of EIA results on Human Health
27 February 1996	Regulators and OSEC	Review of first draft EIA results on Ecology and Human Health
4 March 1996	Regional Municipality of Wood Buffalo - Standing Committee on Oil Sands Development	Presentation on Suncor's response to the committee's issues
7 March 1996	Employees	*Beyond 2000* newsletter outlining the Oil Sands Group's growth and expansion plans mailed to employees

TABLE A3.0-1
PUBLIC CONSULTATION FOR STEEPBANK MINE PROJECT

Event Date	Community	Activities
7 March 1996	Oil Sands Environmental Coalition	Review of draft sections of the Fixed Plant Expansion Application
11 March 1996	Fort McKay First Nation	Meeting with Aboriginal Business Development Subcommittee in Fort MacKay to discuss business opportunities
11 March 1996	Fort McMurray Catholic School Board	Presentation on the projects focusing on community impacts, particularly on education
12 March 1996	Fort McKay First Nation	Discussion relating to their Letter of Concern written in response to the Disclosure Document for the Fixed Plant Expansion
13 March 1996	Adam Germain - MLA	Update meeting on Suncor's projects
14 March 1996	Regional Municipality of Wood Buffalo - Standing Committee on Oil Sands Development	Follow-up presentation regarding Suncor's position on committee's issues
20 March 1996	Aboriginal Business Development Subcommittee	Meeting in Conklin to discuss business opportunities
26 March 1996	Oil Sands Environmental Coalition	Review of draft application for the Fixed Plant Expansion
28 March 1996	Anzac Community	Aboriginal Business Development Subcommittee meeting in Anzac to discuss business opportunities
15 April 1996	Fort McMurray Public School Board	Presentation on Suncor's Oil Sands Group projects, focusing on community impacts and education

TABLE A3.0-2

CONTINUING PUBLIC CONSULTATION - PLANNED ACTIVITIES

Target Date	Community	Activities
April 1996	Fort McKay First Nation	Meetings to review Fixed Plant Expansion Application concerns
April 1996	Aboriginal Business Development Committee	Meetings in Janvier and Fort Chipewyan to discuss business opportunities
17 and 18 April 1996	Northern Alberta Development Committee, Northern Alberta Aboriginal Business Association, Regional Municipality of Wood Buffalo	Conference "On the Threshold" - an economic business development conference focusing on aboriginal businesses
24 April 1996	Oil Sands Environmental Coalition	Meeting to review Fixed Plant Expansion concerns
May 1996	General Public	Newsletter *Report to the Community* Issue 3
May 1996	Janvier - First Nation	Community presentation to residents on Suncor's Oil Sands Group projects
May 1996	Conklin - First Nation	Community presentation to residents on Suncor's Oil Sands Group projects
1 May 1996	Alberta Environmental Protection Energy and Utilities Board	Meeting to review Fixed Plant Expansion concerns
16 May 1996	Regional Municipality of Wood Buffalo - Standing Committee on Oil Sands Development	Presentation on Suncor's response to the committee's issues, specifically related to Steepbank Mine
May/June 1996	Prime Communities	Application reviews
September 1996	Fort McMurray Chamber of Commerce	Presentation to local business people by Suncor staff and major EPC contractors for Steepbank Mine contract work

3.0 SOCIO-ECONOMIC IMPACT ASSESSMENT

3.1 BASELINE CONDITIONS

The oil sands industry has created fundamental changes to the character and substance of the communities in the Regional Municipality of Wood Buffalo. Most of the people who were drawn to the area, or who otherwise are employed by the oil sands developments, live in the community of Fort McMurray. Other communities within the municipality include Fort MacKay, Fort Chipewyan, Anzac, Conklin and Janvier.

The population of Fort McMurray increased from about 1,100 in 1961 to 6,000 in 1971 (Suncor development period), then from 8,000 in 1973 to 24,000 in 1978 (Syncrude development period). On average, population increases during the period of Suncor development were in the 35 to 45% per year range, while during the period of Syncrude development, population increases varied from 15 to 40% per year. During those periods, Fort McMurray experienced substantial deficiencies in most community services and infrastructure, including housing, medical, retail and commercial services.

Between 1978 and 1991, the population of Fort McMurray stabilized and growth rates fell to normal provincial averages. In 1991, Fort McMurray's population was 34,705, a slight decline of 240 from the 1986 level of 34,945. During the past 10 years, the quality of life in Fort McMurray has also stabilized such that today, Fort McMurray is considered to be a mature, stable urban community.

Based on this past experience, both the oil sands industry and the regional community are sensitive to the potential effects of further oil sands development on economic and social stability, and community character.

Suncor's current work force of 1,700 workers includes 1,400 employees and approximately 300 contractors. Increases in employment related to Steepbank Mine construction will overlap with construction effects from three other projects: Suncor's Fixed Plant Expansion, construction of the Solv-Ex project and construction of Syncrude's Aurora Mine (Figure E3.0-1).

Suncor has a policy which encourages the purchase of goods and services from local vendors. Currently, Suncor spends approximately $90 million annually in the Regional Municipality for the procurement of goods and services. This amounts to about one-half of the procurements budget and this pattern is expected to continue.

3.2 SUMMARY OF ASSESSMENT RESULTS

Six impact hypotheses were developed to examine the potential socio-economic impacts of the Steepbank Mine Project (Table E2.0-2), after mitigation measures have been implemented. Each of the hypotheses is discussed briefly below. A more complete discussion of the impact analysis and baseline information is available in Impact Analysis of Socio-Economic Impacts Associated with the Steepbank Mine (Golder 1996i) as well as a series of background reports (Figure E2.0-2).

Hypothesis 1 ***The Steepbank Mine Project will contribute additional local, provincial and national benefits through additional employment, the procurement of goods and services required for the project and the payment of local, provincial and national taxes and royalties.***

Assessment: The project will provide an increase in local, provincial and national employment and economic benefits. Impacts will be positive, high severity over the short term (i.e., during the construction phase), and positive, low severity over the long term (i.e., during operations). Overall, there will be high, positive economic and employment impacts over more than one year, with local, regional and national effects.

Hypothesis 2 ***Construction-related activities and employment and the associated temporary increase in population will result in increased demands on services and infrastructure within the Regional Municipality of Wood Buffalo.***

Assessment: During construction, there will be a low impact of medium-term duration with both local and regional effects. There is a low degree of concern with respect to the construction-related effects of the Steepbank Mine project within the Regional Municipality of Wood Buffalo.

Hypothesis 3 ***Operations-related employment and the associated increase in population will result in increased demands on services and infrastructure within communities in the Regional Municipality of Wood Buffalo.***

Assessment: There will be a low increase in demand for community services and infrastructure over the long term. Effects will be both local and regional in extent. There is a low degree of concern with respect to the operations-related effects of the Steepbank Mine project within the Regional Municipality of Wood Buffalo.

Hypothesis 4 ***The social stability and quality of life of communities within Regional Municipality of Wood Buffalo will be maintained as a result of the continued operation of the Suncor project, through development of the Steepbank Mine.***

Assessment: There will be a low increase to the stability and quality of life over the medium term within both the local and regional areas. There is a low degree of concern with respect to the Steepbank Mine's effects on the communities of Wood Buffalo.

Hypothesis 5 ***The Steepbank project will contribute to a loss in the traditional resource base of the Fort MacKay community and displace some traditional activities.***

Assessment: During mine operations existing traditional resource use will be displaced. After mine reclamation traditional resource use potential will be restored. There is a high degree of concern for the traditional land use of areas to be occupied by the Steepbank Mine, but low for the remainder of the study area.

Hypothesis 6 ***The cumulative demands from the Suncor, Solv-Ex, and Syncrude Canada Ltd. projects combined with the expected demands from existing populations within the Regional Municipality of Wood Buffalo will result in increased demands on local communities and affect the quality of life of those communities.***

Assessment: There will be a low incremental demand on community services, with a long term effect in both the local and regional context. There is a low degree of concern with respect to the cumulative effects of industry development in the area.

3.3 DISCUSSION OF ASSESSMENT RESULTS

The Suncor Steepbank Mine project will result in a number of socio-economic changes in the area. Below is a brief discussion of those anticipated changes, and the measures Suncor will implement to minimize impacts which may have negative implications to the community.

3.3.1 Employment

The construction phase of the Steepbank Mine project will provide 1,040 person-years of employment over the 1996-2000 period, with the maximum number of construction workers estimated at 435 in late 1999 (Table E3.0-1).

TABLE E3.0-1

STEEPBANK MINE PROJECT CONSTRUCTION PHASE EMPLOYMENT EFFECTS

(work-years)

Employment Category	Employment		
	Total	Alberta	Other Canada
Direct Employment:			
Project Employment	1,040	936	104
From Direct Project Purchases[a]	1,570	1045	525
Indirect Employment[b]	1,700	825	875
Induced Employment[c]	1,550	750	800
Totals	5,860 (100%)	3,556 (61%)	2,300 (39%)

a Employment of first round suppliers of goods and services.

b Employment of second and subsequent round suppliers.

c Employment effect of activity due to spending and respending of incremental household incomes.

This peak in construction labour for the Steepbank Mine project is preceded by earlier construction labour force demands for the Solv-Ex construction (peak phase from 1996 - 1998) and the Suncor Fixed Plant Expansion with a peak of 400 workers in 1997. Syncrude's Aurora Mine peak construction labour force will largely coincide with the Steepbank Mine construction, with a peak labour force demand of 475 workers in 2000. Figure E3.0-1 illustrates the cumulative effects of the construction labour force demands for the Aurora Mine, Fixed Plant Expansion, Solv-Ex and Steepbank Mine projects.

Suncor and other industry operators recognize the importance of avoiding a boom/bust scenario of construction-related employment. Suncor will minimize the potential negative effects on the community caused by its temporary workforce by maximizing the employment of local residents, and housing non-local construction labour in a residential camp. Suncor will work together with Syncrude, Solv-Ex and the Regional Municipality of Wood Buffalo Standing Committee on Oil Sands Development to coordinate activities. Despite these mitigations, increased demand for temporary services (e.g., restaurant meals, accommodation, transportation) will be experienced by the community during construction.

During the operational phase of the Suncor projects (i.e., to 2020), project employment and direct suppliers of goods and services will maintain an average of 2,650 jobs per year, for a total of approximately 66,000 work-years of employment (Table E3.0-2). In addition, indirect employment is expected to maintain approximately 635 jobs per year (almost 16,000 over the project's life) and a further 1,475 jobs per year of induced employment (almost 37,000 work-years from 1996 to 2020).

TABLE E3.0-2

STEEPBANK MINE PROJECT OPERATING PHASE EMPLOYMENT EFFECTS - TOTAL SUNCOR FACILITY (Total Work-years, 1996 to 2020)

Employment Category	Employment		
	Total	Alberta	Other Canada
Direct Employment:			
Project Employment	42,500	42,500	--
From Direct Project Purchases[a]	23,515	21,840	1,670
Indirect Employment[b]	15,830	6,530	9,300
Induced Employment[c]	36,835	24,035	12,805
Totals	118,680 (100%)	94,905 (80%)	23,775 (20%)

[a] Employment of first round suppliers of goods and services.

[b] Employment of second and subsequent round suppliers.

[c] Employment effect of activity due to spending and respending of incremental household incomes.

To enhance the opportunities for local residents to obtain employment, Suncor will continue to give hiring preference to local residents and suppliers.

3.3.2 Capital Costs, Procurement and Economic Contributions

Assuming project approval in early 1997, construction of the Steepbank Mine will require direct expenditures of $336 million between 1997 and 2001. Nearly 60% ($200 million) is expected to be spent in Alberta. Operations of the Steepbank Mine are expected to require a total of $6.4 billion ($1995) in operating expenditures over the period from 1996 to 2020.

To enhance the involvement of local businesses in the provision of goods and services (currently valued at $90 Million) for the Steepbank Mine Project, Suncor has, and will continue to work with local groups (e.g., Aboriginal Business Development Committee, Chamber of Commerce) to ensure they are aware of opportunities and are well positioned to participate.

3.3.3 Support Services and Demands, and Contribution to the Public Economy

At the height of the Steepbank Mine construction (in 1999), the population of Fort McMurray is expected to increase by 711, in a community of 34,700 (2% of the population). Most construction workers will be housed at the Suncor construction camp and other than use of recreation and entertainment services, little demand on community services is anticipated.

The operation of the Steepbank Mine is expected to result in a population increase of 350, with this growth starting in 2007. This level of population growth for the operational phase represents a growth rate of less than 1%.

As the municipal infrastructure of the urban service area of Fort McMurray is well developed, the anticipated population increase will not require significant capital expenditures. The existing industrial park, the newest housing sub-division (Timberlea) and the water and sewage plants are sufficient to handle the level of growth anticipated. Discussions with RCMP representatives indicate that the city is adequately policed and few additional law enforcement-related problems are expected.

Demand on roads and transportation is estimated to increase by 1 to 2% on Highway 63 north of Fort McMurray during construction. Additional transportation of employees and contractors is estimated to result in a 1% increase in bus traffic and a 1.5% increase in private vehicle traffic. Effects on transportation infrastructure will be minimized by Suncor's continuing policy of busing workers to the site, and working with the Regional Municipality of Wood Buffalo and Alberta Transportation to monitor and address any Highway 63 issues related to the Steepbank Mine project.

Taxes generated by the construction of the Steepbank Mine and operation of the Suncor facility over the 1996-2020 period will total approximately $3.5 billion (undiscounted $ 1995). Over $1.2 billion of this will accrue to Alberta. The Alberta municipal tax revenue of $305 million during this period, will be paid directly by Suncor (Table E3.0-3). Revenues to governments will also include royalties. These royalties will be substantial, but can not be calculated at this time.

TABLE E3.0-3

STEEPBANK MINE PROJECT: FEDERAL/PROVINCIAL/MUNICIPAL TAX GENERATION, TOTAL SUNCOR FACILITY (1996 to 2020)

(Millions $1995)

	Canada	Federal	Alberta	Other Provinces
Personal Income Taxes	1,988	1,074	759	155
Corporate Income Taxes	221	155	55	11
Indirect Taxes (federal and provincial)	957	392	94	471
Indirect Taxes (municipal)	368	--	305	63
Totals	3,534	1,621	1,213	700

3.3.4 Quality of Life

Fort McMurray experienced population increases as high as 45% per year during the construction of the original Suncor and Syncrude plants. Substantial deficiencies in most community services and infrastructure were experienced at that time. Over the past 15 years, however, Fort McMurray has developed into a stable, fully-serviced community of 35,000 with a high quality of life. Changes to quality of life are generally a result of substantial relative changes in population size or the nature and characteristics of the population. The population change from the Steepbank Mine Project is expected to be small.

Potential impacts from Steepbank Mine operations are expected to be low, given that the mine development is intended as a replacement for the existing mining operation. Suncor recognizes that a prosperous, stable and healthy community is essential to the quality of life of the company's employees and their families and is required to retain a highly skilled and capable workforce. Suncor will continue to work with local groups and agencies, meet regularly with political representatives, support local initiatives through its corporate donations program, and encourage its employees' contributions to social, recreational and other volunteer activities.

The additional employment created by the Steepbank Mine is expected to increase the population within Fort McMurray less than 1%, and local service agencies have indicated existing services and infrastructure have sufficient capacity to accommodate this growth. Community representatives have indicated that the continuation of employment will reinforce the existing high quality of life which exists within the Fort McMurray area.

The region can accommodate cumulative effects of the Suncor project, Solv-Ex and proposed Aurora mine. Any negative impact of the projects on the quality of life is expected to be small. Community residents have been anticipating these projects and that sentiment has contributed to the sense of community and economic stability which now exists in Fort McMurray.

To enhance the ability of the aboriginal community members to obtain work and business opportunities with Suncor, the company will promote aboriginal training and hiring, and sponsor summer employment programs for aboriginal students.

3.3.5 Traditional and Other Land Uses

The Steepbank Mine area is located within the Fort McKay First Nation's traditional resource use area. Traditional land uses within the region include hunting, trapping, fishing, berry picking and gathering of herbs, medicinal plants and food. Two trappers will be displaced from traplines which are situated on the Steepbank Mine site, and agreements have been reached to compensate them for this loss.

Recreational activities on the site have been limited because of difficult site access. Forestry harvesting in the area has been initiated, and remaining timber will be harvested during mine clearing.

Suncor is committed to continuing dialogue with the Fort McKay First Nation to identify appropriate mechanisms for protecting traditional resource use. In the long term, the use of dry landscape reclamation will provide flexibility in creating landscapes with a variety of land use opportunities. Suncor will involve traditional users in defining the desired characteristics of the reclaimed landscapes.

3.4 MONITORING

Monitoring of socio-economic parameters will enable Suncor and the Regional Municipality to identify potential problems or opportunities and develop actions to address emerging issues, and enhance local benefits. The Regional Municipality of Wood Buffalo Standing Committee on Oil Sands Development is expected to take a lead role in identifying issues and actions. Suncor can assist in this process by monitoring project parameters (e.g., construction and operation work force numbers and originating communities, Highway 63 traffic, employment and business opportunities) and providing that information to the Committee for distribution within the community and to service agencies.

FIGURES SECTION E3.0

FIGURES

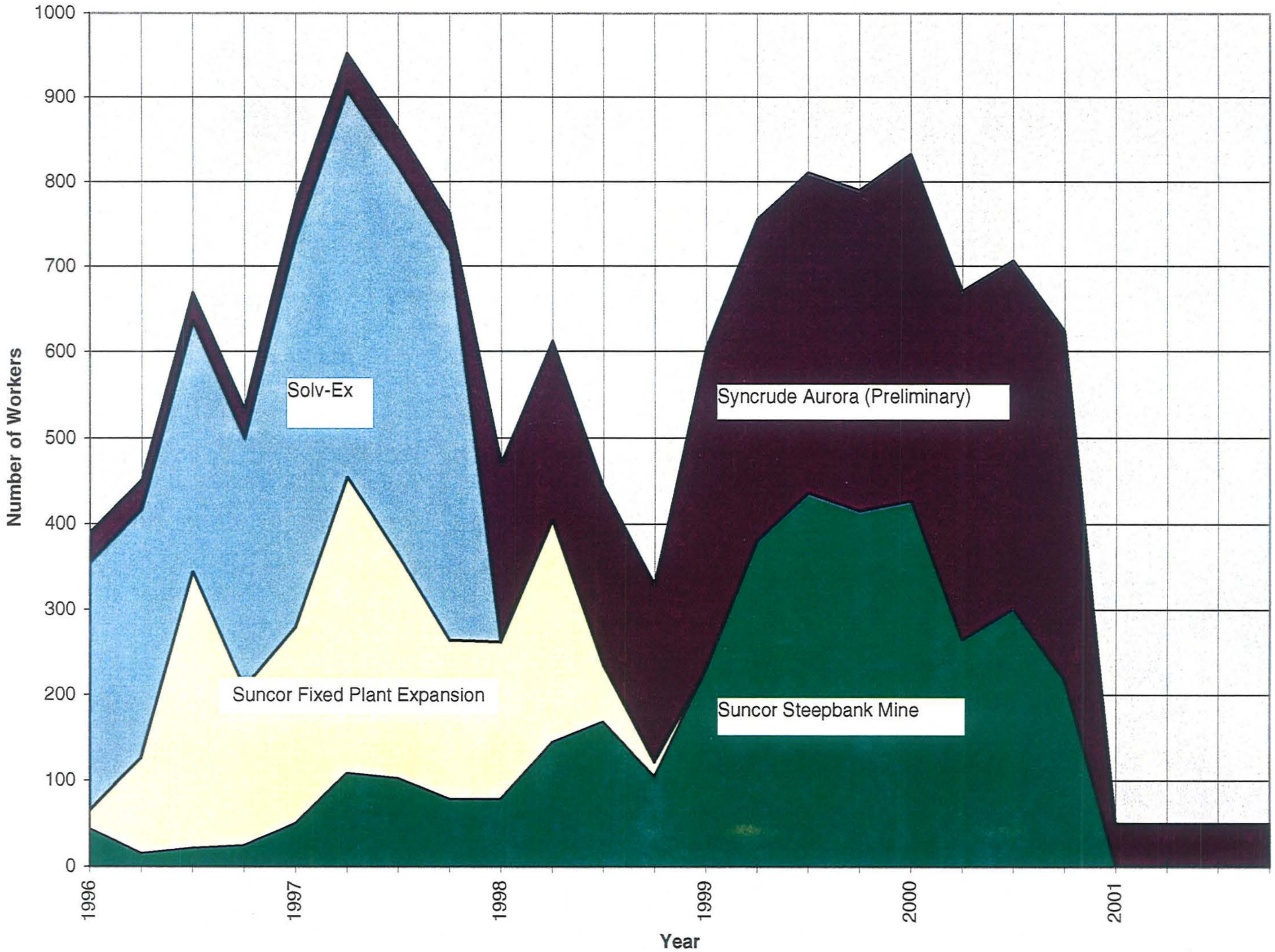


Figure E3.0-1 Cumulative Peak Construction Work Force

4.0 SUMMARY OF ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACT ASSESSMENT

4.1 INTRODUCTION

The Steepbank Mine Environmental Impact Assessment (EIA) was prepared to assess the impacts associated with the development, operation and reclamation of the Steepbank Mine, reclamation of Lease 86/17 and the net impacts associated with increasing plant production of upgraded crude oil to 107 kbpcd. It predicted impacts which could result from the projects, identified mitigations to avoid or reduce those impacts, and evaluated the residual effects. The EIA was conducted over a period of 18 months, and focussed primarily on issues raised by communities. It describes the assumptions used, is quantitative wherever possible, and explains the effects of Suncor's development in a regional perspective. In doing the regional impact analysis, cumulative effects of other oil sands developers (Syncrude and Solv-Ex) and forest harvesting (Al-Pac and Northlands) were also considered.

This section (A4.0) summarizes the environmental impact analysis and mitigation plans which are presented in Section E of this document and in greater detail in Impact Analysis reports that are referenced in this Application.

The EIA investigations focused on addressing the key concerns identified by the public and regulators. It also considered Alberta land use guidelines (draft Integrated Resource Plan for the Athabasca River corridor). Key concerns include:

- economic and employment opportunities for aboriginal communities;
- opportunities for local businesses;
- cumulative impacts on infrastructures and community services in the Regional Municipality of Wood Buffalo;
- effects on traditional uses and historical resources;
- health protection of local and regional residents and Suncor's employees;
- 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 populations, and the possibility that Suncor's river valley development could affect wildlife movement along the Athabasca River;
- protection of water quality;
- aquatic ecosystem health in the Athabasca and Steepbank Rivers; and
- effect of production increases on local and regional air quality.

4.2 SOCIO-ECONOMIC IMPACT ANALYSIS

Development and operations of Steepbank Mine will provide a number of economic benefits to the Wood Buffalo region, the Province of Alberta and to Canada. Development of the Steepbank Mine project will provide approximately 1000 work years of employment during construction, with a peak requirement of 435 jobs in 1999. Of importance to the Regional Municipality of Wood Buffalo and to Fort McMurray, operation of the Steepbank Mine will provide the continued employment of 1700 people (1400 Suncor employees and 300 contractors), as well as provide additional employment for an estimated 100 employees by the year 2010.

The additional employment created by the Steepbank Mine is expected to increase the population within Fort McMurray less than 1%, and local service agencies have indicated existing services and infrastructure have sufficient capacity to accommodate this growth. Community representatives have indicated that the continuation of employment will reinforce the existing high quality of life which exists within the Fort McMurray area.

Development of Steepbank Mine is expected to cost approximately $336 million ($1996), and over the life of the mine, $6.4 billion will be spent on operating costs. These expenditures will create sizeable benefits for Alberta and Canada. Development expenditures have been estimated to generate $324 million in income within the Canadian economy and $209 million (65%) within the Alberta economy. Operating expenditures have been estimated to generate income of over $7 billion within the Canadian economy, with $5.8 billion (84%) in Alberta. In addition to purchases of goods and services, Suncor will continue to pay taxes to all levels of government and royalties to the Province of Alberta. Municipal taxes paid by the Suncor Steepbank project over its 25-year life have been estimated at approximately $300 million.

Suncor has a purchasing policy which encourages the supply of goods and services from local suppliers. Currently, Suncor spends approximately half its annual goods and services procurement budget within the Fort McMurray area ($90 million per year). This pattern is expected to continue through the Steepbank operations.

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

- provide housing for temporary construction labour force in a camp;

- work actively with Fort McKay, Fort Chipewyan and other local aboriginal communities to develop business opportunities in both the near and long term, and maximize employment and training opportunities;
- maximize hiring of local residents in its workforce;
- give preference to local suppliers and contractors when purchasing goods and services;
- work actively with local organizations like the Regional Municipality of Wood Buffalo and other community organizations to minimize potential community impacts; and
- co-ordinate activities with others on the Standing Committee on Oil Sands Development to minimize cumulative effects of industrial development.

The Steepbank Mine project will have substantial and positive economic impacts to the local communities, particularly when compared to the alternative of depletion of ore reserves in the existing mine, and retirement of the existing Suncor facility.

4.3 TRADITIONAL LAND USE

Steepbank Mine will impact existing traditional land uses on Leases 97, 19 and 25. A traditional use study of Steepbank Mine, undertaken by the Community of Fort McKay, confirmed that there are direct, on-site traditional uses of the area. Meanwhile, reclamation of Lease 86/17 will restore mined areas to landscapes suitable for a variety of land uses, including traditional land use.

Suncor will mitigate the impacts of Steepbank Mine development to existing land uses by:

- reaching an agreement with trappers who will be displaced from their traplines (completed); and
- using dry landscape reclamation so that traditional use of the land can be restored on all leases.

Suncor is committed to working with aboriginal communities in the region to design a final reclamation landscape that is sustainable and productive from a traditional use perspective.

4.4 HEALTH IMPACT ANALYSIS

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

Project-related activities that could possibly affect community health include changes in air and water emissions and chemicals associated with the reclaimed landscape.

To protect human health, Suncor will:

- improve most air emissions levels, especially for parameters that have potential consequences to human health;
- design and develop reclaimed landscapes that are safe for future users of the land. This will include early development of a demonstration landscape to provide additional data about CT reclamation;
- manage water discharges to ensure potential downstream water uses are protected; and
- participate in the Fort McMurray regional health study.

A health impact analysis of existing and future potential water discharges indicates these releases will not adversely affect downstream users. A similar analysis of the CT reclaimed landscape indicated health concerns to be very low, however the potential bio-accumulation of metals through vegetation to wildlife and humans needs to be further evaluated through field studies. The substantial reduction in air emissions will improve air quality. This in turn should reduce further concerns about air quality health impacts. The direct assessment of existing air quality health impacts will be monitored through the Regional Health Study.

4.5 TERRESTRIAL RESOURCE IMPACTS

The terrestrial environment (i.e., landforms, soils and vegetation) on the east side of the Athabasca River will be affected by the following mine development activities:

- construction of the access bridge;
- placement of ore transport facilities (truck dump and hydrotransport system), shop area, conveyors and infrastructure in the Athabasca River valley;
- mining of the Athabasca River escarpment and uplands;
- alterations to drainages on Lease 97, 19 and 25; and
- overburden disposal on the Athabasca River floodplain.

Suncor will implement mitigating measures to minimize the extent of landform and vegetation impacts, including:

- no disturbance of the Steepbank River valley;
- maintaining a natural vegetation buffer along the Steepbank Valley escarpment and the Athabasca River bank. Some reduction in buffer width will be required in the vicinity of the bridge, barge landing and along limited sections of the access road;
- minimizing overburden placement in the river valley so that the loss of Shipyard Lake wetlands area is small; new wetlands will be developed as part of the upland reclamation;
- replacing the mined area of the Athabasca River escarpment with overburden dykes (not sand) which allows for more rapid and effective revegetation;
- contouring dyke and storage area slopes where possible;
- restoring vegetation on the overburden dykes to a diversity and community type compatible with non-disturbed vegetation communities;
- managing flows into Shipyard Lake during mine operations to protect water quality and restoring natural drainage to this wetlands in the long term;
- adopting a dry landscape reclamation strategy through the implementation of Consolidated Tailings (CT) technology for fine tails; and
- moving all infrastructure, except the mine access road and bridge, from the Athabasca River valley by the year 2030.

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 is disposed.

Revegetation of the disturbed areas will restore pre-development diversity and vegetation community types. It will, however, take some time for vegetation communities to advance into mature balsam poplar and white spruce forests.

The vegetation buffers and setbacks from the Athabasca River will minimize the visual impact of the development during mine operations. With removal of facilities out of the river valley by 2030, the only notable long-term visual impact will be the bridge and existing operations on the west bank of the river.

Overall reclamation of Steepbank Mine 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 likely will be more deciduous forest and wetlands, and less peatlands. There is flexibility to adjust the mix of habitat types to meet preferences of land users and maintain sustainable ecosystems at the regional level.

The overall size of Shipyard Lake wetlands will be reduced from 150 to 110 hectares, however, its supply of fresh water will be maintained in both the short and long term. Although the Shipyard Lake wetlands habitat will be reduced, there will be an increase in wetlands habitat in the upland reclamation areas. In terms of a more regional context, this wetlands is not unique within the Athabasca River corridor.

After considering the primary mitigations noted above, and other mitigative measures explained in Section E and the detailed Impact Analysis reports, the project's impact on the terrestrial environment is generally considered to be moderate during the operation period, and low following final reclamation. None of the terrestrial impacts are regionally significant.

4.6 WILDLIFE HABITATS AND POPULATION IMPACTS

The upland Boreal forest ecosystem in the vicinity of Suncor's existing and proposed mines 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 overwintering habitat for moose and wolves.

Potential effects on wildlife populations due to Steepbank Mine, Lease 86/17 and production expansion developments could include:

- direct loss of habitat, especially high value habitats in the valleys of the Athabasca and Steepbank Rivers;
- fragmentation of habitats by restricting wildlife movement along the river valley;
- direct mortality during clearing and overburden removal; and
- accumulation of contaminants from plant air emissions and CT in plants and animals.

Some of the major wildlife impact mitigations that will be implemented by Suncor include:

- avoiding development in the Steepbank River valley or its escarpment;
- rapidly reclaiming disturbed vegetation, especially deciduous and mixed-wood communities;
- reclaiming CT landforms back to a mixture of wetlands and stands of deciduous and mixed-wood coniferous forests;
- maintaining vegetation buffers along the Athabasca River;
- incorporating a wildlife by-pass at the bridge; and
- reducing SO_2, particulate and hydrocarbon air emissions, and soil capping of CT deposits.

During the operational phase of Steepbank Mine, there will be a moderate local impact on wildlife populations caused by habitat loss from the mine's surface disturbance and placement of facilities, particularly in the river valley. Fortunately, the Athabasca River valley in the vicinity of Suncor does not provide a major movement corridor for overwintering moose and wolves, so the impact of the bridge and the valley infrastructure on wildlife movement should be minimal. A wildlife underpass will, however, be developed to ensure options for future wildlife movement. Improved air emissions from the Suncor plant should reduce potential habitat impacts due to vegetation stress.

In the longer term, reclamation of the river valley dykes and the CT deposits with a relatively high proportion of deciduous and mixed wood forest will restore the overall quality of habitat conditions for most species. On a regional basis, the combined reclamation and revegetation activities of the oil sands and forestry industries could actually enhance regional population levels of some species -- moose, for example -- with regional integration of reclamation and reforestation.

Projections of contaminant accumulation in plants and animals and associated toxicity due to use of CT as a reclamation material indicates a low potential for impact on wildlife populations. Large scale field demonstrations are planned to confirm this expectation.

4.7 ATHABASCA RIVER WATER QUALITY AND AQUATICS ECOSYSTEM IMPACTS

Studies conducted by the Northern River Basins Study (NRBS) indicate water quality in the oil sands reach of the Athabasca River is not generally impaired by upstream industrial and municipal developments. Investigations to identify the prevalence and potential cause of fish tainting from upgrader effluent are continuing. Aboriginal communities currently limit their catch of fish from the river because of concerns about poor taste. The Alberta Government advises limited consumption of river fish due to elevated mercury levels, however the mercury advisory is common to many Alberta rivers. The mercury source is thought to be natural.

Specific NRBS studies, done in collaboration with Suncor, found that fish in the lower Athabasca River have moderately elevated liver enzyme levels, which indicates that they are metabolizing and excreting hydrocarbons. Studies conducted as part of the Steepbank Mine EIA indicate the liver enzyme induction is caused primarily by the natural background hydrocarbon levels in the region and is not impairing fish health.

Potential effects to Athabasca River water quality, fish habitat or aquatic ecosystem health that could result from Suncor activities include:

- reduced river flows caused by river water withdrawal or diversion of natural groundwater or surface water flows from the mined leases;
- physical habitat impacts resulting from construction of access roads, barge facilities or placement of the bridge piers;
- sedimentation caused by mine site and river valley soil erosion;
- accidental spills from the hydrotransport system and other pipelines crossing the bridge;
- water quality changes resulting from release of operational (mine water, treated sewage and treated wastewaters) and reclamation (reclamation landform seepage and run-off) waters to the Athabasca and Steepbank Rivers; and
- impacts resulting from drainage changes to Leggett and Wood Creeks, plus Unnamed Creek which drains to Shipyard Lake.

Mitigating measures that Suncor will implement to protect the aquatic habitats and water quality include:

- collecting all Steepbank Mine affected waters for return to Lease 86/17 and use as Extraction water;
- maintaining freshwater flows to Shipyard Lake during mine operations and long term re-development of surface drainages;
- maximum recycling of CT drainage waters back to the plant so that water withdrawal and effluent discharge to the Athabasca River can be minimized;
- improving the Upgrading and Utilities wastewater treatment system, including increased recycling of cooling water and eliminating some wastewater sources;
- designing the bridge deck and pipelines crossing the river to contain and collect any accidental spills;
- maintaining vegetation buffers along the Athabasca and Steepbank Rivers to control mine erosion;
- designing cofferdams and timing bridge pier construction to minimize impacts to fish; and
- developing a long-term reclamation drainage plan that maximizes the potential for natural treatment of run-off and seepage waters; and
- rapid revegetation of land disturbances for erosion control.

Water releases and aquatic habitat changes associated with Suncor's proposed development will not impair Athabasca River water quality, reduce fish abundance or affect aquatic ecosystem health. Downstream users will not be affected. The reduction of surface run-off and groundwater flows to the Athabasca and Steepbank Rivers during mine operation is negligible and will not affect fish habitat.

Similarly, bridge pier construction effects to fish habitat will be minimal and will not affect fish populations.

The wastewater effluent potential for tainting may be reduced by changes to the wastewater treatment system proposed as part of the Fixed Plant Expansion. Meanwhile, further investigation for the cause and extent of potential tainting compounds is being undertaken.

4.8 AIR QUALITY IMPACTS

Community concerns about air emissions from the Suncor facility focused on

- greenhouse gas emissions (i.e., CO_2);
- sulphur dioxide (SO_2), which can acidify surrounding soils and water bodies, and directly affect vegetation and human health;
- nitrogen oxides (NO_x), which contribute to ground-level ozone;
- hydrocarbon emissions which include volatile organic compounds (VOCs) which could cause odours, health impacts and ozone generation;
- sulphur compounds which could cause odours; and
- particulate emissions, which could affect vegetation and human health.

Through its program of continuous reduction of air emissions, Suncor will be able to reduce, or hold constant, air emissions from the plant even with the production expansion to 107 kbpcd -- an increase by more than one third. Major facility improvements (e.g., Flue Gas Desulphurization; improved diluent recovery) will enable the following achievements:

- SO_2 emissions will decrease to 22% of current levels;
- NO_x emissions will decrease to 97% of current levels;
- CO_2 levels will increase 1% - 2% above current levels;
- VOC emissions will decrease to 31% of current levels; and
- particulates from source emissions will decrease to 22% of current levels.

The air emission improvements summarized above will result in improved air quality in the vicinity of the Suncor plant and the oil sands region. Off-site odours should be reduced as a result of the odour abatement program. The Naphtha Recovery Unit will be modified so that diluent losses to ponds are no more at 107 kbpcd than at 79.5 kbpcd. The implementation of the Flue Gas Desulfurization (FGD) unit on the main stack will greatly reduce SO_2 and particulate emissions, thereby reducing potential impacts to soils, vegetation and associated contaminant impacts. In the long term, concerns about fugitive hydrocarbon emissions from the tailing ponds will be reduced by adoption of CT technology; the full extent of the improvement can only be estimated after the technology has been fully implemented and monitored. Suncor is a participant in Canada's "Climate Change Voluntary Challenge and Registry Program" and is committed to restricting its greenhouse gas emissions at or below the 1990 level, even with the production expansion.

4.9 HISTORIC RESOURCES IMPACTS

Extensive on-site surveys of the area to be affected by Steepbank Mine development located two sites where isolated cultural artifacts were subsequently found. The potential for significant undiscovered sites within the area is limited and further mitigation requirements prior to mining are not considered necessary.

Suncor will assess and evaluate archaeological sites that are identified during construction and mining operations.

4.10 SUMMARY CONCLUSION

Suncor is committed to implementing mitigating measures that will ensure that the development of the Steepbank Mine, reclamation of Lease 86/17 and the Fixed Plant Expansion will not create significant impacts. There will be low to moderate local impacts during project construction and operation, however, these are to be expected for a resource development project of this scale. The Integrated Resource Plan guidelines for Athabasca River valley development can be satisfied. Reclamation of areas disturbed by mining activities will restore the Lease 86/17 and Steepbank mines to biologically productive and diverse landscapes. Because there is flexibility in reclamation options, future land users will be invited to participate in setting the long term reclamation goals.

5.0 APPROVALS GUIDE AND APPLICATION DESCRIPTION

5.1 APPLICATION SCOPE AND PURPOSE

Suncor Inc., Oil Sands Group is applying for approval to construct and operate the proposed Steepbank Mine and to make necessary modifications in access, ore transport, extraction, and tailings handling to sustain an increase in production to 6 209 000 m^3 of synthetic crude oil and other oil sands products in each calendar year from its oil sands operation north of Fort McMurray. Secondly, approval is sought for the operation of the proposed Steepbank Mine, based on a twenty-year mine plan. Thirdly, this Application seeks approval for the integrated conceptual reclamation plan for Lease 86/17 within the area of the existing approval scheme and the proposed Steepbank Mine.

The new mine would begin operation by the year 2000 and would reach full capacity by 2001, by which time the reserves in the current mine on Lease 86/17 will be exhausted.

This Application describes the current operation and provides details of the proposed Steepbank Mine development and its incremental impacts. The downstream boundary of the Steepbank project is the inlet of the diluted bitumen transfer line at the oil sands plant. From there the bitumen product is transferred to the Upgrading plant at Suncor's oil sands operation.

5.2 REFERENCE TO APPLICABLE LEGISLATION

5.2.1 This Application

This application seeks approval from the Alberta Energy and Utilities Board (AEUB) and Alberta Environmental Protection (AEP) for both the construction and operation of the proposed Steepbank Mine and reclamation of Steepbank Mine integrated with reclamation of the current Lease 86/17 mine in accordance with the following legislation:

- Review and acceptance of Steepbank Mine Environmental Impact Assessment Report by the Director of the Environmental Assessment Division, AEP; under AEPEA;
- Amendment of Approval No. 7632 (as amended) under the Alberta *Oil Sands Conservation Act* (OSCA);
- Amendment of the existing Approval under the (EPEA) (referred to under Subsection 5.2.3 of this Application as the Consolidated EPEA Approval); or alternatively, to amend the existing Clean Air Licence (No. 92-AL-359 as amended), Clean Water Licence (No. 92-WL-147 as amended) and Reclamation Approval (No.OS-1-79 as amended); and

- *Water Resources Act* for diversion of watercourses in the course of mine development and operation, and wastewater management of both Steepbank Mine and Lease 86/17 operations. Suncor will submit the requisite Application for Licence pursuant to Section 11(1)(a)(b)(c) of the *Water Resources Act*, form WR1 (February 1994) in a separate transmittal.

By this Application Suncor also seeks approval from the AEUB pursuant to the following legislation in respect of related aspects of Steepbank Mine:

- Alberta *Hydro and Electric Energy Act,* for construction, operation and connection of a power supply line; and
- Alberta *Pipeline Act*, for construction and operation of hydrotransport, hot water, natural gas, diesel, tailings and recycle water pipelines.

5.2.2 Other Project Applications

Suncor is filing applications for approval of other aspects of the Steepbank Mine project under other statutes. The following is a list of identified federal and provincial application and approval requirements applicable to this project:

Federal

- *Navigable Waters Protection Act*, for construction of a bridge over the Athabasca River and other works in navigable waters; and
- *Radiocommunication Act*, for the installation and operation of towers and apparatus.

Provincial

- *Quarries Regulation Act,* for an operating permit for the operation of Steepbank Mine;
- *Surface Rights Act*, for removal of gravel;
- Part 17 of the *Municipal Government Act*, for a development permit from the Regional Municipality of Wood Buffalo for construction and operation of a new mine, facilities, buildings and bridge;
- *Water Resources Act*, for the construction of the bridge to Steepbank Mine;
- *Public Lands Act*, for surface rights (Licence(s) of Occupation and Mineral Surface Leases(s)) for Steepbank Mine and for the bridge, roads, facilities and all mining activities; and
- *Historical Resources Act*, for confirmation that facilities and activities will not adversely affect historical resources.

5.2.3 Associated Applications

Suncor has already submitted the following Applications associated with Suncor's current operation. These Applications are under review by the AEUB and AEP at the time of submission of the present Application.

- Application to AEP pursuant to EPEA (submitted in February 1995) for consolidation of Suncor's existing Clean Air Licence (No. 92-AL-359), Clean Water Licence (No. 92-WL-147) and Reclamation Approval (No. OS-1-79). Approval of this Application is contemplated by 25 June 1996 (the "Consolidated EPEA Approval").

- Application to AEUB and AEP (dated 29 March 1996) to expand production to 6 209 000 m^3 of synthetic crude oil and other oil sands products in each calendar year by 1998 (the Fixed Plant Expansion Project Application). This Application includes the following:

    (a) Application to the AEUB pursuant to the OSCA to amend Approval No. 7632 (as amended by Approval No. 7632A).

    (b) Application to AEP to amend the Consolidated EPEA Approval or alternatively, to amend the existing Clean Air Licence, as amended and Clean Water Licence, as amended.

    (c) Application to AEP pursuant to the *Water Resources Act* for a licence to alter Suncor's fresh water pond.

- Application to AEP for Fixed Plant Expansion Initial Construction.

5.3 THE APPLICANT

The official name and address of the applicant is:

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

Correspondence about this Application should be directed to the above address, to the attention of: Terry Bachynski, Director, Project Approvals.

Phone:	(403) 743-6892
Fax:	(403) 791-8344
E-Mail:	kwoods.sunosg2b@ccinet.ab.ca

5.4 APPLICATION FORMAT AND CROSS-REFERENCES

The scope of this Application has been described in Subsection 5.2.1. The following series of tables identifies locations within this Application of required information for Alberta Oil Sands Conservation Act approval, AEPEA approvals and the EIA Terms of Reference pursuant to AEPEA.

Information relevant to other approvals is provided in the following sections:

- *Water Resources Act*: Subsection C3.4
- *Hydro and Electric Energy Act*: Subsections C4.1 to C7.5
- *Pipeline Act*: Subsection C4.1

TABLE A5.0-1

AEPEA REGULATORY REQUIREMENTS FOR APPLICATION CROSS-REFERENCED WITH THE SUNCOR APPLICATION

AEPEA Regulation Clause	Regulation Information Required (Abbreviated)	Suncor Application Relevant Sections and Subsections
3(1) a	Name and address of Applicant	A5.3
3(1) b	Location, capacity and size of the activity to which the Application relates	A2.0
3(1) c	Nature of the activity and the change to the activity (amendment, addition or deletion as the case may be)	A5.0
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	A5.0
3(1) e	An indication of whether an environmental impact assessment report has been required	A5.2.1
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	B1.1
3(1) g	Proposed or actual dates for construction commencement, construction completion and commencement of operations	C3.1.12
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	C8.0

AEPEA Regulation Clause	Regulation Information Required (Abbreviated)	Suncor Application Relevant Sections and Subsections
3(1) i	Summary of the environmental monitoring information gathered during the previous approval period	Suncor 1995a
3(1) j	Summary of the performance of substance release control systems used for the activity during the previous approval period	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	C8.0 E
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	C8.0
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	C8.0 D E
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 C8.0
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	C8.0, Suncor 1995a
3(1) p	Conservation and reclamation plan for the activity	D3.0

AEPEA Regulation Clause	Regulation Information Required (Abbreviated)	Suncor Application Relevant Sections and Subsections
3(1) q	Description of the public consultation undertaken or proposed by the Applicant	A3.0
3(1) r	Information required under any other regulation under the Act to be submitted as part of or in support of the Application	A5.0
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	A5.0

TABLE A5.0-2

AEUB GUIDELINES (SEPTEMBER 1991) RESPECTING AN APPLICATION CROSS-REFERENCED WITH THE SUNCOR APPLICATION

AEUB Guideline	Guideline Information Required (Abbreviated)	Suncor Application Relevant Section(s)
1.5.1	Identification of act and section under which Application is made	A5.2
1.5.2	Name and address of the Applicant	A5.3
1.5.3	Statement of need and timing for the project	A2.2
1.5.4	Overall description of the proposed scheme, including location, size, scope, schedule, pre-construction, start-up, duration and reasons for proposed schedule	A2.3, C3.0
1.5.5	Description of the regional setting of the development; reference to existing and proposed land use	E5.0
1.5.6 (a) 1.5.6 (b) 1.5.7 1.5.8	Requirement amended 25 January 1996 (see Table A5.0-3)	C
1.5.9	General description of storage and transportation facilities of the final hydrocarbon product	B1.6
1.5.10	Proposed rate of production of the hydrocarbon product over the term for which approval is requested	A2.0
1.5.11	Description of the subject oil sands owned by or leased to the Applicant	B1.1
1.5.12	Description of status of negotiations held or to be held with the freehold, leasehold and mineral surface rights owners	C1.3
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	C7.5
1.5.14	Description or results of public information programs planned or initiated for the project	A3.0, E1.0
1.5.15	Term of the approval sought, including expected start and completion dates of the scheme	A5.0

AEUB Guideline	Guideline Information Required (Abbreviated)	Suncor Application Relevant Section(s)
1.5.16	Name of person responsible for Application, to whom correspondence should be addressed	A5.3
2.1.1 (a) to (k)	Geological description	C2.0
2.1.2 (a) to (g)	Evaluation of the reserves within the project area, the mine site, tailings site, discard sites and surface facilities	C2.0
2.1.3 (a) to (c)	Description of the project layout and mining equipment selected	C3.0
2.14 (a) to (d)	Description of the mine development plans	C3.0
2.1.5 (a) to (e)	Description of the design, stability analysis, construction method and schedule of pit slopes and discard, including tailings	C3.0, D3.0
2.4.1 (a) to (d)	Separate description of the bitumen extraction, upgrading, utilities, refining, and sulphur recovery facilities	C5.0 B1.4, B1.5
2.4.2	Overall material and energy balances, including information about hydrocarbon and sulphur recoveries, water use and energy efficiency	C7.0
2.4.3	Quality of products, by-products and discard generated and a general description of their disposition	B1.4, D3.0, C8.0
2.4.4	Manner in which surface drainage within the areas of the processing plant, product storage and discharge would be treated and disposed	C3.4, Suncor 1995a
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	C5.3
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	C7.3
2.5.1	Description of any facilities to be provided for generation of electricity to be used by the project	B1.5, C6.0
2.5.2	Identification of the source, quality and quantity of fuels, electricity or steam to be obtained from beyond project site	C6.0

AEUB Guideline	Guideline Information Required (Abbreviated)	Suncor Application Relevant Section(s)
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	C6.0
2.6.1	Description of air and water pollution control and monitoring facilities as well as a liquid spill contingency plan	C8.0, Suncor 1995a
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	C3.4 C7.4
2.6.3	Manner in which the surface drainage within the project area would be collected, treated and discarded	C3.4
2.6.4 (a) to (d)	Description of the emission control system	C8.1, Suncor 1995a
3.1.1 (a) to (g)	Commercial viability information	A1.3, C1.8
3.1.2 (a), (c) and (d)	Description of project capital and operating costs	C1.8
3.2.1	Summary of quantifiable public benefits and costs incurred during both construction and operation and how they pertain to Alberta and Canada	A4.0 E3.0
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	A4.0 E3.0
3.3.1	Appraisal of the economic impact of the project on the region and on provincial and national levels	A4.0 E3.0
3.3.2	Discussion of any initiatives undertaken to accommodate regional economic priorities	A4.0
3.3.3 (a) to (d)	Assessment of direct and indirect employment opportunities	A4.0 E3.0

TABLE A5.0-3

MAPS REQUIRED IN SUPPORT OF AN AEUB APPLICATION FOR STEEPBANK MINE AMENDMENT, 25 JANUARY 1996

AEUB Map Number	Description	Suncor Application Figure No.
1	Topographical map showing the final pit limits, dumps and facilities (DXF file)	C3.0-1
2	Geological evaluation methods (wells and other methods) (DXF file)	C2.0-4
3	Contour map of criteria (TV/BIP) used to define pit limits (DXF file)	C2.0-20
4	Mine sequence plan showing mine advance for each of the first six years and then every three years thereafter	C3.0-4 to C3.0-15
5	Typical plans and cross-sections for pitwalls, dykes and dumps (Detailed cross-sections for dykes and dumps will be required for specific dyke/dump applications.)	C3.0-16

TABLE A5.0-4

EIA TERMS OF REFERENCE

CROSS-REFERENCED TO SUNCOR APPLICATION

EIA Section	Environmental Assessment Topic or Issue (Abridged)	Suncor Application Relevant Section(s)
	Public Consultation	
1.2	Inform the public	A3.0
1.2	Document consultation measures	A3.0, E1.0
1.2	Record suggestions and concerns	A3.0, E1.0
1.2	Demonstrate how concerns addressed	A3.0, E1.0
1.2	Document contact with aboriginal peoples	A3.0, E1.0
	Proponent's Submission	
1.3	Glossary of terms	Glossary
	Project Overview	
2.1	Brief history of Suncor operations	A1.2
2.1	Describe Suncor and key developers/operators	A1.1, A1.2
	Development Plan Summary	
2.2	Processing/treatment facilities	C5.0
2.2	Buildings and infrastructure	C4.0
2.2	Transportation, utilities, access routes	C4.0
2.2	Mining operations	C3.0
2.2	Stages of development: construction, operations, reclamation	C3.0
2.2	Development schedule for each component	C3.0, C3.1.12
2.2	Timing of key construction, operational activities	C3.1.12
	Mine Area and EIA Study Area	
2.3	Legal description and boundary, existing and proposed leases	B1.1
2.3	Maps or equivalent showing proposed mine development area, pits, dumps, infrastructure, topographic features, wetlands, watercourses, existing and proposed areas of disturbance	C3.1.3
2.3	Identify the study areas	E2.0
2.3	Rationale for study area boundaries, by component	E2.0

EIA Section	Environmental Assessment Topic or Issue (Abridged)	Suncor Application Relevant Section(s)
	EIA Summary	
2.4	Summary of results (address i. to v.)	A4.0
2.4	Regional, temporal and cumulative effects	A4.0
2.4	Impact significance - magnitude, extent, duration, frequency, reversibility - quantitative predictions where possible	A4.0 E11.0
2.4	Maps, charts and illustrations - components, existing conditions, implications of development	E
	Regulatory Approval	
2.5	Legislation, policies, approvals: provincial, municipal, federal	A5.0
2.5	Regulatory framework - post-EIA stages	A5.0
	Project Description	
3.1	Describe existing Suncor operation, proposed changes	B, C
3.1	Map of all existing and proposed project facilities	Fig. C3.0-2
3.1	List activities with potential for environmental effects, by development stage	E
3.1	Discuss timing uncertainties and alternatives	C3.1.12
3.1	Extent of surface disturbance; clearing for mining, access, pipelines, utilities, site preparation	C3.1.3
3.1	Activities in river valley; extent and duration of disturbance	C3.0
	Project Need and Alternatives	
3.2	Project need	A2.2
3.2	Project alternatives, environmental implications	C1.0
3.2	Rationale for selected alternative	C1.0
3.2	Component selection; technical, geotechnical, economic, environmental criteria; rationale for selection of components; and rationale for location of components	C1.0, C5.3
3.2	Alternative technologies and methods: substance release	C1.0, C5.3
3.2	Alternative technologies and methods: to reduce the area and duration of disturbance in sensitive areas	C1.0

EIA Section	Environmental Assessment Topic or Issue (Abridged)	Suncor Application Relevant Section(s)
Process Description		
3.3	Mine: material balances, energy balances, flow diagrams	C7.0, C5.2
3.3	Processing oil sands: material/energy balances, flow diagrams	C7.0
3.3	Short-term and long-term mining plans	C3.0
3.3	Hydrotransport operations	C5.0
3.3	Future development and design efforts	C5.0
3.3	Chemical inputs: quantities and regulatory class	C5.2.1, C5.2.3
Utilities, Transportation, Other Infrastructure		
3.4	Infrastructure routing and location: components served, responsibilities, regional implications	C4.0, E3.0
3.4	Utilities components; amount and sources of energy, water needs and sources; energy and water efficiencies	C7.0, C6.0
3.4	Linear developments: alignments, route selection	C4.0
3.4	Access: regional and local road implications: Highway 63; with document input from Municipal District and provincial authorities	E3.0
3.4	Access: control of access, east side of Athabasca River	C4.2
3.4	Needs for road-building materials: sources	C3.1.11, C2.0
3.4	Design and route of pipelines; spill control measures, alternatives considered, hydrotransport lines	C4.0 C5.5
Emissions to Atmosphere		
3.5	Type, volume, sources of emissions from components of integrated operation: fugitive emissions, upset conditions	C8.0
3.5	Compare current and expected regional emissions	E
3.5	Emission control technologies: best available, best practical, best achievable technology	C5.0, C8:0
3.5	Control technologies for volatile, hazardous, odorous species	C5.0, Suncor 1995a, Suncor 1996c
3.5	Life-cycle "greenhouse gas" emissions	C8.1.2

EIA Section	Environmental Assessment Topic or Issue (Abridged)	Suncor Application Relevant Section(s)
Water and Wastewater Management		
3.6	Water and wastewater balance	C3.4
3.6	Water management plan	C3.4
3.6	Water requirements: normal, seasonal, emergency conditions	C7.0
3.6	Water storage, treatment, sources, withdrawal minimization	C3.4
3.6	Balance of options for treatment, storage, recycling and discharge of process-affected waters	D3.0
3.6	Volume and quality of effluents: extraction, upgrading, tailings management, discharges from management works	C3.4
3.6	Characterize each liquid waste stream	C3.4
3.6	Describe wastewater treatment systems	C3.4, Suncor 1995a
3.6	Discharges from reclamation sites	C3.4
3.6	Mitigation strategies to protect river water quality	C3.4
3.6	Monitoring plans for hydrology and water quality	C3.4
Solid and Hazardous Waste		
3.7	Characterize and classify mine and processing waste	C8.1, Suncor 1995a
3.7	Waste management plan	C8.1, Suncor 1995a
3.7	On-site disposal areas: location, timing	C8.1, Suncor 1995a
3.7	Hazardous wastes	C8.1, Suncor 1995a
3.7	Waste minimization plans	C8.1, Suncor 1995a
3.7	Alternatives for storage or reuse/ recycling of coke, sulphur, gypsum; fine tailings as raw materials	C8.1
Monitoring, Operating and Contingency Plans		
3.8	Environmental protection programs: existing, new	B4.0, Suncor 1995a, C8.1
3.8	Environmental monitoring programs: existing, new	B4.0, Suncor 1995a, C8.1
Environmental Information Assessment Requirements		
4.1	"Road map" and brief outline of assessment methods	E1.0

EIA Section	Environmental Assessment Topic or Issue (Abridged)	Suncor Application Relevant Section(s)
4.1	Environmental hazards and constraints considered	E
4.1	Validation of data from previous studies, limitations of data	E
	Land Use	
4.2	Applicable land and resource use policies, management schemes: implications, constraints to development	E1.0
4.2	Unique sites, special features, natural areas, recreational facilities: expected impacts	E
4.2	Existing land uses	E
4.2	Impact on land uses: mitigation	E
4.2	Pre-development and post-development landscape: aesthetic impact	E5.0
4.2	Impact on public access: implications for recreation, traditional uses, other uses	E3.0
4.2	Non-energy natural resources	E5.0
4.2	Surface lease changes to extent and timing of occupation	B1.1
4.2	Document consultations with existing land users	A3.0, E1.0
4.2	Implications for natural resource management: government agencies, other community members	E
4.2	Land use by aboriginal peoples: document consultations	E3.0, E10.0
4.2	Regional activities and cumulative land use impacts	E
	Athabasca River Valley	
4.2.1	Describe the valley, resources and current land uses	E3.0, E5.0
4.2.1	Summarize criteria and guidelines in draft IRP	E1.0
4.2.1	Environmental conditions: defining physical and biological characteristics, diversity of characteristics	E5.0
4.2.1	Explain how environmental protection needs of the valley are reflected in development, operation and reclamation plans	D3.0, E5.0

EIA Section	Environmental Assessment Topic or Issue (Abridged)	Suncor Application Relevant Section(s)
4.2.1	Proposed objectives for reclaimed landscape: target physical and biological parameters and land uses	D3.0
4.2.1	Proposed methods to measure and demonstrate success; responsibilities: timing, milestones, uncertainties, consequences, contingencies	D3.6
	Climate, Air Quality and Noise	
4.3	Baseline climate and air quality conditions	E9.0
4.3	Characterize existing air quality: key parameters	E9.0
4.3	Air quality modelling: selection, constraints, results	E9.0
4.3	Identify activities that affect air quality	E9.0
4.3	Air quality impacts	E9.0
4.3	Air quality monitoring: project, zonal	E9.0
4.3	Impacts on provincial and federal commitments regarding "greenhouse gases"	E9.0 C8.1.2
4.3	Noise impacts	E6.0
	Surficial Geology and Soils	
4.4	Map of surface topography, deposits, drainage	E5.0, E7.0
4.4	Integrate data with ecological land classification	E5.0
4.4	Describe site geology and soils	E5.0
4.4	Characterize sensitivity of soils and terrain to disturbance	E5.0
4.4	Identify activities which may cause soil contamination	E5.0
4.4	Classify soils and overburden for reclamation purposes	D3.0, E5.0
4.4	Assess impacts: disturbance, terrain changes, contamination, erosion potential	D3.0, E5.0
4.4	Discuss mitigation: soil salvage, contamination mitigation, erosion prevention/ minimization	D3.0, E5.0
4.4	Identify constraints on vegetation restoration due to soils	D3.0, E5.0

EIA Section	Environmental Assessment Topic or Issue (Abridged)	Suncor Application Relevant Section(s)
4.4	Soils for reclamation activities: availability, location, use, volumes, organic materials, storage and handling	D3.0, E5.0
	Vegetation and Forest Resources	
4.5	Describe and map vegetation communities	E5.0
4.5	Integrate data with ecological land classification	E5.0
4.5	Integrated ecological land classification map	E5.0
4.5	Identify primary vegetation species of each landscape unit, those used for wildlife food or shelter, indicator species for environmental effects: relative abundance	E5.0
4.5	Identify amount of land disturbed, nature of vegetation communities affected, sensitivity to disturbance	E5.0
4.5	Impacts on vegetation: amount, nature and duration of changes, implications for wildlife and other users	E5.0
4.5	Conceptual objectives for post-development vegetation; compare pre-development and post-development vegetation	D3.0, E5.0
4.5	Mitigation plan for site clearing: timing, run-off, water quality	C3.4, E5.0
4.5	Mitigation plan for overall disturbance: vegetation communities, rare and endangered species; returning self-sustaining habitat equivalent to pre-disturbance conditions; maintaining biological capability and diversity	E5.0
	Wildlife	
4.6	Use of the project area by wildlife: include seasonal use, special-use areas (calving, nesting, movement corridors)	E6.0
4.6	Rare and endangered species: occurrence, habitat needs	E6.0
4.6	Sensitivity to disturbance	E6.0
4.6	Impacts on wildlife, wildlife utilization, habitat quality, during development, mining, following reclamation: site-specific, local, regional: cumulative effects	E6.0
4.6	Map of habitat for key indicator species	E6.0

EIA Section	Environmental Assessment Topic or Issue (Abridged)	Suncor Application Relevant Section(s)
4.6	Impact of bridge and other infrastructure on wildlife movement in the Athabasca River valley; alternatives	E6.0
4.6	Wildlife impact mitigation plan: activities, schedule, learning from the past, compliance with provincial and federal policies for wildlife habitat	E6.0
	Surface Water and Groundwater	
4.7	Describe surface hydrology before and after project	C3.4, E7.0
4.7	Summary of baseline water quantity data	E7.0
4.7	List mining and development activities which affect hydrology	C3.4, E7.0
4.7	Identify temporary, permanent changes to flows, diversions or disturbances: extent, duration, proposed mitigation	C3.4, E7.0
4.7	Effect of changes on hydrology: timing, volume, peak flow, significance for downstream basins, implications for vegetation, soil erosion, water quality, habitat quality	E7.0
4.7	1:100 year flood plain, potential for flooding: project design and contingency plan implications	C3.0, E7.0
4.7	Effects on stream bed or shore of Athabasca River, Steepbank River and smaller streams: mitigation measures	E7.0
4.7	Surface water monitoring program	E7.0
4.7	Describe the groundwater regime	E7.0
4.7	Effects on groundwater	E7.0
4.7	Options to manage and protect groundwater	E7.0
4.7	Interrelationship with surface water: effects	E7.0
4.7	Implications of groundwater effects for terrestrial and riparian vegetation, wildlife, aquatic resources: mitigation	E7.0
4.7	Water supply availability, seasonal fluctuations, impact of withdrawal on water sources and other users	E7.0
	Aquatic Resources	
4.8	Existing fish resources and habitat	E8.0

EIA Section	Environmental Assessment Topic or Issue (Abridged)	Suncor Application Relevant Section(s)
4.8	Map of fish habitat: sensitive areas, spawning, rearing, overwintering habitats, seasonal use, movement pattern	E8.0
4.8	Critical life stages and requirements for key species; rationale for choice of key species	E8.0
4.8	Identify construction and operation activities which may affect fish habitat, fish resources, riparian areas	E8.0
4.8	Effects : nature, extent, duration; mitigation; residual impact	E8.0
4.8	Adherence to provincial and federal policies for fish habitat	E8.0
4.8	Monitoring plans: habitat quality, mitigation effectiveness	E8.0
4.8	Increased fishing : management strategy, access control	E8.0
	Water Quality	
4.9	Describe water quality before and after the project	E8.0
4.9	Baseline water quality	E8.0
4.9	Seasonal variations in water quality: existing, expected	E8.0
4.9	Activities which may influence water quality: construction, operations, reclamation stages	E8.0
4.9	Effects of activities on water quality; mitigation; residual effects for each stage, including post-reclamation	E8.0
4.9	Predict water quality in downstream reaches, basins; compare to baseline water quality and Surface Water Quality Guidelines: significance of any non-compliance	E8.0
4.9	Regional activities and cumulative effects	E8.0
4.9	Water quality monitoring program	E8.0
	Reclamation	
5	Detailed reclamation plan for Lease 86/17 and Steepbank Mine project	D3.0
5	Effect of mining activities in new mine on reclamation on current mine site	D3.0
5	Part 8, *Guide to Preparation of Applications and Reports for Coal and Oil Sands Operations*	D3.0

EIA Section	Environmental Assessment Topic or Issue (Abridged)	Suncor Application Relevant Section(s)
5	End land use objectives	D3.0
5	Species for permanent revegetation: rationale for species selected for reclamation use	D3.0, Suncor 1995a
5	Timing of reclamation and return of lands to Crown	D3.0
5	Material balance in relation to mining activities	D3.0
5	Summary of mine and processing wastes in reclaimed landscape: how and where placed, environmental pathways and fate of contaminants released: timing of effects	D3.0
5	Aquatic components of post-reclamation landscape: function, projected aquatic habitat map, effects of reclamation	D3.0
5	Hydrological assessment for Lease 86/17	E7.0
5	Comparison of pre-development and post-reclamation aquatic landscape: effect of differences: diversity, quality, productivity and aesthetic character	E8.0
5	Reclamation plans for terrestrial components: materials, erosion control, terrain modelling, land stability, revegetation, relevant research	D3.0, Suncor 1995a
5	Projected ecological land classification map, effects of reclamation, comparison of the pre-development and post-reclamation landscape: vegetation species, diversity of landscape units, effect of change on users	D3.0
5	Type and distribution of commercial timber species in reclaimed landscape	E5.0
5	Performance objectives for reclamation: physical and biological parameters: key milestones, how performance is measured and success demonstrated to community	D3.6
5	Ability to achieve a reclaimed landscape comparable in character, quality, diversity and usefulness	D3.6
5	Reclamation constraints: timing, materials, natural processes and cycles, need for research and development, biodiversity considerations and constraints	D3.0

EIA Section	Environmental Assessment Topic or Issue (Abridged)	Suncor Application Relevant Section(s)
5	How development and reclamation will maintain biodiversity and promote restoration of equivalent capability for habitat	D3.0, E5.0
	Heritage Resources	
6	Document heritage resources review and consultation with Alberta Community Development	E10.0
	Socio-Economic Information	
7	Describe social impacts: employment, training, procurement, population changes, demand for local services, infrastructure, regional and provincial benefits, trapping, hunting and fishing	A4.0, E3.0
7	Describe economic impacts	A4.0, E3.0
7	Describe employment and business opportunities	E3.0
7	Describe the workforce: construction, operations	E3.0, C3.0
	Public Health and Safety	
8	Aspects of the project with health and safety implications	E4.0
8	Change in exposure to contaminants	E4.0
8	Plans to study environmental conditions and implications for human health	E4.0
8	Summary emergency response plan: public input to plan	C8.0, Suncor 1995a
8	Mitigation and emergency contingency plans for public safety	C8.0, Suncor 1995a
8	Uncertainties and risks: contingency plans	C8.0, Suncor 1995a
	Issue Groups	
2, 3	Project definition and alternatives	C1.0
2, 4.2.1	Siting: valley development	C1.0
2, 3	Siting: components and infrastructure	C1.0, C4.0
2, 3, 4, 5, 8	Substance release: water	C8.0
2, 3, 4, 8	Substance release: air	C8.0
2, 3, 4, 5	Land use	E3.0
2, 3, 4, 5	Renewable resource management	E

EIA Section	Environmental Assessment Topic or Issue (Abridged)	Suncor Application Relevant Section(s)
2, 4, 5	Fish and fish habitat	E8.0
2 ,4, 5	Wildlife	E6.0
2, 7, 8	Health and social issues	E4.0
2, 3, 4, 5, 8	Reclamation, site water management, land stability, site waste management, groundwater and soil protection, ecosystem risk management	C3.4, D3.0
2, 3, 7	Economic definition	A4.0
2, 4, 7	Public involvement opportunities	A3.0

TABLE OF CONTENTS

SECTION B **PAGE**

LIST OF TABLES AND FIGURES

TABLES **PAGE**

FIGURES

(Located at end of each section - where applicable)

B CURRENT BITUMEN PRODUCTION OPERATION

1.0 OVERVIEW OF THE SUNCOR INC., OIL SANDS GROUP PLANT

1.1 GENERAL INTRODUCTION

The Suncor Inc., Oil Sands Group (Suncor) plant is located in the geographical centre of the Athabasca Oil Sands deposit, 35 km north of Fort McMurray on the west bank of the Athabasca River. Suncor operates on two Oil Sands Leases - No. 7387060 T04 (Lease 86) and No. 7279120 092 (Lease 17) - covering an area of 2465 ha. In this document these leases are collectively referred to as Lease 86/17.

Other Oil Sands Leases under the *Mines and Minerals Act* held by Suncor in the immediate area are:

- No. 7280060 T23 (Lease 23)
- No. 7276030 T11 (Lease 97)
- No. 7279080 T19 (Lease 19)
- No. 7280100 T25 (Lease 25)

Suncor also holds Fee Lots 1 through 6, Quarriable Minerals Lease No. 1993010001 on Lease 86/17 (to provide limestone for road building and FGD unit) and Mineral Exploration Permit No. 9390110001 on Lease 86/17 (for metallic and industrial minerals).

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

- Mineral Surface Leases: Nos. 901468, 920406, 941307;
- Miscellaneous Land Leases: Nos. 890170 and 950032; and
- Licences of Occupation: Nos. 1839, 1971, 2003, 3489, 770976, 950761, 950913.

Suncor holds the fee simple title to its plant site.

These Suncor leases are located in Township 92, Ranges 7 to 10, west of the 4th Meridian. The major land leases are illustrated in Figure B1.0-1.

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

- Alberta Energy and Utilities Board Approval No. 7632A
- Alberta Environmental Protection Development and Reclamation Approval No. OS-1-79
- Alberta Environmental Protection Air Licence No. 92-AL-3591
- Alberta Environmental Protection Water Licence No. 92-WL-147D
- Alberta Environmental Protection Water Resources Licence to Divert and Use Water No. 10400

Approval documents are available for examination from Suncor Inc., Oil Sands Group. As well, a copy of the AEPEA Approvals is appended to the March 1996 Fixed Plant Expansion Project Application.

Currently, the plant has capacity to produce 79.5 kbpcd of upgraded crude oil. The Alberta Energy and Utilities Board gave Suncor approval in December 1995 for an increase in production rate to 79.5 kbpcd from the previously-approved production rate of 72 kbpcd. Pertinent data for the Suncor operation (based on the higher production rate) are provided in Table B1.0-1.

Suncor Inc. Oil Sands Group's business unit structure is shown in Figure B1.0-2

1.2 MINING OF OIL SANDS

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

Trees are cleared is executed 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 well in advance of the mining operation.

Muskeg and overburden aquifers are drained by a network of ditches in advance of muskeg and overburden removal. Water drained from these aquifers is channelled via drainage ditches to settling basins, designed for settling solids and removing minor amounts of oil and grease. Water from the basins and control weirs is discharged to the Athabasca River. Flow is controlled to reduce erosion of natural embankments. Systems to control discharge of water from the existing mine are detailed in Section IV-2.2 of the Application for Renewal of Environmental Operating Approval, February 1995.

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

Overburden is removed and used to construct tailings pond dykes or hauled to waste areas.

TABLE B1.0-1

OPERATIONAL DATA BASED ON PRODUCTION OF 79 kbpcd

Parameter	Production/Usage
Oil Sands Mined	137 kt/cd
Gas Consumed	0.460 Mm^3/cd
Electric Power Imported	16.5 MW
Coke Stockpiled	1185 t/cd
Sulphur Produced	485 t/cd
Water Taken From River	110 000 m^3/cd
Water Returned to River	82 000 m^3/cd
Tailings (Water and Mineral) Produced	171 000 m^3/cd
Sulphur Dioxide Emitted[a]	233 t/cd
Carbon Dioxide Emitted	9.8 k t/cd

[a] Sulphur dioxide emission will be reduced to approximately 51 tpcd following commissioning of the Flue Gas Desulphurization plant in 1996.

A limestone quarry is located in the existing mined oil sands pit. Limestone from this quarry is used for road building and will feed the Flue Gas Desulphurization Unit currently under construction in the Utilities plant. The location of the quarry is illustrated in Figure B1.0-3. Sand and gravel deposits are located in the northern portion of the Suncor plant area.

The technique for mining oil sands at Suncor changed during 1993 and early 1994, from a bucketwheel excavator operation to a truck and shovel operation using equipment similar to the overburden removal operation. Mined oil sand is sized through a crusher and then carried to the Extraction plant by conveyors, a distance of 4 km.

Suncor expects to complete mining on its current lease by 2001. Remaining reserves at the end of 1995 on Lease 86/17 were 33.9 Mm^3 (213 million barrels) of recoverable bitumen.

1.3 BITUMEN PRODUCTION

Bitumen is extracted from oil sand using the Clark hot water process: fundamental extraction steps include oil sand conditioning; separation of bitumen; cleaning of bitumen froth; and disposal of tailings. These steps are depicted in Figure B1.0-4.

The Primary Extraction plant (Plant 3, Figure B1.0-5) has five process trains, one of which is normally on maintenance or standby. Oil sand feed (with a bitumen concentration that varies between 8 wt% and 14 wt%) is processed through the four operating trains at a combined rate of up to 8000 tph. The oil sand conditioning step involves:

- diluting the oil sand with water heated to 93°C by using condensing steam discharged from Utilities and the Upgrader.
- increasing the temperature of the resulting slurry by direct sparging with steam.
- adding caustic (only when required) which promotes the separation of bitumen from the minerals.
- stirring the slurry in a horizontal drum for breakdown of oil sand lumps and to allow coalescence of bitumen droplets.

Conditioned slurry is sent through a vibrating screen to remove rocks and clay lumps larger than one centimetre in diameter. These oversize reject materials (which on average represent about 5% by weight of the oil sand feed) are trucked to an oversize dump.

Screened slurry drops into the separation cell feed sump where it is further diluted with hot process water before being pumped into a separation cell. The final weight ratio of oil sand to dilution water is about 0.6 to 1, although this ratio varies depending on the nature and composition of the oil sand feed. In the separation cell the sand component of the slurry settles quickly to the bottom of the vessel. A suspension of fine mineral particles and bitumen droplets forms above the sand bed in an area called the middling zone. The easily-separated bitumen droplets quickly rise from the middling zone to the top of the cell and form a layer of froth containing about 60 wt%.

A sidestream from the middlings zone containing harder-to-separate bitumen is continuously transferred to a series of flotation banks. There is a fine dispersion of air bubbles is mixed with the middlings in the banks and a froth layer of variable-concentration bitumen forms at the surface. This froth layer is transferred to a froth settler where some of the water and minerals are removed.

There is potential for spillage from conveyors and from the various vessels and piping during the extraction process. All spillage is collected and diverted to a sump, from where it is pumped back into the process. When the sump pumping system is not available spillage flows by gravity to the Extraction Emergency Pond, where the materials are collected and pumped to the tailings ponds.

Tailings from the separation cells and scavenger banks are combined and the result pumped via the Final Tailings Pump House (FTPH) to the tailings ponds for disposal. The FTPH includes five separate pump trains and associated support equipment. During routine operation, as each pump train is brought down for maintenance the tailings line is flushed with pond water and drained. In an emergency shutdown a pump train is brought down and drained without flushing the tailings line. The water or tailings in this line are collected in a Decant Pond, where most of the sand settles. Remaining fluid flows from the Decant Pond into the Extraction Emergency Pond, joining materials pumped from it to the tailings ponds.

Froth from the separation cell (primary) and froth settler is collected in the froth deaerator, where direct steam sparging is used to heat the mixture. Heating the froth promotes air removal and reduces viscosity before the froth cleaning operation (Plant 4 - Froth Treatment).

Heated froth is diluted with diluent (distillate naphtha - light hydrocarbon), so the weight ratio of diluent to bitumen is about 0.6 to 1. At this point, the stream consists of 5% to 12% mineral, 20% to 30% water and 40% to 60% diluted bitumen. The stream is passed through a series of scroll (Bird) centrifuges (to remove the majority of the mineral component) and then sent to disc (Westfalia) centrifuges, where most of the water and the remaining minerals are removed. The froth treatment plant final product stream (which is about 0.5% mineral, 4.5% water and 95% diluted bitumen) is piped to storage tanks in the South Tank Farm. Hydrocarbon recovery rate for the froth treatment process is 97.7%.

The froth treatment process (i.e., bitumen dewatering/demineralization) requires dilution with light hydrocarbon heated to 82°C. At this temperature hydrocarbon vapours form in the centrifuges and process vessels. The hydrocarbon vapours from froth treatment and the diluted bitumen tanks are collected and recovered by a vapour recovery unit which was installed in 1995.

Stripped sour water from Upgrading is combined with centrifuge plant tailings and fed to the Naphtha Recovery Unit (NRU - Plant 16). Approximately 70% of the diluent contained in the NRU feed stream is recovered in the NRU and is combined with the diluent stream from Upgrading for use in the froth treatment process. Vapour from the NRU is also collected by the vapour recovery unit.

All tailings operations result in the release into the atmosphere of water vapours containing small amounts of hydrocarbon. Tailings are mainly sands, clays and water, with residual bitumen.

Hydrocarbon balance for the Suncor operation is provided in Section C7.0. The Extraction plant is the scene of continuous improvement in bitumen recovery and efficiency. Since 1988 Suncor has spent $7.6 million on such projects (Table B1.0-3). Extraction recovery has improved about 5% over 1988 levels at the average ore grade of about 12%. At lower ore grades the improvement is about 6% (Figure B1.0-5).

Suncor applied to AEUB and AEP in March 1996, in the Fixed Plant Expansion Project Application March 1996, to expand Extraction capacity (by 1997) to support 87 kbpcd of upgraded crude oil. The equipment changes that will be required to accomplish that rate are listed in Table B1.0-2.

TABLE B1.0-2

EQUIPMENT CHANGES FOR 87 kbpcd PRODUCTION

Activity or Process	Change Required
Ore Delivery	Purchase three new 240-t trucks Upgrade conveyor motors
Slurry Preparation	Install larger vibrating screens
Separation Circuit and Froth Handling	Modify the deaerator Upgrade froth launders Install interstage froth storage tank
Froth Treatment	Upgrade feed pumps and electrical systems Upgrade first-stage centrifuge feed mechanisms Install one filter Install one second-stage centrifuge
Diluent Stripper	Install cooling water pump
Diluted Bitumen Pipeline	Install another delivery line to tankage

Slurry preparation capacity may be improved by replacing the existing 1.8 m x 4.9 m reject screens with 2.4 m x 6.1 m screens. This change should lower bitumen losses to rejects even at the higher slurry production rates needed for 87 kbpcd operation.

One larger screen will be installed by fall 1996 and an assessment of its performance will be completed by late 1996.

In the separation circuit and froth handling plant, launders (which move froth from the separation cells to the deaerators) will be altered by removing flow obstructions. Their capacity will increase by about 200 m^3/h.

The deaerators will be modified to enhance their capacity to accommodate higher flow rates and to condense the vent emissions.

An interstage storage tank for hot, deaerated froth upstream of the froth treatment plant is included proposed. This tank is expected to allow the centrifuge plant operation to be uncoupled from the separation circuit operations, resulting in improved performance for both plants and decreased hydrocarbon loss to the tailings pond.

TABLE B1.0-3

COMPLETED EXTRACTION RECOVERY IMPROVEMENT PROJECTS

PROJECT	YEAR	COST
PLANT 3		
Operating Procedures	1988	$ 0 k
Secondary Froth Pumping (Discflo Pump)	1989	168 k
Separation Bottoms Density Control (OPC Control Program)	1989	150 k
Separation Bottoms Density Control (Bottoms Cone Modification)	1991	100 k
Separation Bottoms Density Control (Rake Lift Program)	1991	50 k
Froth Settler Bottoms Pump	1991	65 k
OSLO Froth Cleaning Pilot	1991	250 k
Secondary Froth Pumping (Piping Modifications)	1992	50 k
Separation Bottoms Density Control (Improved Middlings Control)	1992	75 k
Scavenger Bank Level Control	1992	32 k
OSLO Froth Cleaning Installation	1992	320 k
Wright and Wright Oil Sand Analyzer	1992	23 k
Secondary Froth Pumping (Recessed Impeller)	1993	20 k
Secondary Froth Recycling	1993	150 k
Separation Cell Interface Level Control	1993	35 k
Separation Cell Feed Well Modifications	1993	25 k
Line 5 Warm Water Test Program	1993	500 k
Separation Cell Feed Well Modifications	1994	100 k
Wright and Wright Oil Sand Analyzer	1995	100 k
Line 5 Test Program	1995	1400 k
TOTAL		**$3613 k**
PLANT 4 / 16		
Operating Line Control	1992	$ 40 k
Ring Dam Water Replacement	1993	150 k
Plant 16 Separator Water Pumps	1993	100 k
Plant 16 Steam Injection Relocation	1994	150 k
Plant 16 Feed Temperature Control	1994	10 k
Increased Centrifuge Capacity	1995	1300 k
Increased Centrifuge Capacity	1995	2250 k
TOTAL		**$4000 k**

In the froth treatment plant the feed pumps, headers and associated electrical installations must be upgraded for both the first-stage and second-stage centrifuges. The capacity of the main operating units will be increased as follows:

- New internal mechanisms for introducing feed to the first-stage centrifuges will be installed on eight of the machines. This will increase their capacity by at least 20%. A full-scale test is underway to confirm the expected benefit.
- An additional interstage filter will be installed, bringing the total to five.
- A new second-stage centrifuge (between four and five times the capacity of the existing machines) has been installed and its performance is being assessed.

While the diluent stripper tower has enough capacity for higher production additional cooling is required to condense the overhead vapours. This will be achieved by adding a pump to the condenser cooling water supply.

The diluted bitumen pipeline from the centrifuge plant to the tank farm will be modified to provide adequate capacity for the higher flows. Any benefits from adding another diluted bitumen tank to provide more surge capacity between Extraction and Upgrading are being assessed.

1.4 BITUMEN UPGRADING

Bitumen produced by the extraction process is not suitable for most markets. It is a highly-viscous, tarry, black material having an American Petroleum Institute (API) gravity of about 9° which contains about 5% sulphur and trace amounts of metals such as nickel, vanadium and iron. Bitumen is upgraded to marketable crude oil products in Upgrading. The location of these facilities within the Suncor plant site is illustrated in Figure B1.0-6. Figure B1.0-7 shows the steps in the Upgrading operation.

The Upgrading facilities consist of the following process units:

- Diluent Recovery Unit (flash drums and diluent recovery tower);
- Delayed Coking Unit (coker furnaces, coker drums and fractionating tower);
- Gas Recovery Unit (distillation columns and wet gas compressor);
- Hydrotreaters (naphtha, kerosene and gas oil hydrotreaters);

- Amine Gas-Sweetening plant;
- Sulphur plant;
- Hydrogen plant;
- flares;
- Sour Water Treatment System;
- Wastewater Treatment System; and
- North and South Tank Farms.

Diluent recovered in the Diluent Recovery Unit from diluted bitumen (received from Extraction and stored in the South Tank Farm) is returned to Extraction for re-use. The bitumen is heated in coker furnaces and sent to the coke drums. There the bitumen is thermally cracked into hydrocarbon vapours and coke (solid carbon). A large portion of the sulphur and virtually all of the metals from the bitumen are contained in the coke. The coke is used in Utilities to generate electricity and steam; surplus coke is stockpiled.

The coke drum vapours are separated into four main components: wet gases, naphtha, kerosene and gas oil. Wet gases are either directed to the naphtha hydrotreater, used for fuel gas or used for hydrogen manufacturing. Each of the three distillate components (naphtha, kerosene and gas oil) is pumped either to the hydrotreaters (to remove remaining sulphur, nitrogen and trace metals by contacting with hydrogen) or to intermediate storage. Hydrogen used in the hydrotreating step is produced from methane gas in the Hydrogen plant.

Upgrading distillate and hydrotreated products (naphtha, kerosene and gas oil) are sent to the North Tank Farm, blended to form custom crude oils and shipped south to various markets via the Suncor pipeline.

Gases containing H_2S are generated as a result of the various Upgrading operations. These gases are treated in the Amine Gas-Sweetening plant. Sweetened hydrocarbon gas (i.e., gas without H_2S) is recovered as fuel gas for use in Upgrading furnaces, the Hydrogen plant or Utilities boilers. The H_2S that is removed is concentrated in a separate gas stream (acid gas).

The sulphur plant uses two parallel Claus units and a common Superclaus unit to recover 98% of the sulphur in the acid gas stream. Small amounts of unconverted H_2S from the Sulphur plant are combusted to sulphur dioxide (SO_2) in an incinerator and discharged to the atmosphere through a 106.7-m-high incinerator stack.

Sour water (containing H_2S) is also produced in various Upgrading process units. This water is fed to the Sour Water Treatment System where the majority of H_2S is removed for reprocessing in the Upgrading operation. The stripped water is pumped to the Naphtha Recovery Unit to provide added heat transfer and further removal of H_2S prior to its discharge to Tailings Pond 1.

The flare stack system consists of two hydrocarbon flares, an acid gas flare and a hydrogen plant flare. The hydrocarbon flares continuously emit between two and three tonnes of SO_2 per day and dispose of gas streams during Upgrading upsets and emergencies. The acid gas flare disposes of amine plant acid gas when there is an upset or emergency in the sulphur plant. The hydrogen plant flare is used primarily for the controlled disposal of unused hydrogen product gas from the hydrogen plant.

Drainage waters from the Upgrading facilities are collected in a closed sewer system. Oily water is sent to API separators and settling tanks where oil is separated from the water. The oil is returned to Upgrading for reprocessing while the separated water is pumped to the Naphtha Recovery Unit prior to its discharge to Tailings Pond 1. Improvements are planned to enable the water to be discharged to the wastewater system after hydrocarbon has been removed. Other Upgrading water is treated and discharged through the wastewater treatment system.

1.5 UTILITIES

The Utilities Business Unit supplies energy to fulfill most of the needs of the Suncor operation. On-site facilities provide steam, electricity, water and compressed air used by Mining, Extraction, Upgrading and administrative areas. Three main power boilers and two turbo-generators convert water and coke fuel into energy. Three smaller boilers use either fuels produced by Upgrading or natural gas obtained from off-site sources. Suncor's power supply is augmented through connection with the Alberta Power Limited (APL) grid.

Utilities operations are located primarily in one building. Outlying facilities include the river water pump houses, electrical distribution stations, package boiler facility, compressor building and a new firewater pump house fed from the Fresh Water Pond. High-pressure steam (5450 kPa) is produced by three main boilers which together generate over 1.1 M kg of steam per hour. Two back-up steam units are used as standby steam production units. High-pressure steam is used to drive two 38-MVA turbo generators, which produce a maximum of 64 MW of power.

Most of Suncor's energy requirements are met by the Utilities plant. However, two APL ties are used to import approximately 16 MW of energy. The ties allow energy import when a main boiler is down or when the Suncor generating system is operating below capacity.

The Utilities plant draws water from the Athabasca River to produce the average daily requirement of approximately 26 M kg of steam. This water is conditioned, filtered and treated at a water treatment plant before it is used in the boilers. Water treatment facilities consist of a settling pond, a clarifier, filters, hot-lime reactors, zeolite softeners and deaerators. Currently the plant prepares approximately 60% of the steam generation water requirements from river water while the other 40% is obtained from condensate return.

Coke produced in Upgrading is used to fire the three large Utilities boilers. Sulphur dioxide, particulates and associated metals are released in the flue gas as a result of combustion of the coke.

Electrostatic precipitators (ESPs) are employed to collect flyash particles in the exhaust flue gases discharged from the boilers. Electric fields in the ESPs negatively charge the particles, which are then attracted to the positively-charged collecting plates. Ash from the plates is collected, stored and sent to tailings ponds via the Extraction tailings lines.

Water effluent from Utilities is discharged to one of three destinations: a main common system that goes to Pond A of the Wastewater Treatment System; directly to API cells for water that may be contaminated with oil; and water containing ash (from the wet-ash removal system) is directed to the Ash Pond from where decanted water drains to Pond A. Water treatment sludge drains from a collection pit to the Ash Pond, where lime sludge settles out before the water drains to Pond A.

A Flue Gas Desulphurization (FGD) plant is under construction for late 1996 start-up. The plant has been designed to remove up to 95% of the SO_2 currently emitted into the atmosphere from the Power House stack by capturing it with a limestone slurry to form gypsum. The FGD plant is also expected to recover 85% of the remaining particulates in flue gas which are currently not recovered in the electrostatic precipitators.

1.6 OTHER FACILITIES

1.6.1 Tank Farms, Tankage and Pipeline

Intermediate and final products from Upgrading are stored in the North Tank Farm. The South Tank Farm (nine tanks) provides storage and pumps for diluted bitumen and diluent, and for fuel storage tanks (fuel oil and diesel) used by Utilities. The North Tank Farm (13 tanks) provides storage for coker distillate and unifined products. Pumping facilities for the pipeline and for internal blending and recycling of final and intermediate products are also located in the North Tank Farm.

Four slop-oil (recovered oil) tanks located in the vicinity of the API separators are used for handling slop oils and waters.

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

Tanks that hold naphtha are equipped with floating roofs to control hydrocarbon emissions which result from high vapour pressure. Slop-oil tanks are equipped with emission treatment devices to control odorous emissions. Diluted bitumen tanks are equipped with a vapour recovery system.

Upgraded crude oil is transferred to Edmonton by a Suncor-owned, 406-mm pipeline (operated by Suncor Resources Group). From there product is available for transfer to Alberta and other Canadian and United States markets.

1.6.2 Sulphur Handling and Storage

Elemental sulphur is recovered from acid gas in the Upgrading Sulphur Recovery Unit. Approximately 485 t of liquid sulphur are generated daily.

Liquid sulphur is normally transferred to trucks for transport off-site. When trucks are unavailable and storage capacity of the underground sulphur pit is reached, sulphur is transferred to a sulphur storage pad where it is temporarily blocked. The sulphur storage pad has a liner (to prevent groundwater contamination) and a drainage control system (with all collected waters diverted to the Upgrading wastewater system). This sulphur pad is prepared for temporary storage of sulphur only.

Sulphur balance for the Suncor operation is presented in Section C7.1.

1.6.3 Coke Handling and Storage

Coke from the delayed coking operation in Upgrading is stockpiled pending either use or storage. A daily production rate of 79.5 kbpcd means that approximately 1000 t/cd of coke has been stockpiled. The stockpiled coke storage area is located between the main plant and the Athabasca River; coke which is to be consumed is stored just east of the Utilities plant.

As storage of stockpiled surplus coke is now approaching maximum capacity (expected by 1999), Suncor sought and received approval in 1993 to expand the stockpile to the west. Coke stockpile resloping work resulted in a reduction of the overall stockpile slope angle; this facilitated placement of temporary vegetative cover on the pile as part of routine dust suppression activities. Suncor is evaluating the transfer of coke after 1999 to a site yet to be determined.

Water from the coke stockpile is collected and pumped to the Upgrading wastewater treatment system. The collection system includes a surface and groundwater interceptor ditch.

1.6.4 Sewage Lagoons

All domestic sewage from offices, plants and the camp facility is directed to the Sewage Treatment System for retention and treatment. In 1995 the system was upgraded by construction of aeration treatment cells and a final treatment polishing cell. Final treated effluent is discharged to the Athabasca River at the Mid-Plant drainage outfall. The upgraded sewage treatment system meets all AEP treated sewage discharge standards on a year-round basis.

1.7 TAILINGS AND WATER MANAGEMENT

1.7.1 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 three active tailings ponds (Nos. 1, 2/3 and 4 - Figure B1.0-3) and one pond (Pond 1A) which is used to increase the settling time of the recycle water, to reduce the fines content. Another tailings pond (Pond 5) is currently being commissioned in the mining area north of Tailings Pond 2/3. Each of the current tailings ponds contains a turbid top water zone (1.5 m to 8 m in depth) interspersed with bitumen globules and purged by gases generated within the underlying anaerobic layer of fine tailings (particularly in Pond 1).

Construction of tailings pond dykes is regulated under Suncor's Licence to Divert and Use Water, issued under the authority of the *Water Resources Act*. 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 the construction of temporary sand retaining walls. As the water flows into the pond sand settles on the top of the dyke, where it is packed during the summer using tracked vehicles. Sand is beached on the edge of the pond during the winter, producing no increase in dyke height. Construction of dykes with overburden is accomplished by excavating the overburden, hauling it to the site and compacting it according to design specifications.

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

- monitoring piezometers, slope indicator installations and drainage discharges;
- conducting 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;
- undertaking analyses to ensure dykes in the vicinity of explosion blasts are not endangered by those blasts;
- establishing either coke filter systems or cores on tailings dykes, to control internal erosion and seepage waters from dyke interiors;
- evaluating dyke performance of construction lifts, which are limited to about 3 m; and
- implementing surface erosion protection measures on completed portions of the downstream side of dykes.

Fine clays, which are associated with in situ oil sands and are contained in the effluents discharged from the Extraction process to the tailings ponds, form a water-clay suspension referred to as fine tailings. The fine tailings (which settle to the bottom of the 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 for the tailings dyke and the fine tailings, the tailings consolidate quickly as water seeps into the dyke. This creates a very-low-permeability layer which significantly reduces the losses of process water from the tailings pond basin.

1.7.2 Water Management

Fresh water for use in the Suncor Inc. oil sands plant is withdrawn from the Athabasca River. Suncor is licenced to withdraw 59.8 Mm^3 annually (equivalent to 163 800 m^3/cd) from the river at a maximum instantaneous rate of 3.8 m^3/s (Licence No. 104000). The water balance for Suncor's operation at 79.5 kbpcd is described in Section C7.1; a summary is provided in Table B1.0-4.

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

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

Suncor's average water intake requirements constitute approximately a 1% and 1.5% diversion of river water (expressed as a percentage of the two low-discharge conditions for the Athabasca River). Actual consumption during these low-discharge conditions is 0.24% and 0.37% respectively, because approximately 74% of water diverted from the Athabasca River is returned to the river.

Overburden and muskeg drainage water is surface run-off that discharges to the river via separate licensed mine drainage discharge points, as shown in Figure B1.0-8. Mine-affected waters are directed to the tailings ponds. Water-control systems associated with the Suncor plant are discussed in detail in Section IV-2.2 of the Application for Renewal of Environmental Operating Approval, February 1995.

1.8 RECLAMATION

Suncor's current reclamation practices are detailed in the February 1995 Application for Renewal of Environmental Operating Approval. 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 consolidated tailings technology will allow reclamation of the tailings ponds to a dry landscape. This Application proposes a new, combined reclamation plan (described in detail in Section D3.0) which includes both the current Lease 86/17 and the proposed Steepbank Mine.

TABLE B1.0-4

PLANT-WIDE WATER BALANCE AT 79.5 kbpcd

Water Input	Water Volume k m^3/d
From River	110.5
From Ore	4.0
TOTAL INPUT	**114.5**
Water Output	
Outfall to River	81.5
To Ponds	22.6
Sewage System	0.3
To Atmosphere	7.3
Upgrader Loss to Process	0.6
Seepage Losses	2.2
TOTAL OUTPUT	**114.5**

FIGURES SECTION B1.0

FIGURES

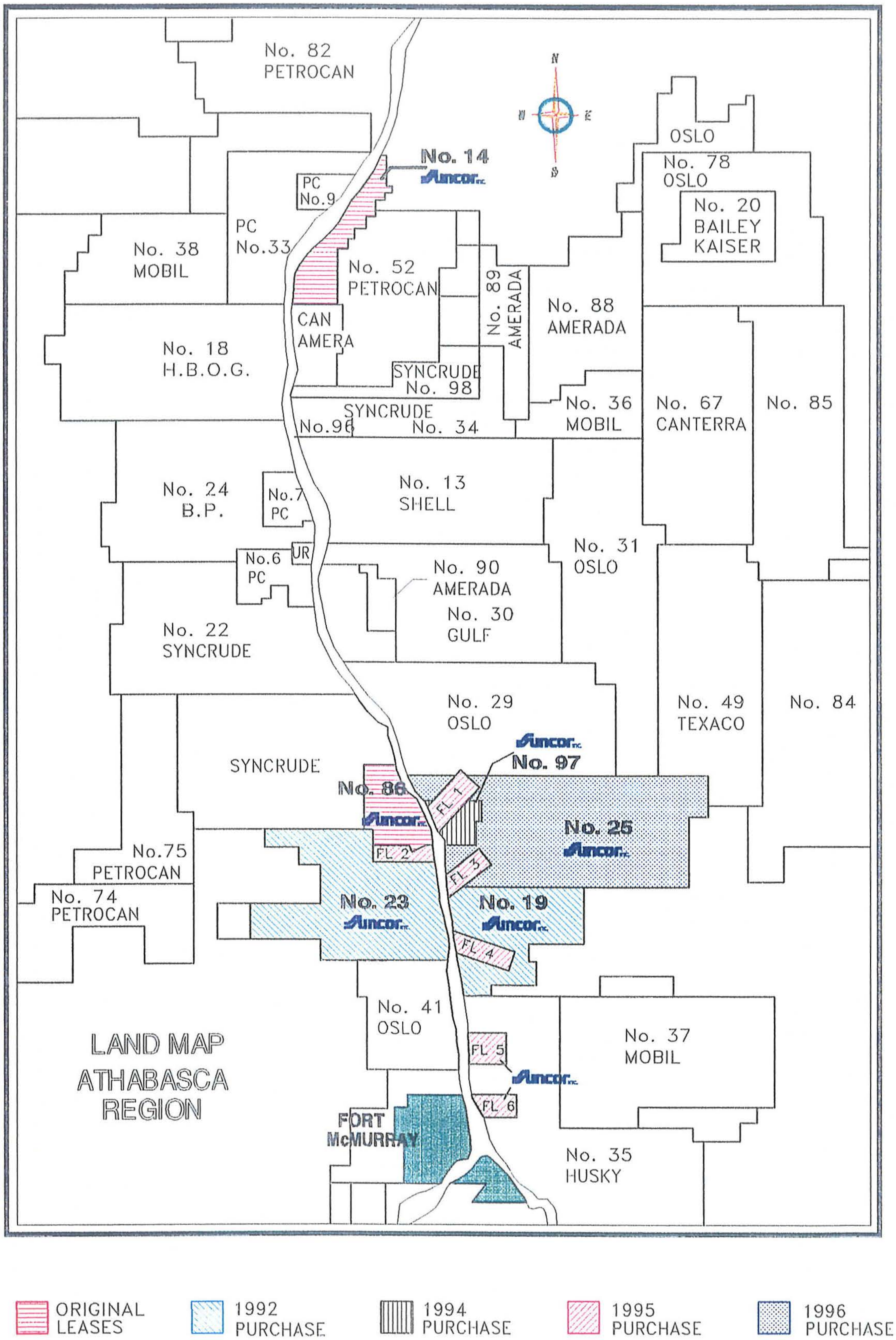


Figure B1.0-1 Suncor Inc. Oil Sand Lease Locations

Suncor Inc., Oil Sands Group
Business Unit Structure

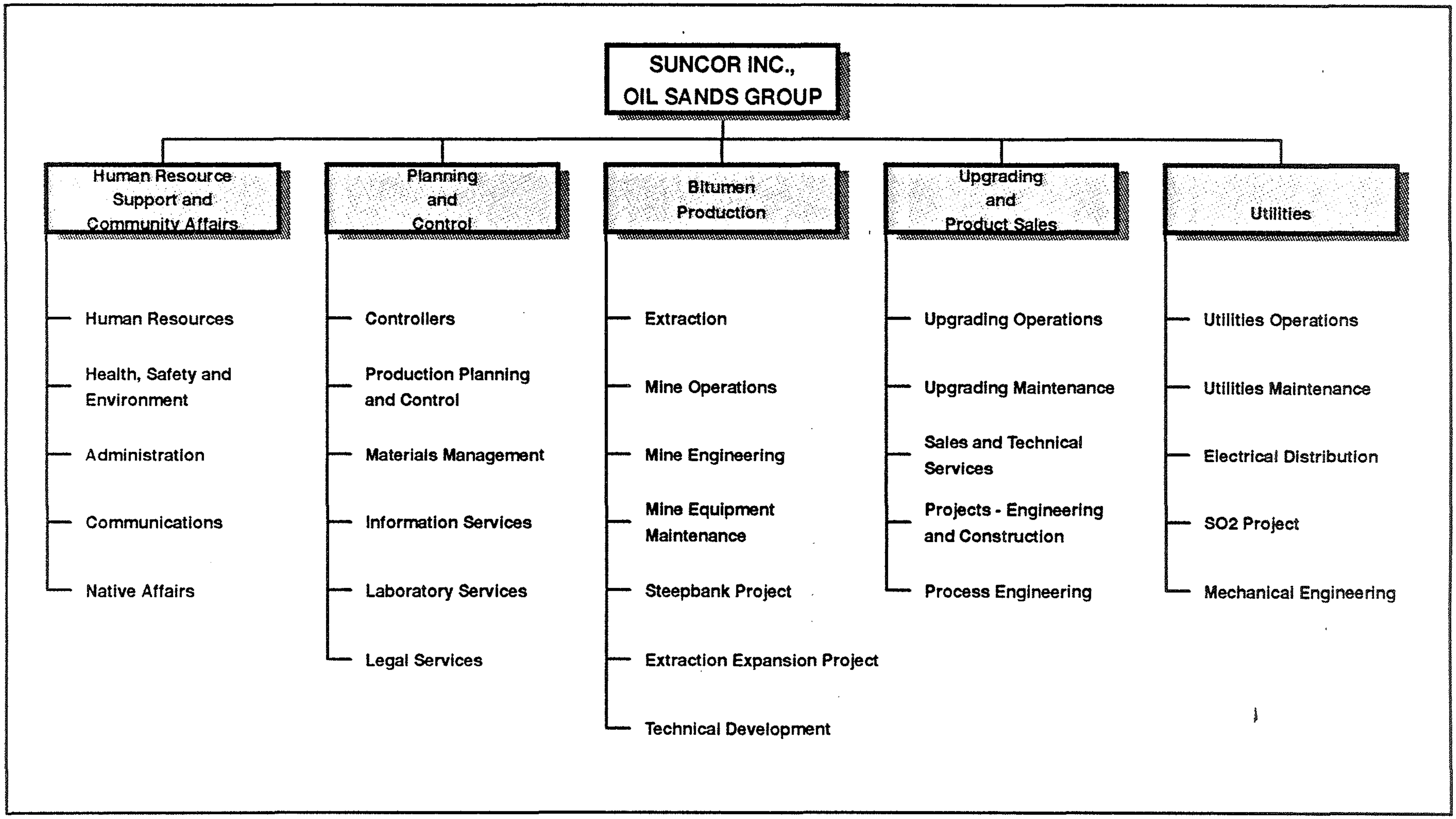


Figure B1.0-2: Suncor Inc., Oil Sands Group - Business Unit Structure

Aerial Photo of Suncor Operation

Figure B1.0-3

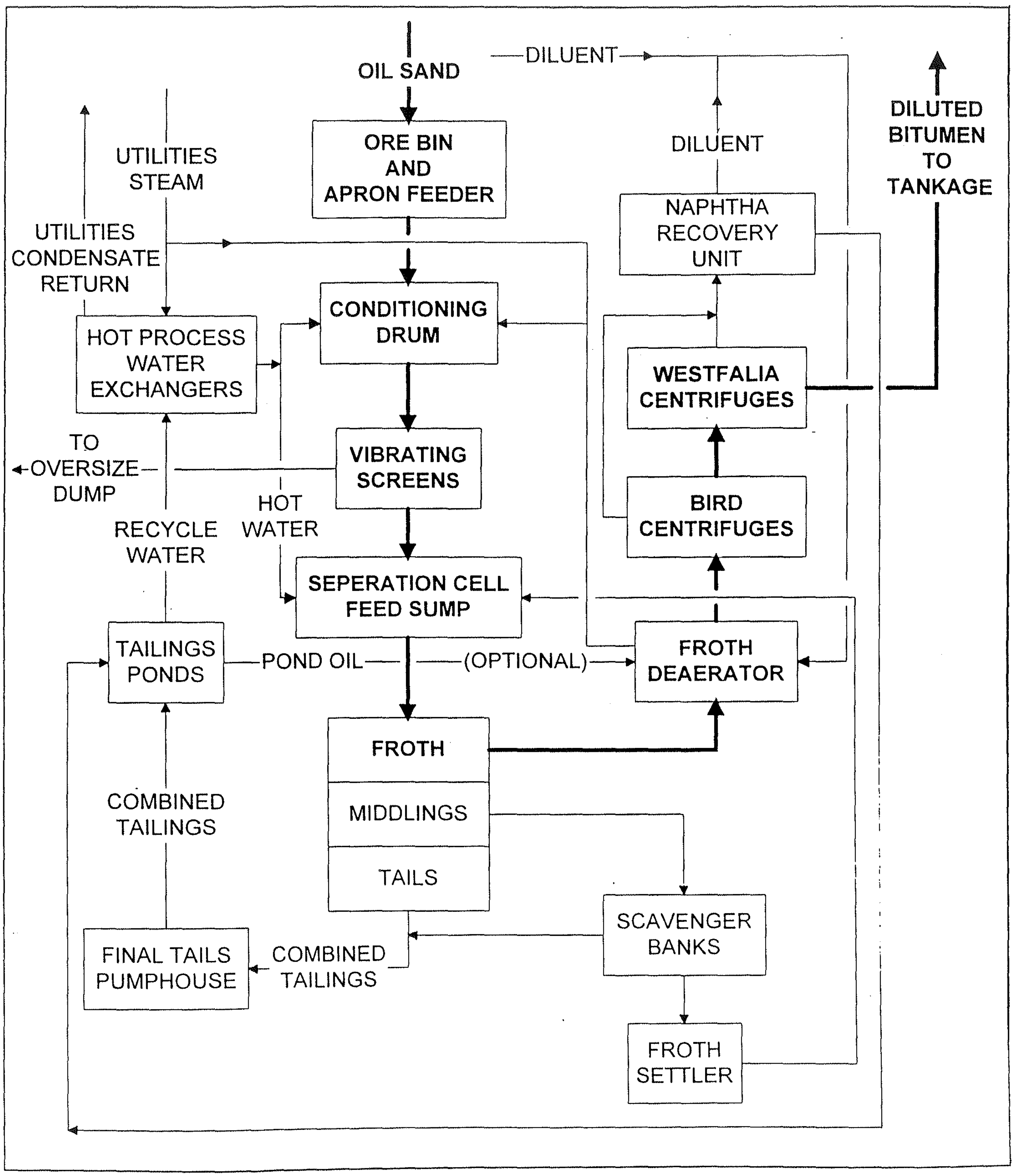


Figure B1.0-4 **Extraction Operation Flowsheet**

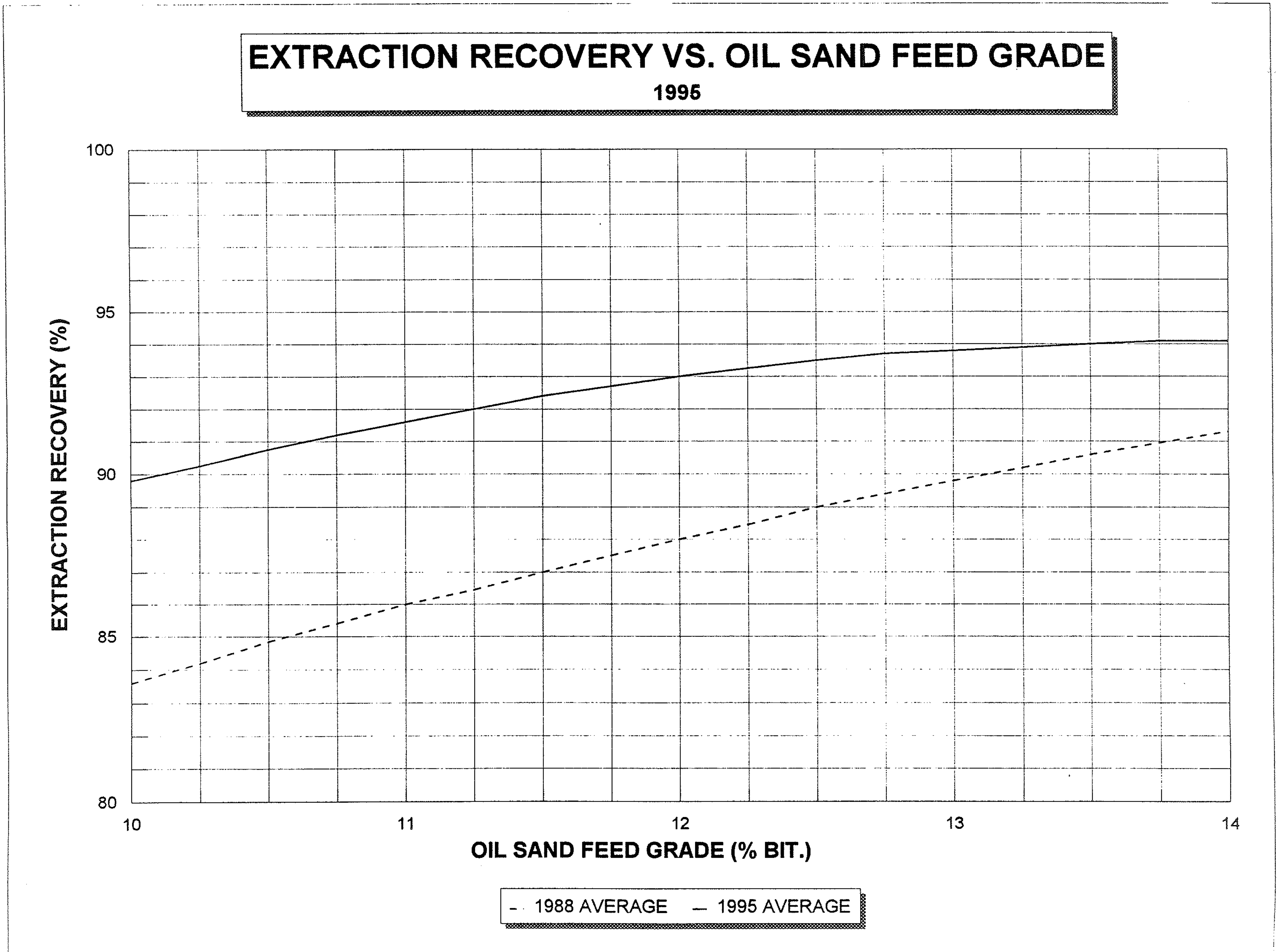

EXTRACTION RECOVERY VS. OIL SAND FEED GRADE
1995
EXTRACTION RECOVERY (%)
100
95
90
85
80
10
11
12
13
14
OIL SAND FEED GRADE (% BIT.)
1988 AVERAGE
1995 AVERAGE

Figure B1.0–5

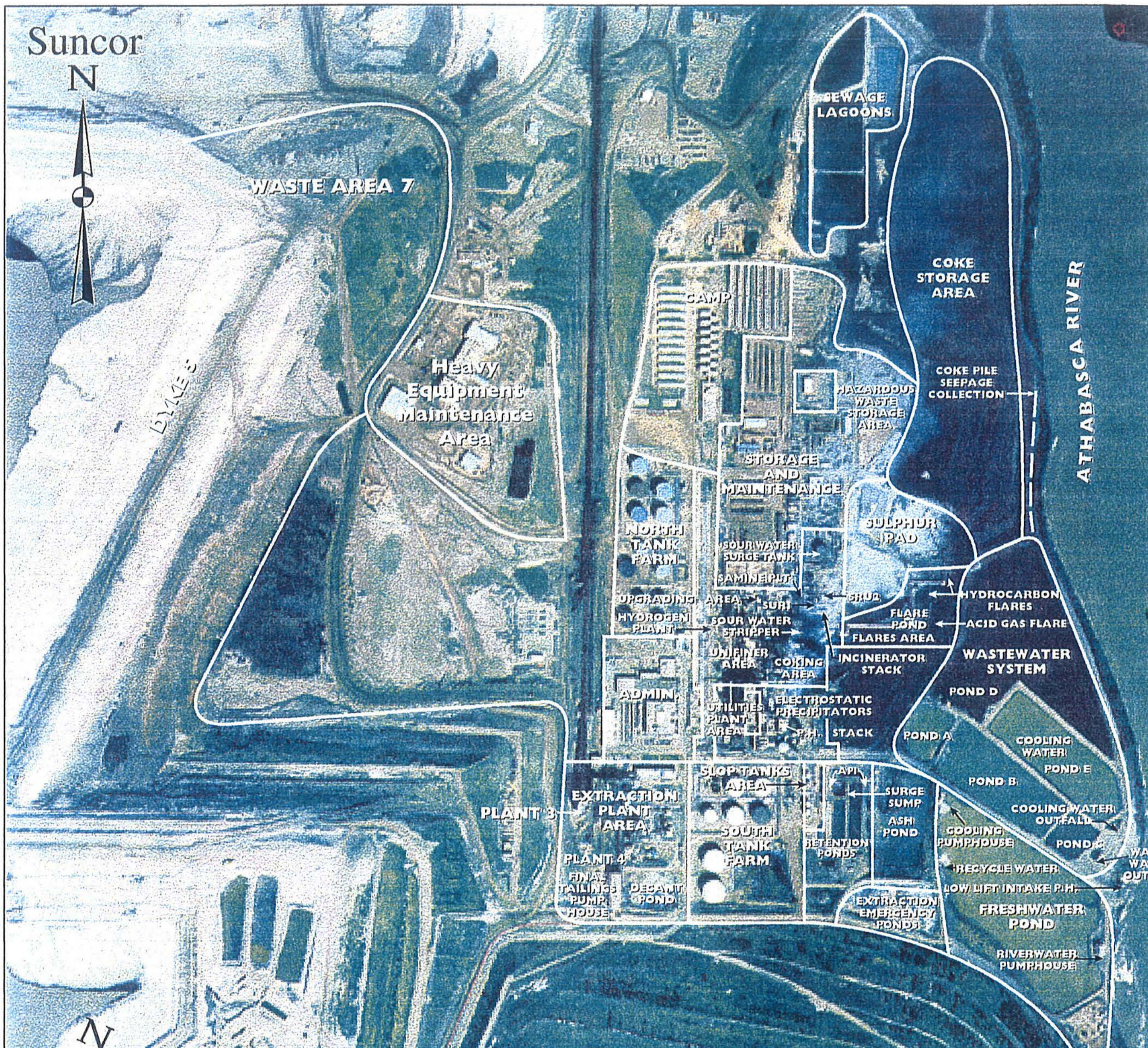


Figure B1.0-6 Plantsite Layout

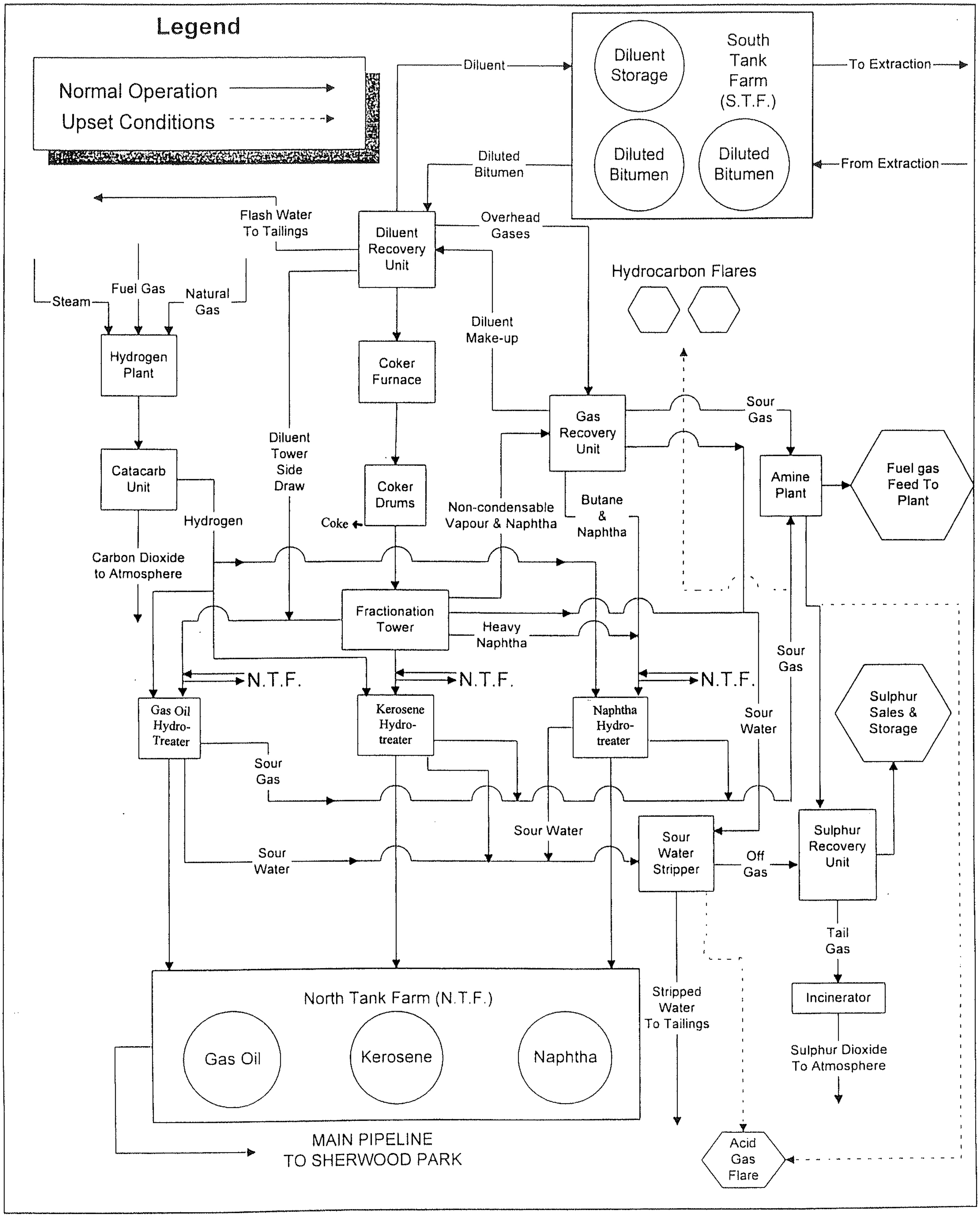


Figure B1.0-7 Upgrading Operation Flowsheet

Figure B1.0-8 Suncor Inc., Oil Sands Group - Surface Drainage

2.0 ENVIRONMENTAL MANAGEMENT

2.1 POLICY AND MANAGEMENT SYSTEMS

Suncor Inc. 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 a "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:

Integrity: By their leadership and exemplary behaviour senior managers demonstrate that environmental protection is a high priority for them and for Suncor's success. Employees are made aware of the potential impacts associated with their areas of responsibility and are provided the tools, processes and training necessary to mitigate these impacts.

Accountability: Suncor management is responsible for setting goals and establishing standards and work procedures which are protective of the environment. All employees will understand their responsibilities and accept accountability for their actions.

Prevention: Suncor will adopt programs aimed at anticipating and preventing emission of pollutants and generation of wastes from its operations.

Self-Regulation: In setting standards and pollution reduction goals Suncor will strive to achieve levels of performance governed not only by legislated requirements but also by the expectations of its communities, customers, shareholders, government and the public while recognizing that the ability to go beyond compliance is subject to the limits of technology and ability to pay.

Integration: Suncor will integrate environmental decision-making 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.

Continuous Improvement: Suncor will strive for improvements in environmental performance and will encourage innovation, recognize achievement and support research to this end.

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 problems. On its part Suncor will openly share timely, accurate and relevant information about its raw materials, products, wastes, operations and environmental performance.

Preparedness: In the event of an accidental release of contaminants, Suncor will be prepared to respond promptly in a manner that will both protect the health and safety of its employees and the public, and lessen adverse effects on the environment.

Suncor's Oils Sands Group is committed to the "We Care" environmental policy and implements this policy when developing, maintaining and enhancing management systems to achieve progressive environmental performance (thus ensuring that environmental issues and concerns are addressed in both continuing operations and in project planning). Components of the environmental management systems include:

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

These policy principles and management systems prevail in all Suncor business units. Bitumen production activities related to environmental management include:

- reclamation,
- surface mine drainage and groundwater,

- coke handling and storage,
- tailings management,
- landfill management,
- waste management and recycling, and
- emergency response.

The above activities have either been described in the February 1995 Application for Renewal of Environmental Operating Approval or are summarized in this Application.

Suncor's bitumen production unit has developed operation-specific emergency response procedures for its mining and extraction activities. 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
  Comprised of fire-fighting, 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.

2.2 ENVIRONMENTAL ACTIVITIES AND INITIATIVES

The Oil Sands Group's environmental protection program requires planning and disciplined implementation at all levels to eliminate, minimize or mitigate (as appropriate) the impacts associated with the Group's operations. Substantial funding of plant-wide environmental initiatives in the period 1990 to 1995 is a demonstration of Oil Sands Group's commitment to a high standard of environmental performance.

In the years 1990 to 1995 Suncor invested about $220 million on projects that would either enhance control over potential impacts of its oil sands plant on the environment or allow more effective evaluation of emissions and potential impacts of its oil sands plant on the environment. A description of Suncor's plant-wide environmental activities and initiatives (including their associated benefits) is provided in Appendix II. Of these initiatives approximately $52.8 million was spent in the area of Bitumen Production Operations; its environmental activities and initiatives are itemized in Table B2.0-1. As these initiatives overlap with the Upgrading and Utilities areas it is not possible to assign costs with precision, therefore allocations are approximate. In this table, diluted bitumen storage projects are included with bitumen production operations.

Section C8.0 discusses environmental initiatives relative to the Steepbank Mine. Greenhouse gas emissions are discussed in Subsection C8.1.2.

TABLE B2.0-1

LIST OF ENVIRONMENTAL ACTIVITIES AND INITIATIVES RELATING TO BITUMEN PRODUCTION OPERATIONS SINCE 1990

Category	Project Summary	Value ($K)
Air Emissions	Odour Abatement 1	3200
	Odour Abatement 2	10 735
	Extraction Recovery Improvements	125
	NRU Improvements	250
	Air Conditioner Coolant Changeover	160
	Total Expenditure on Air Emissions Activities and Initiatives:	**14 470**
Water Emissions	Tar Island Seepage Assessment Project	195
	Groundwater Monitoring System	800
	Dyke Drainage Control Systems	3000
	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 Upgrade	1045
	Regional Groundwater Model	8
	TID Seepage Collection System Enhancement	860
	Mine Drainage Control Structure Upgrade	30
	Pond 5 Seepage Study	85
	Fish Health and Tainting Study	130
	Total Expenditure on Water Emissions Activities and Initiatives:	**7713**
Water Treatment and Potable Water (Allocated)	Upgrade of Potable Water Plant	1358
	Firewater System	2000
	Total Expenditure on Water Treatment and Potable Water Activities and Initiatives:	**3358**

Category	Project Summary	Value ($K)
Environmental Diligence	Environmental Auditing	165
	Community Consultation	50
	Environmental Impact Assessment Projects	543
	Total Expenditure on Environmental Diligence Activities and Initiatives:	**758**
Waste Management (Allocated)	Hazardous Waste Storage Building	87
	Waste Inventory Work	25
	Hydrocarbon Recovery Basin	25
	Total Expenditure on Waste Management Activities and Initiatives:	**137**
Reclamation	Land Reclamation Activities	3343
	Coke Pile Modifications	250
	Fine Tails Transfer	7391
	Pond 1 Reclamation	780
	Research - Wetlands Research -Sustainable Lake Research - Environmental Implications of Dry Landscape Technologies - Reclamation Landscape Model	3088
	Oil Sands Reclamation Performance Assessment Protocol	260
	Freeze-Thaw Treatment of Fine Tailings Project and Non-Segregating Tailings Field Assessment Projects	5970
	Reclamation Rooting Study	15
	Erosional Resistance of Tailings Sand Dykes	175
	Ecological Sustainability of Revegetated Areas of Tailings Sands Dykes	75
	TID Toe Berm Erosion Assessment	47
	Consolidated Tailings Commercial Trial	5000
	Total Expenditure on Reclamation Activities and Initiatives:	**26 394**
Total Expenditure on Environmental Activities and Initiatives - Bitumen Production Operations:		**52 830**

TABLE OF CONTENTS

SECTION C **PAGE**

LIST OF TABLES AND FIGURES

FIGURES

C PROPOSED STEEPBANK MINE

1.0 PROJECT BASIS AND ALTERNATIVES

1.1 INTRODUCTION

Suncor proposes to develop a new mine (Steepbank Mine) to sustain its oil sands operation beyond 2000. The proposed mine will be located across the Athabasca River from Suncor's current operations 35 km north of Fort McMurray, Alberta (see location map Figure A2.0-1). When placed into full operation by 2001 the mine will support a production level of 107 kbpcd of upgraded crude oil.

The scope of the project includes all activities required to plan, construct and operate the new mine, to transport the ore, to modify Extraction facilities from 87 kbpcd to 107 kbpcd and to produce a diluted bitumen product for transfer to the Suncor Upgrading facility (where it is used to produce upgraded crude oil). Included are management plans for all tailings produced by the Extraction plant and the ultimate reclamation plan for current and future tailings ponds. The management, control and mitigation of environmental impacts during construction, operation and reclamation of the mine is inherent in the project scope.

This section describes the sequence of major decisions that led Suncor to the proposed Steepbank Mine development, namely:

- decision to surface mine,
- selection of location,
- selection of technology,
- selection of site access, and
- selection of mine plan.

1.2 DECISION TO SURFACE MINE

The currently-active Suncor leases (i.e., Lease 86/17) are expected to be depleted by the end of 2001. In order to sustain its operation, Suncor will require a replacement source of bitumen.

Additionally, Suncor's business plan calls for an increase in production capability to 107 kbpcd by 1998 (from the current capacity of 79.5 kbpcd) by modifying the Extraction, Upgrading and Utilities plants. This proposed fixed plant expansion was the subject of a public disclosure document in December 1995 followed by filing of an Application dated March 1996.

Suncor's existing bitumen production operation is closely integrated with the Upgrader and Utilities plant. The Utilities plant generates electricity, steam and hot water which are used to significant advantage in the mining-extraction operation. Suncor has examined its options to support the expanded fixed-plant capacity. Clearly one option would be to source external supplies of bitumen. While Suncor may be receptive to competitively-priced external sources (particularly in the period 1998 to 2001) its base strategy is self-sufficiency for the majority of bitumen requirements. To do otherwise would dissipate Suncor's unique energy integration advantages, its investment in extraction and mining facilities, its technology, and the know-how and experience vested in its work force.

Also, Suncor has introduced new tailings reclamation technology which (in conjunction with the Steepbank Mine development) will enable practical reclamation of both the current inventory of fine tailings and future tailings in a consolidated, dry state. This is possibly the most significant technology breakthrough to date, overcoming an environmental impediment to growth of the oil sands industry.

Suncor OSG has chosen to continue with surface mining as its source of bitumen supply for a number of reasons including the following:

- Suncor has significant existing infrastructure (in mining equipment and extraction facilities) and energy integration advantages, which provide a capital cost advantage over any other supply method.
- Suncor has a significant investment in technology and work force know-how.
- Surface mining is a proven technology with high reliability and high recovery of bitumen at a relatively-low operating cost.
- New and evolving reclamation techniques provide assurance that disturbed lands can be reclaimed to an ecological capacity equal or better than pre-disturbance.
- The Lease lands in proximity to the Suncor operation are more amenable to surface mining than in situ techniques. While in situ techniques (e.g., Steam-Assisted Gravity Drainage or

SAGD) offer potentially-low operating cost, the technology is not well-developed for all geological conditions and it introduces more technical risk as well as lower rates of bitumen recovery.

Faced with the prospect of ore depletion on the current operating leases Suncor began the process of examining options for further development in the mid-1980s. Resource evaluations were conducted and additional lease holdings near the plant were acquired.

1.3 SUNCOR LEASE HOLDINGS

Suncor's current lease holdings are shown in Figure B1.0-1. Lease 14 has been held for many years; Leases 23 and 19 were acquired in 1992; Lease 97 and Fee Lots 1 to 6 were acquired in 1994; and Lease 25 was acquired in January 1996.

Suncor currently holds appropriate surface rights under the Public Lands Act to permit lease exploration. Suncor will apply for appropriate surface rights under the Public Lands Act to accommodate facilities and mine operations.

Suncor augmented previously-existing core hole data with results from additional drilling to bring the information base to a level sufficient to enable lease selection decisions to be made for the location of a new mine.

1.4 SELECTION OF LOCATION FOR NEW MINE

After the successful implementation of truck and shovel mining in the current operation in 1993, a pre-feasibility study was conducted in 1994 to examine the economics of developing a replacement mine by 2000 and to assist in decision-making for an appropriate location.

Five cases were examined. These are listed below, each case itemizing a sequence of lease development: e.g., Case 1 (Leases 97, 25) mines Lease 97 followed by Lease 25.

The five cases are:

1. Leases 97, 25
2. Leases 97, 19

3. Leases 23, 97, 19
4. Leases 13
5. Leases 97, 25

These cases were selected in order to evaluate sequencing options of nearby leases and to test the relative attractiveness of a more remote lease (Lease 13) without regard to ownership. Oil sands resources estimated at the time for each lease area are summarized in Table C1.0-1.

TABLE C1.0-1
PRELIMINARY ESTIMATE OF LEASE OIL SAND RESOURCES

Lease	Oil Sand Ore (Mt)	Overburden / Interburden (Mt)	Bitumen (wt %)	Recovered Bitumen (million bbls)	Strip Ratio (t waste/ t ore)
13	6350	4600	11.7	4200	8.73
19	1360	2000	11.5	830	1.45
23	1000	2000	11.3	630	2.00
25	1800	2500	11.7	1200	1.38
97	430	315	11.7	280	0.73

A development plan was prepared for each case. Hydrotransport of ore was assumed for Leases 23, 97 and 25. Desanding and bitumen slurry transport was assumed for the more remote Leases 19 and 13. These cases were evaluated at a planned production rate of 77 kbpcd with the exception of Case 5, which was evaluated at the then-current upgraded crude oil production rate of 68 kbpcd. Each case had thirty or more years of resource life and comparable ore grade at approximately 11.5 wt % bitumen. Truck and shovel mining was assumed for overburden removal and ore mining and hydrotransport/desanding combinations for ore transport, depending on distance. Major factors influencing relative economics were initial transportation distance, initial capital cost and the plan stripping ratio. A discussion of each case follows:

Case 1: Leases 97, 25

This plan has the advantage of beginning in low strip ratio ore. It has an average strip ratio of 1.23 t/t. Hydrotransport was used to move ore to the Extraction plant, a distance of 7.3 km.

Case 2: Leases 97, 19

Like Case 1, this case features a low initial strip ratio. The average strip ratio for this plan is 1.13 t/t. Initially, hydrotransport is used to convey ore 3.7 km to extraction. After the mining of Lease 97 is completed, a desanding plant is commissioned on Lease 19. A bitumen-water mixture is then pumped 12.3 km to the Extraction plant.

Case 3: Leases 23, 97, 19

In this case Lease 23 was developed first, to examine the impact of delaying the construction of a bridge access across the Athabasca River. However, this lease has three main disadvantages: the mining area is 11.7 km from the Extraction plant; the resource life is insufficient to support the capital cost of a desanding plant; and the lease strip ratio is high (1.98 t/t). Savings from a delay in bridge construction do not offset these disadvantages. In addition, any infrastructure built for this mine will be of little use for the next mine. The distant location results in environmental impacts through higher energy demand and more widespread disturbance with creation of a connecting corridor.

Case 4: Lease 13 (Alsands)

Lease 13 is located 22 km north of the existing Suncor operation. Due to the remoteness of this mine a desander as well as totally-independent office and maintenance facilities are required. The desander will need 8100 m^3/h of 90°C hot water which must be generated on-site with coke-fired boilers. The use of natural gas would add about $20 million to the annual operating cost. This case also presents significant environmental impacts because of high energy demand for desanding and widespread disturbance with construction of a connecting corridor. The main advantage of this case is the plan strip ratio of 0.83 t/t combined with large oil sands resources.

Case 5: Leases 97, 25 (at 68 kbpcd)

This case is similar to Case 1 except for a lower production rate. It was developed to examine the effect of production rate on capital cost.

Results of the pre-feasibility study showed that off-site leases can be developed economically. Net Present Values (NPV) were calculated for each case. Case 1 had the best NPV followed by Cases 2, 3, 4 and 5 respectively.

Case 1 also had the lowest capital and operating costs per barrel followed by Cases 2, 5, and 3; Case 4 (Lease 13) had the highest cost. Even though Lease 13 has an attractive strip ratio the advantage is more than offset by the high cost of operating a remote facility. Case 3 also has a high cost because of the long initial transport distance and a high strip ratio.

Main conclusions reached from the pre-feasibility study are as follows:

- Mining of Lease 97 followed by either Lease 25 or 19 would provide the best Net Present Value.
- There is sufficient ore of acceptable grade and strip ratio in the proximity of the existing plant to allow economical mining to continue for thirty years or more.
- Truck and shovel mining is an appropriate system for stripping overburden and mining the oil sand.
- The success of developing off-site leases is largely dependent upon using hydrotransport or desanding technologies.
- Utilization of existing infrastructure reduces costs and encourages the development of adjacent leases first.
- Environmentally, all cases result in surface disturbance and involvement with the Athabasca River valley because of the choice of bitumen production technology – surface mining. Distant case options result in higher energy demands (and emissions) and infrastructure corridor disturbance. All case options require river access.

The pre-feasibility study resulted in a decision to develop a new mine on the east side of the Athabasca River in the area of Leases 97, 25 and 19 with Lease 97 as the initial mining area. This decision was driven by economic considerations, capital cost and technical risk exposure. Environmental factors were not a main driving force in the location selection at the time because it was felt that each area would entail reasonably similar environmental disturbances which would have to be mitigated in any case. However, the plan to develop a new mine across the Athabasca River (in proximity to the current operation) has a major environmental advantage versus the development of a more remote lease: the plan allows very practical integrated tailings management between the current operation and the new mine area, thus permitting earlier dry reclamation of Lease 86/17 ponds.

1.5 TECHNOLOGY SELECTION

At the end of 2001 mining of oil sand is expected to be completed on Lease 86/17. A new mine (utilizing efficient mining and processing methods) will then sustain operations on the east side of the Athabasca River.

In order to select the most cost-effective mining system several different technologies have been studied. Since 1992 the Steam-Assisted Gravity Drainage (SAGD) bitumen recovery system and the Taciuk extraction partial-upgrading process have been examined use at Suncor. The mining method on the current lease was changed (from use of bucketwheel excavators to utilizing truck and shovel) as a result of studies completed in 1992. Hydrotransport was also reviewed and recommended for further evaluation.

As a result of these studies and specific Steepbank Mine feasibility studies, mining and extraction methods have been selected. The new mine will use truck and shovel mining methods linked to hydrotransport of oil sand to the existing Extraction plant. The Extraction plant will be modified from hot-water extraction to warm-water extraction. Details of the main alternative technologies from a mining perspective are discussed in Appendix I. In summary, the SAGD in situ process was judged unsuitable for application on nearby leases and the Taciuk process cannot compete on a capital cost basis with existing infrastructure (Suncor is however currently evaluating the application of the Taciuk process to oil shales in Australia). Additional discussion from an Extraction perspective is found in Section C5.3.

Suncor has many years of satisfactory experience with the use of truck and shovel methods of overburden removal and has elected to continue with the technique at Steepbank Mine. This method provides the requisite flexibility for stripping rate, segregated placement of materials and selectivity to readily accommodate mine plans that are ever-evolving in the course of optimization. The method is economical and reliable; its performance is continuously improving with the introduction of larger and more dependable equipment.

Conversion of ore mining to truck and shovel methods at Suncor's current operations in 1993 exceeded Suncor's expectations and reduced operating costs by \$3.50/bbl upgraded crude oil. The method offers several important advantages:

- High productivities and availabilities can be achieved.
- Equipment can be interchanged between overburden removal and oil sand mining operations.
- A steady crushed ore feed is provided to the Extraction plant; this has a positive impact on bitumen recovery.
- Truck and shovel mining methods can deal effectively with complex geology and restrictive operating conditions.
- Overburden haul distances are reduced because face conveyors no longer obstruct haul routes.
- Truck and shovel mining methods are a known technology.
- The methods require few equipment components, providing ease of maintenance.

Selection of truck and shovel mining carries minimal technical risk. Economical and innovative road-building methods have overcome problems of movement of heavy, ore-laden trucks in all weather conditions.

Assurance of reliable, continuous feed from truck and shovel mining enables the use of hydrotransport methods with only a minimum requirement for buffer storage of ore (to accommodate shift changes and breaks). The selection of hydrotransport of oil sand over traditional conveyor systems from the mine Extraction site has several advantages:

- The full cost of transportation for hydrotransport is less than that of a conveyor system.
- The hydrotransport system presents environmental advantages over open conveyors. Hydrotransport is completely enclosed (reducing the ore spillage, and dripping diesel fuel and glycol associated with conveyors) and allows a more direct route to the Extraction plant.
- Hydrotransport pre-conditions the ore in the pipeline, eliminating the need for conditioning drums in the Extraction plant. This simplifies the extraction process, allows bitumen separation at 55°C instead of 70°C to 75°C and reduces energy inputs to Extraction. Emissions associated with energy production are reduced.

The hydrotransport system is proven technology and presents little technical risk. Suncor has nearly thirty years of experience with slurry transport and will draw on that experience in the design and operation of a hydrotransport system. Additionally, the system is in use at Syncrude and Suncor has full access to the technology.

1.6 SELECTION OF SITE ACCESS

The decision to develop the new mine on the east side of the Athabasca River prompted a review of the options available to access the site.

Access to the site must accomplish several purposes:

- Before mining commences, access is required for the construction of plant and maintenance facilities.
- Means of access must incorporate hot water, hydrotransport and tailings pipelines.
- Access must accommodate transport of personnel, communications, heavy equipment and materials, electricity, fuel oil and waste products.

The ore body requires pre-clearing and pre-stripping of muskeg, topsoil and overburden, and unrestricted movement of mining equipment between Lease 86/17 and Steepbank Mine. After the mine is in full production, the access route will be used to transport employees and materials for a period of thirty years or more. The shortest route between the new mine and existing facilities would have many cost advantages over the long term.

Four options were studied for accessing the east bank of the Athabasca River:

- bridge with pipelines on deck,
- tunnel,
- bridge with pipeline river crossing, and
- northern road access with pipeline river crossing.

For the bridge option, the structure would be located just north of Pond 1 (Tar Island tailings pond). At this point the crossing is about 550 m in length and is the shortest route to Lease 97. The bridge was designed to carry an empty ore haulage truck, water, hydrotransport and tailings lines and other utilities. This option would allow mobile equipment to move freely between the current operations and Steepbank Mine which would facilitate the transition of operations and maximize the use of existing mining equipment.

The tunnel option was sited in a location similar to that for the bridge. Designed for one-way traffic, the tunnel would accommodate a tractor-trailer unit, hydrotransport and tailings lines and other utilities. The tunnel has a long construction period (thirty-two months) as well as geotechnical risks. Its height and width restrictions would prevent easy movement of mining equipment Over the long-term the tunnel would be expensive to operate and maintain (due to the need for lighting and ventilation). Its estimated capital cost is about $9.4 million more than the bridge option.

The bridge and pipeline river crossing option would permit inclusion of seven pipelines in a single trench under 3 m of cover across the Athabasca River in the same location as the bridge. This option would make pipeline inspection and maintenance more difficult. Cost of laying the pipelines is $8.9 million. The total cost of this option is $7.6 million more than the bridge option.

The northern road access option proposed accessing Lease 97 via the bridge on Highway 63, 20 km north of the Suncor site. This bridge is capable of handling normal provincial highway loads. Two bridges (across the Muskeg and Steepbank Rivers) and 20 km of all-weather new road would be required in addition to the pipeline crossing of the Athabasca River. One-way travel time from the current operation to the new site would be about thirty-five minutes and would offer major inconvenience. More significantly return travel time from Fort McMurray would nearly double, to 2.5 h per shift. This option also opens up considerably more area to environmental encroachment. Total cost of this option is $5.6 million less than the bridge option.

Both the tunnel and the bridge-with-pipeline river crossing options were eliminated on the basis of high capital cost. They both require river bank approaches so their environmental impacts would be similar. The northern road access option was eliminated due to higher maintenance and travel costs, significant increase in travel time for shiftworkers and environmental considerations.

Later a fifth option was considered: crossing the Clearwater River at Fort McMurray then a new all-weather road north along the east side of the Athabasca River to Steepbank Mine. While the travel time from Fort McMurray would be the same as to the current site, movement of personnel and equipment between operating sites would be inconvenienced. This option also opens up a substantial area to new environmental encroachment. Total cost of this option (including a Clearwater bridge, a pipeline river crossing and a new all-weather highway) is considered to be in excess of $10 million more than the bridge option. This option was eliminated due to a combination of costs, travel time and environmental impacts.

In summary, the first site access option has been selected.

1.7 STEEPBANK MINING SEQUENCE

Previous discussion reviewed the decision-making process that Suncor went through to arrive at its fundamental conclusions regarding the need for Steepbank Mine, its location, the technology it would use and how to best access the new mine. Subsequently, engineering feasibility studies were conducted to develop the proposed Steepbank Mine plan. These studies (together with input from public consultations) will be the basis for final design of Steepbank Mine. Public consultations will continue through the planning and construction phases of the mine (see also Section A.3.0).

This section describes Suncor's plans for Steepbank Mine which will still be subject to modification from the consultation and regulatory processes.

1.7.1 Design Rates

The following design rates are used for feasibility mine planning and design purposes. For this purpose Upgrader yield was conservatively estimated at a nominal 81%.

Lease area mined, general sequence	Fee Lot 1, Lease 97, Lease 25, Fee Lot 3, Lease 19	
Cut-off grade of oil sand	8 wt %	
Mine plan duration	2000 to 2020	
Ore in mine plan	1350 Mt	
Average grade of ore in plan	11.9%	
Average stripping ratio	0.9 t waste/t ore	
Average overburden moved	57 Mt/y	
Ore feed rate	8100 t/ch (tonnes per calendar hour) 195 kt/cd	
Bitumen in feed to cyclofeeder	23 260 t/d 145 kbpcd (23 000 m^3/d)	
Bitumen to upgrader	132 kbpcd (21 000 m^3/cd)	
Overall bitumen recovery factor	91.1%	
Upgrading conversion factor	81% (nominal)	
Upgrader gross product	107 kbpcd	(17 000 m^3/d)
Upgrader net product	105 kbpcd	(16 700 m^3/d)

1.7.2 Geology and East Bank Resources

Geological interpretation and reserves calculation for this Application are based on data from a total of 228 drillholes on the east bank (which includes those holes drilled in 1995 but excludes the 1940 drillholes). Leases and fee lots specifically evaluated include:

- Lease 97
- Lease 19
- Lease 25
- Fee Lots 1, 2 and 3

The drill density is approximately 3.3 drillholes per square kilometre. Suncor believes that this drill density is sufficient for ore body identification and general characterization, and it is prepared to continue with project development on that basis. Suncor intends to continue delineation of the ore with additional drilling. Typically, the area representing the first five years of mining would be drilled to a density of 30 to 40 holes per square kilometre (depending on the ore body complexity). Such density would enable detailed bench design and ore-blending schemes to maximize bitumen recovery.

Details of the geological evaluation are provided in Section C2.0 The oil sand ore body was modelled using Mincom Mine Planning software.

Figure C1.0-1 depicts the ore bodies identified on the east bank. Table C1.0-2 summarizes their resource potential. The total potential in these ore bodies represents about 3.5 billion barrels of recoverable bitumen or about seventy years of production at a rate of 107 kbpcd upgraded crude oil.

1.7.3 Selection of Steepbank Mine Plan

After identification of the general location of the east bank ore bodies, the next step was determination of the initial mining sequence for the first twenty-five years of operation. Five strategies were considered, all of which took into account the fact that Suncor had not yet acquired Lease 25 (it was acquired in January 1996). In each case the first eight years of mining were on

TABLE C1.0-2

SUMMARY OF EAST BANK RESOURCES

Ore Body	Oil Sand (10^6 t)	Waste (10^6 t)	Stripping Ratio (t/t)	Bitumen (wt %)	Years at 107 kbpcd
North	940	1200	1.3	11.5	13
Centre	560	370	0.66	11.5	8
South	3680	4700	1.3	11.7	51
Total Resource:	5180	6270	1.2	11.7	72

Lease 97 because it has the lowest stripping ratio. In addition, each strategy mined the residual portion of the Centre pit on Lease 25 (although it was not then owned) for practical mining and resource conservation reasons. The strategies are as follows:

Strategy 1

Mine south of the Steepbank River

Maximize mining of Suncor-owned property (Lease 97, Lot 3, Lease 19)

Mine a practical portion of Lease 25 in the South ore body

Strategy 2

Mine north and south of the Steepbank River

Mine a portion of Lease 25 North ore body

Mine a practical portion of the South ore body on Lease 25

Strategy 3

Mine south of the Steepbank River

Maximize mining of Lease 25 in the South ore body

Strategy 4

Mine north and south of the Steepbank River

Mine on Suncor lands only (except in Centre ore body)

Strategy 5

Mine north and south of the Steepbank River

Mine all of North ore body on Lease 25

Upon review, Strategy 4 was eliminated because the requisite tailings plan sterilized a significant quantity of ore between Lot 3 and Lease 19 West, and creating an impractical mining situation. Strategy 5 was also eliminated because it has a relatively high stripping ratio and lower bitumen grade. The remaining three strategies were evaluated in detail with an economic analysis. Figures C1.0-2 to C1.0-4 illustrate the three strategies and Table C1.0-3 compares the strategies.

TABLE C1.0-3

STEEPBANK MINE SEQUENCE STRATEGY COMPARISON

Strategy 1	Strategy 2	Strategy 3
Mostly Suncor leases Steepbank River undisturbed Least economical Includes desander in 2018	Mostly Suncor leases Must cross Steepbank River Slightly better economics than Strategy 1	Includes ten years of mining on Lease 25 Steepbank River undisturbed Best economics depending on acquisition cost of Lease 25 Best mine layout with most potential for optimization

Suncor subsequently decided to develop a twenty-year mine plan which incorporated the best features of the above three strategies, namely mostly Suncor leases; limit mining to the south of the Steepbank River, to reduce environmental impacts; and exclude the requirement for the desander. This plan also features low strip ratios in the early years, it entails an easy-to-open site and it does not sterilize reserves with waste dumps or facilities.

The selected strategy mainly mines Lease 97 for the first eight years followed by mining an area that includes ore from Lot 3, Lease 19 and a portion of Lease 25. Illustrated in Figure C1.0-5, it is the basis for this Application. Detailed mine planning based on more core hole drilling and other information will optimize the strategy over the mine's life. Certain changes have already been incorporated as a result of consultation with interested communities. Pit 1 will now not include the "peninsula" area near the confluence of the Steepbank and Athabasca Rivers as originally contemplated. The fact that Suncor acquired Lease 25 in January 1996 may result in some optimization of the plan post-2007.

Areas north of the Steepbank River and the remainder of Leases 25 and 19 are available for future mining and represent a projected resource potential of fifty years at a rate of 107 kbpcd.

This mine plan recognizes the environmental sensitivity surrounding disturbance of the Steepbank River. On the south side of the Steepbank River an undisturbed 100-m set-back is maintained from the top of the escarpment.

With respect to the Athabasca River, the mine plan specifies removal of ore from the escarpment (i.e., the mine "daylights") with the constraint that the intersection with the escarpment be above the 1-in-100-year flood level (at elevation 241 m ASL). The east bank escarpment has a relatively gentle slope. The result is that the undisturbed set-back from the Athabasca River exceeds 500 m along the length of the Steepbank Mine with the exception of a 2000-m section encountered in the third year of mining on Lease 97. In this area a minimum 70-m set-back will be maintained. As well, by 2009 that portion of the escarpment will be "rebuilt" with Dyke 10 (constructed with suitable overburden materials to elevation of 330 m ASL) to a height approximately equal to that of the current escarpment.

Suncor examined and rejected the option of not mining the river valley escarpments (i.e., maintaining a 100-m setback from the top edge of the escarpment). The evaluation showed that 256 Mt of economic ore would be sterilized, equivalent to approximately 170 million barrels (27 Mm^3) of bitumen or 138 million barrels (22 Mm^3) of upgraded crude oil.

Artist's renderings of Steepbank Mine for the years 2000, 2009, 2015 and 2030 are presented in Section A2.0 (Figures A2.0-3 to A2.0-6); these renderings are realistic representations of the mine plans described in this Application. Revegetation of waste dumps and dykes, progression of waste dumps and dykes, and infilling of ponds with consolidated tailings as well as advances of mine and overburden faces are depicted in these three figures.

Hydrotransport and extraction processes are discussed in detail in Section C5.0 including the decision-making process for selection of the technology.

Tailings management, the formation of new landforms and subsequent reclamation are discussed in Section D3.0.

1.8 ECONOMIC VIABILITY, PROJECT COST AND NET BENEFIT

1.8.1 Economic Viability

Suncor has acted to improve the economic viability of its oil sands operation by reducing operating costs through new technology and other efficiencies. At the same time environmental performance has been improved with substantial investment. Some of these key accomplishments are reviewed in Section A1.0. Details of expenditures on environmental initiatives are found in Subsection B2.2.

Steepbank Mine is expected to result in reduced unit energy and operating costs through the introduction of lower-cost technology, namely hydrotransport and warm-water extraction. In addition, the 32% increase in production rate will provide economies of scale. Markets for upgraded bitumen (in particular the diverse blends produced by Suncor) are available. All of these factors combine to indicate a continuing viable operation (tolerant of price uncertainty) and justify the $336 million investment in Steepbank Mine.

1.8.2 Project Costs

Capital cost for Steepbank Mine is estimated at $336 million (1996 dollars) and will be internally financed by Suncor Inc. The approximate breakdown of the capital cost expended in the period 1995 to 2001 is as follows:

- lease evaluation, engineering, environmental and project management - 10%;
- mine and access development - 75%; and
- Extraction and final tails pump house modification - 15%

Cash costs (including both operating costs and sustaining capital costs) are expected to average $15 per barrel in 1996 and 1997. Bitumen production is about 40% of the cost. When annual production averages 107 kbpcd cash costs are expected to fall to $11 to $12 per barrel.

1.8.3 Net Benefit

The Steepbank Mine development has a positive net socio-economic benefit for Canada, Alberta and the region; this analysis is presented in Section E3.0.

A royalty regime is in place for the leases currently being mined and negotiations continue for a new regime applicable to the leases that will form the basis of the next mine. The new royalty regime will be based on generic terms announced by the Premier of Alberta on 30 November 1995.

FIGURES SECTION C1.0

FIGURES

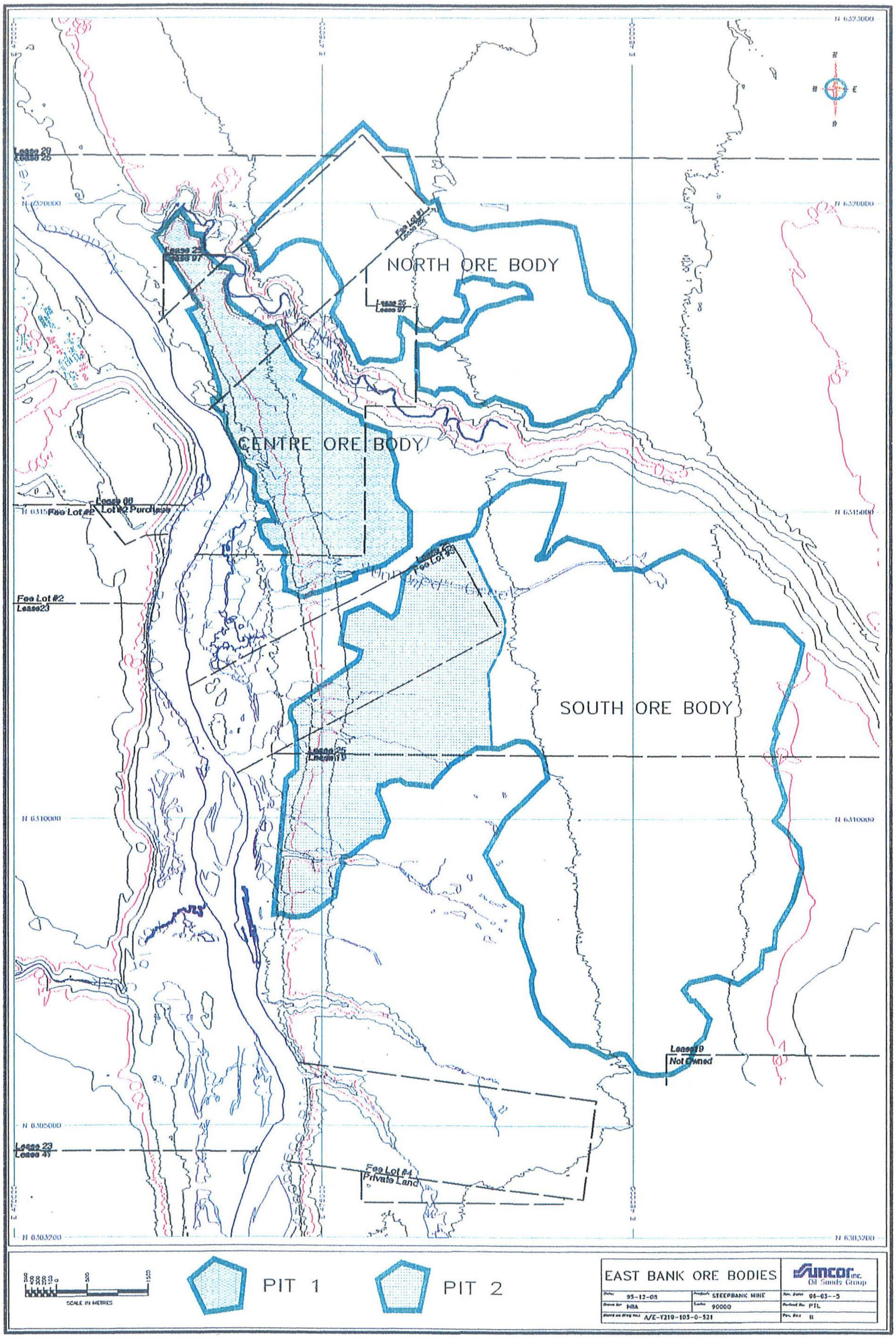


Figure C1.0-1 East Bank Ore Bodies

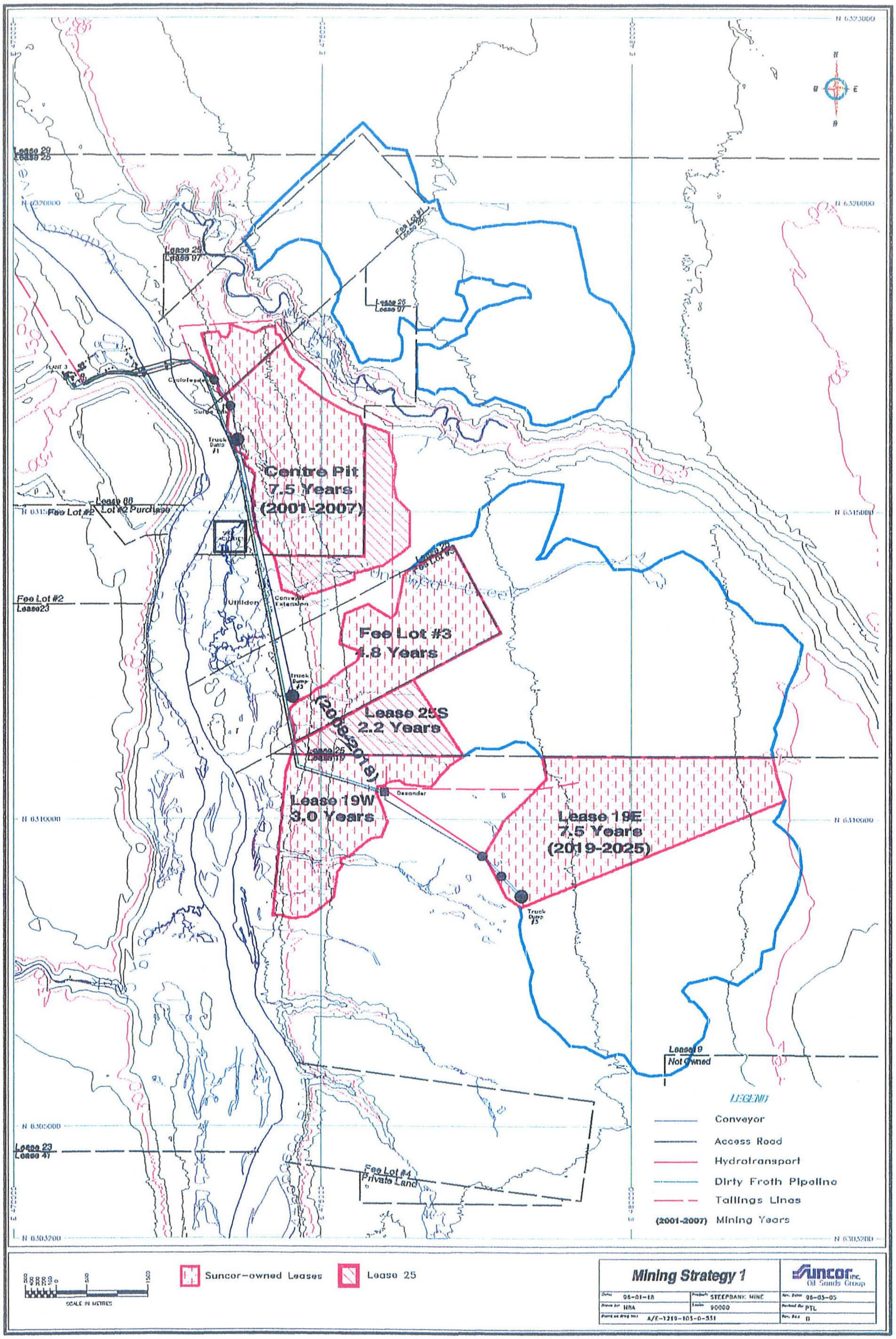


Figure C1.0-2 Mining Strategy 1

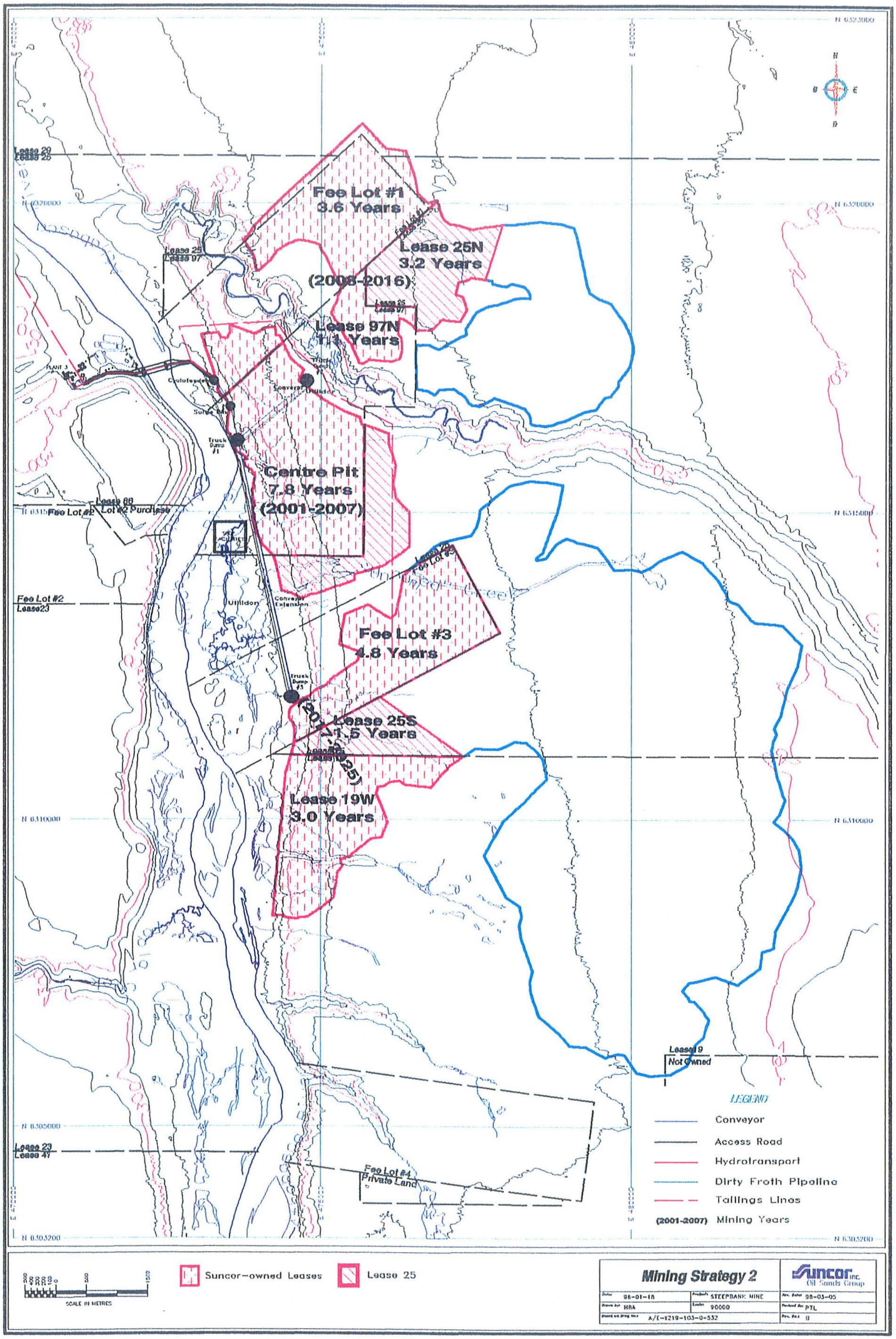


Figure C1.0-3 Mining Strategy 2

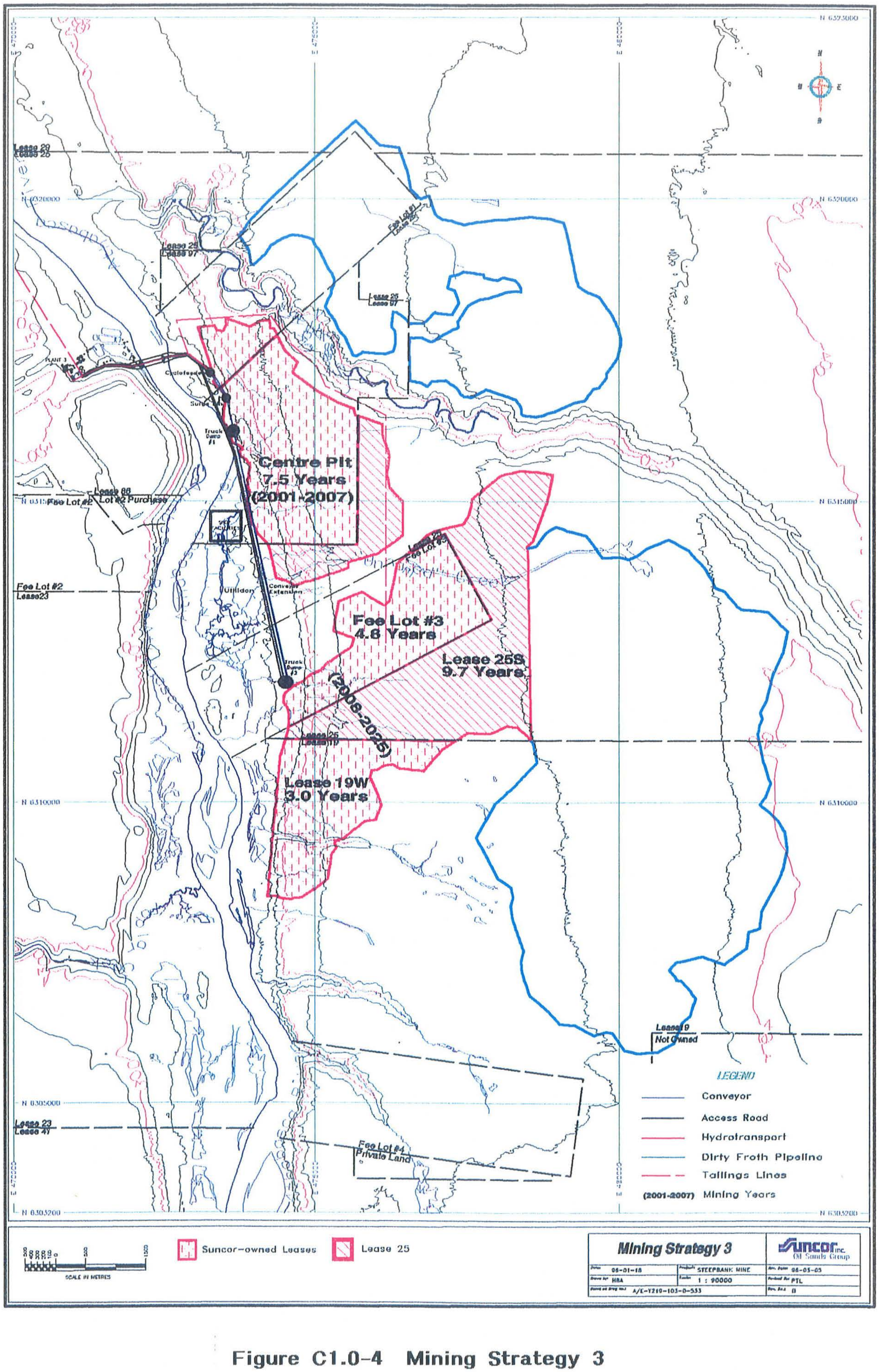


Figure C1.0-4 Mining Strategy 3

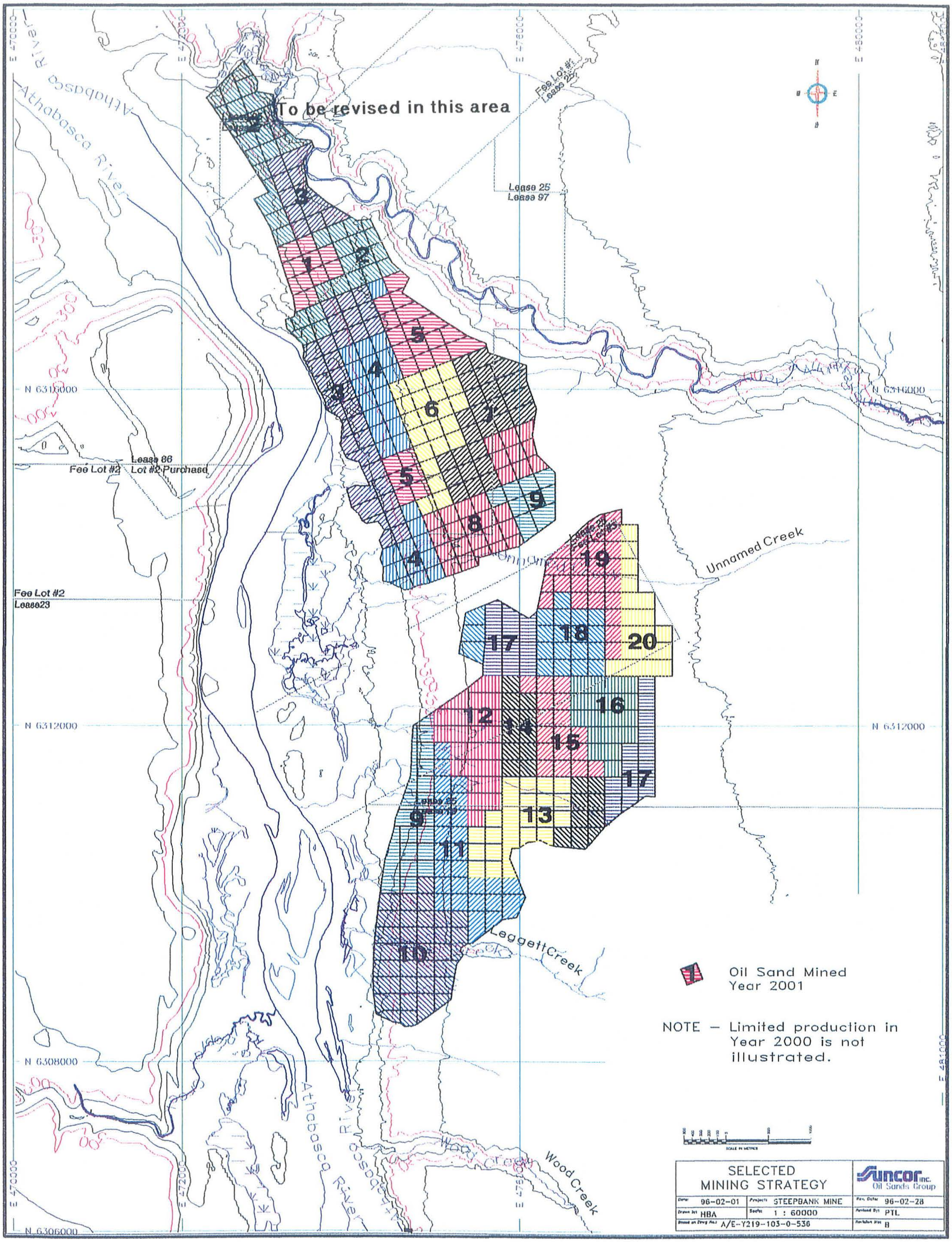


Figure C1.0-5 Selected Mining Strategy

C PROPOSED STEEPBANK MINE

2.0 GEOLOGY AND RESERVES

2.1 GEOLOGY

2.1.1 Regional Setting

Situated in northeastern Alberta, the bituminous sands of the Lower Cretaceous Period McMurray Formation contain an estimated 900 billion barrels of bitumen. Approximately 10% of this petroleum resource is recoverable by surface mining methods such as those proposed for Steepbank Mine. 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 extents of the oil sands and the region amenable to surface mining are illustrated in Figure C2.0-1. A schematic cross-section of the region's geology and stratigraphy is shown in Figure C2.0-2.

2.1.2 Regional Geology

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

Paleogeographic lows on the Devonian deposit surface directed drainage into a northwest-flowing river system, where fluvial sediments initially accumulated within the broad river valley. Slowly, as the Clearwater Sea encroached upon the region from the northwest, it caused progressively-rising water levels. The river system was flooded, resulting first in deltaic marsh conditions followed by a large tidal estuary and finally by open marine conditions (Figure C2.0-3). Each of these depositional environments exhibited an assemblage of sediments, of which the various sand facies acted as reservoirs for the heavy oil of the oil sands.

An unconformity and erosional surface separates the Cretaceous deposits from the Pleistocene glaciation, which covered the region with thick ice for tens of thousands of years until retreating approximately 10 000 years ago. The melting ice left widespread unconsolidated sands, silts and clays blanketing the region, on which thin organic and clastic Holocene sediments have developed.

The geological formation of interest for oil recovery (both by in situ techniques and mining) is the McMurray Formation, an up-to-80-m-thick sequence of unconsolidated sands, silts and clays. Within the McMurray Formation are laterally-extensive, very-fine-grained to fine-grained sand sequences up to 50 m thick which were deposited in wide, accretionary fluvial and estuarine tidal channels. These sands form excellent oil reservoirs, with porosities of 30% to 35% and bitumen contents ranging from a few percent to over 16% (averaging 11% to 12% by weight).

2.1.3 Geology of the Steepbank Ore Body

The exploration drilling, geological modelling and a summary of the geology of the Steepbank area and ore body are discussed in the following subsections. Suncor lease holdings have been illustrated previously (Figure B1.0-1).

a) Drilling and Logging

Drilling on the east bank leases was undertaken in the 1940s, 1970s, 1989, 1994 and 1995. A drilling campaign is being undertaken in the winter of 1996, the results of which will be available by summer 1996. Location of all drillholes is shown in Figure C2.0-4 along with the 1996 hole layout. Drilling density is greatest in the Lease 97/Fee Lot 1 area south of the Steepbank River but the quality of some of the data is questionable. Much of the drilling and analytical work was completed in the 1940s to standards much different than those required today.

All holes from recent drilling programs (1989 onward) were cored from the top of the Cretaceous into the Devonian. A suite of geophysical logs was run in each hole by a geophysical service company specializing in slim-hole logging. Logs obtained included caliper, gamma, density, sonic, neutron, resistivity and spontaneous potential. Dipmeter logs have not been run to date. Four dipmeters will be run in 1996 holes. Not all logs described in this suite are available from older holes.

b) Core Description, Sampling and Laboratory Analyses

Core from 1989, 1994, 1995 (and 1996) drilling was obtained in plastic sleeves, frozen (to preserve moisture content) and subsequently sawn in half in the laboratory for sampling and description. Then core was correlated with geophysical logs to ensure a consistent and reliable depth reference.

Detailed observations were recorded about depositional facies, lithology, sedimentary structures, bedding dips, hardness and ore type as well as colour, burrowing, texture, sorting and features of potential geotechnical concern. Core descriptions utilize a facies model developed by Suncor for the Lease 86/17 area and modified for the east bank (Figure C2.0-5).

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

Samples from recent work (1989 onward) were obtained and submitted for laboratory testing. All samples were routinely analyzed for bitumen/mineral/water and particle sizes and check samples were submitted to verify laboratory precision and accuracy. As well, visual estimates were made of bitumen content while describing core as a quick check to identify anomalous lab results. Reliable fines data are available only from the 1989, 1994, 1995 (and 1996) data acquisition programs.

During 1994, 1995 (and 1996) special tests for evaluating ore characteristics were undertaken. These tests included fluid chemistry, to help predict chemical and process reactions in Extraction and Upgrading; extraction processibility, to evaluate recoveries of ore from different depositional systems and to obtain data used in ore-blending strategies; and bitumen chemistry, to allow comparison of bitumen characteristics (during Upgrading) between the new leases and Lease 86/17. Overburden and interburden were tested for sodium adsorption ratios to assist in planning material disposal.

c) <u>Data Quality</u>

Data from various drilling programs vary considerably in quality. For use in evaluating new leases and to assist with planning future drilling, data have been classified as of good, fair or poor 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, containing a full suite of logs, facies-based core descriptions, bitumen/mineral/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 and bitumen/mineral/water assays. Poor-quality data sets exhibit sparse and incomplete information which require much interpretation and numerous assumptions. These latter data sets are only used if nothing else is available. Geological, geophysical log and laboratory data available from drillholes are summarized in Table C2.0-1.

d) Future Exploration

Exploration will continue to complete the area's geological information. Actual drilling densities required for different stages of exploration and mine planning will depend on the complexity of the geological setting in different areas of the mine and the information needs for mine planning and reserves calculation. As a general guideline a drilling density of 2.5 to 3 holes per square kilometre is required for a pre-feasibility study; a density of 7 to 10 holes per square kilometre for a feasibility study; a density of 30 to 40 holes per square kilometre to enable five-year mine planning; and a density of 90 to 150 holes per square kilometre for one-year to two-year mine planning and operational control purposes. This pattern of drilling is similar to that used in existing mining operations.

If required and justified, surface geophysical surveys will be undertaken in the future. None have been undertaken to date nor are any planned at this stage.

Overburden evaluation will continue in 1996 with a sixty-hole drilling program. A test pit program will continue exploration for granular materials. Subsequent work will be planned after evaluation of the 1996 program's findings.

Baseline groundwater monitoring was conducted in 1995 as part of the EIA. This program will be expanded or modified in accordance with AEPA substance release approvals.

e) Geological Modelling

Geology has been modelled using the mine planning and mining geology modelling software package commercially available from Mincom Inc. This modelling tool is strongly oriented towards a mining model rather than a geological model. Hand-drawn geological cross-sections of overburden and ore zones will be prepared when drilling densities have improved following the 1996 drilling campaign. These will be used to develop a more realistic computer model.

TABLE C2.0-1

GEOLOGICAL DATA AVAILABLE

Years Drilled	Holes Drilled	Data Quality	Lab Data	Logs Run
1940s	98	Poor/Fair [a]	Bitumen Only	No
1950s	1	Poor	None	Yes
1960s	2 [b]	Fair	BMW Partial [c] Sieves	Yes
1970s	28	Fair	BMW Full Sieves	Yes
1989	33	Good	BMW Full Sieves	Yes
1994	3	Good	BMW Full Sieves	Yes
1995	36	Good	BMW Full Sieves	Yes
1996	55	Good	BMW Full Sieves	Yes

[a] 1940s holes, although listed as poor quality (due to lost core intervals), were drilled in an area of rich, homogeneous ore; data is supported by subsequent drilling.

[b] 1960s holes: two densely-drilled locations (about 15 holes each) counted as two holes.

[c] BMW: Bitumen, Mineral and Water content
Partial Sieves: Particle size distributions were either not done or were done on selected intervals using unconventional sieve sizes.

The computer modelling software comprises of a number of interrelated modules as follows:

- Minescape: a core module;
- Geodas2: contains the geological database;
- Stratmodel: provides geological modelling capability;
- Mine Design: provides mine design capability; and
- Reserves: calculates reserves.

Geological data are stored in a database module (Geodas2) which holds geological horizons, bitumen/mineral/water analyses and particle size distribution data. A subroutine in Geodas2 compares bitumen data from sampled intervals and calculates both ore and interburden zones, determining interburden to be aggregated intervals greater than 3 m thick with bitumen content less than 8%.

The geological data are modelled using the Stratmodel module, a three-dimensional stratigraphic model for layered deposits. Stratmodel develops a series of fundamental and derived surfaces which divide the geological sequence from the topographic surface to the Devonian surface. Fundamental surfaces are determined from surface topography, core or log picks; they include topography, top and bottom of Clearwater, top and bottom of oil sand, top and bottom of ore, top and bottom of basal aquifer, drillhole collars and Devonian surface. These are entered into Geodas2 as geological horizons. Derived surfaces are a function of both fundamental surfaces and Geodas2 ore and interburden input. They include four ore and three interburden unit tops and bottoms, and various user-defined isopachs such as overburden, Clearwater, ore and interburden, and basal aquifer among others. Since the Stratmodel surfaces are from a gridded model, the surface may vary slightly from some of the data points used to generate the grids. Generated stratigraphic surfaces are reviewed and (if necessary) adjusted manually. Ore and interburden units may be discontinuous but they always occur in the same sequence from top to bottom. The sequence of ore zones is shown in Figure C2.0-18.

f) Overburden

Overburden is defined as those materials and lean oil sands which overlie the ore. Materials are variable, from muskeg to unconsolidated clays, silts and sands, as well as occasional thin, discontinuous, indurated beds. Those materials commonly encountered are summarized and described in Figure C2.0-6. For engineering and material utilization, 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 Figure C2.0-7. An overburden isopach map is presented in Figure C2.0-8.

Muskeg forms the top overburden layer and varies in thickness from nil (close to the river valleys) to 7.0 m in the southeast of the area. Muskeg generally thickens towards the east and south, away from the valleys of the Athabasca and Steepbank Rivers. Detailed determination of muskeg volume is still to be established.

Underlying the muskeg are glacial deposits. In the initial mining area of Pit 1 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 (characterized by sands less than 5 m thick) from an eastward thickening sequence of tills (overlaid by sands and gravels) that reaches a thickness of up to 20 m.

The Clearwater Formation which forms a part of the overburden is of potential concern because it contains clays (which can act as zones of geotechnical weakness) and sands (which can potentially act as shallow natural gas reservoirs). For these reasons this formation is identified in core descriptions and mapped to provide information for engineering purposes. An isopach map of the Clearwater Formation is presented in Figure C2.0-9.

The upper part of the McMurray Formation may be included in the overburden if it meets at least one of these conditions: if it is very high in fines content; if oil-bearing, if it is too thin or discontinuous to mine; or if it is too lean to be designated as ore.

Preliminary mapping of overburden over a selected area (using test pits) was undertaken in 1995. Limited laboratory testing - to characterize materials for grain size distribution and geotechnical characteristics - was part of this work. This area is situated in the northeastern region of Pit 1, roughly parallel to the Steepbank River.

No deep, glacially-derived buried channels have been encountered during the exploration work to date.

Sodium Adsorption Ratio tests have been completed on a few selected overburden materials to characterize their suitability for disposal or utilization.

g) <u>Devonian Surface</u>

On Leases 97, 25 and 19 the Devonian surface is extremely rugged with topographic lows evident north and south of a northeast-trending central high. Relief of up to 40 m is evident on the south flank of the high and up to 20 m on the north flank. Relatively small sinkholes of several tens of metres in diameter (similar to those encountered in Lease 86/17 Mine) are expected in the Steepbank area but will require closely-spaced drilling (typical of pre-production infill drilling) to identify and define. The Devonian surface is illustrated in Figure C2.0-10.

h) Ore and Interburden Zone

Ore zones of interest for mining are in a sequence of bituminous sands 40 m to 50 m thick (which dominate much of the area of the Steepbank) as well as thinner sequences of high-grade material close to the escarpment (where overburden is thin). These wide, accretionary, estuarine channel sand sequences form rich oil reservoirs. Basal fluvial channel sand sequences (when they act as reservoirs) are of interest but they are often water-bearing, forming basal aquifers.

The floor for practical mining, termed the Base of Ore (Figure C2.0-11), may coincide with the Devonian but is often above it (especially in Pit 1), where lean oil sand, clay or water sand occur between the Devonian contact and the Base of Ore.

Top of Ore surface (Figure C2.0-12) indicates the first 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. Two restricted areas near the pit centre have been identified where the ore is locally somewhat thinner. Ore thickness on Lease 25 averages slightly over 50 m. An ore isopach is shown in Figure C2.0-13.

Interburden zones are discontinuous and usually have been difficult to correlate stratigraphically among core holes. This is not surprising in an accretionary sequence, where repetitive cycles of erosion and deposition occurred across the depositional basin, leaving interburdens that are likely to be discontinuous and restricted in areal extent. Considerable additional work will be required to define interburden zones well enough so that reliable maps or sections can be generated.

Three cross-sections generated by the Mincom computer modelling system have been presented to illustrate the mining geology of the area. Locations for the cross-sections are illustrated in Figure C2.0-14 and the cross-sections themselves are presented in Figures C2.0-15, C2.0-16 and C2.0-17.

i) Aquifers

Basal aquifers are present in Pit 1 in fluvial sands filling Devonian lows. Minor, thin, discontinuous perched aquifers (similar to those found on Lease 86/17) are present within the ore body but do not pose any difficulty for mining operations. Basal aquifers have been identified beyond the twenty-year mine in the eastern part of Lease 25, on Lease 97 (north of the Steepbank River) and in isolated locations on Lease 19.

The overburden aquifer in the muskeg, 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 mine (see Section C3.4).

2.2 ORE AND RESERVES

2.2.1 Ore Characteristics

The estimated average ore grade for the twenty-year mine is 11.9 wt% bitumen, 17% fines and average (D50) particle size of 120 microns. Ore in the initial mine area, mainly on Lease 97/Fee Lot 1 (Pit 1), grades 11.5 wt% bitumen. The subsequent pit, on Fee Lot 3, Leases 25 and 19 (Pit 2), grades 12.2 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 1 for example, 40% of the ore is less than 11wt % bitumen and 40% is over 12 wt % bitumen. Modelling shows that ore within the ore zones varies from lower grades in the upper part to higher grades in the centre to both high and low grades in the lower levels, depending on the location. Histograms of grade and tonnage distribution within the Pit 1 area are shown in Figure C2.0-18.

Suncor routinely performs short-range planning in advance of the mine face. Plans are based on drilling densities much greater that those used for either feasibility studies or long-range planning as previously discussed in Subsection 2.1.3.d.

Insufficient data are available to generate a reliable fines model for the east bank pits. Additional data will be acquired as exploration proceeds. In general, highly-elevated fines content in the ore can contribute to reduced bitumen recovery.

2.2.2 Pit Boundaries

Pit boundaries were determined by a method which calculates net cost per barrel of bitumen production (Net Cost) and verified by a method employing the ratio of the total volume of all material to be removed (overburden, interburden and ore) to the total volume of bitumen in place (TV/BIP). For feasibility purposes, mining costs of $2.40 per bank cubic metre for all materials handled and extraction costs of $1.50 per barrel of bitumen recovered were used. A Net Cost contour of $6.50 per barrel was used to define the pit and a TV/BIP ratio of 12 was used for comparison. An adjustment was made to pit boundaries for a 100-m set-back from the Steepbank River. 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. The pit limit is shown as a crest along the Steepbank River and a toe elsewhere. Figures C2.0-19 and C2.0-20 illustrate the extent of the mine pit determined by each of these methods. Given the density of drilling, these pits are essentially the same.

2.2.3 Reserve Potential

Reserves were calculated using the Reserves module of Mincom Minescape mine modelling system software. The pits (defined from the Net Cost modelling) were divided into 200 m x 200 m blocks with vertical internal walls except at the pit boundaries where the pit wall was used. At lease boundaries vertical walls were used. It was assumed that there would be no dilution from overburden, interburden or pit floor material. Dilution of ore-grade material by sub-grade material (contained within the ore zone) is included in the reserve calculations.

Total volume of bitumen in-place for Pit 1 is 63 Mm^3 (396 million barrels) and for Pit 2 it is 96 Mm^3 (604 million barrels). Additional details about reserves, tonnages and volumes are presented in Table C2.0-2.

These volumes are based on modelling of relatively-sparse core hole data: Pit 1 density is 7.1 holes per square kilometre and Pit 2 density is 2.8 holes per square kilometre. These bitumen resources are classified as potential reserves. Suncor believes that this drilling density is sufficient for ore body identification and general characterization and it is prepared to continue with engineering design toward mine development. Delineation work is continuing with additional core drilling to be completed during the winter of 1996 and further drilling planned for subsequent years. The 1996 drilling program will increase drillhole density in Pit 1 to 11 to 12 holes per square kilometre, allowing reserve classification to be upgraded to a probable category. Drillhole density in Pit 2 will be increased to 3.2 holes per square kilometre. Future drilling will both permit reclassification of reserves into a proven category and will provide detailed geological data to facilitate mine planning. Future exploration and development will follow operating criteria similar to that for current mining operation on Lease 86/17.

TABLE C2.0-2

POTENTIAL OIL SAND RESERVES - PIT 1 AND PIT 2

	Pit 1	Pit 2	Total
Oil Sand			
Mass (Mt)	553	796	1349
Volume (M bank m^3)	263	379	642
Grade Bitumen (wt%)	11.5	12.2	11.9
Bitumen in Place (Mm^3)	63	96	159
Bitumen in Place (Mbbl)	396	604	1000
Recoverable Bitumen at 91% (Mbbl)	360	550	910
Upgraded Crude Oil at 81% Yield	292	446	738
Interburden			
Mass (Mt)	55	99	154
Volume (M bank m^3)	26	48	74
Grade Bitumen (wt%)	4.8	3.4	3.8
Overburden			
Mass (Mt)	176	445	621
Volume (M bank m^3)	84	212	296
Lean Oil Sand Overburden			
Mass (Mt)	132	258	390
Volume (M bank m^3)	63	123	186
Total Waste			
Mass (Mt)	362	805	1167
Volume (M bank m^3)	173	383	556
Indicators			
Overall Strip Ratio (t waste/t ore)	.65	1.01	.86
Material Moved per bbl Upgraded Crude Oil (t/bbl)	3.1	3.6	3.4

2.2.4 Implications of Ore Grade Cut-Off

In its feasibility planning Suncor has used an 8 wt% bitumen content to delineate the ore body. The implications of using a lower-grade cut-off are considered in the following discussion.

Suncor believes that Steepbank Mine contains an important quantity of ore between 6 wt% and 8 wt% bitumen. The mine plan was based on a minimum 8% bitumen ore definition for what would be considered preliminary ore body definition drilling. Ore body definition for lower-grade cut-offs does not presently exist and the effects on average bitumen content and fines content are not quantified.

Low-grade (6 wt% to 8wt %) ore is generally found at the top of the ore body (the majority), in an interburden layer or at the base of the ore body, and is the product of different depositional environments. The following is the estimated portion of low-grade ore by depositional type for Pit 1.

	Estimated Portion of Low-Grade Ore	Deposition Type
Top of Ore Body	60%	Lower Estuarine
Interburden	20%	Lower Estuarine 50% Upper Estuarine 50%
Base of Ore Body	20%	Fluvial

The three facies in which low-grade ore (6 wt% to 8 wt%) may occur have different processing characteristics:

Lower Estuarine: Low-grade oil sand, generally contains dispersed fine clay particles with some underbedding. Losses to reject are low, but losses to fine tailings become significant.

Upper Estuarine: Low-grade oil sand is interbedded with structural clays. These clays are generally hard and plastic and they contribute to high reject losses due to plugging of vibrating screens in the Extraction system.

Fluvial: Low-grade oil sand with high (10% to 12%) water content occasionally lies between rich ore and limestone in thicknesses reaching 20 m. The oil sand is medium-grained with low fines and the ore is quite suitable for processing.

Thus, the majority of low-grade ore presents difficulties for processing. There are a number of key implications of processing lower-grade ore including the following:

Recovery Factor on Low-Grade Ore

Recovery of bitumen from low-grade ore can be expected to be significantly reduced. Suncor has limited experience with low-grade ore at its operation but it has access to Syncrude data which indicate a range of overall recovery from 77% to 85%. In a hydrotransport system test (with 8.6% bitumen and 30% fines) overall recovery was 80%. Suncor's extraction process (although similar) is not directly comparable to Syncrude's and thus may not perform as well for high fines ore without modifications: the overall recovery factor is expected to be lower. Suncor believes it would be difficult to maintain the committed 91.1% overall recovery factor with a lower-grade cut-off.

Tailings Losses

Introduction of lower-grade ore would increase tailings losses. In particular, production of fine tailings and unrecovered hydrocarbon would increase.

Environmental Impact

The environmental impact of introducing low-grade ore would be greater due to increased energy use (both to process more ore and to handle and reclaim more tailings).

Economics and Conservation

There is a negative impact on economics (because of increased energy and tailings management costs) generated by processing low-grade ore. Suncor's objective is to optimize the economic value of Steepbank Mine; the company is therefore motivated to mine the next most economic tonne of oil sand at the margin. Mining costs increase with time because the mine stripping ratio increases with time, making future tonnes progressively less favourable. Therefore, Suncor is motivated to capture each economic tonne as it mines. Thus, conservation interests are well-served by economic interests. Suncor will mine all ore on the basis of economics not grade. Once ore is stripped, as long as the recovered oil produces a meaningful margin over costs, the ore will be mined.

Suncor recognizes that this issue needs further analysis. Tasks identified for this analysis include the following:

- obtain additional drillhole data;
- establish the quantity and quality of oil sand in the low-grade category;
- determine the processability of low -grade oil sand, and the overall bitumen recovery factor in both the present extraction process and the future hydrotransport/extraction system;
- determine the effect of blending low-grade ore on processability and recovery factors;
- quantify the impact of the introduction of low-grade ore on energy usage, the environment and tailings management;
- evaluate process modification options; and
- define economic criteria for low-grade cutoff.

Suncor has formed a task force to pursue this work plan and the company will keep the AEUB advised with respect to progress.

FIGURES SECTION C2.0

FIGURES

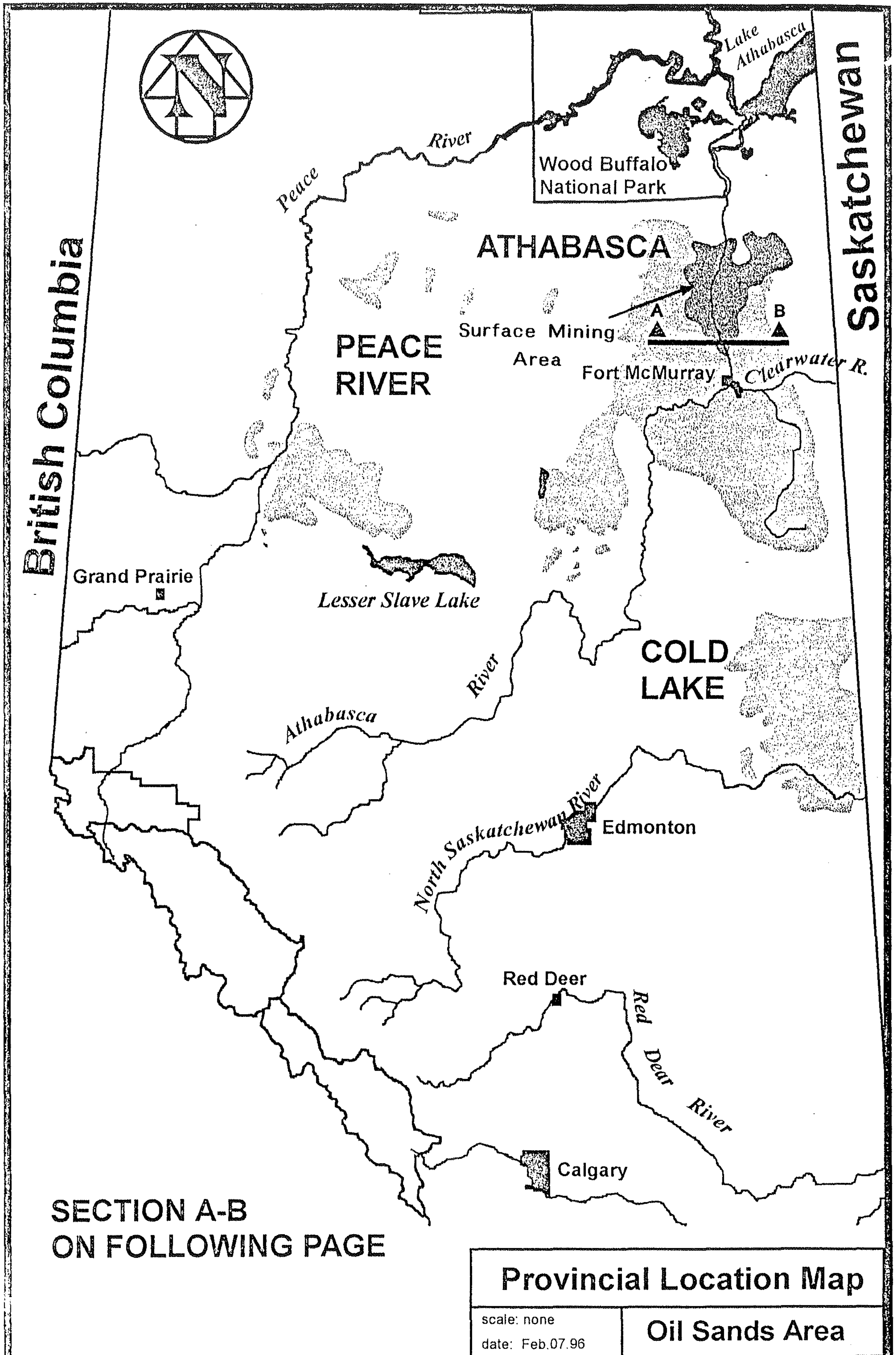

British Columbia
Saskatchewan
Lake Athabasca
River
Peace
Wood Buffalo National Park
ATHABASCA
Surface Mining Area
A
B
PEACE RIVER
Fort McMurray
Clearwater R.
Grand Prairie
Lesser Slave Lake
COLD LAKE
River
Athabasca
North Saskatchewan River
Edmonton
Red Deer
Red Deer River
Calgary
SECTION A-B
ON FOLLOWING PAGE
Provincial Location Map
scale: none
date: Feb.07.96
Oil Sands Area

Figure C2.0-1

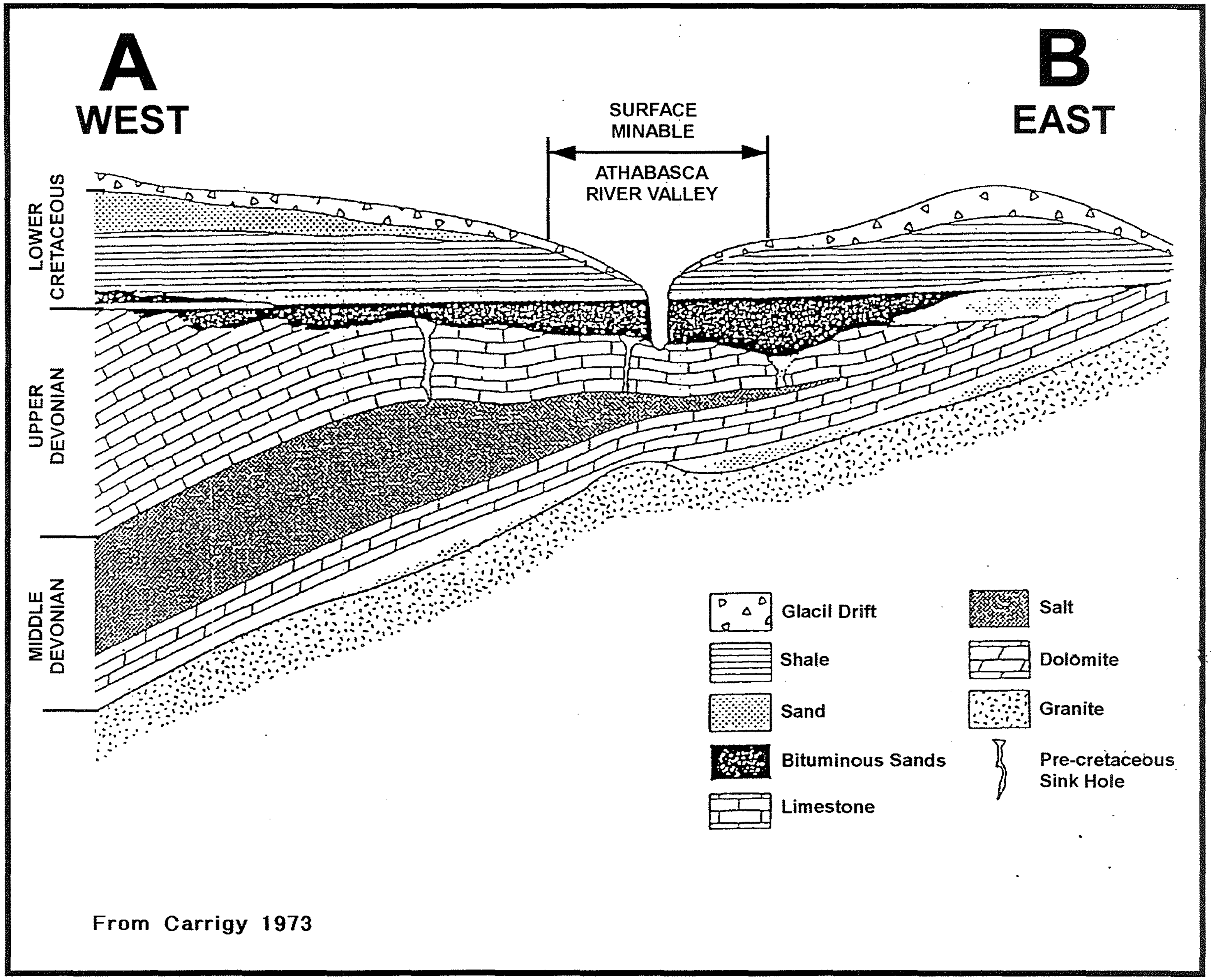


Figure C2.0-2 Simplified Geological Cross-Section

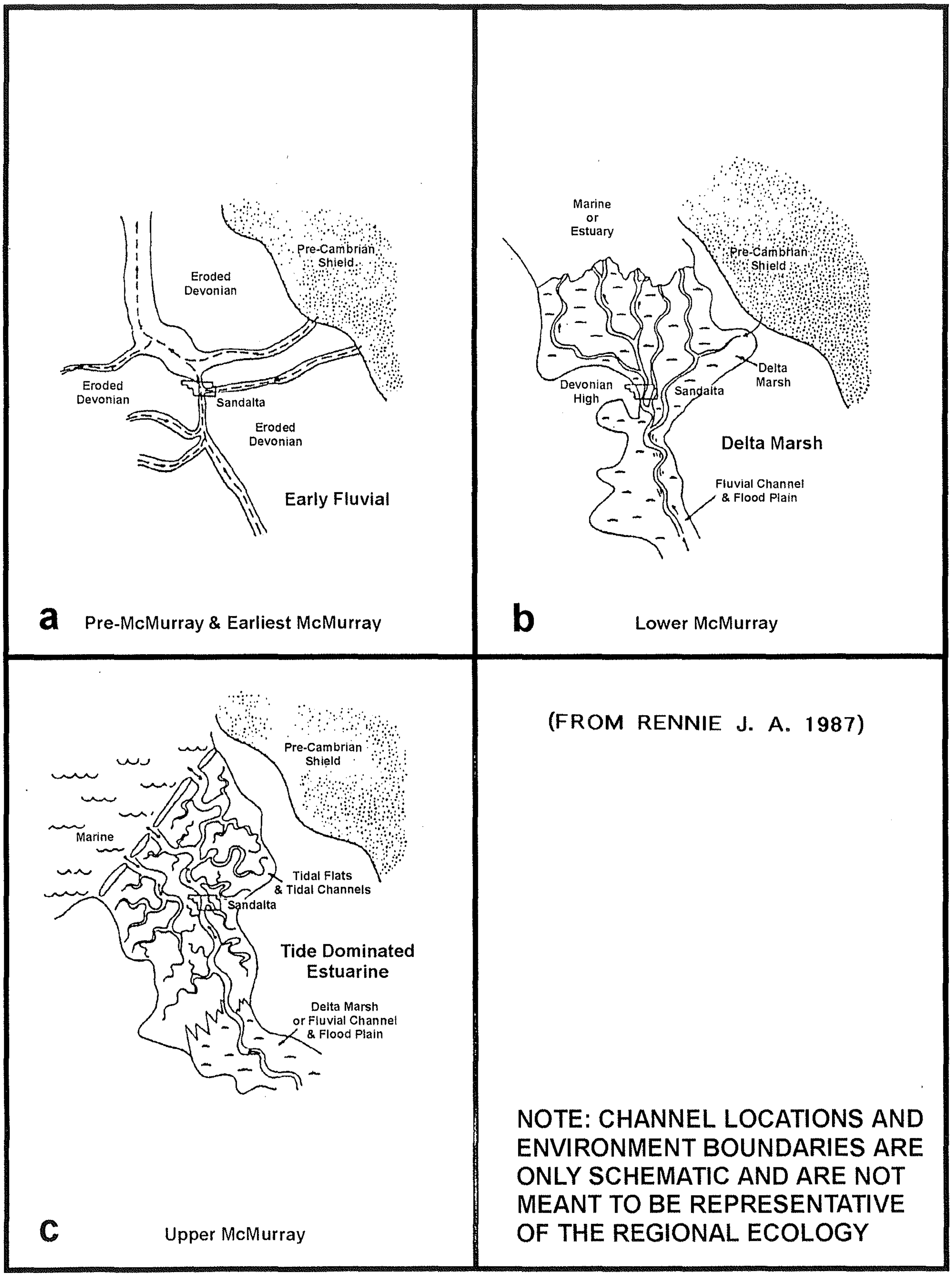


FIGURE C2.0-3 DEPOSITIONAL ENVIRONMENT OF McMURRAY FORMATION

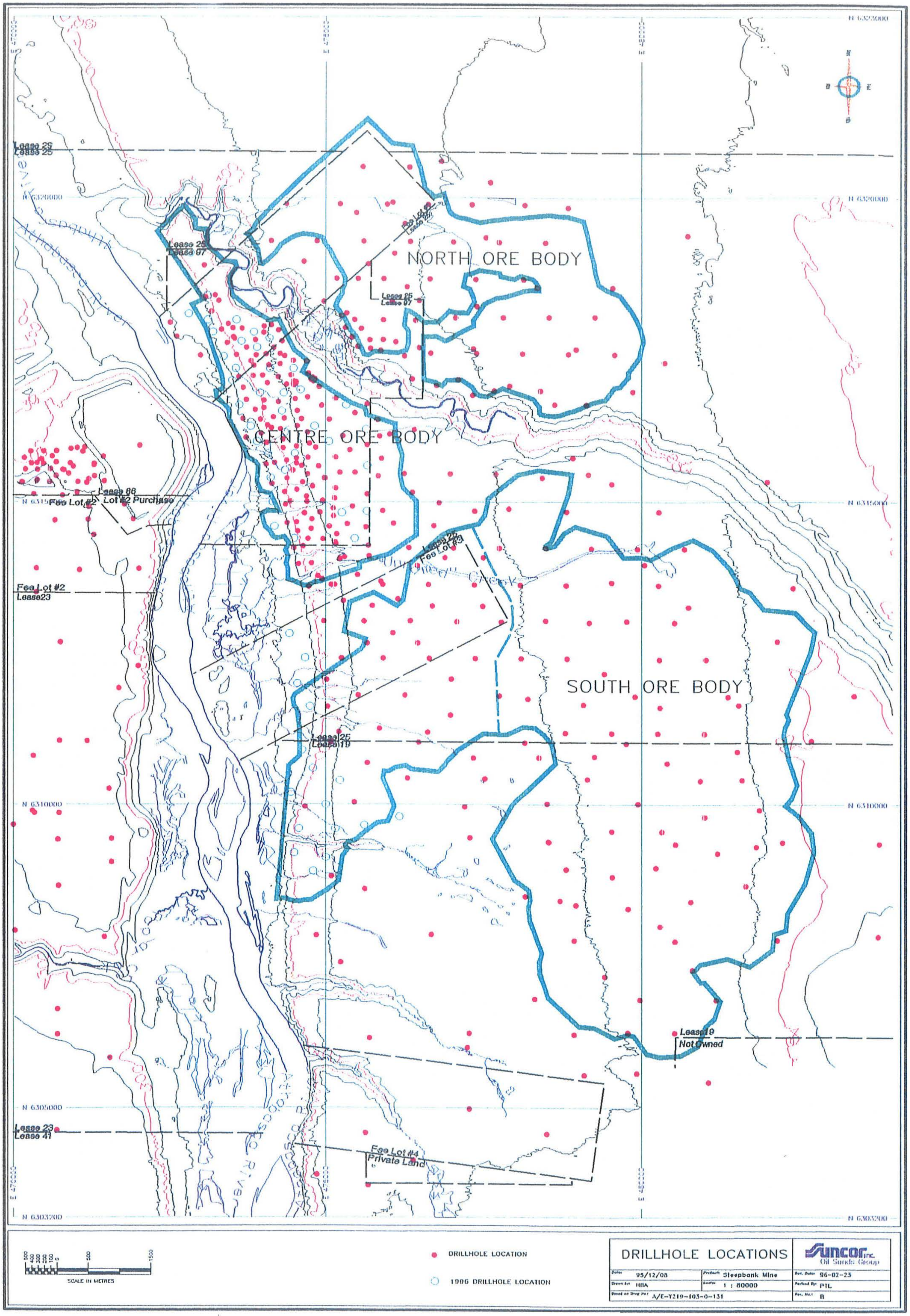


Figure C2.0-4 Drill Hole Locations

Formation Age	Despositional Environment	Facies Type & Abbreviations	Lithology	Typical Grade & Fines (<44μ)	Processability Comments	Diagnostic Characteristics
Pleistocene & Recent		Recent & Pleistocene Overburden (undifferentiated) (PR)	Muskeg Silt & Clay Sand & Gravel Till	No Bitumen Saturation	Not processed used in part for mine construction	Recent muskeg & organic stream silts. Light buff terrace deposit sands & gravels (outwash deposits) with frequent granitic & Athabasca sandstone pebbles; surficial aquifers & till deposits.
Clearwater FM. (Cretaceous)		Other Members (undifferentiated)	Black Clay	<1% Bitumen >40% Fines	Not processed used in part for mine construction	Pronounced erosional outwash channels such as Mildred Lake channel contain gravel & varved clays. Dark grey to black organic marine laminated shale.
		Wabiskaw Member (Kcw)	Flushed Sand & Glauconite	2% Bitumen 35% Fines		Presence of glauconite & frequent thick induration near base.
McMurray Formation (Upper Cretaceous)	Marine Group	Marine Beach (MB)	Sand & Silty Sand	9% Bitumen 20% Fines	Thin poor quality feed due to high fines	>8% bitumen bearing coarsening upward marine sand.
		Marine Shoreface (MS)	Silt, Fine Sand & Black to Dark Grey Clay	2-5% Bitumen >30% Fines Quite variable	Generally considered to have very poor processability due to high fines & pelitic nature of clays & low bitumen content	Intensely burrowed or churned with frequent large (¼" diam.) sand filled burrows & frequent dark grey to black wavy or bifurcated clay laminations or bands. Overall greyish color. Indurations common near base.
	Estuarine Group — Lower	Estuarine Shoreface (ES)	Silt, Clay & Fine Sand Clay is Light Grey Color	2-7% Bitumen >30% Bitumen Quite variable	Generally considered poor due to low bitumen content & high fines	Frequently burrowed, bioturbated with smaller burrows (< ¼" diam.) no dark grey clay, common light grey clay & overall brownish color, some sideritic nodules & thin indurations. Bedding when discernible commonly has dip component & scour structures.
		Silty Flat (SF)	Silt, Clay & Fine Sand	<8% Bitumen 30% Fines	Poor processability if thick zone	Buff to brown silty waste zones 1 foot or greater in thickness that are associated with estuarine sands.
		Lower Estuarine (LE)	Well Sorted Sand & Thin Clay, Silt Interbeds Sand Bed Scale 1 Foot Common	9-12% Bitumen 15% Fines	Generally considered good due to bitumen content & low fines. Maybe poor if intercalated with frequent thick tidal muds	Individual sand bed of 1 to 3 foot in thickness, with low angle parallel cross beds. Frequent ripple marks. Thin tidal muds between master sand beds on a 1 foot interbed scale & general absence of reworked clasts is characteristic.
		Upper Estuarine (UE)	Well Sorted Sand & Thin Clay Silt Interbeds Scale 3 Feet Common	12-14% Bitumen 6% Fines	Generally considered excellent due to high bitumen content, low fines & good sorting of medium to fine grained sand	Individual sand beds of 3 foot or greater thickness frequent high angle cross beds (20°) thin tidal mud interbeds between master sand beds have frequent dip component. The unit is intimately associated with reworked flat ie. has breccia fragments.
	Upper	Reworked Flat (breccia) (RF)	Well Sorted Sand With Clay Clasts	7-10% Bitumen 20% Fines	Considered good providing fines content not over 20%	Contains angular & subrounded clasts & fragments of tidal flat or marsh deposits; sand is well sorted.
	Salt Marsh / Upper Flat Group	Muddy Flat (MF)	Clay, Silt & Minor Fine Sand	<2% Bitumen 50% Fines	Considered poor due to high fines	Fine laminated light grey clay with greater than 50% fines.
		Fluvial Estuarine Mixed (FEM)	Sand, Silt & Minor Clay	12-13% Bitumen 10% Fines	Considered excellent; low fines; good grade	Exhibits both fluvial & estuarine characteristics ie. coarse sand & interbedded well sorted medium & fine sand.
		Marsh/Pond Mud (MPM)	Clay (Dark Black) Minor Silt	<2% Bitumen >60% Fines	Considered poor due to high fines	Laminated dark grey clay with common carbonaceous material & waxy appearance. Greater than 60% fines.
	Continental Group	Fluvial Channel Coarse (FCc)	Coarse Sand Silt & Minor Clay	13-16% Bitumen 6% Fines	Generally considered excellent due to high bitumen content; however coarse fraction may impede process	Coarse grained poorly sorted sand with fining upward graded beds; unit has more than 10% greater than 40 mesh coarse fraction. Some rip up clasts & mud balls.
		Fluvial Channel Fine (FCf)	Fine to Coarse Sand Silt & Clay	13-16% Bitumen	Considered excellent due to high bitumen content; coarse content not predictable	Coarse & medium poorly sorted sand. Unit has less than 10% greater than 40 mesh coarse fraction.
		Fluvial Channel Coarse (FCc)	Coarse Sand Silt & Minor Clay	2-16% Bitumen	As coarse fluvial above; may be water bearing (WS)	In pronounced lows the unit frequently overlies limestone & may be water bearing (WS).
		Overbank & Flood Plain (OVFP)	Silt, Clay & Fine Sand with some Coarse Sand	3-7% Bitumen 40% Fines Quite variable	Considered poor due to low grade & high fines	Waste zones intimately associated with fluvial sands & thin point bars. Consist of predominantly thin interbeds of silt & light grey clay. Overall brownish color.
Waterways Formation (Devonian)	Marine	Paleosol (PSOL)	Limy Soil	<1% Bitumen	Not processed	Light grey-green.
		Devonian Waterways (DW)	Limestone & Argillaceous Limestone	Infrequent Bitumen <1% Bitumen	Not processed, used for mine construction	Light grey-green to whitish cemented limestone with frequent fossil crinoid & brachiopod fragments.

Figure C2.0-5 Facies Model - Suncor Lease 86/17

AGE	DEPOSITIONAL ENVIRONMENT	UNIT/FORMATION	SYMBOL	U.S.C.*
HOLOCENE (RECENT)	COLLUVIAL	COLLUVIUM	Hc	VARIABLE
	ORGANIC DEPOSITS	MUSKEG/SOIL	Ho	PT/OL
	LACUSTRINE	LAKESHORE/LAKE BOTTOM	Hl	VARIABLE (MH/CL/ML/OH/OL)
	FLUVIAL	ALLUVIAL	Hf	VARIABLE
	AEOLIAN	DUNE	Hae	SP/ML
PLEISTOCENE	GLACIO-LACUSTRINE	CHANNEL/LAKE BOTTOM/ LAKE SHORE	Pl	CL/ML
	GLACIO-FLUVIAL	OUTWASH & MELTWATER CHANNEL SAND	Pfs	SM/SP/SW
		OUTWASH AND MELTWATER CHANNEL SAND AND GRAVEL	Pfsg	SP/SW
		OUTWASH AND MELTWATER CHANNEL GRAVEL	Pfg	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	

*MODIFIED UNIFIED SOIL CLASSIFICATION SYSTEM

Figure C2.0-6 Summary of Overburden Classifications

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	Clauconitic Clay	Waste below Till, Green Clay	Green coloured clay		None (downstream dyke construction if not wet?)
Lean Tarsand	Core Spec.	Lean Tarsand	LOS, Lean Oil Sand, LTS	> 20% fines, 3-6% Bitumen		Dyke Core Dyke Construction
	Dyke Spec.	Lean Tarsand	LOS, Lean Oil Sand, LTS			Dyke Construction
	Waste	Lean Tarsand	LOS, Lean Oil Sand, LTS	Wet or Silty		None

Figure C2.0-7 Overburden Material Use by Class

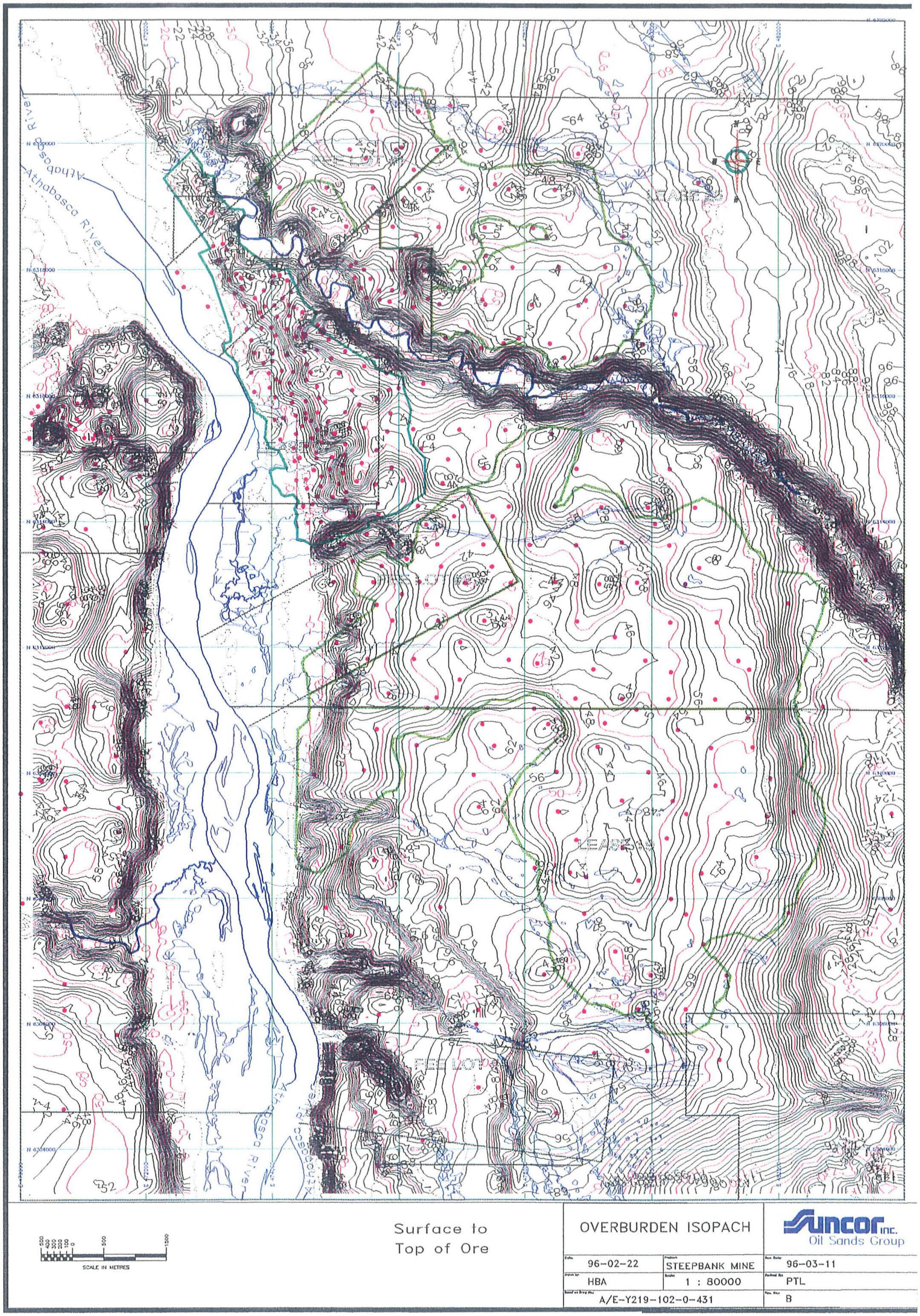


Figure C2.0-8 Overburden Isopach

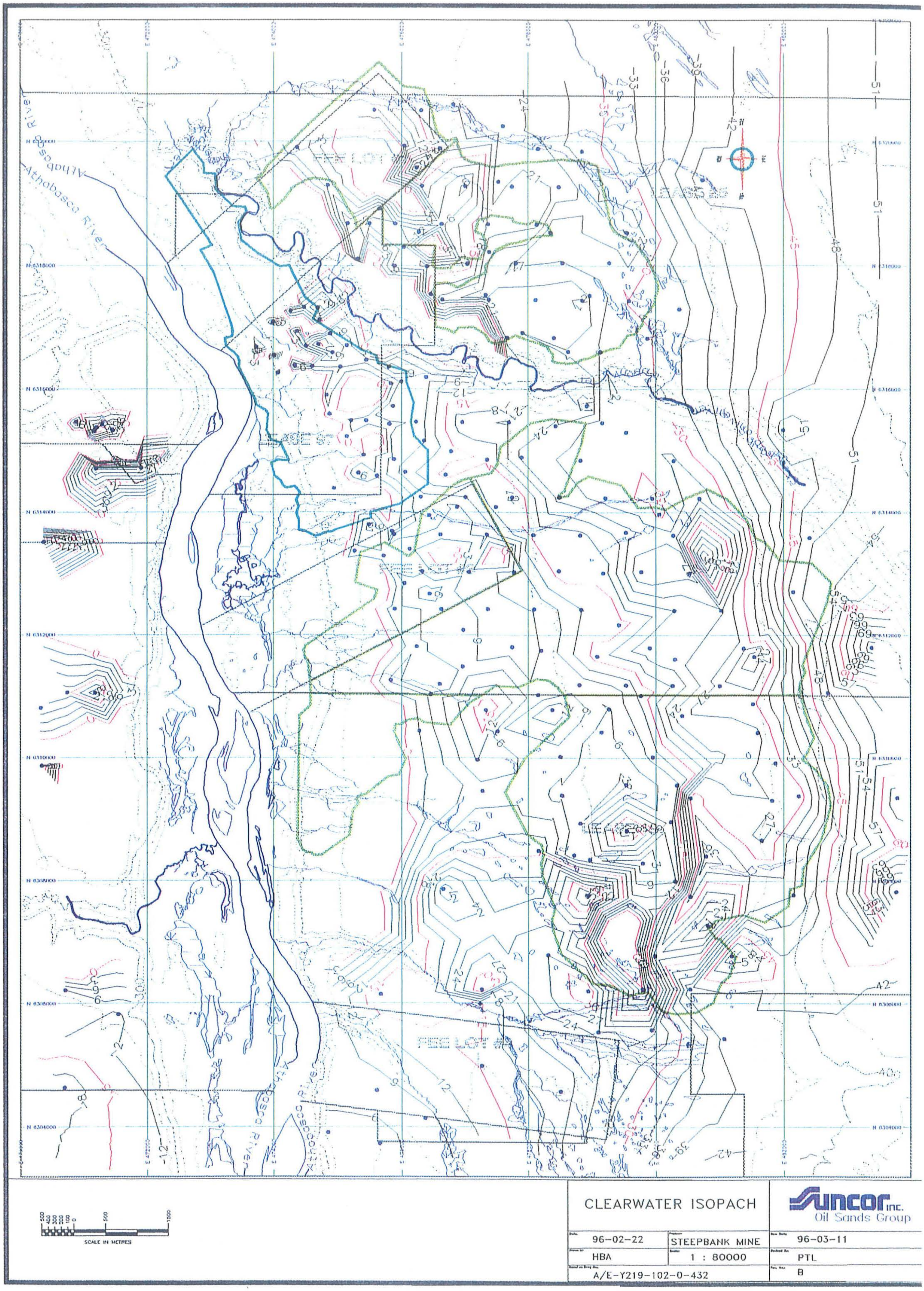


Figure C2.0-9 Clearwater Isopach

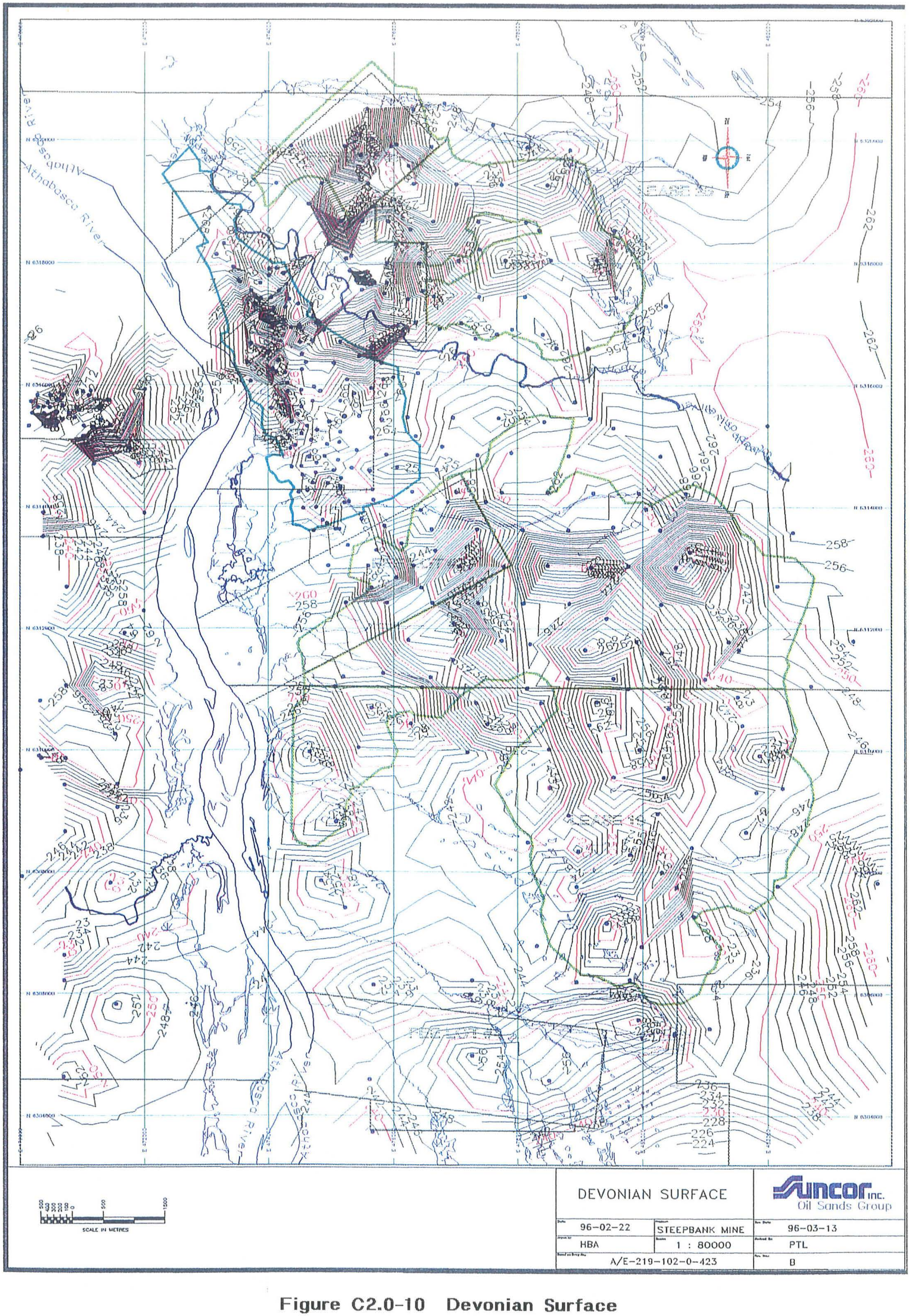


Figure C2.0-10 Devonian Surface

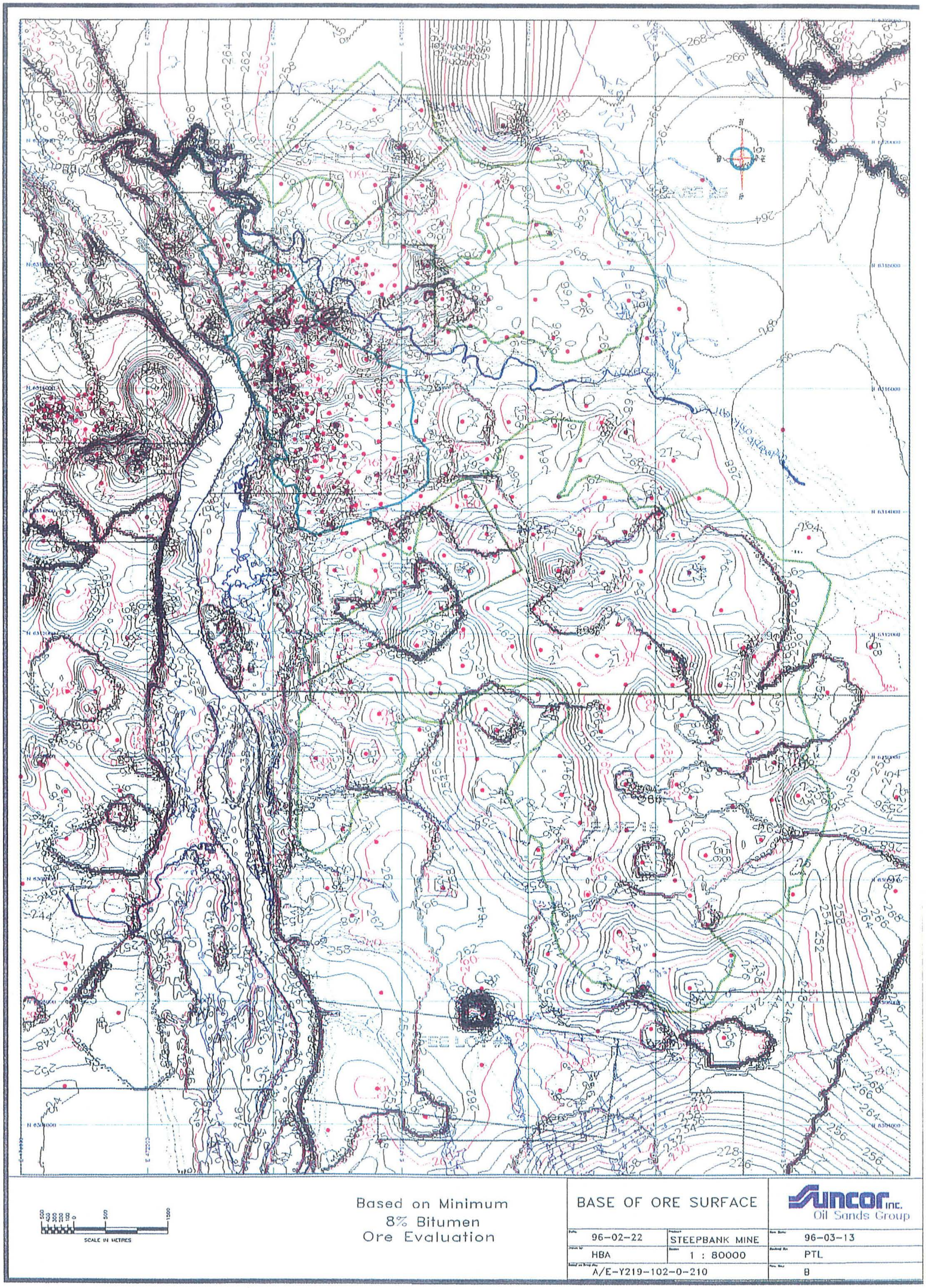
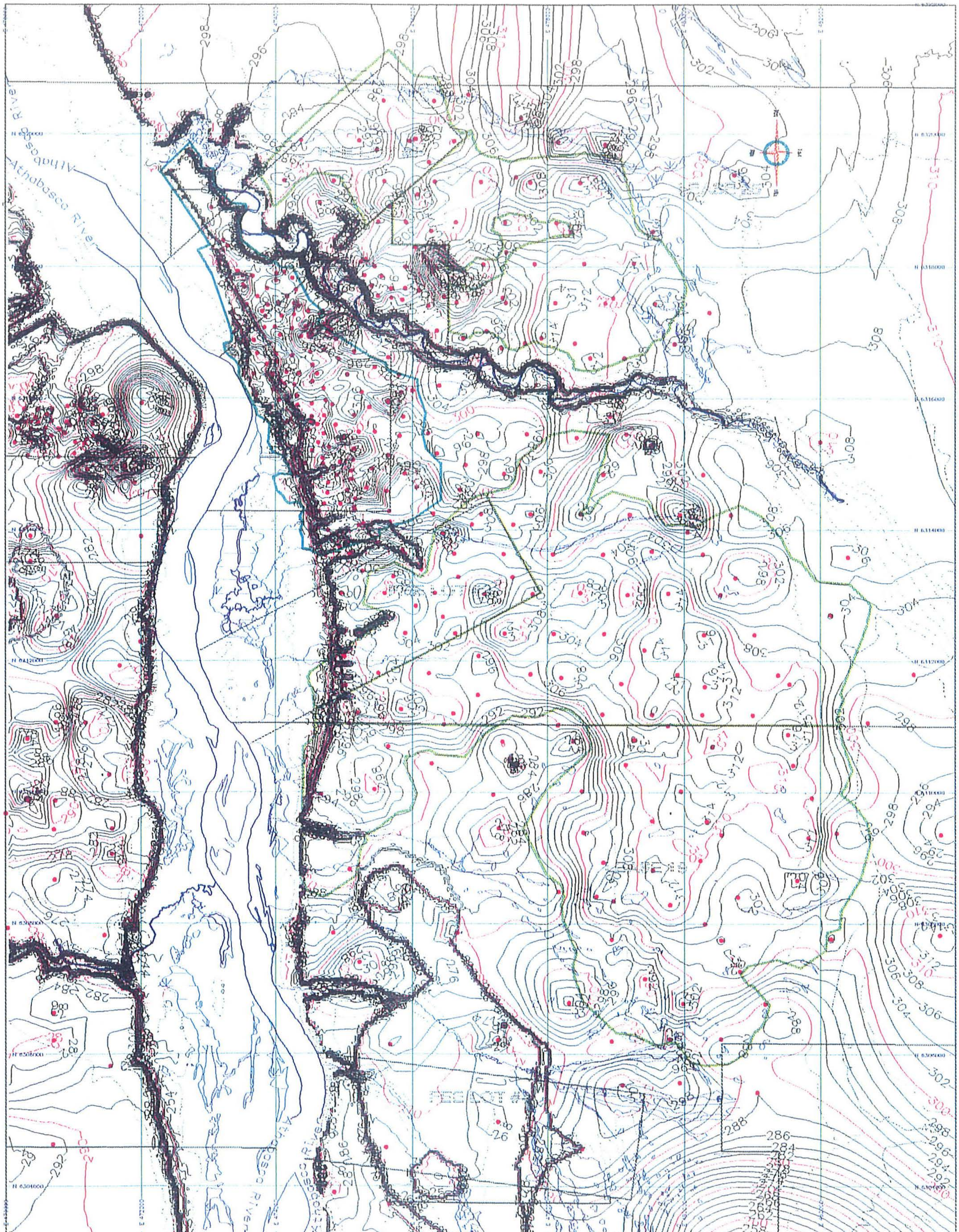


Figure C2.0-11 Base of Ore Surface



Based on Minimum 8% Bitumen Ore Evaluation	TOP OF ORE SURFACE	Suncor INC. Oil Sands Group
	96-02-22 / STEEPBANK MINE	96-03-13
	HBA / 1 : 80000	PTL
	A/E-Y219-102-0-212	B

Figure C2.0-12 Top of Ore Surface

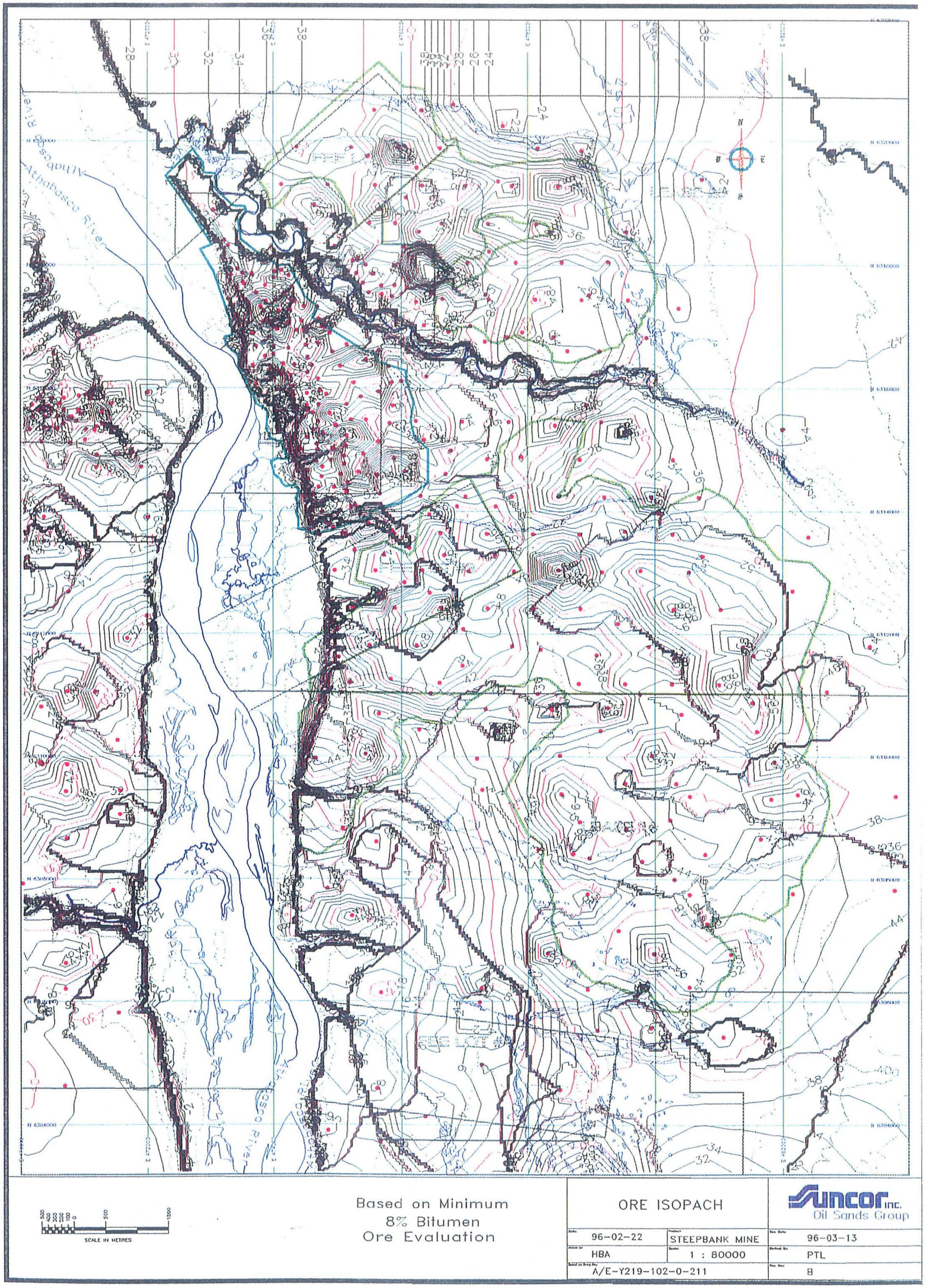


Figure C2.0-13 Ore Isopach

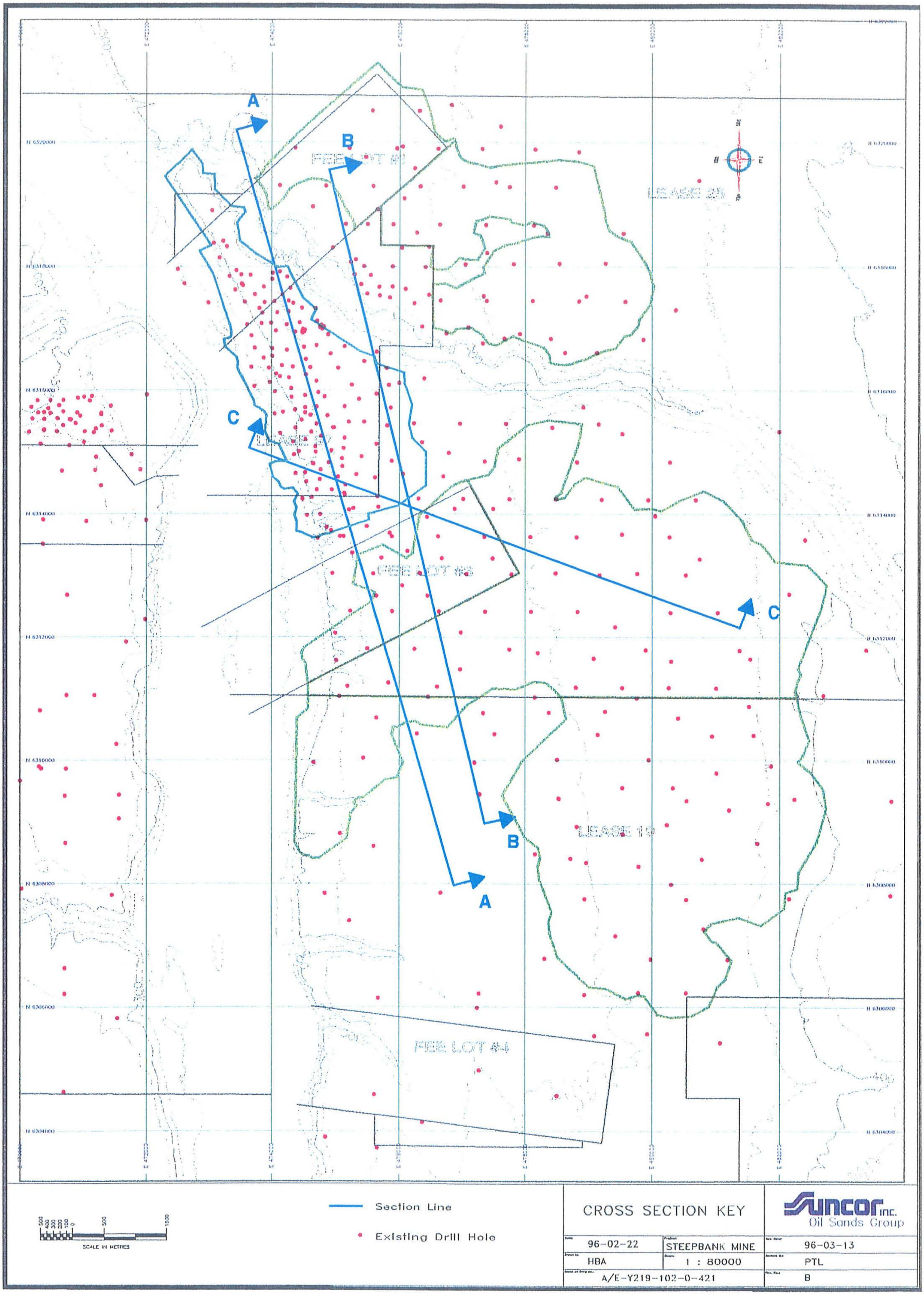


Figure C2.0-14 Cross Section Key

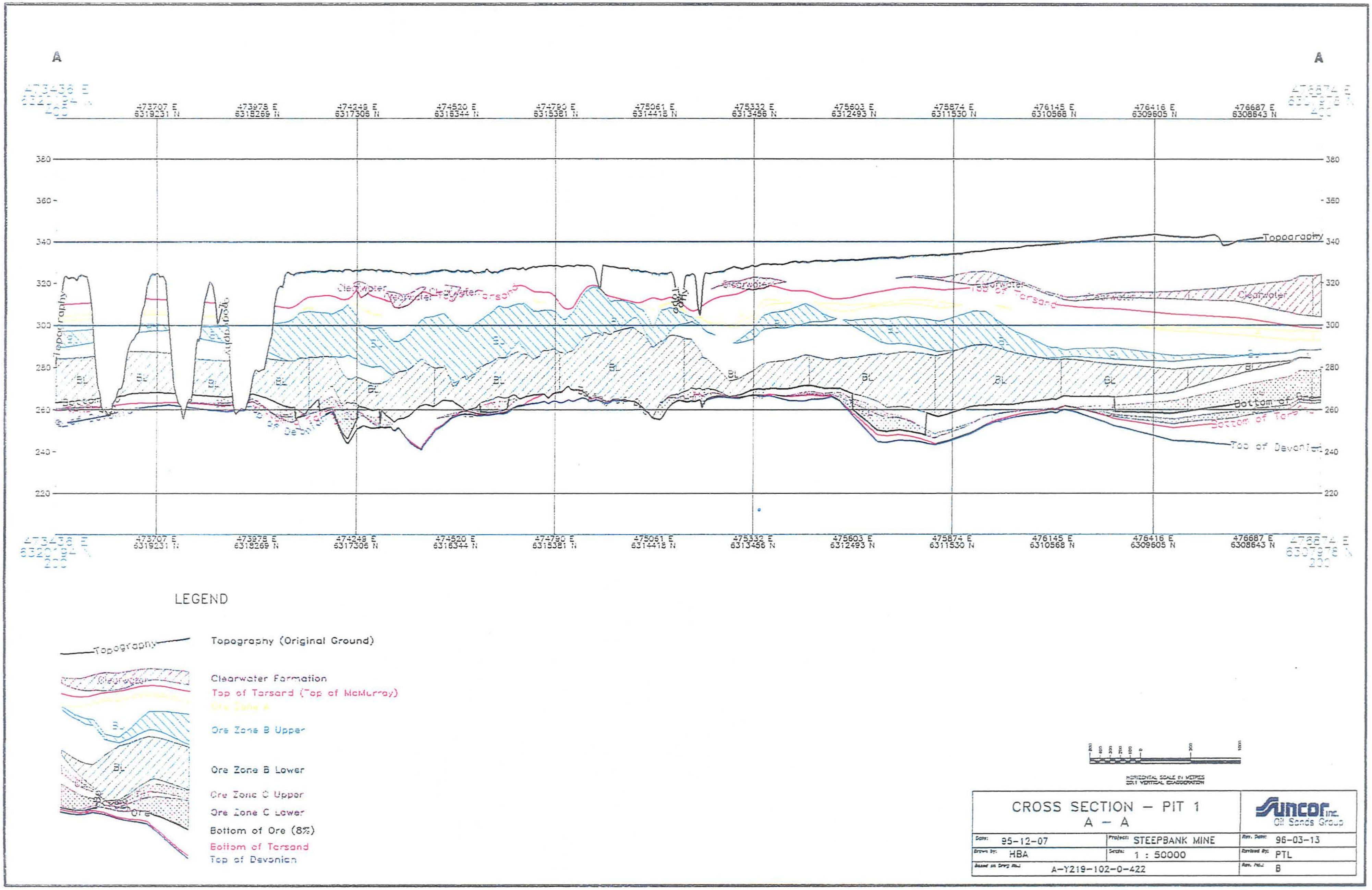


Figure C2.0-15 Cross-Section - Pit 1

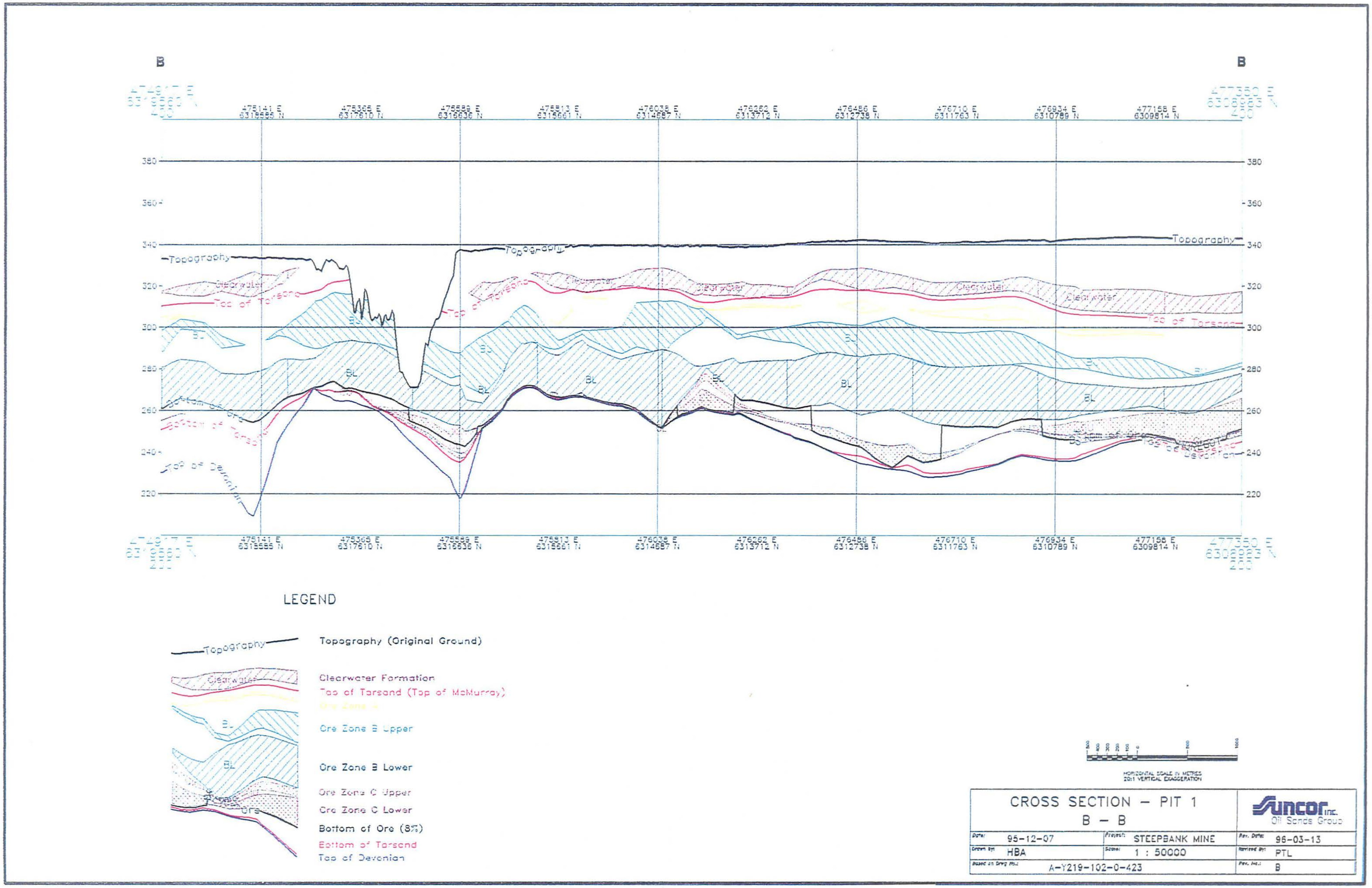


Figure C2.0-16 Cross-Section - Pit 1

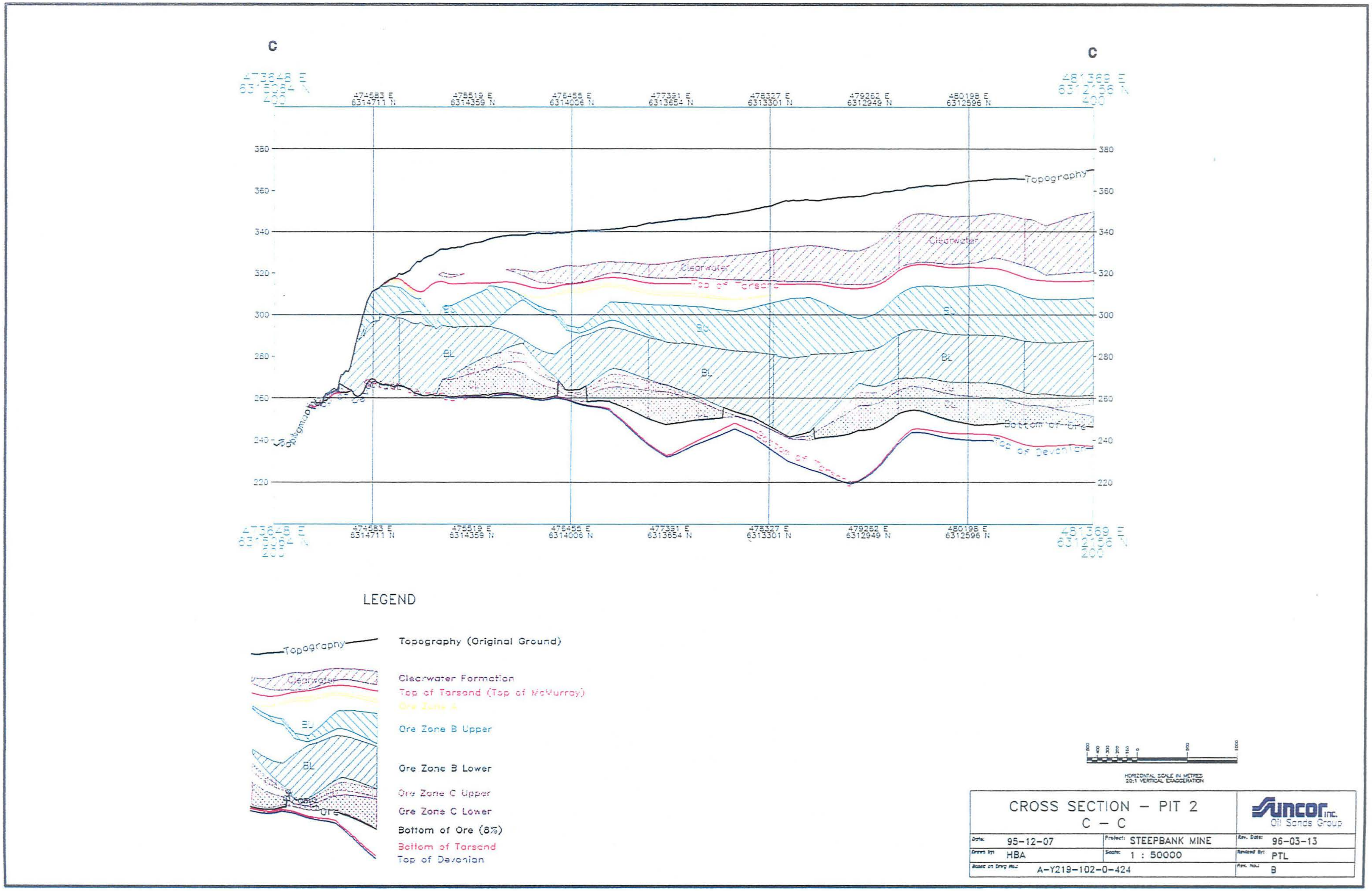


Figure C2.0-17 Cross-Section - Pit 2

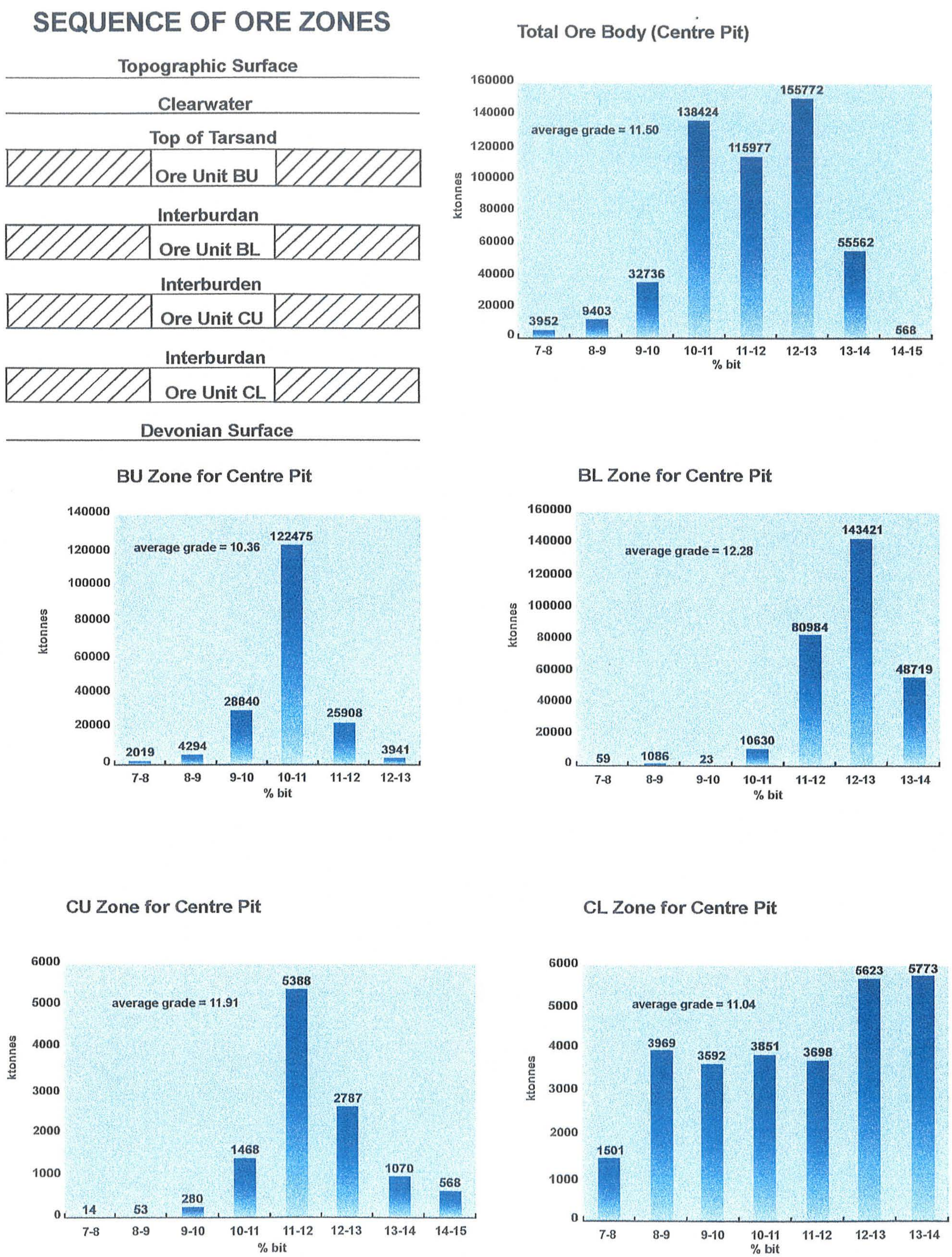


Figure C2.0-18 Grade and Tonnage Distribution – Centre Ore Body

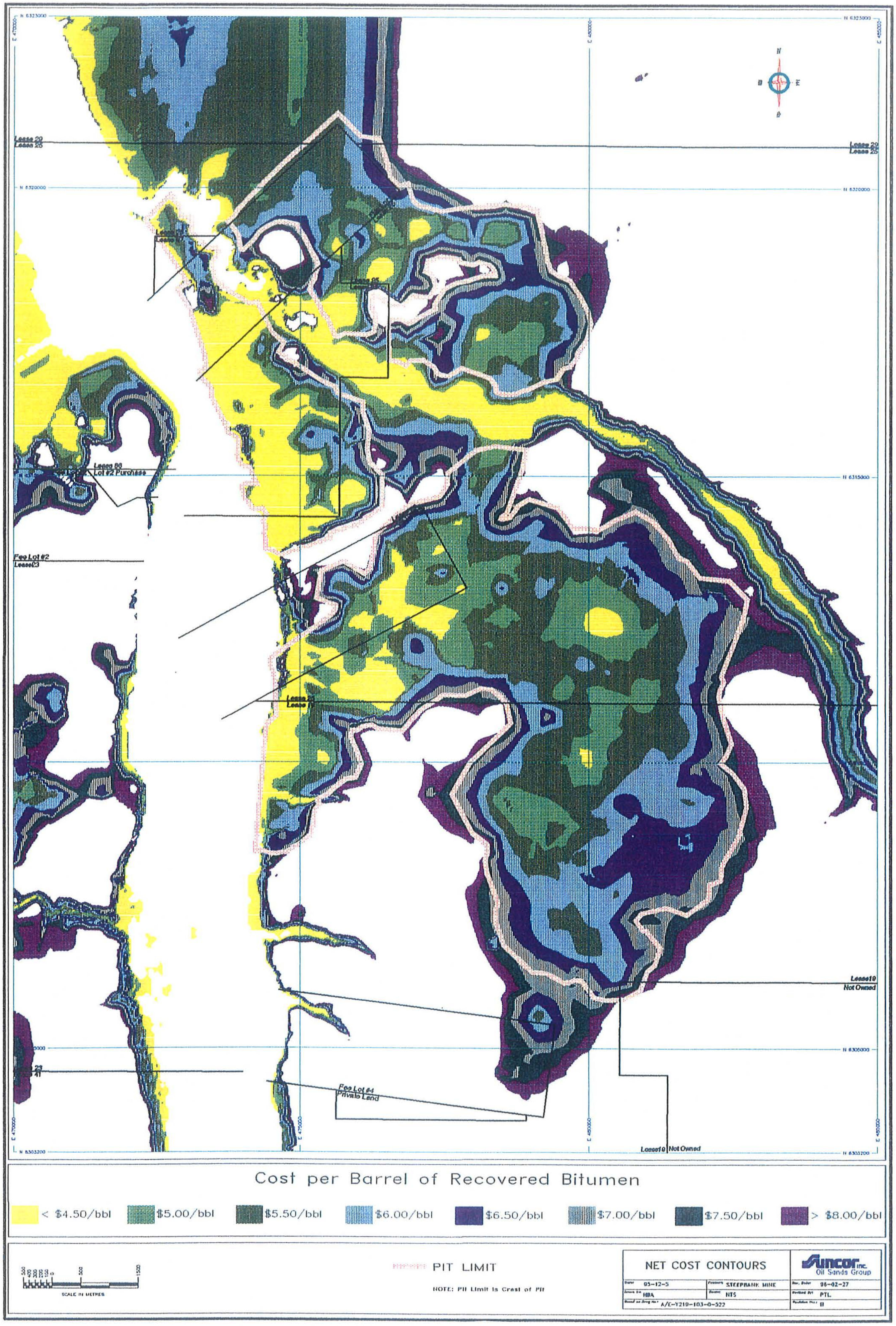


Figure C2.0-19 Net Cost Contours

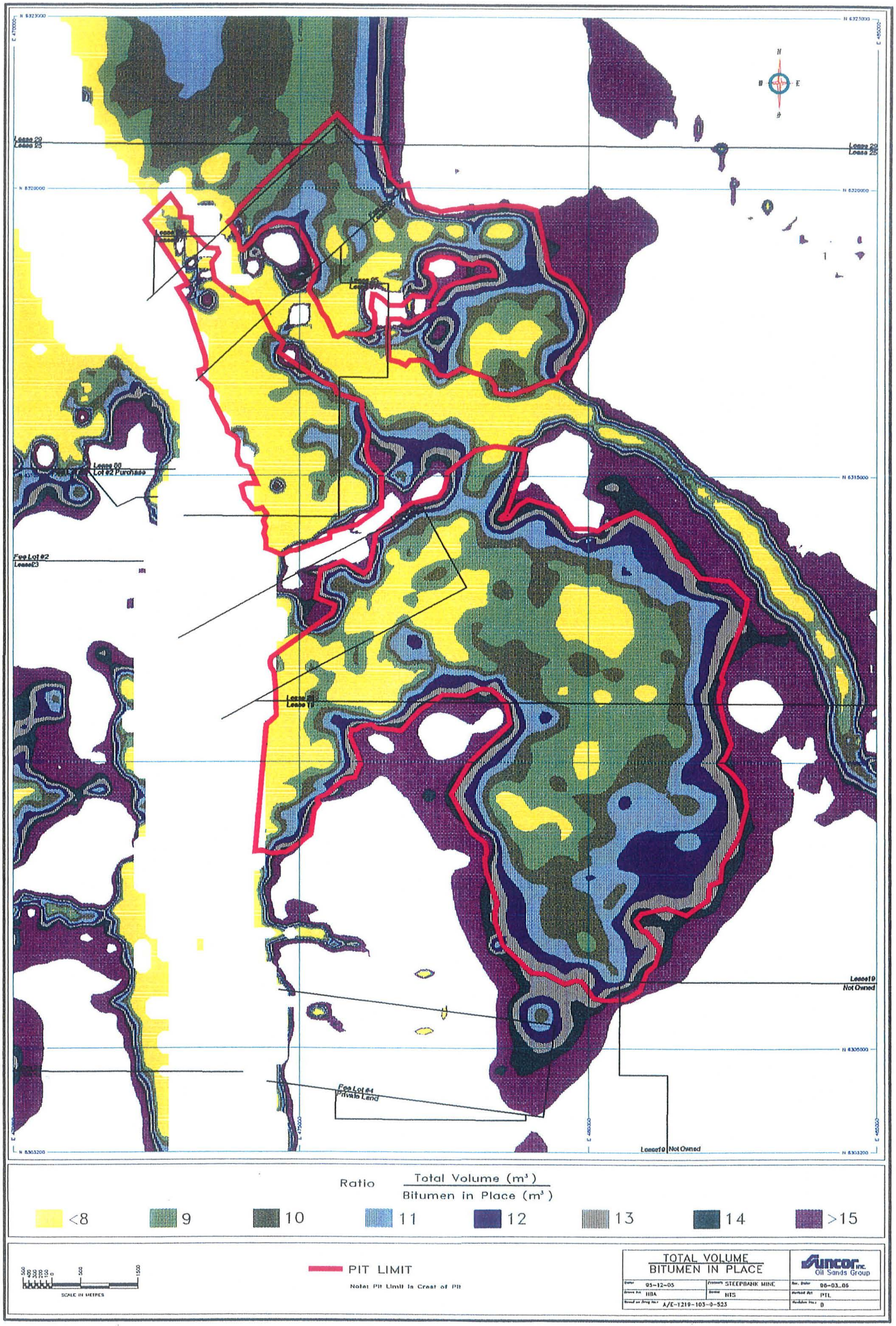


Figure C2.0-20 Total Volume/Bitumen-in-Place Contours

C PROPOSED STEEPBANK MINE

3.0 DEVELOPMENT PLAN

3.1 MINE PLAN

3.1.1 Introduction

Previous discussion described the sequence of decisions leading to the selection of the Steepbank Mine area for development, the selection of technology to be employed and the subsequent formulation of a twenty-year mine plan supported by geological description. This section explains the general layout of the proposed mine, the sequence of development and operational events and the creation of new landforms in the course of operations which will lead to eventual reclamation. As well, the transition plan from existing operations to full operation at Steepbank is discussed.

An overview of Steepbank Mine operations is presented in Subsection A2.3. In brief, land will be readied for mining with pre-clearing and drainage, overburden will be removed and ore will be mined with truck and shovel methods. The ore will be transported to truck dumps where it will be crushed and conveyed to a surge bin. From the surge bin ore will be conveyed to a cyclofeeder where it will be prepared for hydrotransport as a slurry by mixing with warm water. Subsequently, the slurry will be pumped to modified existing Extraction facilities for recovery of bitumen. Hydrotransport, extraction of bitumen and formation of tailings are discussed in Section C5.0. Management of overburden soil and waste volumes, tailings, recycle water and wastewater will require construction of landforms such as dumps and dyke containment ponds. Detailed management of tailings, conversion to a consolidated tailings system and reclamation of landforms for both the existing Lease 86/17 and Steepbank Mine is presented in Section D3.0.

Initial access to the Steepbank Mine site will be by winter ice bridge and summer barge for the years 1997 and 1998. Bridge access will be available in 1999, or sooner.

3.1.2 Mine Plan Basis

Parameters used in the design of Steepbank Mine are either those used successfully in the existing mine operation or those that have been developed specifically for the proposal (based on sound logistical and engineering concepts in conjunction with existing practices). Key mine-planning criteria are listed in Table C3.0-1.

It is to be expected at this stage of Steepbank Mine planning (before completion of all of the detail engineering) that issues will arise which have not yet been addressed. Similarly, actual details of the mining-suitable pit limits, ore and overburden volumes and detail mine plans will change as the continuing drilling program identifies previously-unknown features of the oil sand deposit. Once mining operations commence opportunities will occur to improve both operational and environmental performance and to reduce costs through technological changes and other appropriate initiatives.

Therefore, it is Suncor's intent (where practical) to outline both the guidelines and basic criteria that will be used in the mine plan. This is done with the expectation that future monitoring and evaluation will employ these criteria rather than comparison with specific detailed design in each instance.

With respect to construction of landforms, dumps and containment dykes, Suncor has developed extensive design, construction, monitoring and remedial practices over the years. These practices and the security of all landform structures are audited by an expert review panel on a regular basis. Suncor proposes to continue with that practice at Steepbank Mine. Specific design criteria and other practices relating to landforms are discussed further in Sections C3.3 and D3.0.

The mine plans referred to in the following sections are preliminary and are subject to change. Certain changes have already been incorporated into the mine plan as a result of consultation with interested communities. For example, Pit 1 will now not include the "peninsula" area near the confluence of the Steepbank and Athabasca Rivers as was originally contemplated. That decision recognizes the environmental sensitivity of the Steepbank River area.

3.1.3 Clearing

For this and following subsections, refer to the following:

- Figure C3.0-1, a topographic map of Steepbank Mine showing final pit limits, dumps and facilities, topographic features, wetlands and watercourses.

TABLE C3.0-1
KEY MINE-PLANNING CRITERIA

Item	Criterion
Plan duration	20 y from 2000
Upgraded crude oil production (gross)	107 kbpcd (17 km^3/cd)
Upgrader yield	81% (nominal)
Bitumen required	132 kbpcd (21 km^3/cd)
Overall bitumen recovery	91.1%
Bitumen required in ore	145 kbpcd (23 km^3/cd)
Ore required	8100 t/ch
Ore stream capacity	10 000 t/h
Bench height (nominal)	15 m
Safety berm:	
• at overburden and oil sand interface	30 m
• at every second bench in oil sand	10 m
Overburden slope angle	27°
Oil sand slope angle	45°
Minimum ore grade	8 wt%
Minimum thickness of recoverable oil sand	3 m
Minimum thickness of interburden removed	3 m
Dilution or ore losses	0%
Mining recovery	100%
Dyke construction materials	Overburden
Landform design criteria	See Sections C3.3 and D3.0
Tailings management	Consolidated tailings integrated with Lease 86/17
Recycle water	Pond 2/3, Lease 86/17
Cyclofeeder oversize reject	3 wt%, disposed in pit
Pond space contingency	8 mos available each 1 May
Reclamation plan	See Section D3.0

- Figure C3.0-2, an overall layout plan of Steepbank Mine and Suncor's current operations.
- Figure C3.0-3, an aerial photo showing Steepbank Mine area.
- Figures C3.0-4 to C3.0-15, proposed Steepbank Mine sequence plans showing the mine advance for the first six years, then for subsequent maximum three-year intervals.

Prior to either mine development or facility construction, land will have to be cleared of muskeg and root-bearing materials. In areas where overburden dumps and site facilities are constructed all trees, roots and organic materials will be removed from the surface. Commercial trees will be recovered and sold. Initial clearing will begin in 1997; for the mine plan a total of 3850 ha will be cleared.

Surface topography of the proposed mine development area is such that the area is naturally drained; therefore, pre-drainage will not be required except in isolated instances. In the initial mining area (Pit 1) only minor basal aquifer sands exist and no major dewatering is anticipated. More significant basal aquifer sands occur in the Pit 2 area and these will have to be defined further.

Surface soils will be either stockpiled for reclamation purposes or applied directly to areas undergoing reclamation. (See Section D3.0 for discussion of vegetative cover and soil construction.)

3.1.4 Overburden Removal

Pre-stripping of overburden with truck and shovel methods would commence in 2000 with the removal of 10.5 Mt of material. This material (except for muskeg soil) will be either used for access road construction (to the North Dump) or placed in the North Dump itself (Figure C3.0-5). Placement of material in the North Dump will be completed in 2003 by which time Dyke 10 construction will have begun (Figure C3.0-7).

Table C3.0-2 provides a schedule for projected overburden (and ore) production by year. Table C3.0-3 provides a proposed destination schedule for waste materials over the twenty-year mine plan. Scheduling of overburden removal is based on a six-month lead time to mining of ore. Approximately 40% of overburden waste will be used for dyke construction. Granular materials will be segregated for use when required as construction materials. A small amount of unstable Clearwater silt material will be placed in pit. Muskeg soil will be stored for reclamation use in suitable out-of-pit waste areas.

Annual one-way haul distances for overburden will range from 1.7 km to 3.4 km, averaging 2.5 km.

TABLE C3.0-2

MATERIALS HANDLING SCHEDULE

YEAR	TOTAL WASTE Pit 1 (Mt)	TOTAL WASTE Pit 2 (Mt)	TOTAL WASTE Total (Mt)	ORE Oil Sand (Mt)	ORE Operating Strip Ratio (t/t)	ORE Grade % Bitumen
2000	10.5		10.5	2.3	4.6	10.3
2001	10.5		10.5	23.8	0.4	11.8
2002	29.4		29.4	72.6	0.4	11.6
2003	29.4		29.4	73.4	0.4	11.5
2004	29.4		29.4	74.3	0.4	11.4
2005	58.8		58.8	67.4	0.9	11.5
2006	58.8		58.8	72.4	0.8	11.6
2007	69.3		69.3	72.1	0.9	11.7
2008	58.8		58.8	73.7	0.8	11.5
2009	7.3	51.5	58.8	63.9	0.9	12.2
2010		58.8	58.8	71.1	0.8	11.9
2011		69.3	69.3	69.6	1.0	12.0
2012		73.0	73.0	70.2	1.0	12.0
2013		73.0	73.0	60.8	1.2	12.8
2014		73.0	73.0	69.2	1.1	12.1
2015		73.0	73.0	69.5	1.1	12.1
2016		73.0	73.0	72.0	1.0	11.8
2017		73.0	73.0	64.1	1.1	12.1
2018		73.0	73.0	64.0	1.1	13.1
2019		73.0	73.0	69.1	1.1	12.2
2020		73.0	73.0	70.8	1.0	11.9
TOTAL/ AVERAGE:	**362.2**	**836.6**	**1198.8**	**1346.3**	**0.9**	**11.9**

TABLE C3.0-3
PROPOSED DESTINATION SCHEDULE FOR WASTE QUANTITIES
(MILLIONS OF TONNES)

Year	DYKE CONSTRUCTION								WASTE DISPOSAL								Total Waste Mt
	Dyke 10 Mt	Dyke 10a Mt	Dyke 11 Mt	Dyke 11a Mt	Dyke 11b Mt	Dyke 12 Mt	Sub-Total Mt	% to Dyke	Pond 7 Mt	Pond 8 Mt	North Dump Mt	East Dump Mt	West Dump Mt	South Dump Mt	Muskeg Disp. [a] Mt	Sub-Total Waste Mt	
2000											10.2				0.3	10.5	10.5
2001	1.0						1.0	9			9.2				0.4	9.6	10.5
2002	7.7						7.7	26			12.8	8.4			0.4	21.7	29.4
2003	14.6						14.6	50			14.4				0.4	14.8	29.4
2004	15.8						15.8	54	1.8			8.6	2.9		0.4	13.6	29.4
2005	20.6						20.6	35	1.8			16.2	19.9		0.4	38.2	58.8
2006	34.1						34.1	49	1.8			11.2	21.8		0.4	35.2	69.3
2007	22.3	9.6					31.9	54	1.8			4.2	20.6		0.4	26.9	58.8
2008	14.5	3.5					18.0	31	1.8			6.0	32.6		0.4	40.8	58.8
2009	12.0		9.7				21.7	37	1.8				20.0	14.9	0.4	37.1	58.8
2010	5.0		33.0				38.0	65		1.8				18.6	0.4	20.8	58.8
2011			37.5				37.5	54		1.8				29.7	0.4	31.9	69.3
2012			21.1				21.1	29		1.8				49.7	0.4	51.9	73.0
2013			10.2	0.8			11.0	15		1.8				59.8	0.4	62.0	73.0
2014			15.9	2.0			17.9	24		1.8				53.0	0.4	55.2	73.0
2015			4.0	21.6			25.6	35		1.8				45.2	0.4	47.4	73.0
2016			3.0	6.0	1.0		10.0	14		1.8				60.8	0.4	63.0	73.0
2017					5.0	33.5	38.5	53		34.1					0.4	34.5	73.0
2018					24.2	12.7	36.9	51		30.0					0.4	36.1	73.0
2019					7.0	38.4	45.4	62		15.3					0.4	27.7	73.0
2020						36.0	36.0	49		24.6					0.4	37.0	73.0

[a] Muskeg disposal volumes are preliminary estimates.

3.1.5 Mining of Ore

Mining of oil sand with truck and shovel methods will commence in 2000 in an area immediately east of the truck dump (Figure C3.0-4). In 2002 and 2003 the northern part of Pit 1 will be mined to provide room for the placement of overburden in the North Dump (the precise sequence remains to be established pursuant to the decision not to mine the "peninsula" area). As well in 2001 through 2004, ore will be removed from the footprint of Dyke 10. This sequence will allow for early construction of the dyke. After the footprint is exposed the mining faces will advance to the southeast corner of Pit 1.

In 2008 the truck dump and the crushers will be relocated to the northwest boundary of Pit 2 and a 5 km conveyor extension will be built to the cyclofeeder area. By the middle of 2009 oil sand mining in Pit 1 will be completed and production from Pit 2 will be phased in. Development of Pit 2 will be similar to that of Pit 1 (i.e., oil sand will be removed from the escarpment area in the early years to open up an area for a dyke footprint). Mining then will proceed in an easterly direction. Table C3.0-2 lists projected annual ore quantities. Annual one-way ore haul distances would range from 1.5 km to 4.2 km, averaging 2.7 km.

While the mine plan was developed prior to the acquisition of Lease 25 (in January 1996) little change in the plan prior to 2007 is expected as a result of the addition. The major contribution of this acquisition will be the availability of resources provided by Lease 25 for the period following 2020.

This plan assumes a transition period of approximately fifteen months (from the third quarter 2000 to the beginning 2002) and then the new mine will be at full capacity.

3.1.6 Dumps, Dykes and Pitwalls

Two types of landforms will be constructed in the course of mine operations: dykes assembled for the impoundment of tailings; and waste dumps required for the placement of surplus overburden materials.

Waste dump and dyke foundation areas will require preparation to ensure their stability. On dry waste dump sites the surface will be cleared and grubbed. On wet dump sites all unstable or muskeg-type material will be removed. The west toe of the west dump (in the area between Pit 1 and Pit 2 west of the relocated truck dump) would be located in a wetland area (Shipyard Lake) which contains muskeg. In 2004, 600 000 m^3 of muskeg will be removed and stored for reclamation purposes. The foundation will be prepared in the winter (when the wetland is frozen) to avoid undue drainage. Yearly dump elevation changes would be 10 m to 20 m; slopes would be 3H:1V (three horizontal units to one vertical unit).

Currently tailings on Lease 86/17 are stored in ponds enclosed by dykes. The extraction process creates tailings that have a swell factor of 30% (ratio of tailings volume to ore volume). There is insufficient overburden material to construct the dykes needed to contain these tailings volumes; therefore, tailings sand must be used for dyke construction.

With the introduction of consolidated tailings technology, the swell factor will be reduced to near zero, and the need for using sand for dykes will be eliminated. The Steepbank Mine dykes (to contain consolidated tailings and water) will be constructed entirely of overburden materials. Generally, annual dyke elevation changes would be 20 m to 30 m. Overall dyke slopes would be 3H:1V, with 30 m-wide tops.

Pitwalls (both overburden and lean oil sand) also form part of the containment perimeter for tailings ponds. The overall pitwall slope angles for overburden and oil sand would be 27° and 45° respectively.

Figure C3.0-16 shows typical plans and cross-sections for dumps, dykes and pitwalls. Detailed cross-sections for dykes and dumps will be provided after final design for specific dyke/dump approvals as required. Geotechnical considerations for dumps, dykes and pitwalls are discussed in Subsection C3.3.

Final design of dykes and dumps will incorporate features to enhance their use for wildlife habitat whenever possible.

3.1.7 Ponds

Two major disposal ponds for placement of consolidated tailings will be established at Steepbank Mine, one each in Pit 1 and Pit 2 (refer to Figures C3.0-4 to C3.0-16). Nomenclature for dykes and ponds at Steepbank Mine will continue the sequence presently used on Lease 86/17. These ponds will contain consolidating tailings and the water released in the process of consolidation.

a) <u>Steepbank Pond 7 (Pit 1)</u>

Dyke 10, the primary dyke enclosing Pond 7 in mined-out Pit 1, will be built to elevation 330 m ASL entirely of overburden (lean oil sand and clay). Construction will begin in 2002 and will be completed in 2010. The strike of Dyke 10 will be configured to allow a 70 m right-of-way between the overland conveyors (to be installed in 2008) and the toe of the dyke. This right-of-way will be occupied by the main haul road from 2003 to 2009 and then by tailings pipelines from 2015 to 2020.

The first consolidated tailings line into Pond 7 will be operational in 2007. As Pit 1 will not be completely mined out until mid-2009, interim Dyke 10a will be constructed across the pit bottom to establish Pond 7a to the north. Dyke 10a will be built to elevation 300 m ASL during 2007 and 2008 for storage of tailings in Pond 7a through 2009. The second and third CT lines will be placed in Pond 7a/7b in 2008 and 2009 respectively. Pond 7a will be full to elevation 297 m ASL in the fourth quarter 2009 and Pond 7b will be full by the fourth quarter 2011, when the two ponds will be merged. Pond 7 will be full to elevation 327 m ASL by the second quarter 2017. A water return system from Pond 7 (initially 7a) to Lease Pond 2/3 on Lease 86/17 will be required beginning in 2007. Figure C3.0-17 shows a typical mine tailings plan for 2009.

b) <u>Steepbank Pond 8 (Pit 2)</u>

Pond 8 will eventually be enclosed by two major dykes: Dyke 11, enclosing the pond to the west and Dyke 12 to the east. Construction on the north-south portion of Dyke 11 will begin in 2009. The east-west portion of the dyke will be set back 200 m to 300 m from the pitwall to allow ore truck access to the sizers.

The first consolidated tailings line into Pond 8 will be run in 2015 and because Pit 2 will not be mined out until 2020, interim Pond 8a will be established. Beginning in 2014 and through 2017 interim Dyke 11a will be constructed north-south across the pit bottom, from Dyke 11 to the south pitwall. Final height of Dyke 11a will be elevation 310 m ASL. The resulting enclosed Pond 8a will store consolidated tailings through 2018. Both the second and third consolidated tailing lines will be relocated from Pond 7 to Pond 8a in 2016 and 2017 respectively. Figure C3.0-18 shows a typical tailings plan for 2015.

Construction will begin on Dyke 11b in 2015. The dyke's northern toe will be off-set from the pitwall 200 m to 300 m to allow ore truck access to the sizers. Dyke 11b will be essentially an eastward continuation of Dyke 11 but it will be constructed only to elevation 310 m ASL, the same as Dyke 11a. In 2017 construction will begin on Dyke 12 from the south pitwall north to connect with Dyke 11b. Three dykes - 11a, 11b and 12 - will enclose Pond 8b. In 2019 two CT lines will be extended from Pond 8a into Pond 8b . By the end of 2020 Dyke 12 will be at elevation 320 m ASL and Dykes 11a and 11b completed to elevation 310 m ASL. Both Pond 8a and 8b will be at elevation 301 m ASL, nine metres below the lowest surrounding dykes. Figure C3.0-15 shows landforms at the end of the mine plan in 2020. The reclamation plan for these landforms is discussed in Section D3.0.

This proposed configuration of dykes around Pond 8 represents a potential five to six years of additional tailings storage volume of 200 Mm^3 in the pond post-2020. This capacity would allow continued mining on the east bank.

3.1.8 Steepbank Tailings Disposal

Section D3.0 presents the integrated tailings management and reclamation plan for Lease 86/17 and Steepbank Mine including annual material balances. Three tailings lines (610-mm diameter) will cross the bridge initially to the Steepbank ponds, one each in 2007, 2008 and 2009. During dyke construction interior ramps will be constructed for CT line access to the bottoms of the ponds. In 2007 a water recycling return line will be installed to Pond 2/3 on Lease 86/17.

3.1.9 Limestone and Granular Material

Limestone for the purpose of flue gas desulphurization (at the Utilities plant) and haul road construction will continue to be extracted from a pit on Lease 86/17. While some limestone is present in Steepbank Mine a detail plan for its exploitation has not been developed as total limestone requirements are not fully identified. Availability of suitable granular materials for construction purposes will be determined from results of continuing drilling.

3.1.10 River Set-Back Design

This mine plan recognizes the environmental sensitivity surrounding the disturbance of the Steepbank and Athabasca Rivers. On the south side of the Steepbank River a 100-m set-back from the escarpment crest will be maintained along the mine. Preliminary drilling assessment indicates that a relatively small amount of resources would be sterilized with this plan. As stated previously, Suncor extended the mining set-back to the peninsula area due to both the area's environmental sensitivity and the marginal resource potential.

With respect to the Athabasca River, the mine plan will remove ore from the escarpment (i.e., the mine "daylights") with the constraint that the intersection with the escarpment be well above the 1-in-100-year flood level, at elevation 241 m ASL. The east bank escarpment has a relatively gentle slope. As a result the undisturbed set-back from the Athabasca River will exceed 500 m along the length of Steepbank Mine, with the exception of a 2000-m length encountered in the third year of mining on Lease 97. In this area, a minimum 70-m set-back will be maintained. By 2009 that portion of the escarpment will be "rebuilt" with Dyke 10 to elevation 330 m ASL (approximately the height of the current escarpment) and will be reclaimed.

Figure C3.0-19 illustrates details of the set-back plan for the Steepbank and Athabasca Rivers.

Artist's renderings of Steepbank Mine for 2000, 2009, 2015 and 2030 are presented in Figures A2.0-3 to A2.0-6.

3.1.11 Mine Road Design

Haul distance for overburden to placement areas will range from 1.7 to 3.4 km, averaging 2.5 km over the mine life. For ore the haul distance will range from 0.4 km to 4.2 km, averaging 2.7 km. Main haul roads will be classed as "permanent" if they are to be used for a substantial period; others will be classed as "temporary". During the twenty years of mining construction of 30 km of permanent roads and 125 km of temporary roads will be required.

The proposed haul road design for the 218-t trucks is based on experience gained on Lease 86/17. Basic road construction specifications are as follows:

Maximum haul road grades	6%	(10% short-distance and temporary roads)
Minimum running surface	30 m	
Safety berm height	1.5 m	
Grade on surface for drainage	1%	
Minimum ditch depth	0.5 m	
Ditch wall slope	1H:1V (45°)	

Efficiency and effectiveness of the truck and shovel fleet will vary depending on the quality of the running surfaces constructed and maintained. Road construction will be based on the following criteria:

	Surface (Crushed Gravel/ Clay Mixture) (<75mm)	**Base (Pit Run Limestone)**	**Sub-Base (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

Based on experience at the current operations, weather delays can be expected to minimally impact production.

3.1.12 Transition Sequence and Schedule

Production from Steepbank Mine is expected to begin by 2000 and increase to full production capability (107 kbpcd equivalent) by the end of 2001, at which point Lease 86/17 reserves will be exhausted. A fifteen-month transition window will allow sufficient time to resolve start-up problems and to bring the mine up to its design capacity. The first hydrotransport line will start up at 50% capacity by fourth quarter 2000. A second hydrotransport line will start up by third quarter 2001. By the end of 2001 both lines should be at 100% capacity.

A number of construction projects and a new bridge must be completed before the new mine can be brought into production. A best-estimate transition schedule is presented in Figure C3.0-20. Suncor is seeking pportunities to accelerate this schedule.

3.1.13 Mining Equipment

Truck and shovel methods will be used to excavate overburden and mine 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 clean-up, and to load trucks for road-building. The haulage fleet will consist of large (218-t) trucks for overburden and ore and smaller trucks for muskeg removal and hauling road materials. Support equipment will be required for dyke construction, road maintenance and tailings placement. Table 3.0-4 presents an outline of projected equipment requirements.

3.1.14 Blasting

Blasting of overburden and ore benches will be used to reduce the impact of frost on mine productivity in the months December to March. Occasionally, summer blasting of ore benches will be used to improve productivity on hard faces.

For overburden a hole depth of two metres will be used on a 3.7 m x 3.7 m pattern. In ore a hole depth of two metres will be used on a 2.4 m x 2.4 m pattern.

TABLE C3.0-4

STEEPBANK MINE: PROPOSED MAJOR MINE EQUIPMENT REQUIRED

Mine Equipment		Year	
		2002	2008
Cable Shovel	(44 m^3)	4	5
Hydraulic Shovel	(23 m^3)	2	2
Hydraulic Shovel	(17 m^3)	1	1
Front-End Loader	(11 m^3)	3	3
Front-End Loader (Forks)		1	1
Truck	(218 t)	20	38
Truck	(85 t)	3	4
Dozer	(127 kW)	2	2
Dozer (Sideboom)	(212 kW)	1	1
Dozer	(388 kW)	9	11
Grader	(4.9 m)	4	9
Water Truck		2	3
Rubber Tire Dozer-Compactor		1	3
Rubber Tire Dozer - Clean-up		2	3
Backhoe	(3 m^3)	3	3

Frost blasting will be done with a powder factor of about 0.9 kg/ t blasted. Based on Suncor's extensive experience with frost blasting technology and the relatively small volumes of explosive used, there will be no adverse impact (geotechnical, noise or dust) from blasting on the areas surrounding the mine.

3.2 MINING ACTIVITY BEYOND 2020

When mining of Pit 2 is completed in 2020 significant ore suitable for mining will remain in the east bank ore bodies. Initial resources in the North, Centre and South ore bodies total over 5 billion tonnes oil sand at 11.7 wt% bitumen. The twenty-year mine plan projects extraction of 1.2 billion tonnes at 11.9 wt% bitumen. Thus, fifty years worth of resource (at a production rate of 107 kbpcd upgraded crude oil) will remain located on Leases 25 and 19 and north of the Steepbank River. The dyke configuration around Pond 8 will allow storage of five years of tailings after 2020.

Depending on the direction taken for additional mining there could be a significant increase in ore transportation distance after 2020. A choice would have to be made to either extend the ore transportation system or to build a desanding plant and reduce materials handling cost. As a third alternative mining could be conducted north of the Steepbank River, but this would require bridge construction. For the purposes of this Application and EIA considerations the most likely scenario (continued mining of the south ore body) has been projected to 2030 as illustrated in Figure A2.0-6.

3.3 GEOTECHNICAL

Suncor will continue to ensure that its earth structures will meet or exceed applicable Canadian standards for geotechnical security.

The company's objectives with respect to landform stability are discussed in Subsection D3.2.2.a. Landform stability during the operational phase is discussed in Subsection 3.5.5.a, and during the post-operation (reclamation) phase in Subsection 3.6.1.a.

3.4 WATER DIVERSIONS AND WASTEWATER MANAGEMENT

This section provides an overview of the water management plan for the proposed Steepbank Mine including surface drainage, groundwater, pit dewatering, potable water supply and sewage treatment. The Application for Renewal of Environmental Operating Approval (February 1995) describes water management on Lease 86/17. This section is also intended to fulfill the requirements for both Lease 86/17 and the Steepbank Mine for separate approval under the *Water Resources Act*, Section 11(1)(a)(iv).

3.4.1 Steepbank Mine Drainage Plan

a) Design Philosophy

Surface drainage for Steepbank Mine will be controlled in a manner similar to current operations: all natural run-off and shallow groundwater will be discharged to the Athabasca River while all run-off that is exposed to oil sand will be contained. Steepbank Mine will contain two drainage systems for surface run-off waters:

- an interception drainage system, for run-on water from undisturbed areas and groundwater from the shallow aquifers. This water will be discharged to the Athabasca River (see Subsection D.3.5.3.b); and
- a mine drainage system, for surface run-off from mined, stripped and developed areas and any basal aquifer depressurization waters. This water will be routed through collection ditches to internal storm water retention basins. Where feasible, mine drainage water will be used as process water. Until Pond 7 is available to store water (in about 2005) mine drainage water in excess of process requirements will either be pumped back to the tailings/extraction system on the west side of the Athabasca River or stored in temporary storm water retention facilities within the mine area (constructed as part of mine advance, similar to current practice on Lease 86/17).

Steepbank Mine and area drainage plans were developed based on the report "Technical Memorandum #2, Hydrology Baseline, Steepbank Oil Sands Mine" (Klohn-Crippen 1996a), which provides baseline hydrological data for the various streams, rainfall and run-off events for the area of Steepbank Mine.

As some mine facilities are located within the Athabasca River valley, Suncor recognizes the importance of minimizing the potential for uncontrolled water releases. This section will discuss the development of the surface drainage plan and will identify areas to be detailed as part of the final design.

b) Surface Drainage Plan Development

The surface drainage plan development has been subdivided into five time periods:

i. Pre-Mine Drainage Patterns

ii. Facilities Construction and Pre-Stripping, 1997-2000

iii. Pit 1 Development, 2000-2009

iv. Pit 2 Development, 2009-2020

v. Reclamation Drainage, Post-2020

Each of these periods is discussed in turn as follows:

i. Pre-Mine Drainage Patterns

Pre-mine drainage patterns are shown in Figure C3.0-21. Major watercourses near the proposed mine are the Steepbank River, and the Athabasca River. Smaller watercourses in the area include an unnamed creek (to be called "Unnamed Creek" here) which drains to Shipyard Lake, Leggett Creek and Wood Creek.

One large, permanent wetland known as Shipyard Lake is within the study area. It is located on the Athabasca River flood plain approximately 6 km upstream (south) of the Steepbank River confluence with the Athabasca River.

The Athabasca River is found in a stream-cut valley incised approximately 80 m below the upland. Valley walls and the flood plain are moderately-forested. The flood plain is moderately-drained to poorly-drained and locally covered with extensive wetland-muskeg. Its channel has irregular meanders with occasional islands and bars.

Uppermost reaches of the local watercourses are poorly drained and covered with muskeg. Relatively steep slopes in the middle and lower reaches of the Steepbank River and in the lower reaches of the smaller creeks, have resulted in a moderately-defined to well-defined entrenched channel system at the Athabasca escarpment. At the downstream end of Steepbank River the valley cuts through the shallow deposits and (close to its confluence with the Athabasca River) through both the Cretaceous (McMurray Formation) and underlying Devonian bedrock. On smaller creeks the entrenched channel systems are generally limited to the immediate vicinity of the Athabasca River valley sides.

Discharge to the Steepbank River from the mine area is from overland flow. No developed stream channels are present in this reach of the catchment.

Of the smaller Athabasca tributaries, Leggett Creek and Unnamed Creek have their drainage basins entirely within the boundaries of the leases. Other tributaries have substantial portions of their drainage outside these limits.

Three small basins designated as Athabasca 1, Athabasca 2 and Athabasca 3 (Figure C3.0-21) have no defined watercourses and appear to discharge run-off only through overland flow or ephemeral streams. Run-off from Athabasca 1 and Athabasca 2 catchments flows to Shipyard Lake while run-off from Athabasca 3 flows directly to the Athabasca River.

ii. Facilities Construction and Pre-Stripping, 1997-2000

Surface water from Athabasca 1, Athabasca 2, Shipyard Lake and the Steepbank basins will be affected during this stage of development. Effects on flow include increased run-off from cleared and stripped areas as well as routing of flows to different discharge points from pre-mine conditions.

During this period the main components of the mine drainage system will be created including storm water retention basins and their connecting channels. The main shop facilities will be constructed during this period including vehicle maintenance shops, a potable water plant and sewage treatment facilities as well as gas and fuel storage and associated distribution facilities. North of the shop facilities the cyclofeeder truck dumps and hydrotransport systems will be built during this period.

Runoff from the facilities areas will be collected and stored only after they have been commissioned, unless oil sand is exposed during construction activities. The mine drainage system, which will collect this runoff, will be designed to contain the 1-in-50-year wet annual runoff.

The potential for increased erosion, run-off and spills into natural watercourses associated with these facilities will require mitigation measures including:

- containment ponds with impervious lining, for liquid storage facilities;
- rapid-response clean-up procedures, for accidental spills;
- drainage channels with settlement ponds, to collect run-off from disturbed areas;
- cross-berms on sloping disturbed areas, to retard run-off and reduce surface erosion; and
- rapid revegetation of disturbed areas, after construction activities are complete.

A site-specific drainage plan (developed for these facilities) will ensure that surface run-off is collected and channelled to the appropriate storm water retention basins.

TABLE C3.0-5

MAJOR DRAINAGE BASINS IN STUDY AREA

Basins	Total Approx. Drainage Area (km^2)
Steepbank River	1370
Shipyard Lake	40.9
Shipyard Lake (Downstream)	3.2
Leggett Creek	34.7
Wood Creek	36.4

Note: Drainage areas are measured to gauging station or if ungauged, to the outlet.

Suncor will implement a water management plan to minimize the potential for spills and overtopping of the mine drainage system. During very wet periods, there may be a requirement to release some of this water to the Athabasca River, particularly before completion of the bridge and the hydrotransport system (about 1999) when all mine drainage water will have to be stored within the Steepbank Mine area. However, careful water management will ensure that this can be done during opportune time periods when water quality can be monitored and necessary approvals obtained, rather than as an emergency procedure. The water management plan, options for containment and any required mitigative measures will be reviewed as part of the final design.

The interception drainage system constructed during this period will collect run-on drainage from the east side of the Pit 1 area and direct it to Shipyard Lake for ultimate discharge to the Athabasca River. Upland drainage channels will include a series of ponds, sized to maintain current water flows to Shipyard Lake. The interception drainage water will be channelled down the escarpment through Unnamed Creek.

Once the interception drainage has reached the river valley it will be discharged from an outfall to be located south of the shop facilities area into Shipyard Lake. The final design will address the outfall requirements and any channel modifications required to handle the interception drainage flow from Shipyard Lake to the Athabasca River.

iii. Pit 1 Development, 2000-2009

Surface water from Athabasca 1, Athabasca 2, Shipyard Lake and the Steepbank basin will be affected during this stage of development. About 60% of the Athabasca 1 basin will be restructured during this period: the northern portion of the basin will become the north overburden storage facility while the southern portion will become Pit 1. The entire basin will be routed through the mine drainage system with the exception of the extreme northern portion of the catchment, on the headland at the confluence of the Athabasca and the Steepbank Rivers. After 2005, Pond 7 will be available to contain excess mine drainage waters.

In 2003, an interception channel will be constructed to divert additional flow from the uplands area to Shipyard Lake before overburden mining. This channel will contain several ponds, to reduce flood event flows, and will replace Unnamed Creek as the channel conveying water from the uplands areas to the Athabasca River flood plain, allowing mining of the Unnamed Creek basin. However, even with upland flood control, volumes and velocities may require some form of engineered drop structure (such as a pipe) and energy dissipation measures to minimize erosion and sediment transport. This may consist of a structure similar to the current South Mine drainage outfall on Lease 86/17.

In 2008, flow to Leggett Creek basin will be increased following the construction of an additional interception channel. Other changes in flow are related to mine advance.

iv. Pit 2 Development, 2009-2020

Development of Pit 2 and its associated overburden dumps will have additional effects on annual run-off and peak flood flows to Shipyard Lake, and to Leggett and Wood Creeks. Between 2009 and about 2015, all of the interception drainage will be directed through either to Shipyard Lake or to Leggett Creek and the Athabasca River. As Pit 2 mining progresses southward, Leggett Creek will eventually be eliminated and all interception flow from the Pit 2 upland area will be diverted through Wood Creek. The total interception flow (Pit 1 and Pit 2 upland areas) can be split, so that sufficient water will flow to Shipyard Lake, to maintain the wetlands and excess flow to Wood Creek will be minimized. The diversion volume split will be determined as part of the final design.

v. Reclamation Drainage, Post-2020

The surface drainage network constructed for a reclaimed Steepbank Mine is discussed in Subsection D.3.6.2.

c) Surface Drainage Impacts

Impacts of surface water diversions due to the Steepbank Mine drainage plan are discussed in Subsection 3.4.3. Local and regional environmental impacts of the Steepbank Mine surface drainage plan are discussed in Subsections D.3.5.5.b and E.5.3.

Negative impacts resulting from the Steepbank Mine surface drainage plan will be minimized during final design by provision of required containment or mitigation facilities.

3.4.2 Groundwater

a) Pre-Mine Hydrogeology

The geology and hydrogeology of the Steepbank Mine area are discussed in Subsection E.5.3 and are summarized below:

- There are three major aquifers in the Steepbank Mine area: shallow surface aquifers, a basal sand aquifer and the Devonian limestone. The basal aquifer and the limestone may be hydraulically connected.
- Most groundwater flows toward the Athabasca River with a minor stream toward the Steepbank River.
- Groundwater discharges to surface streams represent less than 1% of the base flow of the Athabasca and Steepbank Rivers.
- There are no groundwater users in the Steepbank Mine area and no water wells either on the east side of the Athabasca River or south of the Steepbank River within 10 km of the mine area.

b) Groundwater Diversion Development

i. Facilities Development, 1997 - 2000

The only effect the construction phase is expected to have on the hydrogeologic system is associated with the water supply wells for the new facility, which will be developed in the shallow sand and gravel aquifers near the shop area. None of the other aquifers will be affected by mine activity in this period. The potable water supply is discussed in Subsection 3.4.3.c.

As the water wells will be quite close to the river it is expected that they will induce infiltration of water from the Athabasca River. While they are pumped the wells will lower the water level within the aquifer in their vicinity. This change in water level is expected to be small due to recharge from the river. Impact on groundwater flows will be limited to a distance of a few hundred metres from the wells. There will be very little effect on the aquifer east of the water wells. Flow direction, discharge rate and groundwater quality in the upland shallow aquifer and deep aquifers will not be affected.

Any small impact that the water wells will have on the local groundwater will cease within weeks of turning the pumps in the wells off.

*ii. **Pit 1 Development, 2000 - 2009***

During the first eight years of the operation of Steepbank Mine the following groundwater diversions will be imposed on the hydrogeologic system due to the excavation of Pit 1 and pre-stripping around Pit 2:

- In the shallow aquifers the direction of groundwater flow will be changed as a result of dewatering of the overburden in the areas; however, the discharge rate will not be affected.
- In the basal aquifer the direction of groundwater flow near Pit 1 will change because Pit 1 will be excavated below the pre-mine water pressure level in the aquifers. The rate of groundwater discharge from the basal aquifer will change as a result of the change in the flow direction.
- No change in the quality of the groundwater aquifers is expected.

During overburden stripping for the development of Pit 1 shallow deposits in the area will be dewatered. Shallow aquifers will be intercepted with a diversion system on the east side of the mine, and groundwater will be diverted to Shipyard Lake. Total volume of groundwater discharged from the aquifers to surface waters will not change.

Currently, the discharge occurs as seepage to the Athabasca and Steepbank Rivers and Shipyard Lake, along the reach of these water bodies adjacent to the mine. Between 2001 and 2008 the broad discharge will be replaced by discharge from point sources into Shipyard Lake. By 2009 groundwater up-gradient of both Pits 1 and 2 will be diverted to Shipyard Lake and Leggett Creek. During the same period shallow groundwater flow to the Steepbank River will be reduced to near zero due to mining of aquifers. Because groundwater contribution to the rivers will be a minor component of their flow (less than 1%) the impact of these changes in river direction and rate of flow will be very small.

Groundwater flow in the Basal Aquifer and Upper Devonian will be directed toward Pit 1, resulting in reduced rates of discharge to the Athabasca and Steepbank Rivers and to Shipyard Lake. While the pit is being mined discharge to these water bodies from the Pit 1 area will be reduced to near zero. The groundwater contribution to the rivers and Shipyard Lake will be a minor component of their flow (less than 1%), therefore the impact on them will be very small and areal extent of this effect will be limited to within 2 km of Pit 1. This change in discharge will be of short-term duration. In 2009 (once Pit 1 is filled with tails) groundwater from the deep aquifers will again discharge at pre-mine rates.

During the mining of Pit 1 water may recharge the deep aquifers from the Steepbank River and flow toward the pit, due to the elevation difference between the river and the north side of the pit. Based on the hydraulic conductivity of the deep aquifers and the difference in elevation between the river and the pit, the maximum amount of water that may be diverted under steady-state conditions is approximately 1.1 L/s. Compared to the total flow in the Steepbank River this is an insignificant flow. The areal extent of this effect will be limited to within 2 km of Pit 1 and the duration of impact will be short-term. In 2009 (once Pit 1 is filled with consolidated tailings) groundwater from the aquifer will again discharge to the Steepbank River.

Before opening Pit 2 in 2009 it may be necessary to depressurize the basal aquifer within the pit limits. The depressurization program will be detailed as part of the Pit 2 design process. All waters from the depressurization program will be retained within tailings ponds.

iii. Pit 2 Development, 2009 - 2020

During the period 2009 to 2020, Pit 2 will be mined and Pond 7 (formerly Pit 1) will be filled with consolidated tails (CT). These activities are expected to result in the following groundwater changes:

- In the shallow aquifer the direction of groundwater flow will be changed (as dewatering of the overburden near Pits 1 and 2 continues) but discharge rates will not be affected.
- In the deep aquifers the direction of groundwater flow will change because Pit 2 will be excavated below the pre-mine water pressure level in the aquifers.
- The rate of groundwater discharge from the deep aquifers will change because of the change in its direction of flow.

By 2020 it is expected that all groundwater flowing toward the mine in the shallow aquifer will be intercepted and discharged into either Shipyard Lake and Wood Creek and then ultimately to the Athabasca River. As the contribution of groundwater to the Athabasca River is so low the effect of this impact will also be very low; the areal extent of this effect will be limited to within about 300 m of the surface interceptor ditches. Changes in the direction of flow and rate of discharge from the shallow aquifer will be long-term. Diversion of groundwater from the shallow aquifer is expected to continue after the closure of the mine.

The effect of mining from Pit 2 on groundwater discharge from the deep aquifers will be the same as for Pit 1. There will be a short-term reduction of discharge from the Basal Aquifer and Upper Devonian to the Athabasca River and Shipyard Lake. The severity of this impact will be minor, and will be limited to the area near Pit 2. In 2020 (once mining from Pit 2 is finished) groundwater discharge from these deep aquifers will return to pre-mine conditions.

CT deposits in Pond 7 (Figure C3.0-24) will interact with groundwater in the deep aquifers once the mined pits are filled with the tailings. By 2020 pore water from the CT is expected to seep from the bases of both Ponds 7 and 8. Rate of seepage from the ponds will depend on the hydraulic conductivity of the CT, the vertical hydraulic gradient between the CT and underlying deep aquifers, and the area of the ponds. Hydraulic conductivity of the CT has been estimated to be 1×10^{-9} m/s (AGRA 1995b). Impacts of these flows are discussed in Subsection E.7.0.

iv. Long-Term, Post-2020

Some groundwater diversions will continue following mining activities at Steepbank Mine. They include the following:

- a change in the direction of groundwater flow in the shallow aquifer to discharge points into Shipyard Lake and Wood Creek; and
- small changes in flow rates and water quality in the deep aquifers as seepage of pore water from the CT in Ponds 7 and 8 flows through the aquifers to the Athabasca and Steepbank Rivers and Shipyard Lake.

c) Groundwater Impacts

Potential impacts of groundwater diversions due to Steepbank Mine are discussed in Subsection 3.4.3. Local and regional environmental impacts of Steepbank Mine on groundwater are discussed in Subsections D.3.5.5.b and E.5.3.

3.4.3 Water Diversions, 1997-2006

a) Licence Requirements

Suncor is requesting a 10 year (1997-2006) approval to divert a portion of the surface and groundwater on the Steepbank Mine and on Lease 86/17 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 C3.0-6.

b) Steepbank Mine

i. Fence Line for Steepbank Mine Water Diversions

The 'fence line' or perimeter for water diversions on the Steepbank mine is shown in Figure C3.0-22.

ii. Water Balance, 2006

The maximum water diversion volume in the period 1997-2006 will be in the year 2006 as the disturbed area (i.e., active mining and facilities areas) will be greatest at this time. The water balance for this time period is shown in Table C3.0-6. The drainage plan for 2006, including the proposed outfall locations and activity areas is shown in Figure C3.0-23. Details of the outfall design will be supplied following the detailed mine drainage plan design. Suncor requests a water diversion allocation of 5.4 million m^3 per year for the Steepbank mine.

c) Lease 86/17

i. Fence Line for Lease 86/17 Water Diversions

The 'fence line' or perimeter for water diversions on Lease 86/17 is shown in Figure C3.0-24.

TABLE C3.0-6

STEEPBANK MINE MAXIMUM WATER DIVERSION VOLUMES

Source	Activity	Precipitation ('000 m^3)	Evapo-transpiration ('000 m^3)	Net Volume ('000 m^3)	Volume Released ('000 m^3)	Steepbank Mine Allocation ('000 m^3)
Surface Runoff	Mining	6523	1417	5106	0	5106
	Pre-Mine Drainage	20 962	9545	11 417	11 417	0
Shallow Aquifers	Pre-Mine Drainage	N/A	N/A	15	15	0
Bedrock Aquifers	Mining	N/A	N/A	40	0	40
Steepbank River	Mining	N/A	N/A	35	0	35
Athabasca River	Potable Water Supply	N/A	N/A	237	40	197
Total Steepbank Mine Allocation ('000 m^3)						5380

ii. Water Balance

The maximum water diversion volume during the period 1997-2006 will be in the year 2006 as the disturbed areas (i.e., tailings ponds and facilities areas) will be greatest at this time. The water balance for this time period is shown in Table C3.0-7. The drainage plan for 2006, including the outfall locations and activity areas are shown in Figure C3.0-24. Details of the outfall design will be submitted with the application for the water diversion licence. The balance has been developed for surface runoff only as all of the major aquifers on Lease 86/17 will be mined out by 2006. Water diversions from the Athabasca river are currently licenced separately. Suncor requests a water diversion allocation of 8.5 million m^3 per year for Lease 86/17.

TABLE C3.0-7

LEASE 86/17 WATER DIVERSION VOLUMES, 2006

Source	Activity	Precipitation ('000 m^3)	Evapo-transpiration ('000 m^3)	Net Volume ('000 m^3)	Volume Released ('000 m^3)	Lease 86/17 Allocation ('000 m^3)
Surface Runoff	Tailings Operations	16 630	8100	8520	0	8520
	Plant Site Drainage	320	40	280	280	0
	Undisturbed /Reclaimed Area Drainage	1180	610	570	570	0
				Total Lease 86/17 Allocation ('000 m^3)		8520

d) Consolidated Tailings Water Release

The implementation of consolidated tailings (CT) technology will greatly enhance Suncor's ability to reclaim its former mining areas. However, the CT process releases water currently contained within fine tailings, resulting in water volumes in excess of Suncor's extraction processing requirements. One option currently under review is the discharge of excess water (after appropriate treatment) to the Athabasca River; this water management option is discussed in Subsections D.3.4 and D.3.5.3.

e) Potable Water

A potable water supply will be obtained from water wells (likely two or three) constructed in the sand and gravel aquifer between the Athabasca River and the proposed facilities area. Water supply of approximately 7.6 L/s (650 m^3/d) is required The potable water system will supply the maintenance shop and cyclofeeder areas; each area will maintain its own storage and chlorination units. Design of the potable water system will be completed following the installation of test wells and it will ensure the control systems are protected from Athabasca River flooding. If water-well supply is shown to be insufficient alternate sources for water supply such as infiltration galleries will be explored. The water supply will be chlorinated with residual chlorination units.

3.4.4 Sewage Treatment

A sewage treatment facility is required for Steepbank Mine to treat grey water and sanitary sewage from the various facilities within the hydrotransport area and the shops. Sanitary sewage from these facilities will be pumped to the sewage treatment facility which will be located southwest of the shop area.

Sanitary sewage from the hydrotransport area will be directed to a 19 m^3 underground storage tank and then pumped by lift station to the sewage treatment facility. Wastewater from the shop areas will be separated into oily-water and grey-water streams. Oily wastewater will be temporarily stored in two 38 m^3 underground tanks at the main shop area and a 19 m^3 underground tank at the light-vehicle shop. These tanks will be emptied as required and the contents either reprocessed or transferred to the liquid waste disposal site.

The sewage treatment facility comprises a septic/surge tank, a rotary biological contact treatment plant and a wastewater disposal field. The facility will be sized for a capacity of about 110 m^3 /d.

Treated water from the sewage treatment facility will be discharged to the Athabasca River via the Steepbank Mine interception drainage outfall, similar to the current arrangement on Lease 86/17 at the Mid-Plant drainage outfall.

3.4.5 Water Diversions Due to the Steepbank Mine Bridge

a) <u>Pipelines</u>

All of the pipelines (hydrotransport, hot water, tailings, diesel fuel and recycle water) to run on the Steepbank Mine bridge across the Athabasca River will be equipped with emergency isolation valves and other protective measures to prevent discharge to the Athabasca River in case of pipeline seal break or other release during operation. Sufficient storage capacity will be provided at the bridge approaches for the full capacity of all lines on the bridge deck between the isolation valves. In addition provisions will be made for fluids collection and bridge deck treatment in case of a spill.

b) <u>Ice Jamming</u>

Once completed, the Steepbank Mine bridge will not increase the likelihood of ice jamming or bank erosion in the reach of Steepbank Mine in the foreseeable future (AGRA, January 1996k). During bridge construction however, cofferdams built for pier construction may increase the potential for flooding from ice jams. This risk will be mitigated by removal of the cofferdams before spring break-up.

The 1-in-100-year ice jam flood elevation is expected to be about elevation 241 m ASL: this is about 2.4 m higher than the open water 1-in-100-year flood event elevation. Structures, with the exception of bridge abutments, adjacent to the Athabasca River will be constructed above elevation 241 m ASL.

On the east abutment some sediment deposition will be expected both upstream and downstream of the bridge while on the west bank sediment deposition downstream of the bridge is anticipated. This will not affect the hydrology of the river. Aquatic impacts are discussed in Subsection E.5.3.

The bridge is designed to accommodate navigation between the piers up to the 1-in-10-year flood event elevation.

FIGURES SECTION C3.0

FIGURES

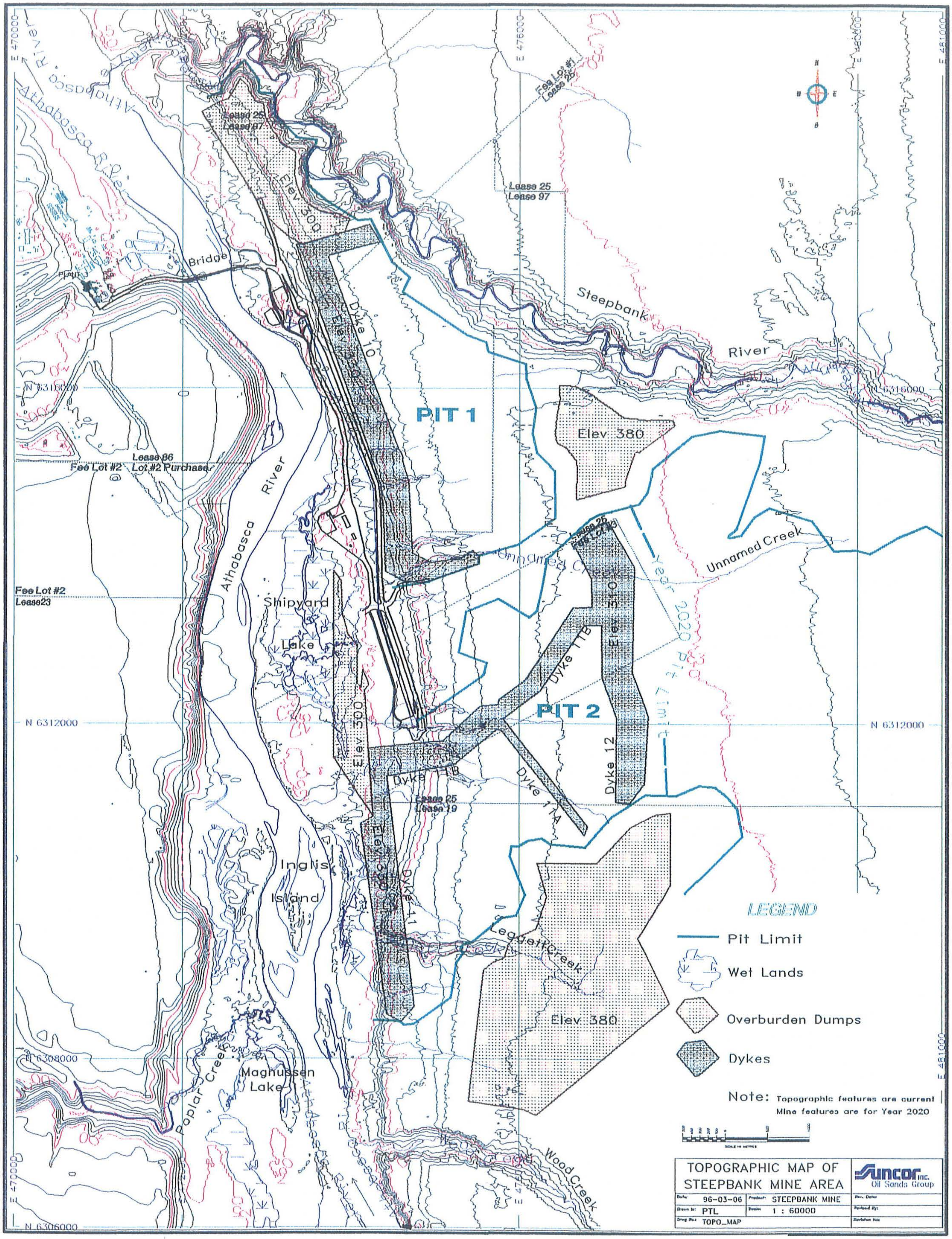


Figure C3.0-1 Topographic Map of Steepbank Mine Area

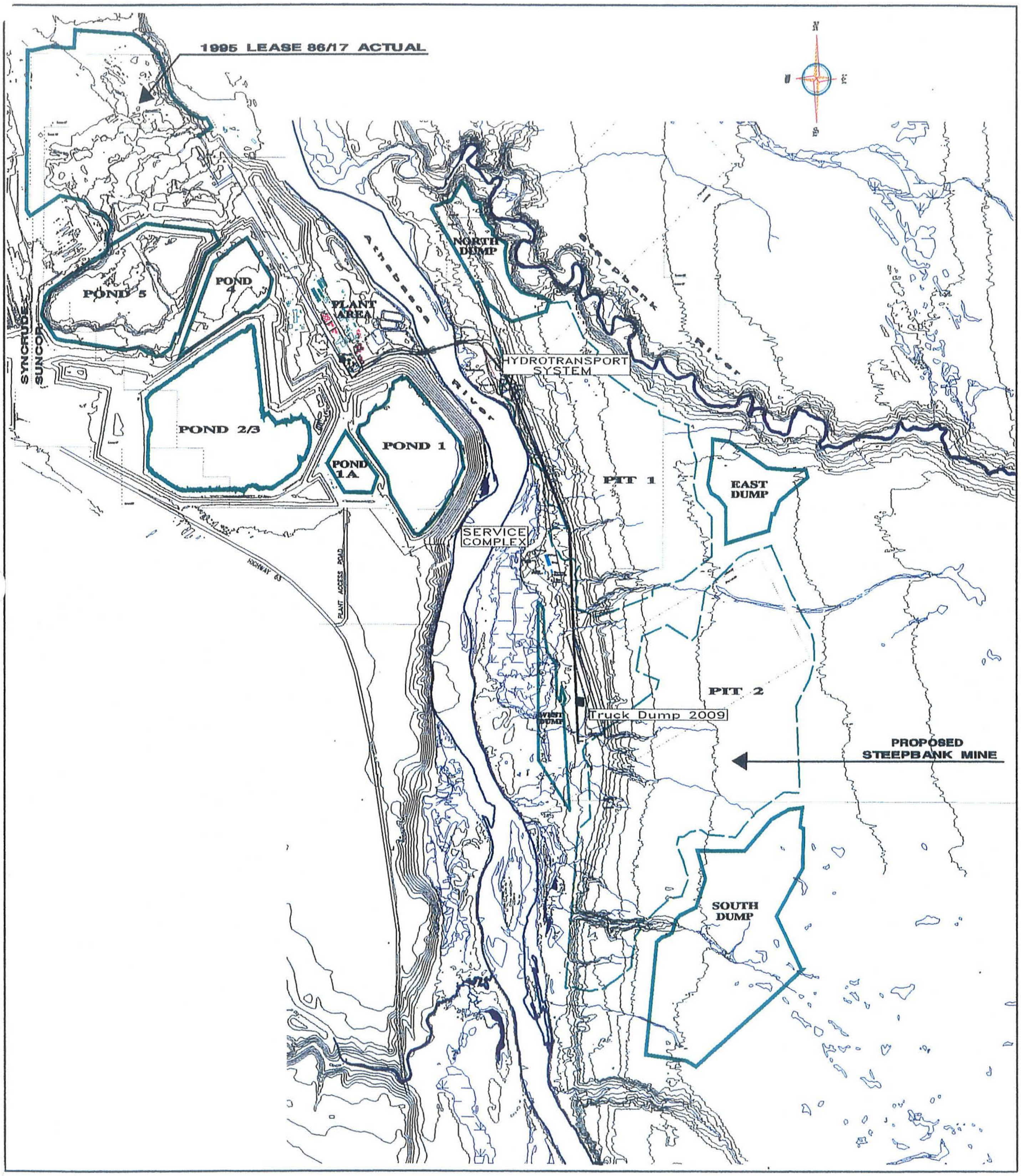


Figure C3.0-2 Present Operations and Overall Layout of Steepbank Mine

Figure C3.0-3 Aerial Photo of Steepbank Mine

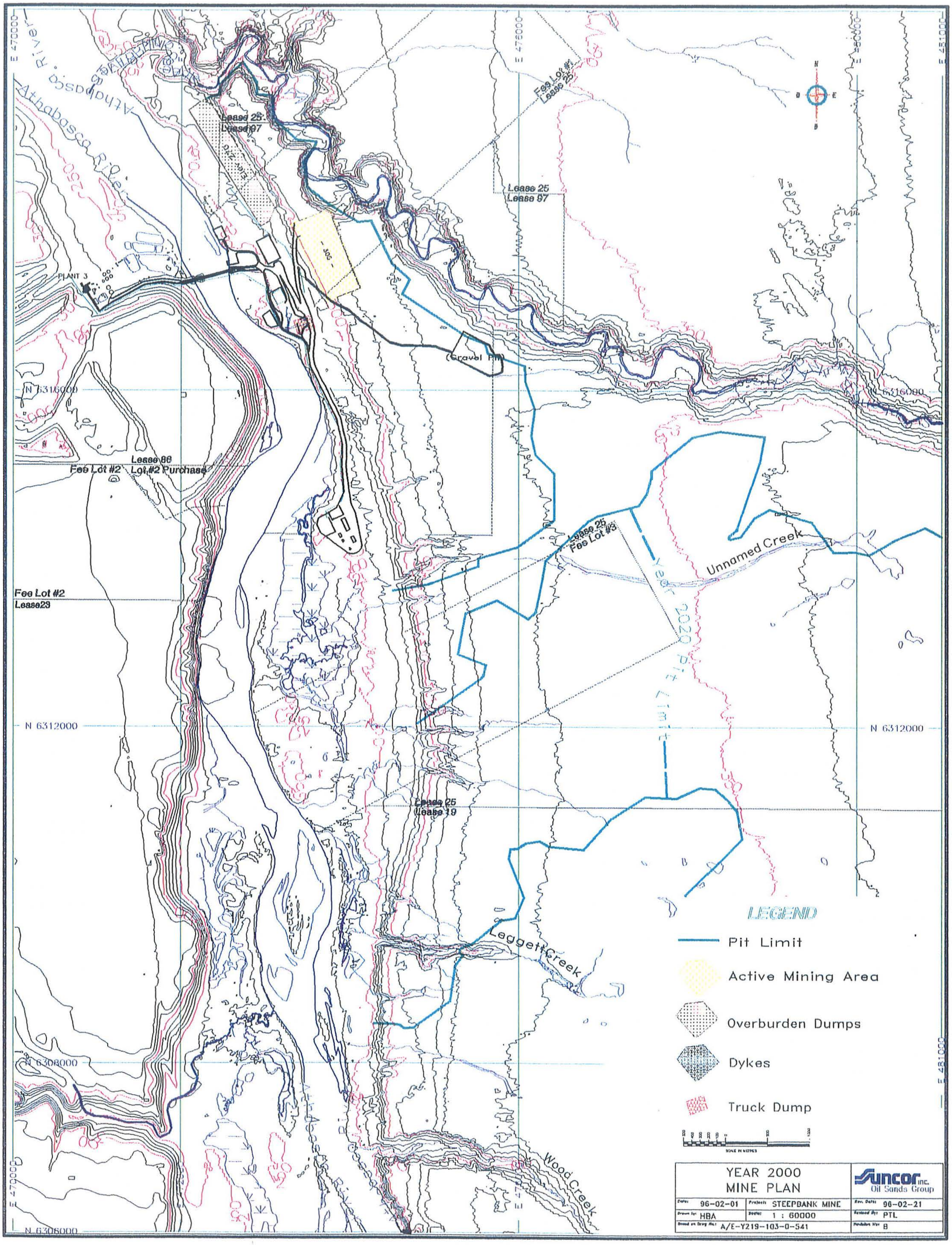


Figure C3.0-4 Mine Plan Year 2000

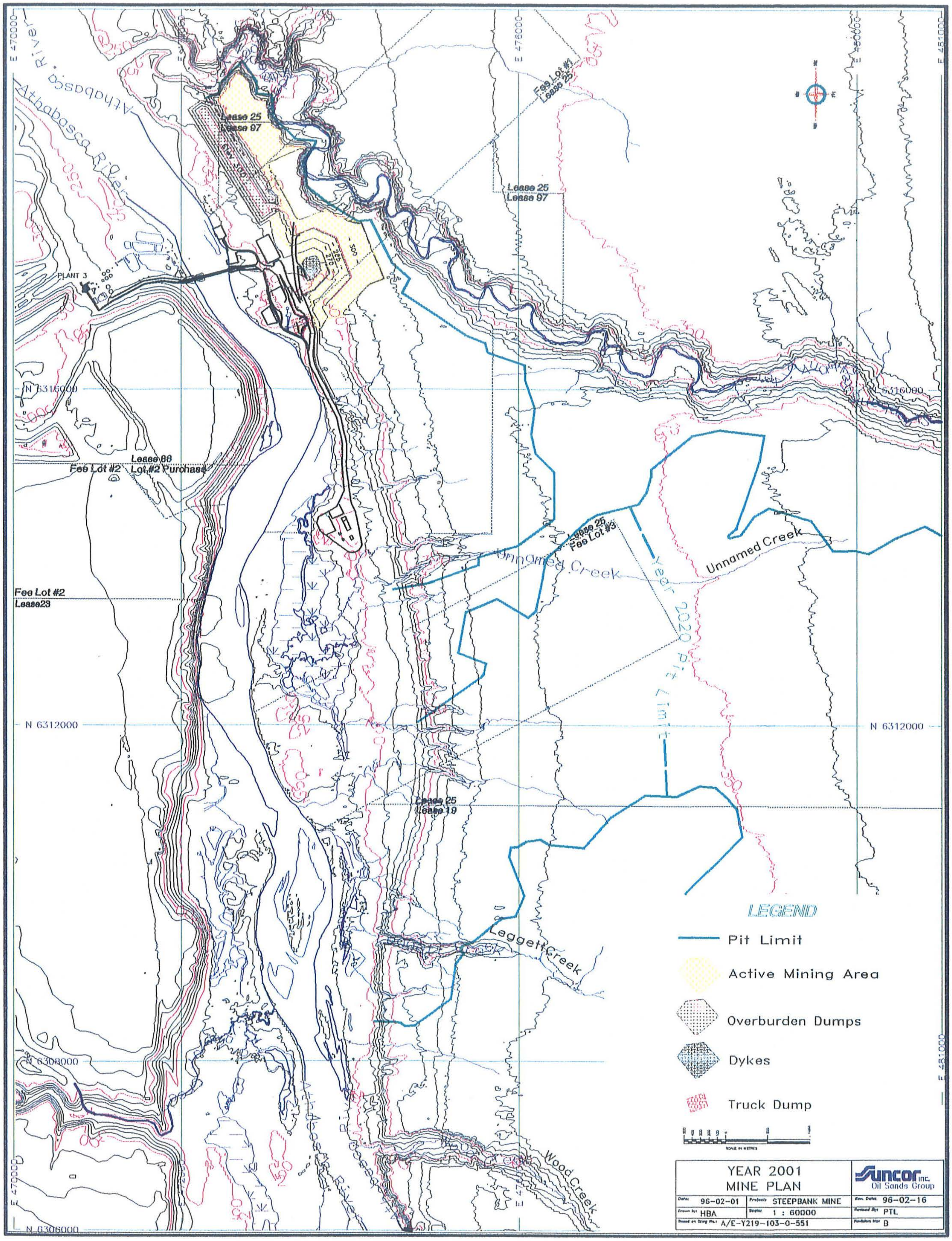


Figure C3.0-5 Mine Plan Year 2001

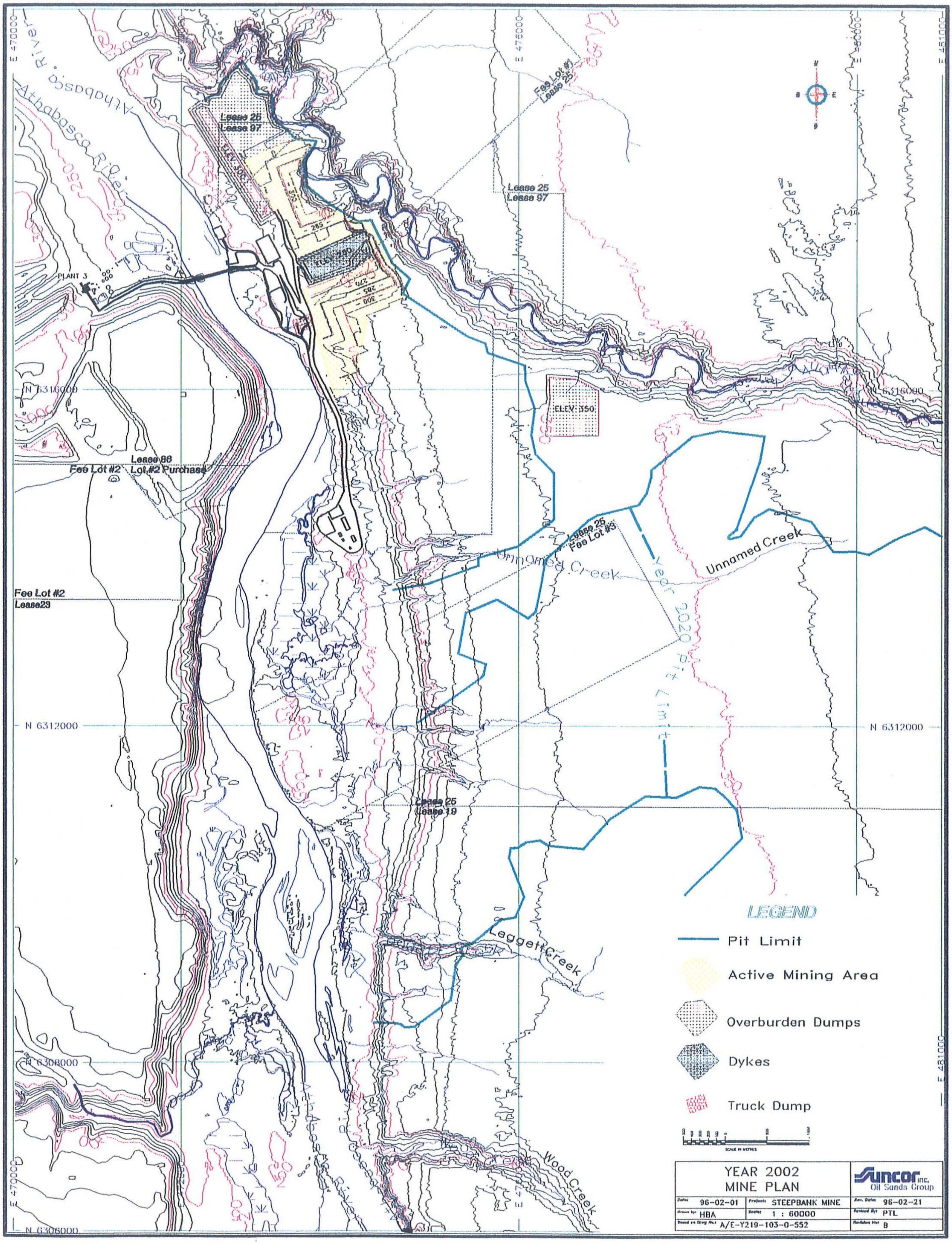


Figure C3.0-6 Mine Plan Year 2002

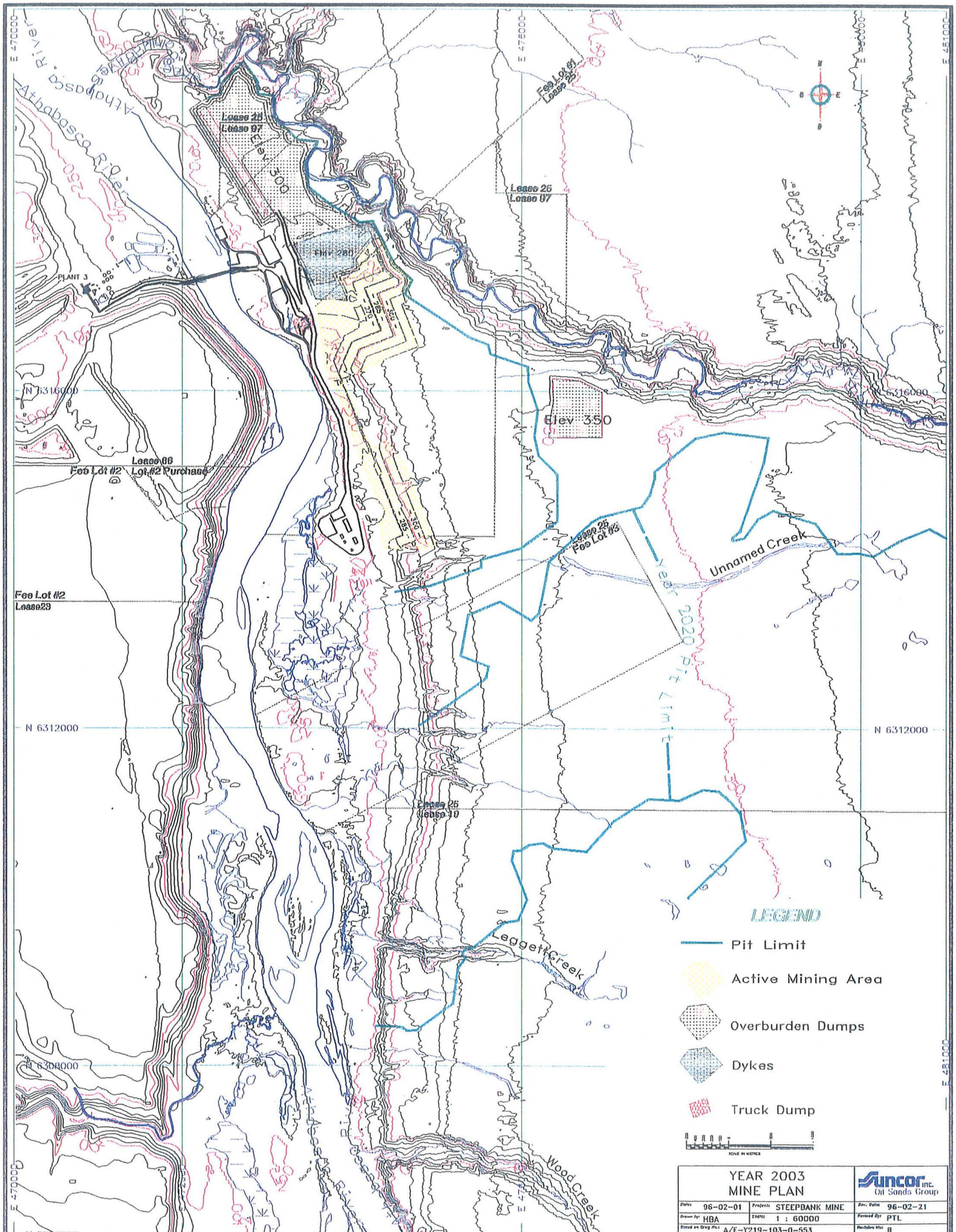


Figure C3.0-7 Mine Plan Year 2003

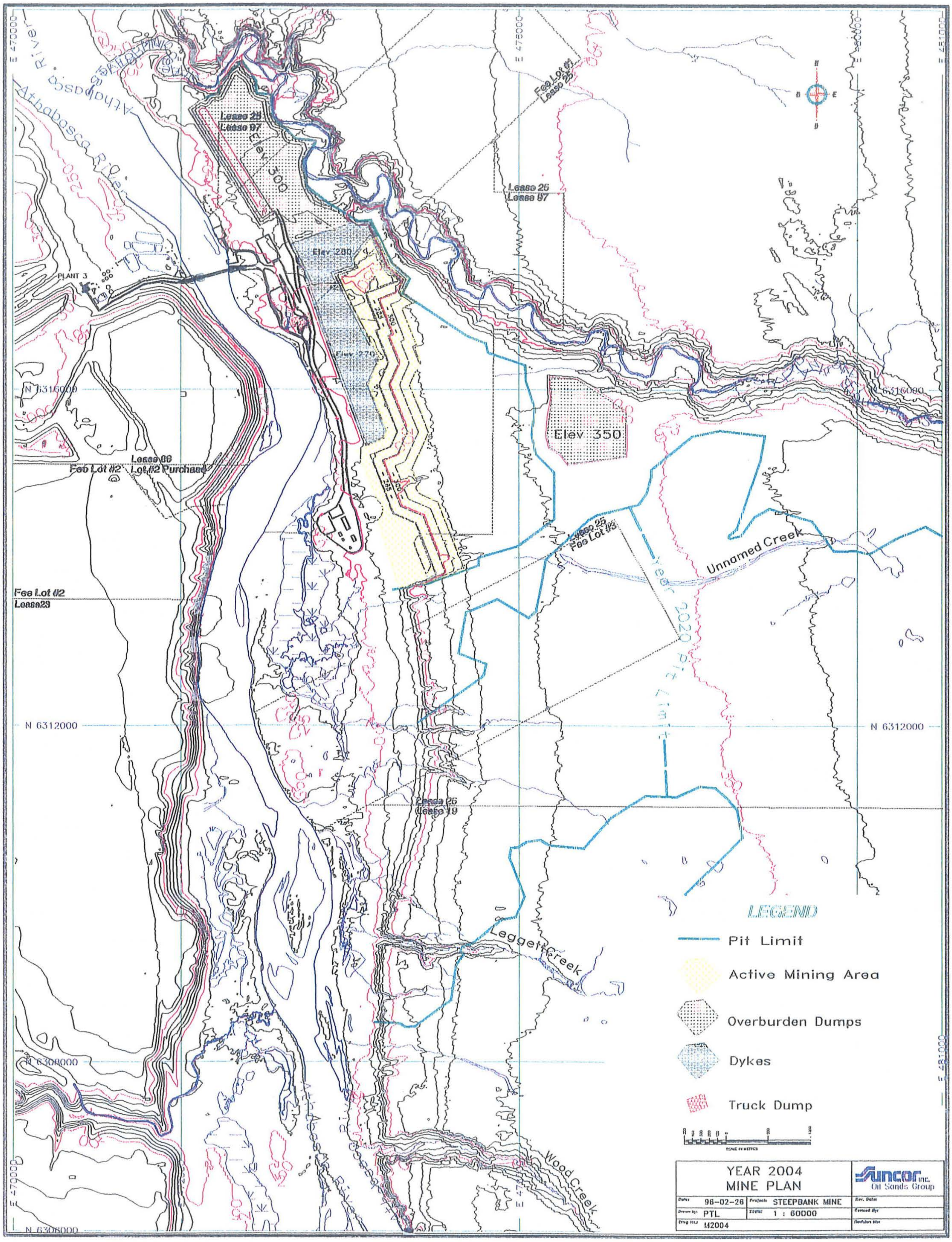


Figure C3.0-8 Mine Plan Year 2004

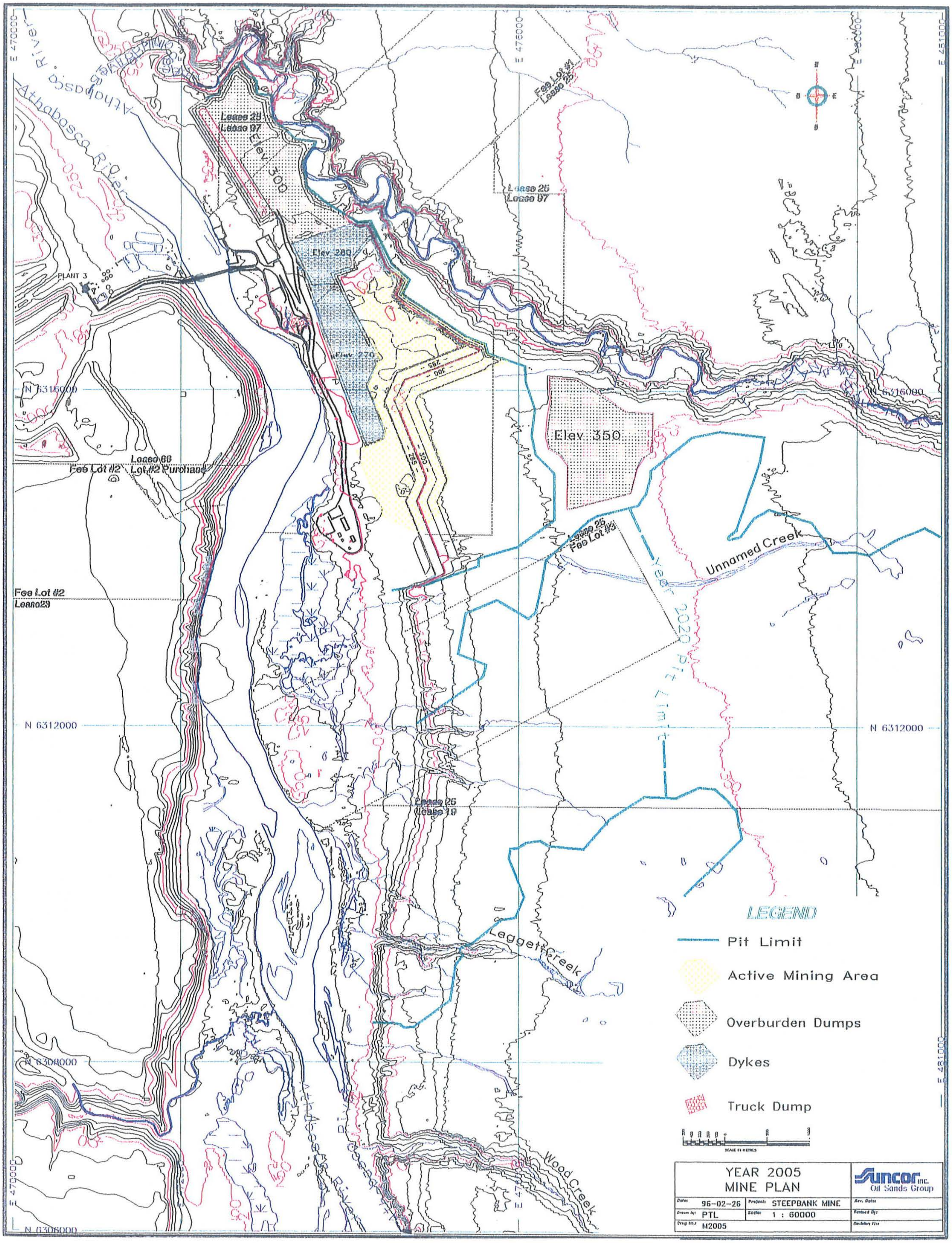


Figure C3.0-9 Mine Plan Year 2005

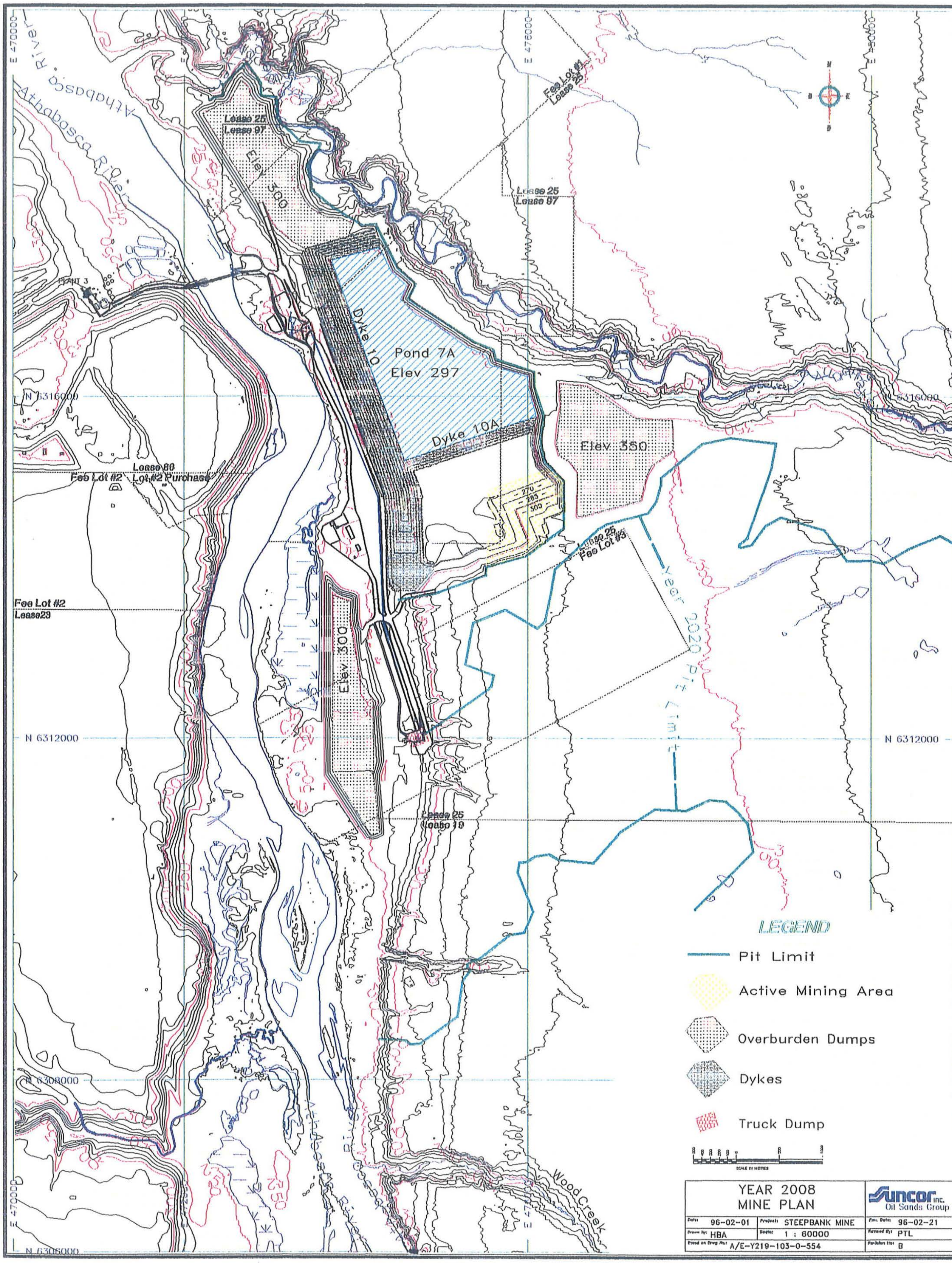


Figure C3.0-10 Mine Plan Year 2008

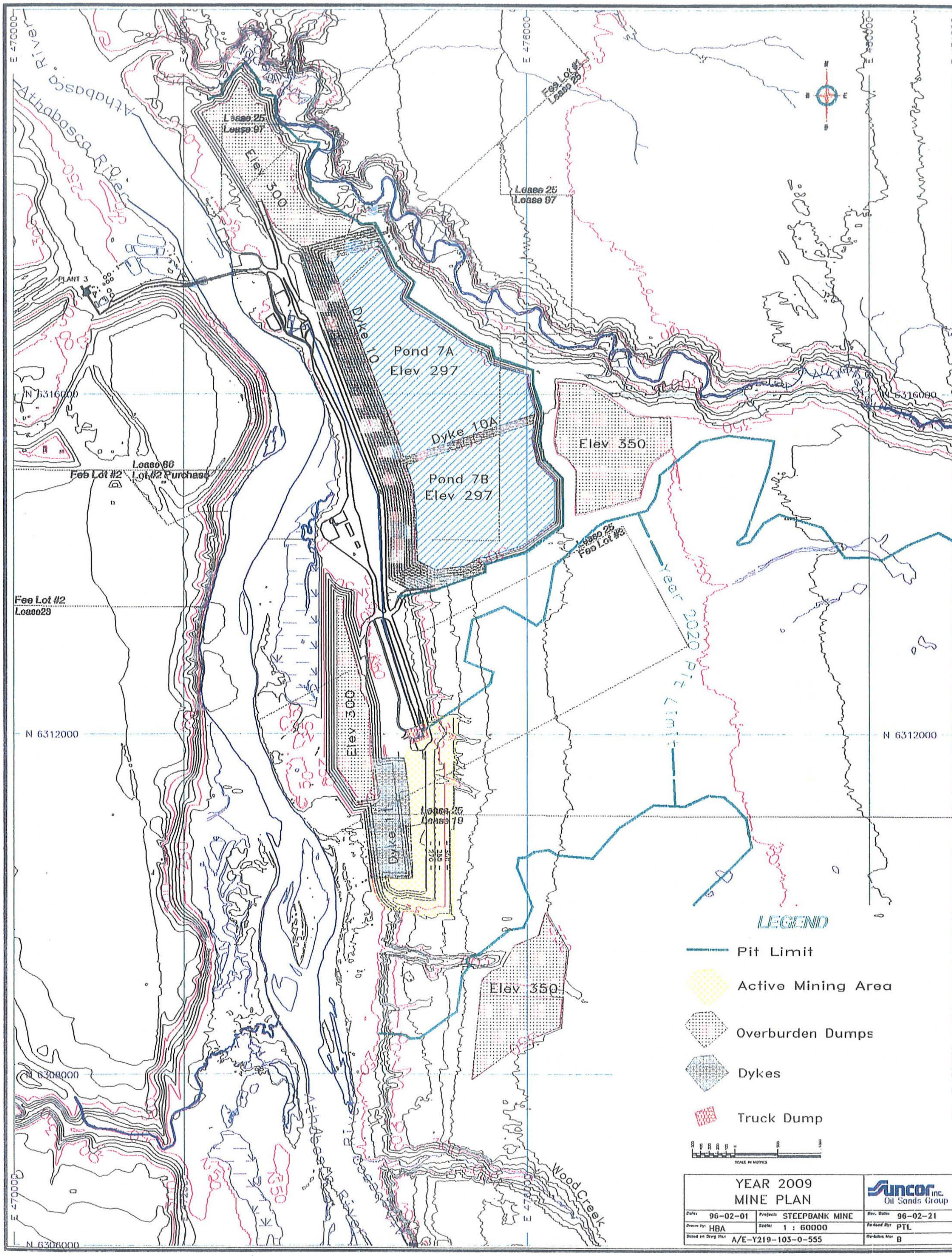


Figure C3.0-11 Mine Plan Year 2009

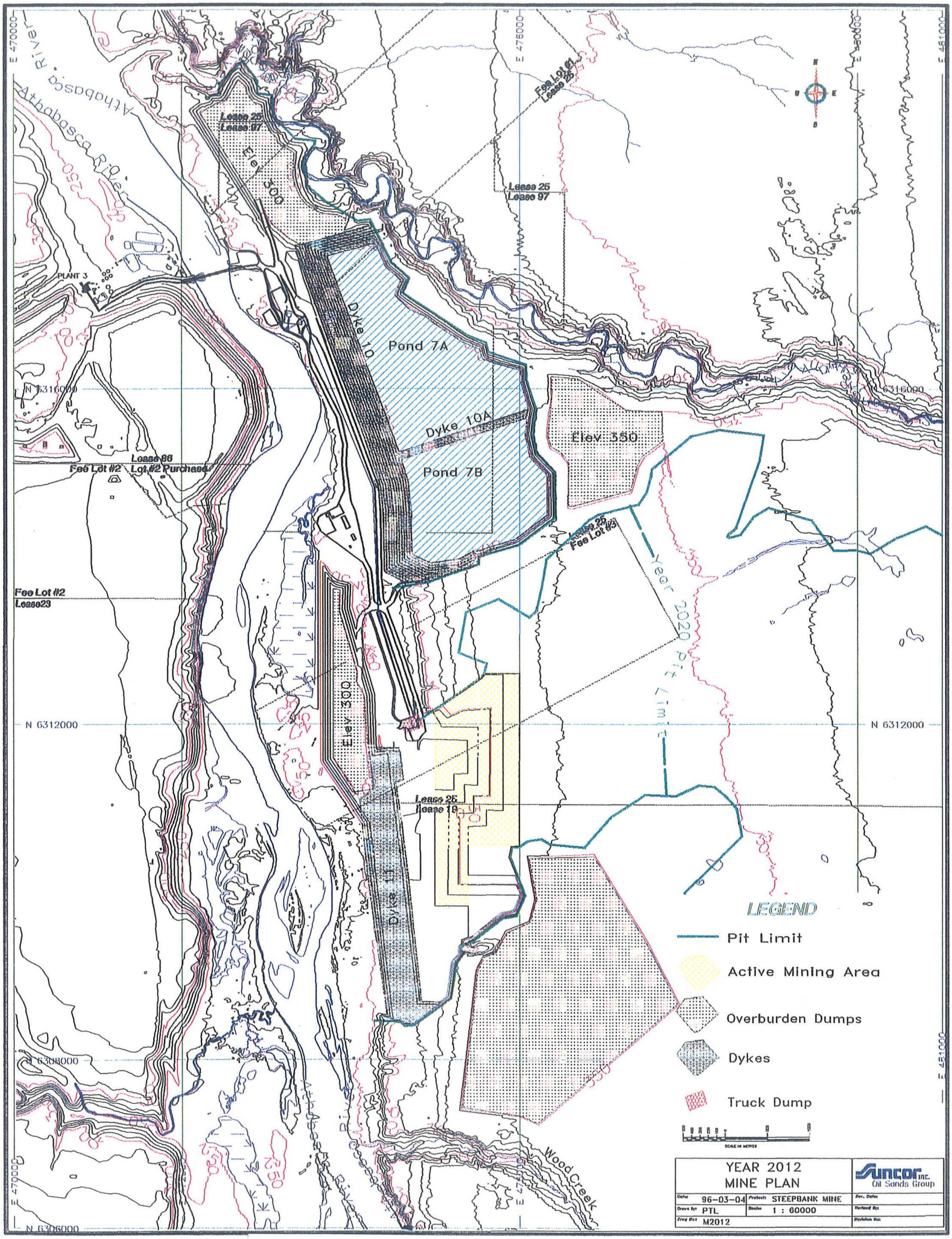


Figure C3.0-12 Mine Plan Year 2012

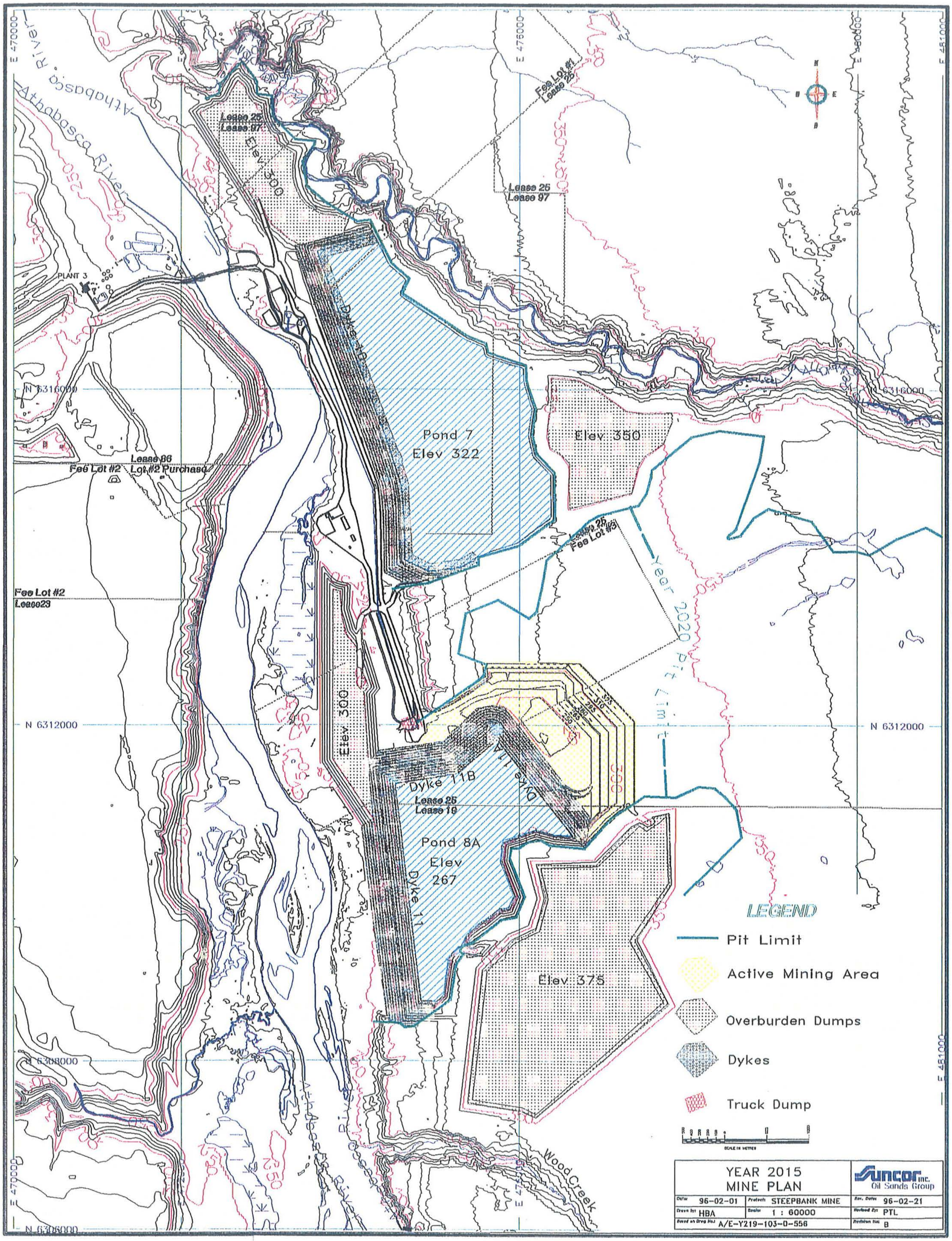


Figure C3.0-13 Mine Plan Year 2015

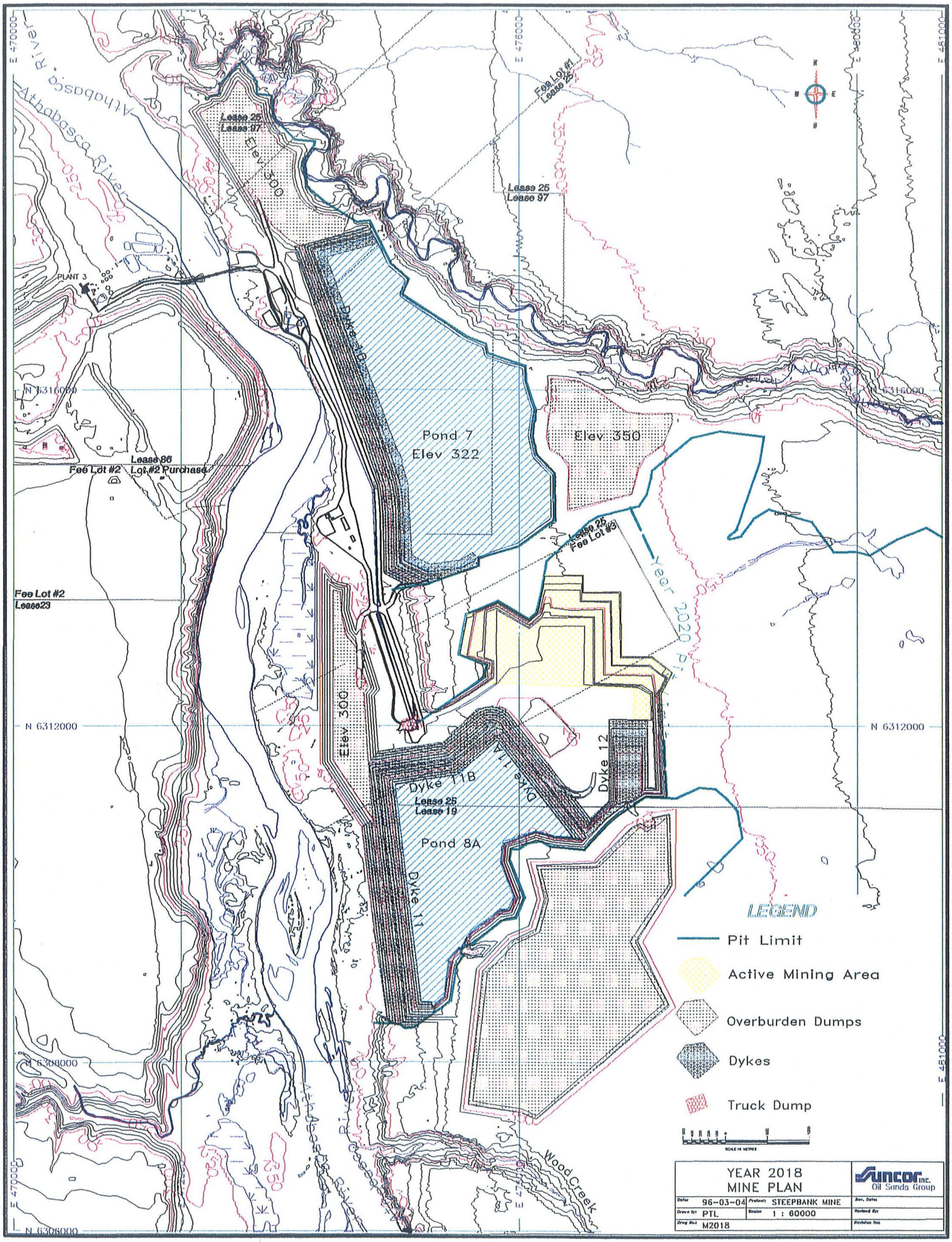


Figure C3.0-14 Mine Plan Year 2018

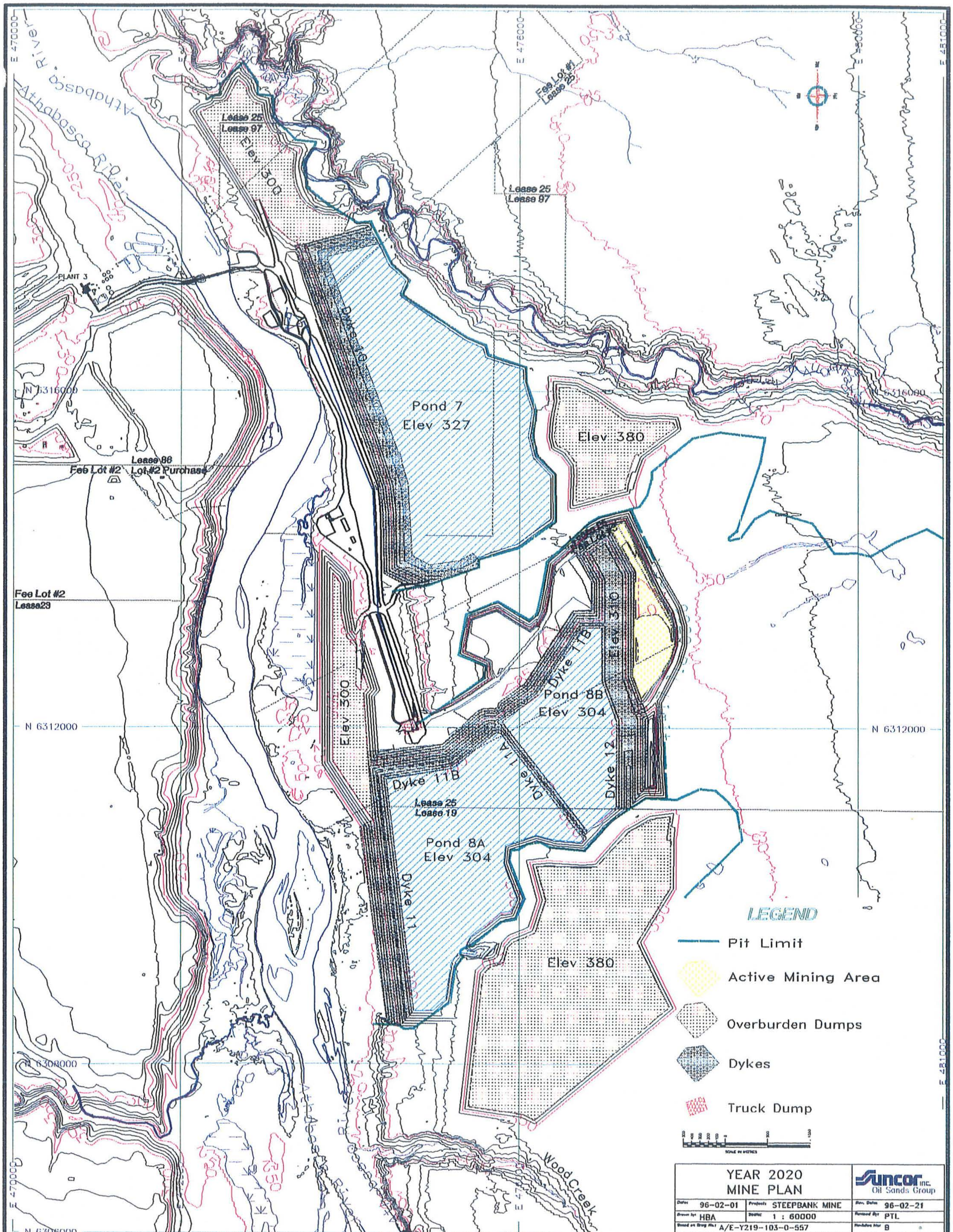


Figure C3.0-15 Mine Plan Year 2020

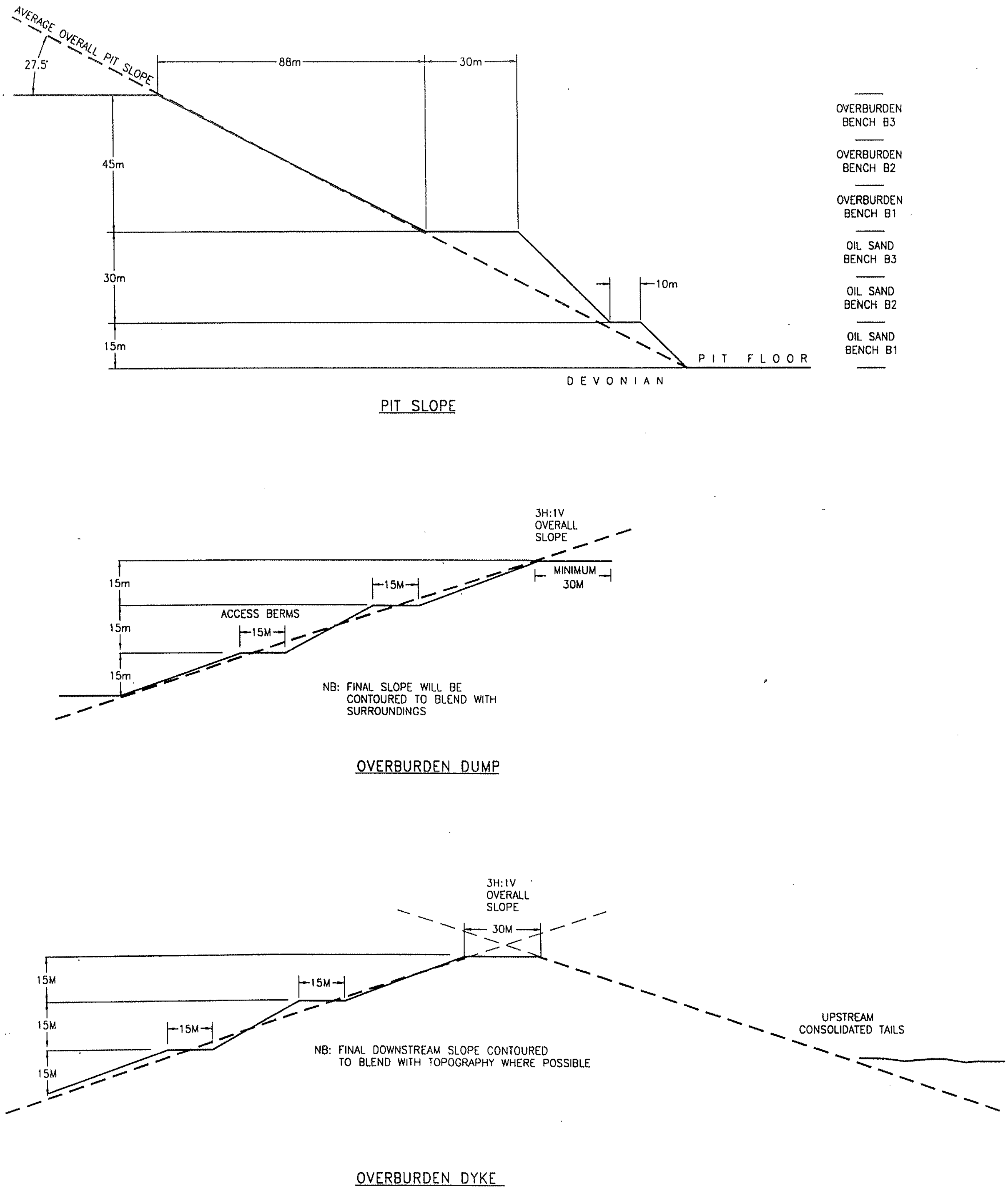


Figure C3.0-16 Typical Cross-Sections for Dumps, Dykes and Pitwalls

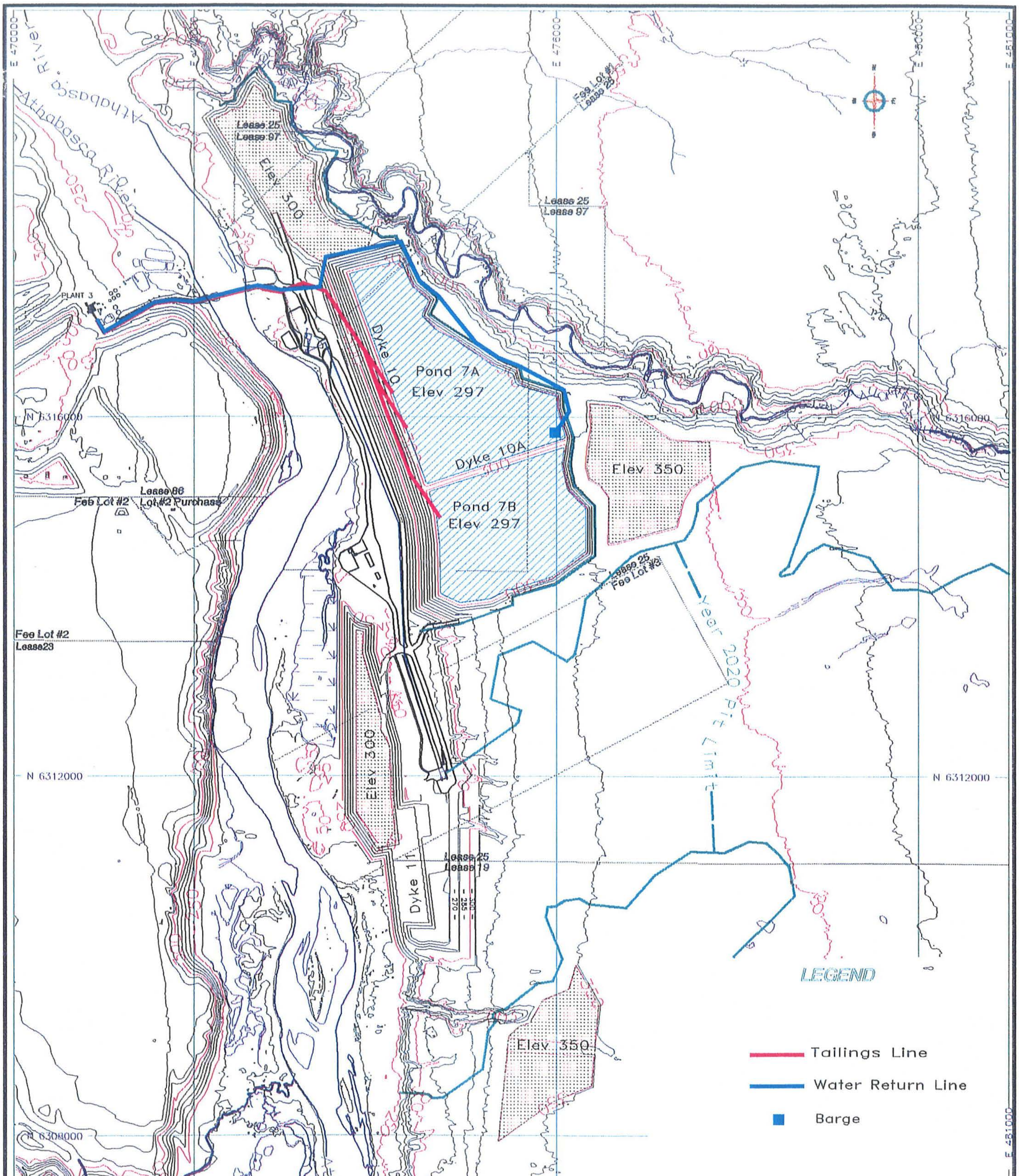


Figure C3.0-17 Tailings Plan Year 2009

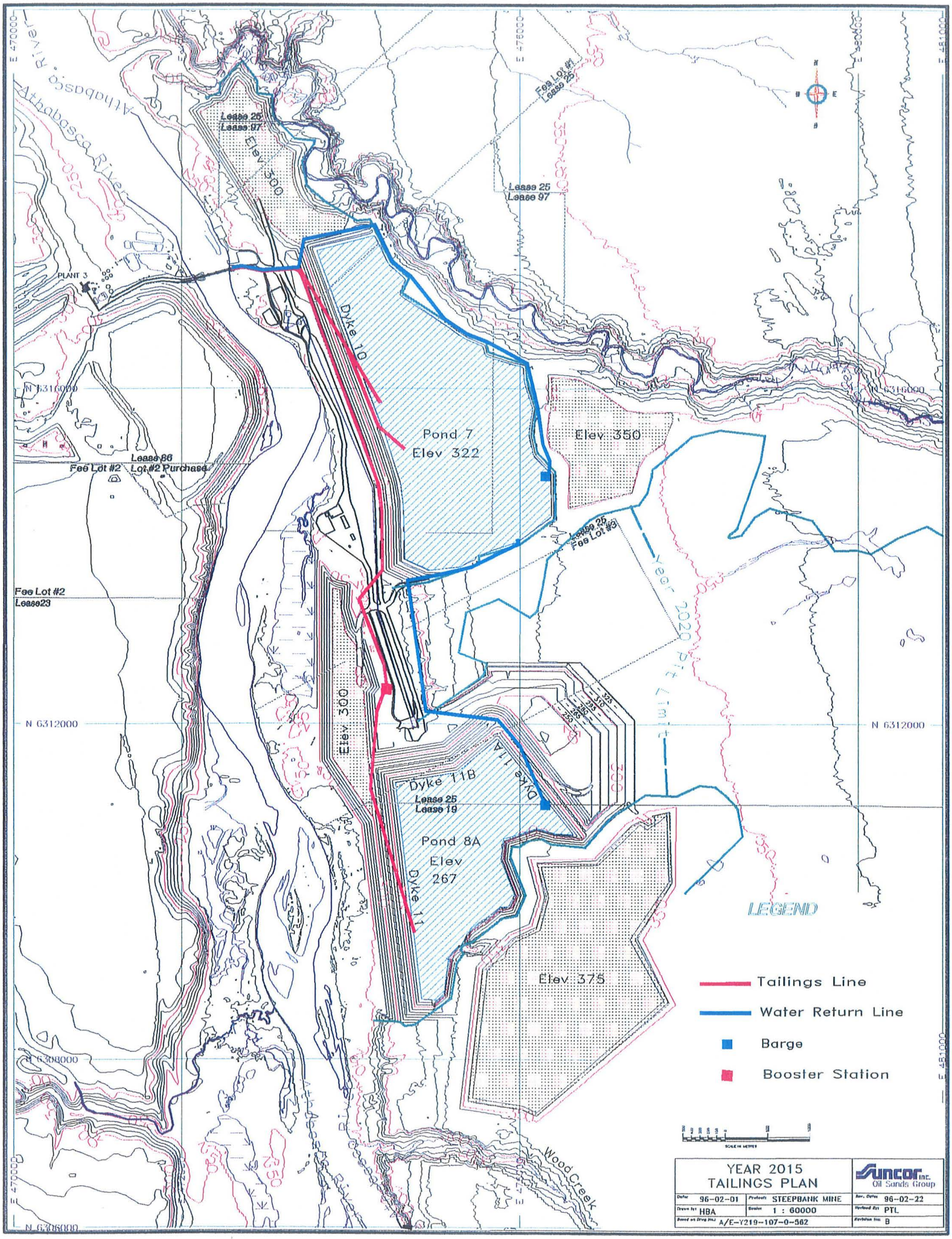


Figure C3.0-18 Tailings Plan Year 2015

952-2307D\SBCLEAN.dwg 15 APR 96

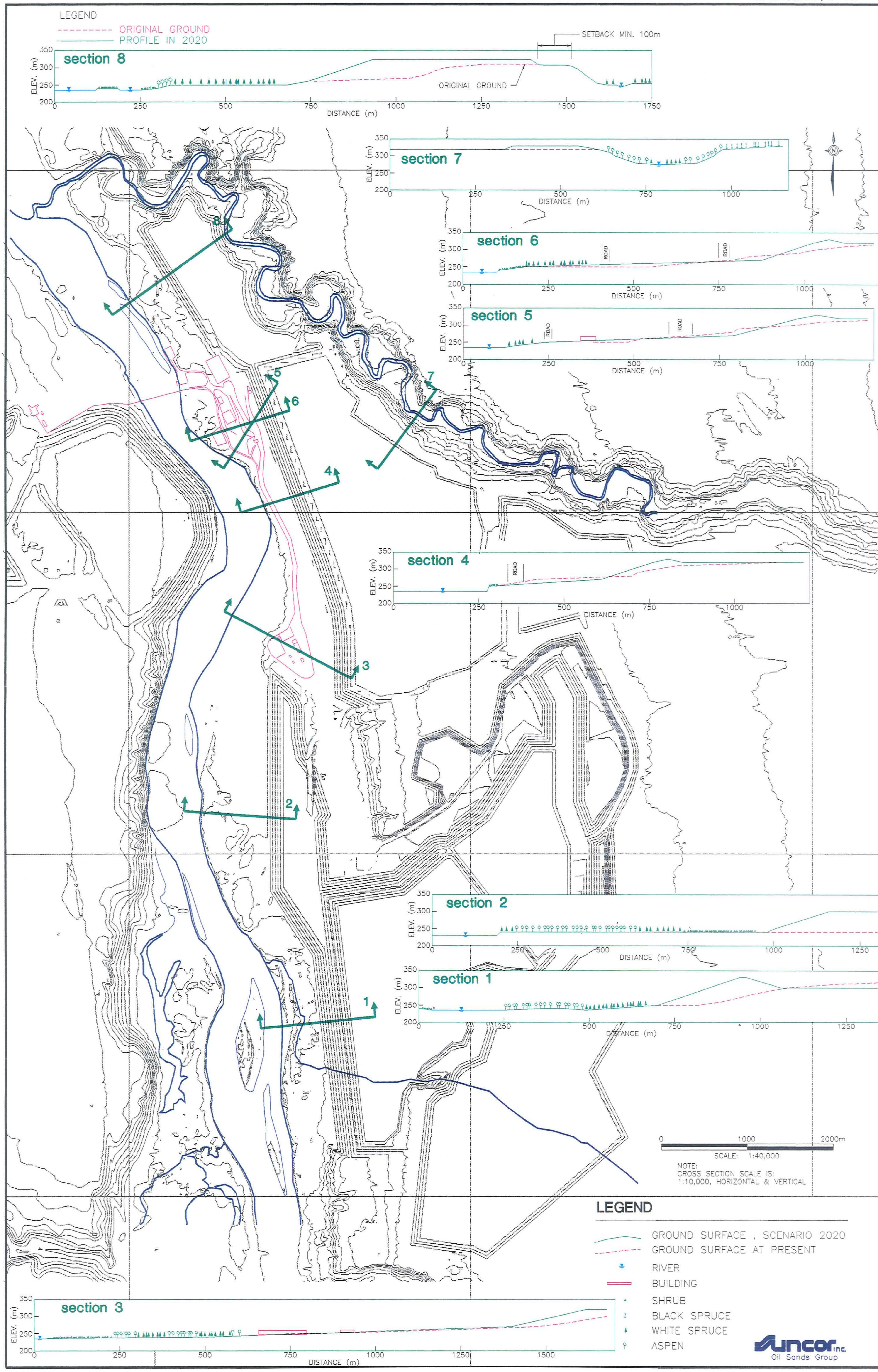


Figure C3.0-19 River Set-Back Plan

STEEPBANK MINE - TRANSITION SCHEDULE

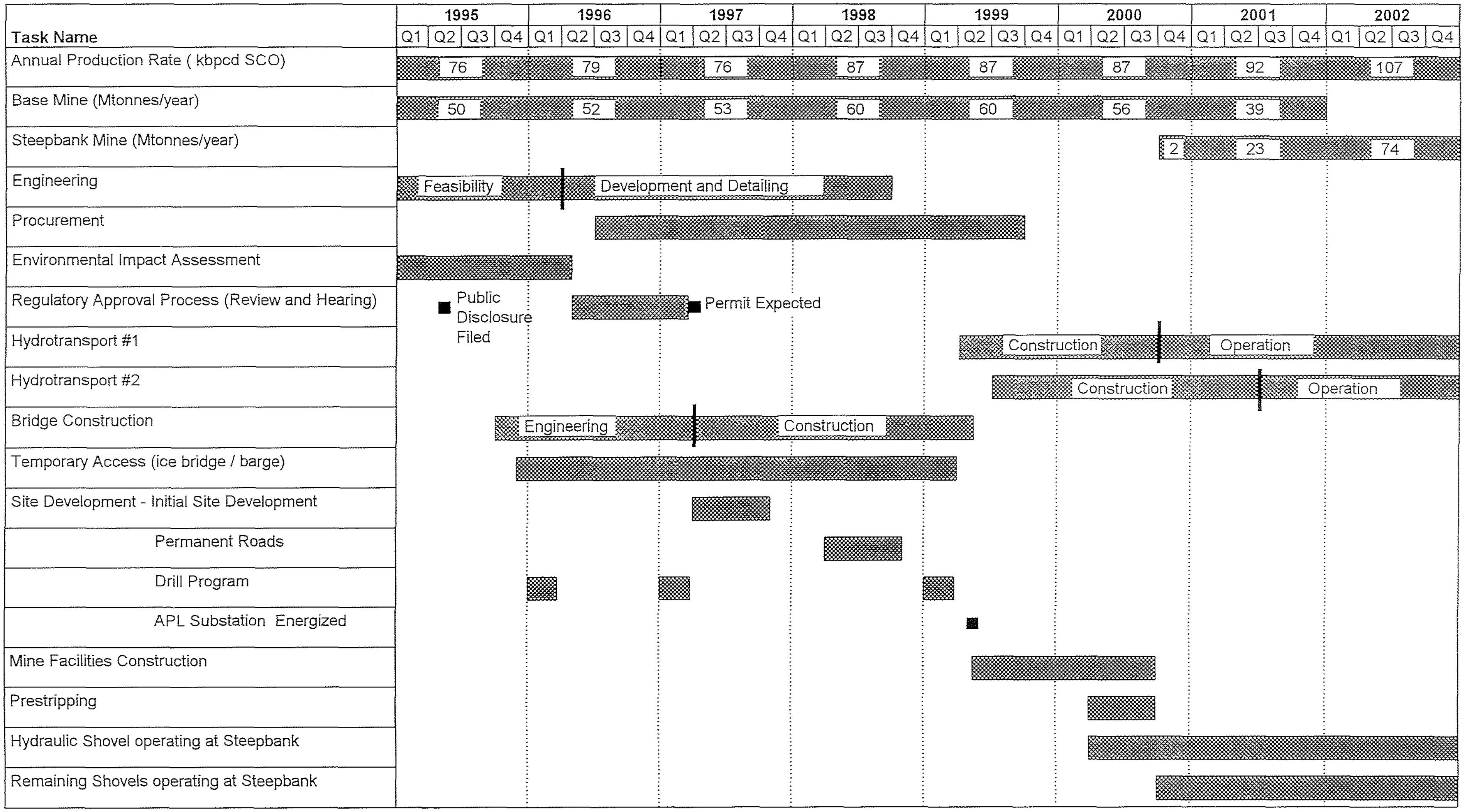
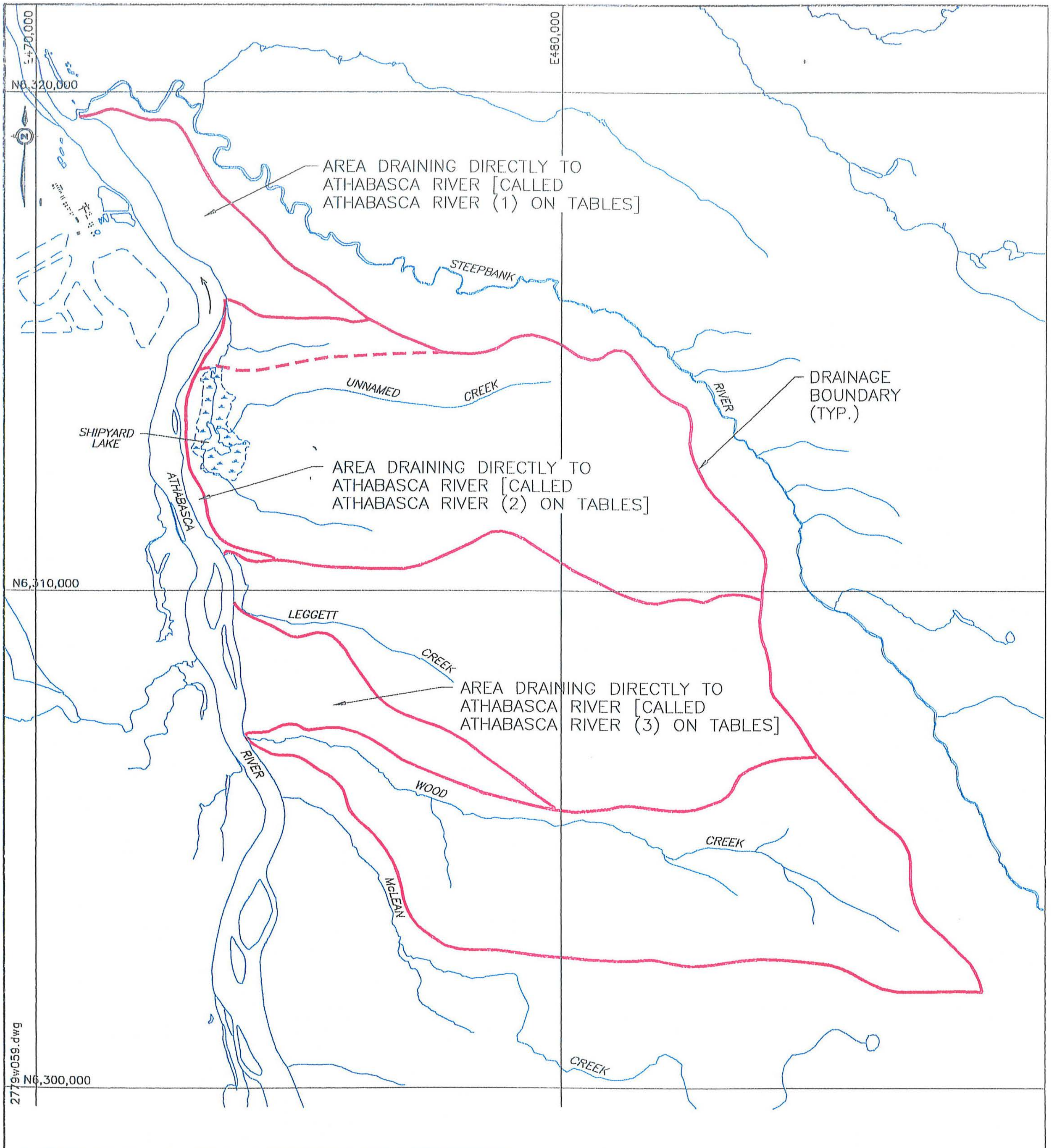


Figure C3.0-20



Pre-Mine Drainage Patterns, Steepbank Mine Area

Figure C3.0–21

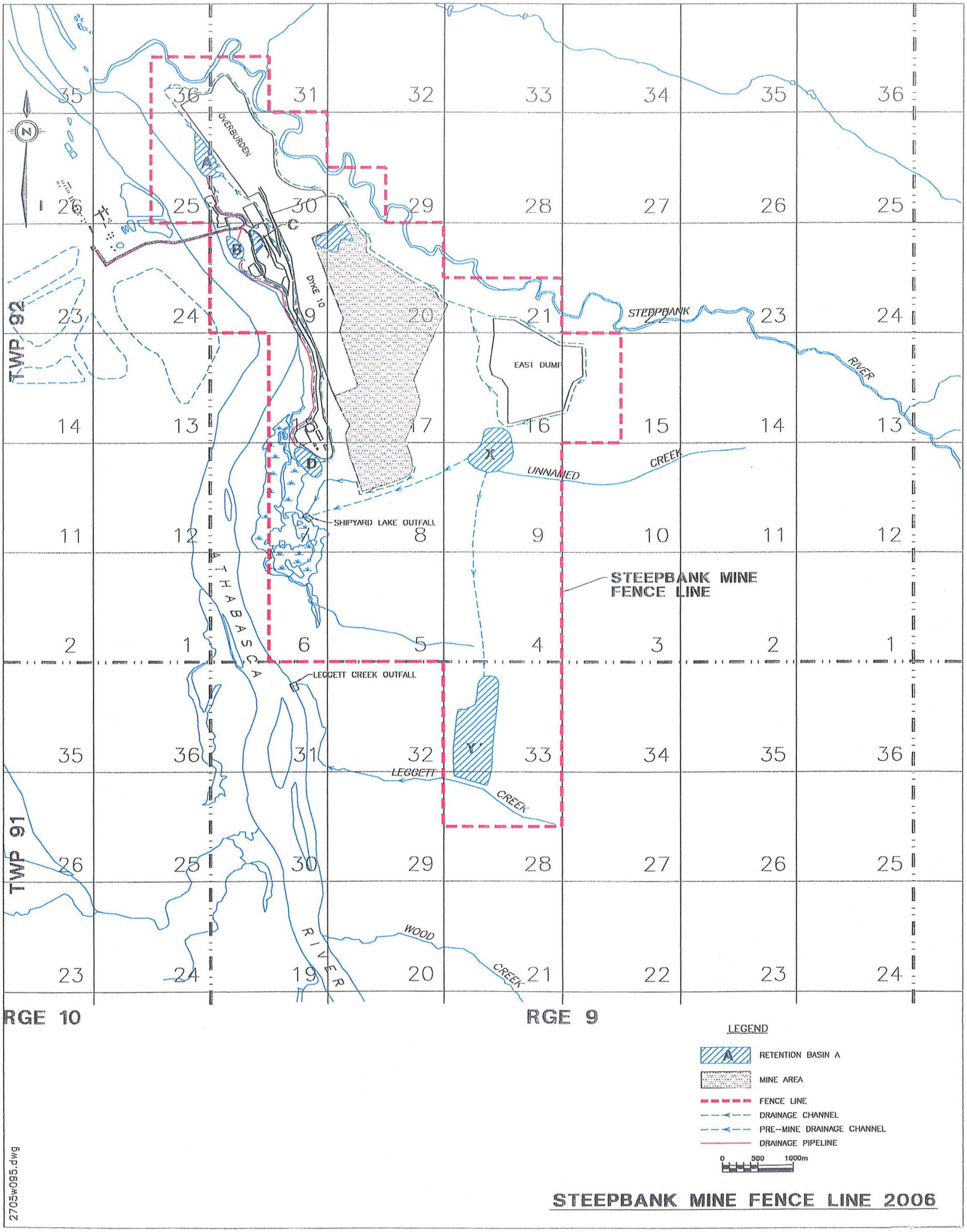
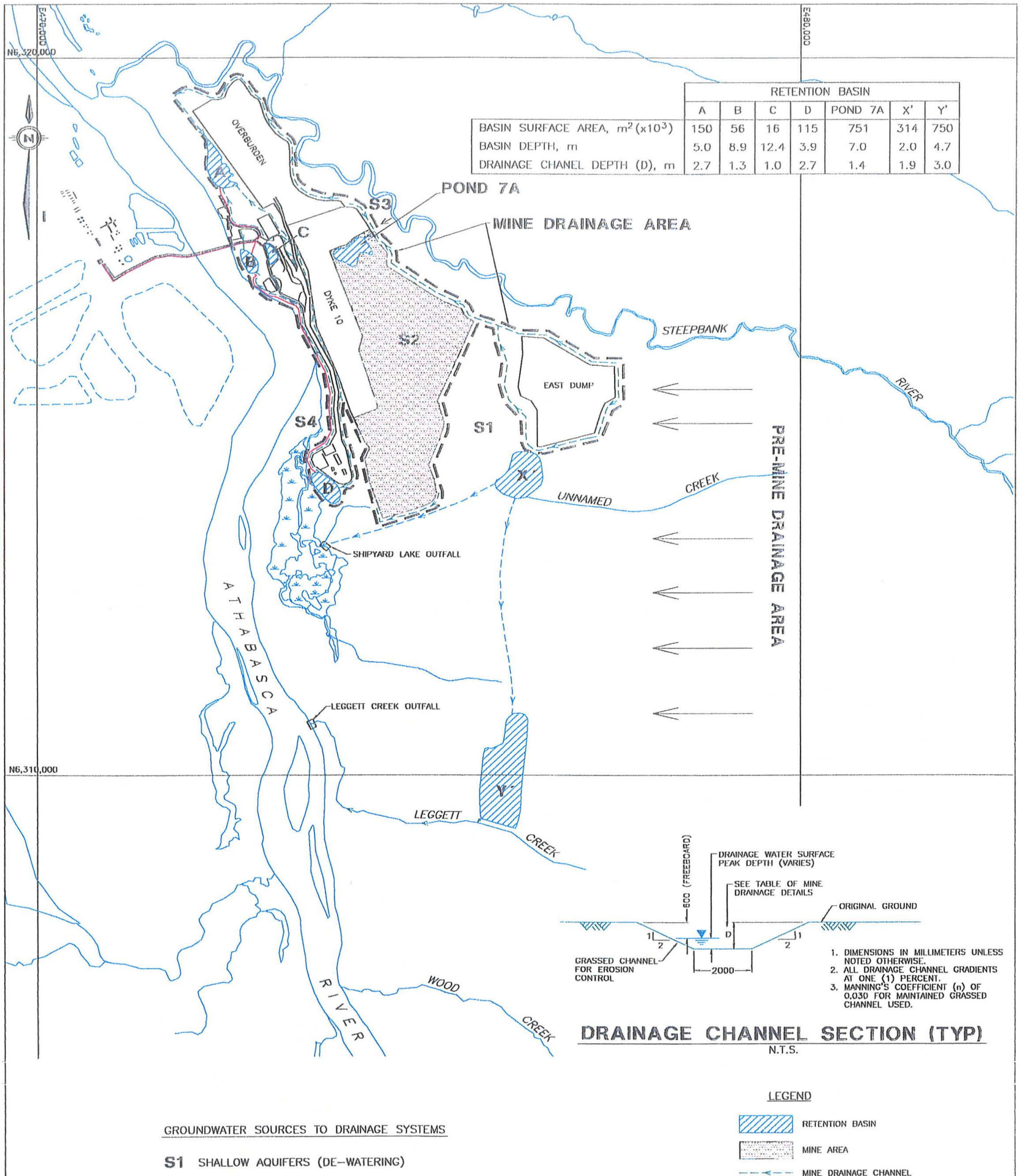


Figure C3.0-22



	RETENTION BASIN						
	A	B	C	D	POND 7A	X'	Y'
BASIN SURFACE AREA, $m^2 (x10^3)$	150	56	16	115	751	314	750
BASIN DEPTH, m	5.0	8.9	12.4	3.9	7.0	2.0	4.7
DRAINAGE CHANEL DEPTH (D), m	2.7	1.3	1.0	2.7	1.4	1.9	3.0

Figure C3.0–23

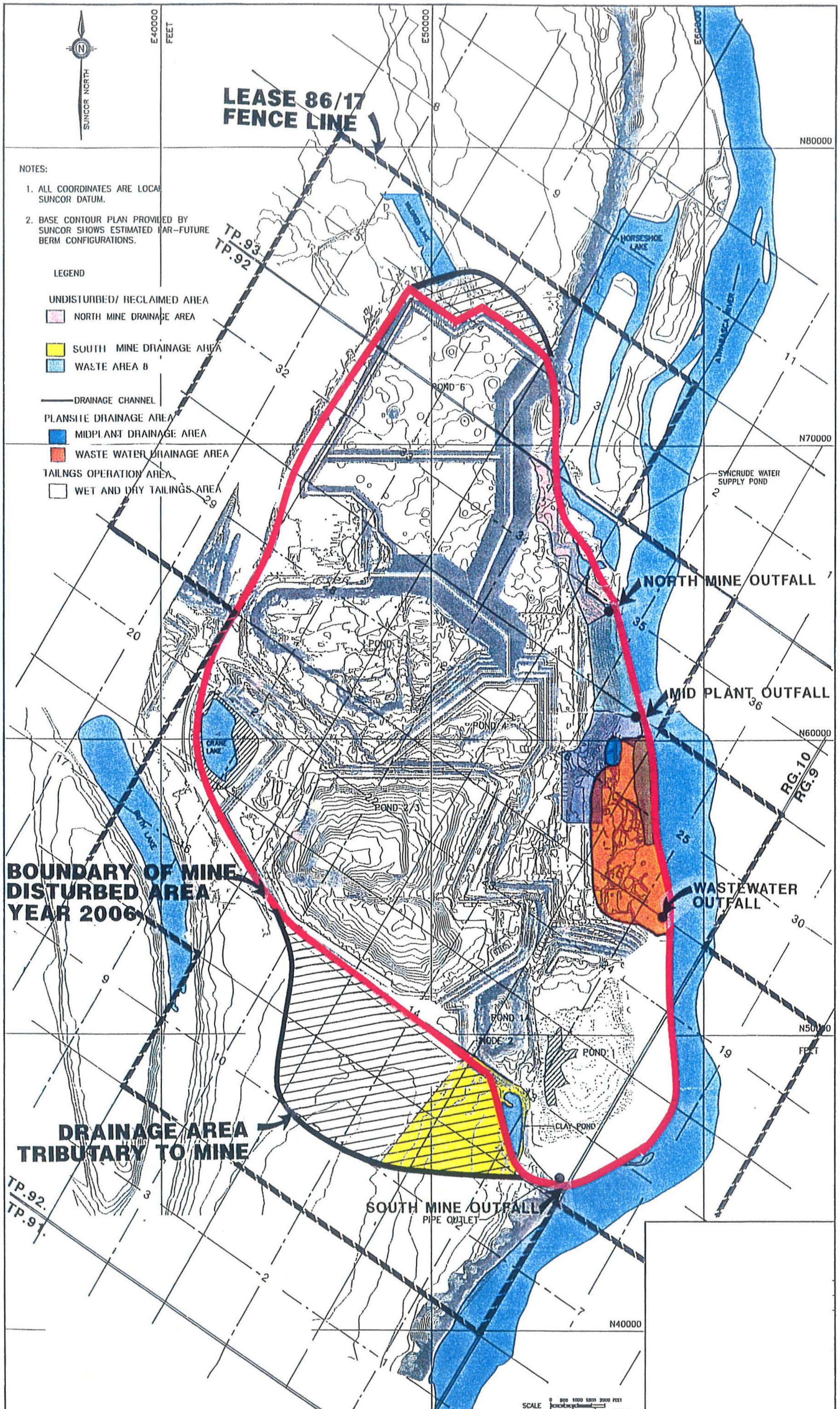


Figure C3.0–24 Fence Line and Drainage Plan 2006

C PROPOSED STEEPBANK MINE

4.0 INFRASTRUCTURE

This section discusses the incremental infrastructure which will be required to support Steepbank Mine.

4.1 SITE FACILITIES

The significant distance between existing operations and Steepbank Mine will require relocation of necessary service functions closer to the active mining area. Figure C4.0-1 shows the proposed layout of required Steepbank Mine facilities, listed below:

- Integrated Service Complex:
  - staff offices
  - maintenance complex:
    - major mine equipment shop
    - light-vehicle shop
    - warm-up shed for mine equipment
    - lube and gas islands
    - cold storage lay-down area

- Hydrotransport Complex:
  - truck dump
  - conveyors to ore bin
  - conveyors to cyclofeeder building
  - oversize rejects bin
  - cyclofeeder and hydrotransport pumps building
  - hydrotransport pipelines

- Utilities:
  - main substation and power lines
  - fuel lines

- Facility access:
  - bridge
  - main access roads from the bridge to the facilities

- Future truck dump (2007):
  - truck dump
  - conveyors to ore bin

Other mine facilities include water drainage, control structures and overburden waste dumps.

4.1.1 Facility Site Rationale

Siting of the Integrated Service Complex, the Hydrotransport Complex, the overburden waste dumps and the access corridor is based on environmental, technical and economic factors. Suncor understands the importance of the Athabasca River valley biophysical environment as identified in the Alberta Integrated Resource Plan (IRP) draft policy document. The IRP has classified the river valley as a Resource Development Area with specific objectives for environmental protection. Through the EIA (as presented in Section E) impacts have been assessed relative to the IRP criteria; the conclusion of the EIA is that these impacts are of a temporary nature.

Wildlife habitat, one of the more significant areas of concern, can be restored through innovative reclamation of the overburden dyke and dump structures comprising the new escarpment. As well, the mining direction beyond 2020 indicates all facilities (except overburden waste dumps) would be relocated to the upland area of the mine by 2030, providing for the assurance of rapid re-establishment of valley ecological values. The bridge and mine access corridor to the upland area would remain indefinitely. When considering technical and economic factors, overburden and ore haulage has been optimized relative to escarpment slope gradients and distance to the mine face. Other advantages to the proposed siting include: foundation quality for facilities, fewer roads and optimal shop location.

4.1.2 Integrated Service Complex

The Integrated Service Complex will provide facilities for the maintenance and service for all mine equipment operating at Steepbank Mine. The facility will include offices for maintenance and mine operations, dry and change room facilities, maintenance shops, fuel/lube storage and distribution and warehousing, and will comprise several discrete structures:

Heavy-Vehicle Shop

This structure will incorporate in one building (150 m x 45 m) offices, warehousing, tool crib and heavy-vehicle servicing facilities. The building will be a two-storey structure with offices and employee change facilities in the north end and heavy vehicle bays at the south end. The shop will accommodate haulage trucks (up to 290 t) with provision for expansion. Included in the facility will be electrical/instrumentation services, machine and tire shops, maintenance, welding and steam bays, warehousing, dispatch, training and first aid rooms.

Light-Vehicle Shop

The light-vehicle fleet will be maintained in a 45 m x 25 m light-vehicle shop which will provide eight bays of heated shop space. Integration of this facility with the Heavy Vehicle shop is being considered.

Lube Storage and Distribution

This 12 m x 20 m structure will provide heated storage and pumping of lubricants to the heavy-vehicle and light-vehicle shops.

Mobile Lube Islands

These will provide fuelling and daily lubrication for the operating fleet.

Fuel Island

This island will fuel light vehicles. Fuel storage will be in above-ground berm-enclosed tanks.

Cold Storage Compound

A 250 m x 160 m fenced area will provide warehousing for major spares.

Warm-up Shed

A ten-bay, 70 m x 30 m warm-up shed will store equipment not in continuous use but required to be in a ready mode during cold weather.

Sanitary Sewage

A stand-alone facility will be provided for sanitary sewage generated at the main shop area (and for that piped from the hydrotransport facility). This sewage facility will treat sanitary and separated grey water from the wash-down facilities; oil and other petroleum products will be separated from grey water at the shop facility, before transport to the sewage treatment facility. It will include an insulated building, a septic-surge tank and a rotary biological contact treatment plant, and will be sized for a through-put of 110 m^3/d.

Potable Water

The potable water facility will be located northwest of the shop area. This facility will include two or three 203-mm wells, a 90 m^3 steel insulated storage tank, two water pumps and a chlorination unit.

4.1.3 Hydrotransport Area

The hydrotransport area will be located near the southeast corner of Lot 1, just south of the bridge crossing and in the vicinity of the opening mine cut. This location was chosen because it is a flat area, reasonably well located in relation to Pit 1, and its use will not sterilize any reserves. Major facilities in this area include the following:

Truck Dumps

Two truck dumps (60 m apart) are planned for receipt of ore, each with 750-t live capacity and two back-in dump points. Each dump station will be equipped with an apron feeder, a sizer and a separate control room.

Conveyors

Conveyors (2.1 m wide x 230 m long) will transfer ore from the bottom of the crushers at the truck dumps to the top of the surge bin.

Surge Bin

A 7500-t ore bin (45 min surge capacity) is planned. It will be about 32 m high x 21 m in diameter and will be equipped with six apron feeders which will discharge to three conveyors that will transfer ore to the cylofeeder building.

Cyclofeeder Building

The cyclofeeder building (approximately 50 m x 45 m x 30 m high) will house three cyclofeeder vessels (each approximately 5 m in diameter x 5 m high), vibrating screens, a reject circuit, recycle pumps and hydrotransport pumps and will also include offices, change rooms, a control room, tool crib and an electrical room.

<u>Other Structures</u>

Other structures will include an electrical substation, a construction lay-down area, an oil sand stockpile area, an emergency pond and a retention basin, the latter to be part of the mine drainage control system.

4.1.4 Future Truck Dump

A future truck dump area will be constructed in 2007 to receive ore from Pit 2. This facility will be located near the centre of Lot 2, just below the escarpment. The area will include three truck dumps and sizers, an electrical substation and a tailings booster station.

4.1.5 Access Corridor

a) <u>Location</u>

The access corridor to Steepbank Mine will run along the north toe of the Tar Island dyke, across the bridge and then south to the hydrotransport facility and the Integrated Service Complex.

Its western segment (west of the bridge) will include road access and the pipeline corridor. Pipelines to be included in this section are:

- two 660-mm insulated hydrotransport lines, with space assigned for a future third line;
- one 910-mm insulated hot water pipeline;
- four 510-mm tailings lines, with space assigned for a future two lines;
- one 1220-mm return water line;
- one 100-mm underground diesel fuel line; and
- one 100-mm underground natural gas pipeline.

This access road will provide an 18-m unpaved surface on the west side of the river and up to a 47-m-wide main haul road on the east side of the river.

The western segment of the corridor will be located approximately mid-height along the north of the Tar Island dyke on a bench created with fill material. An elevated trestle section will support the hydrotransport and hot water pipelines from the toe of the Tar Island dyke, over the existing plant main access road and to the Extraction plant. The tailings pipelines and the return water line will cross the main access road through existing concrete tunnels to the final tails pump house. The return water line will continue to Pond 2/3 along an existing pipeline corridor.

On the east side hydrotransport lines, hot water line, natural gas line, diesel line and a 72-kV power line will proceed directly to the hydrotransport facility along an access road.

One branch of the corridor (near the east end of the bridge) will provide both an access road to the mine and a tailings water return corridor.

A south segment of the corridor will provide access to the office shop complex. Included in this corridor will be an overhead 13.8-kV power line and buried diesel, natural gas and sewage pipelines. This corridor will also be the location of the main haul road until 2007, when the corridor will be widened to accommodate conveyors from the Pit 2 truck dump and the haul road.

b) <u>Environmental Considerations</u>

Two environmental concerns for the access corridor deal with leakage prevention and containment, and drainage control.

Leakage will be mitigated by designing the pipeline with additional strength and wear resistance in critical sections (e.g., over the Athabasca River, elbows and bends, and immediately downstream of pump discharge). The design will accommodate differential expansion and will provide secure support to the lines. A program including development of non-destructive testing, routine inspection and casual observation by corridor traffic permits advance notice of problems. In the event that a hydrotransport or tailings line plugs it may be necessary to open and drain lines, in which case the drainage would be directed to designated pools.

The corridors are designed to incorporate protective berms and drainage systems connected to the overall mine and plant drainage system.

An additional environmental concern is maintenance of wildlife migration; a pathway under the east bridge access is proposed to ensure that a migration route remains for the animals.

4.1.6 Electrical Power Distribution

Power transmission to Steepbank Mine will be supplied by Alberta Power Limited (APL) at 72 kV from the existing substation in Lease 86/17 (APL designation "836S Steepbank River Substation"). APL will have responsibility for crossing the Athabasca River with dual 72-kV overhead lines. A primary substation (72 kV - 13.8 kV) will be located on the east bank of the river in the area of the hydrotransport facility. Power will be distributed via overhead lines to local substations for the cable shovels, hydrotransport facility and the maintenance/office complex. Due to a limitation of existing facilities at the Steepbank substation only one feeder could be energized to Steepbank Mine until current mining activity on Lease 86/17 is completed.

When mining activity moves to Pit 2 a new primary substation (72 kV - 13.8 kV) will be constructed near the new truck dumps to service those loads.

4.1.7 Load Assessment

Load assessment calculations, surveys and estimates have been carried out to determine projected average power consumption and likely peak power demand.

The average power draw will increase from 42 MW in 2001 to 46 MW in 2007 and to 50 MW in 2008. The addition of three tailings booster stations will increase this draw to about 57 MW in 2014. Figure C4.0-2 shows the projected power draw for 1997 to 2020 for both present and proposed Steepbank bitumen production operations.

4.1.8 Communications

A multi-core fibre optic cable will be routed from communication facilities in the Extraction plant to the new mine. Most likely, the cable will be run in conjunction with electric power lines.

4.2 ATHABASCA RIVER BRIDGE

Steepbank Mine will be separated from the present mining operations by the Athabasca River, yet operations will continue to be integrated by means of a transportation and access system. Section C1.0 discussed access alternatives and the basis for the selection of bridge access; this section provides proposed bridge design and construction information.

Several bridge route alignments were investigated and the chosen alignment (north of the Tar Island dyke, shown in Figure C4.0-3) was found to minimize operating and capital costs.

Bridge design criteria were established to support the construction and operation of the Steepbank Mine facility at 107 kbpcd upgraded crude oil, with some expansion capacity beyond that rate through provision of space and structural capacity for one additional hydrotransport line and two additional tailings lines. Features selected included two highway lanes and the capacity to carry one empty 218-t haulage truck. A clearance of 15.2 m above navigational-flood-water elevation was specified for the bridge. The corridor profile on the east embankment will be established to ensure a corridor crest elevation 5 m above 1-in-100-year flood levels.

Geotechnical investigation of the proposed route for the Athabasca Bridge indicated that a sinkhole and variable bedrock conditions with weak fractured zones are present. These conditions will necessitate steel, driven pilings for the river piers and the west abutment while the east abutment piers will be cast-in-place concrete-augured piles.

This bridge will feature a composite five-span plate-girder design with four piers located in the river: Figure C4.0-4 presents an artist's rendering of the completed bridge. Erection of the bridge will require construction of temporary berms in the river (for the two piers close to the river banks) and sheet pile cofferdams (for the two central piers). After installation of the spans completion of the bridge will include casting the concrete deck and installation of the various process and utility pipelines. Figure C4.0-5 shows a bridge deck section.

The following initiatives have been incorporated in the bridge design to mitigate environmental impact:

- The bridge has been designed to allow wildlife migration along the river by means of a pathway under the east end of the bridge.
- The bridge will be cleaned of snow using loaders and dozers. No materials will be pushed over the sides of the bridge. Pool areas and a run-off collection system on either side of the bridge (which has an arch profile) are included.
- Hydrotransport and tailings transport lines will be designed (with chromium carbide-lined, spiral-wound 12.3-mm wall pipe) to prevent leaks. The lines will be elevated so that wear measurements can be made on the slurry and tailings lines for rotation and replacement purposes.
- The 100-mm diesel line will be contained in a continuous outer sleeve for the bridge section.
- Lines on the topside of the bridge are all contained within a concrete trough; the inside wall will be 1800 mm high and the outer wall 1500 mm high.

- The concrete floor in the bottom of the trough will be continuous except at expansion joints. Here the design will incorporate a catchment structure to divert any collected materials to the pools located either end of the bridge.
- Pools at either end of the bridge will be capable of handling a full-flow failure. The pools will pipe materials away to both the emergency pond on the west bank and the emergency pond (hydrotransport area) on the east bank.
- Pipe flanges on the lines on the bridge will be equipped with bolted-on splash guards so that in the event of leakage materials will flow down the trough to one or other pool and will not spray outside the containment trough.
- The bridge design will ensure that no ice dams form and cause upstream flooding.
- The Tar Island dyke will be provided with erosion protection.
- To ensure integrity the crest of the east embankment corridor will be constructed at 5 m above 1-in-100-year flood level.
- Scour protection of the pilings and piers will be installed to provide long-term foundation integrity.
- The bridge elevation will provide 15.2 m clearance over the navigable flood level (238.2 m) for a width of 60 m to allow river transport.

Construction of the bridge is estimated to take twenty-six months after receipt of a permit to proceed. The accuracy of the proposed construction schedule will be dependent on completion of four pre-permit activities: finalization of the bridge design; acquisition of girder material; fabrication of girders; and letting of the bridge construction contract. The bridge is a critical path activity of the Steepbank Mine project and is required as soon as is practical.

This bridge will be operated as a private bridge, for Suncor use only.

FIGURES SECTION C4.0

FIGURES

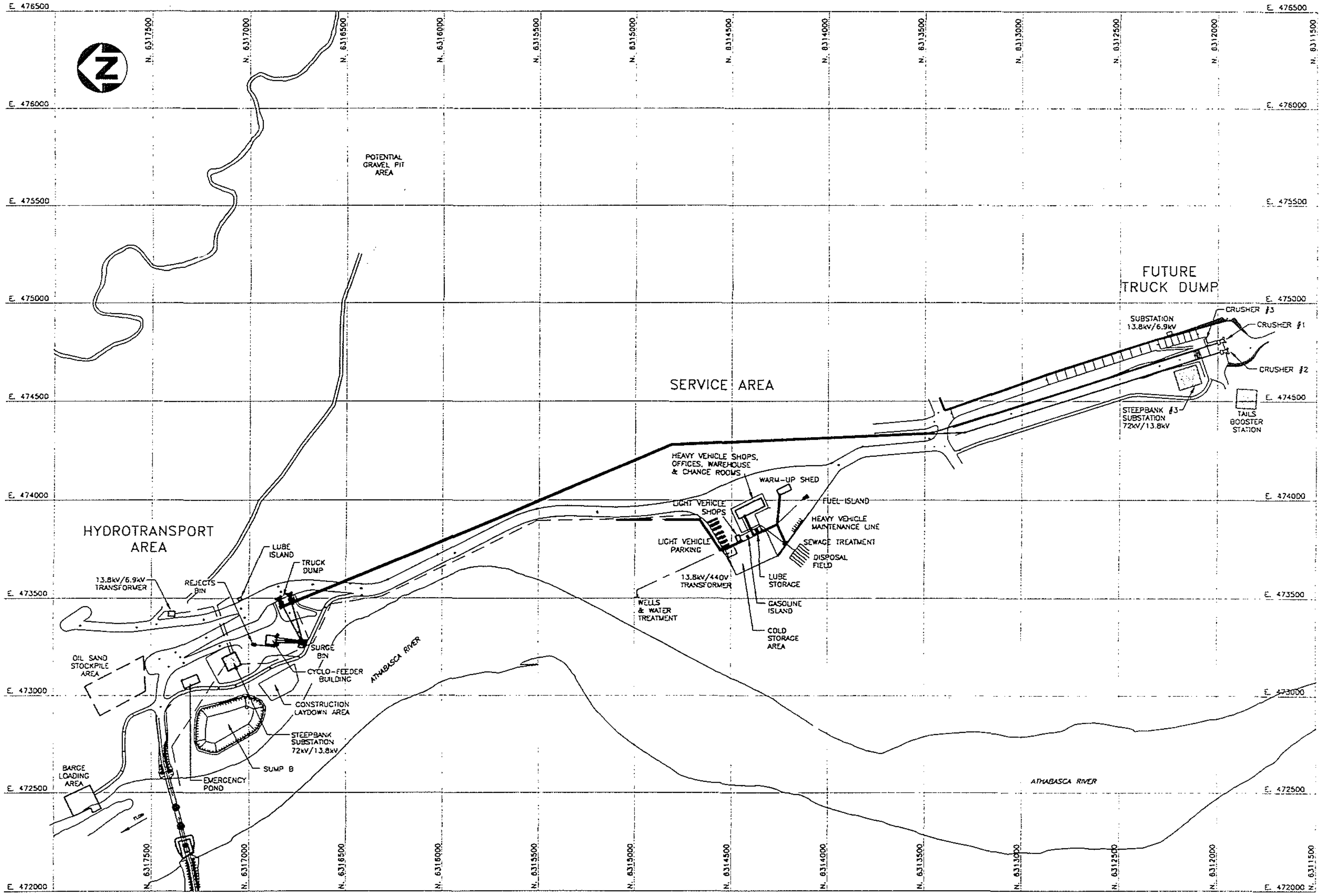


Figure C4.0-1 Steepbank Mine Facilities Site Plan

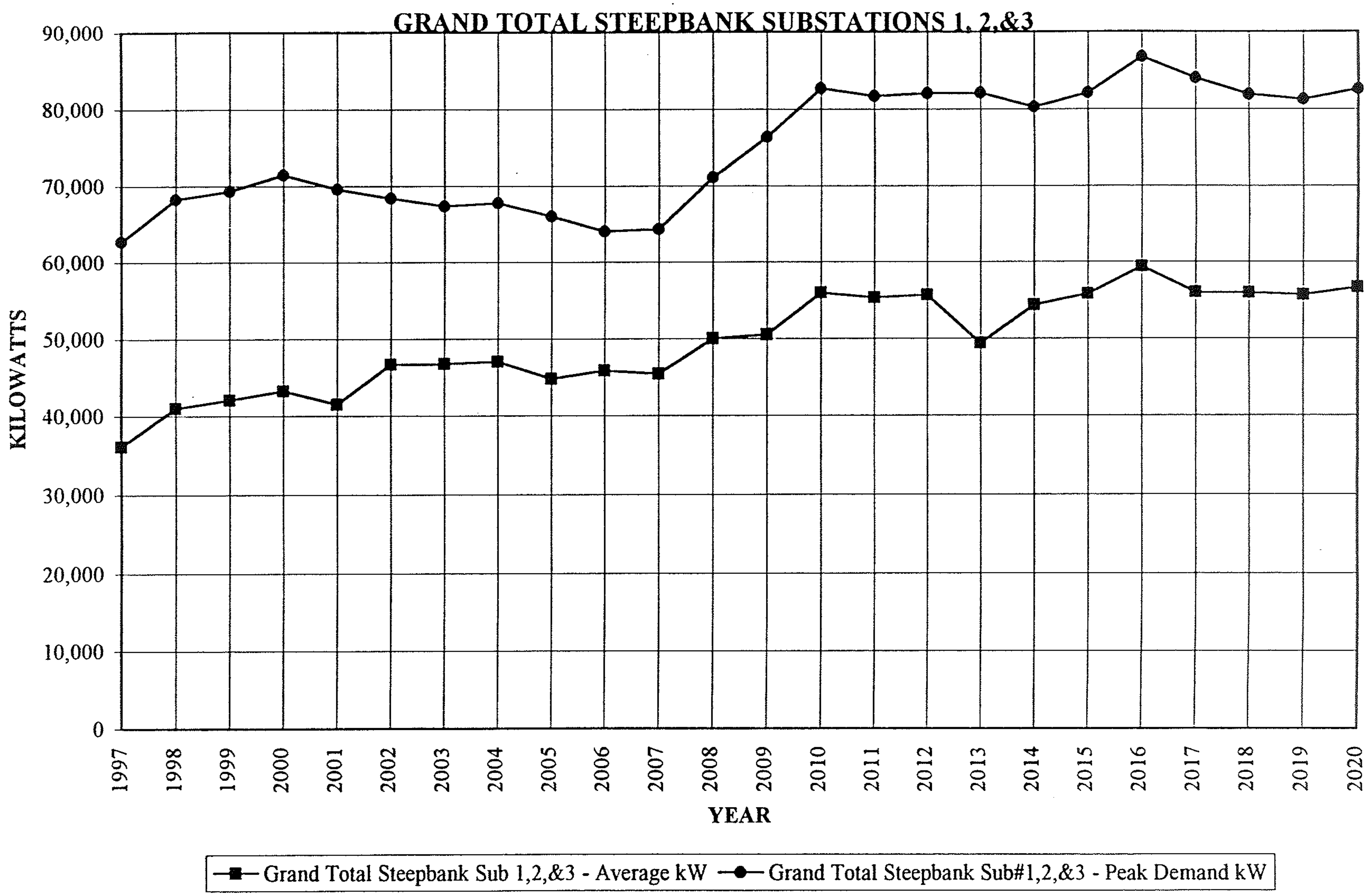
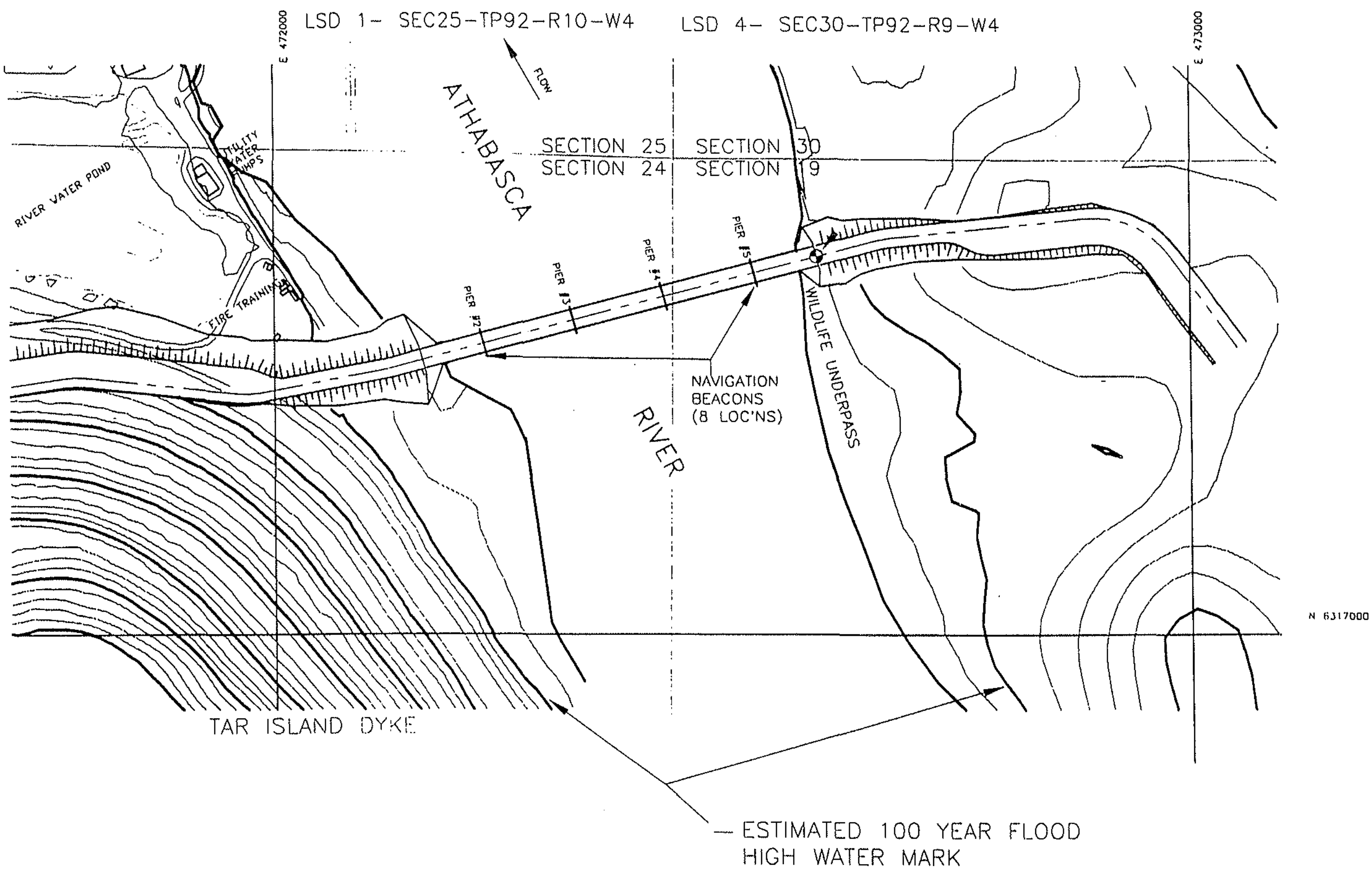


Figure C4.0-2 Power Draw, Bitumen Production



BRIDGE PLAN

Figure C4.0-3

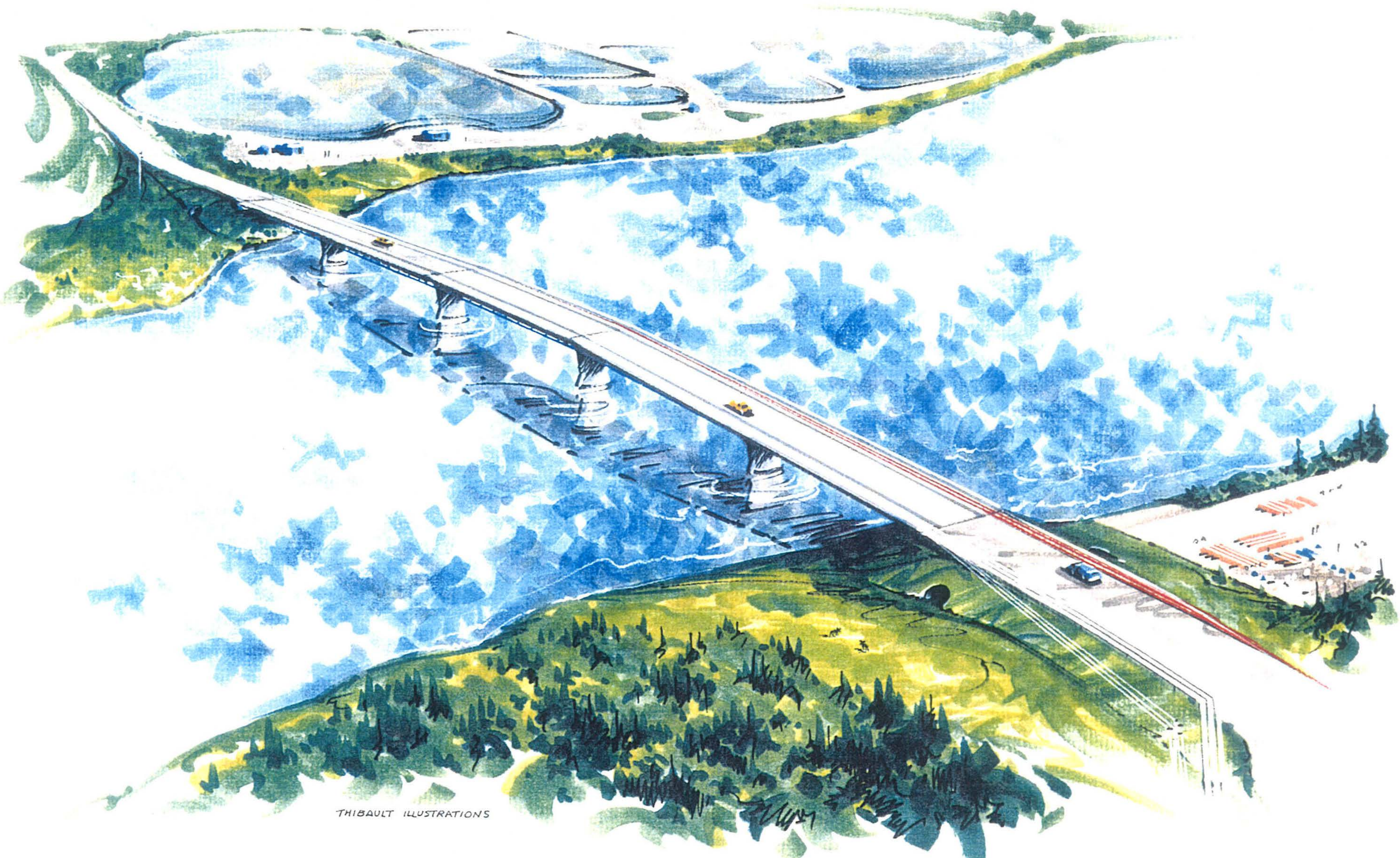


Figure C4.0-4 Artist's Rendering of Athabasca River Bridge

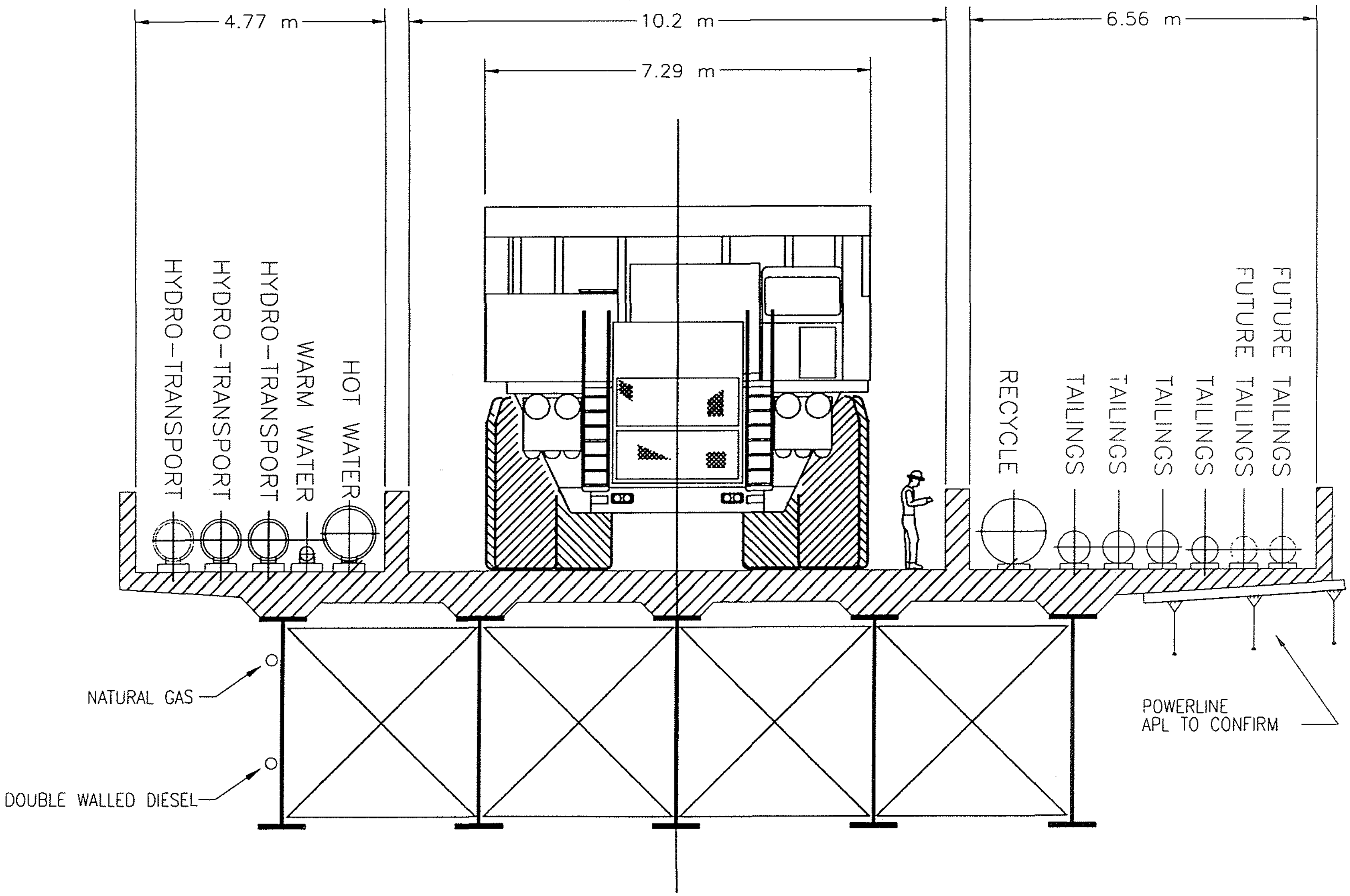


Figure C4.0-5 Bridge Deck Section

C PROPOSED STEEPBANK MINE

5.0 HYDROTRANSPORT, EXTRACTION AND TAILINGS MANAGEMENT

5.1 INTRODUCTION

In 1995 Suncor Oil Sands Group (OSG) production averaged 76 kbpcd upgraded crude oil. Plans are in place for an increase in production capacity to 87 kbpcd upgraded crude oil by 1997, and a further increase to 107 kbpcd upgraded crude oil. In preparation for higher production rates Suncor has completed studies that assess the capability of the existing bitumen Extraction plant and identify requirements for new facilities. Full advantage has been taken of recent developments in bitumen production technology that have evolved to the point that they can be incorporated into a commercial operation with minimal risk to the business. In particular:

- Consolidated tailings technology was developed by Suncor and others and implemented on a commercial scale in fourth quarter 1995.
- Oil sand hydrotransport was developed by Syncrude and has been used at Syncrude as an auxiliary source of feed since 1993.
- Bitumen separation and recovery at warm (50°C to 55°C) rather than hot (70°C to 75°C) temperatures was demonstrated in full-scale tests by Suncor in 1995.

The Steepbank bitumen production process incorporates all this prior work into a design that is cost-effective and carries an acceptably-low technical risk and improves environmental performance.

5.2 DESCRIPTION OF PROCESS

The Steepbank extraction process incorporates:

- new technology for oil sand transport and conditioning;
- an extension of current practice for bitumen recovery and froth handling;

- current technology for froth treatment; and
- new tailings management technology.

5.2.1 Oil Sand Transport and Conditioning

Suncor will use technology developed and demonstrated on a commercial scale by Syncrude Canada Ltd. for the transport and conditioning of oil sand (Figure C5.0-1).

The process flow diagram for the proposed Steepbank operation is shown in Figure C5.0-2a with current operations shown in Figure C5.0-2b for comparison. Once Steepbank Mine is in full production the process shown in Figure C5.0-2b will not be used.

Referring to Figure C5.0-2a, ore is delivered to sizers where it is crushed to less than 400 mm. Two sizers will be installed initially with provision for a third when required. The capacity of each sizer is sufficient to sustain full production at 10 300 t/h.

Crushed oil sand is delivered by conveyor to a surge bin with a nominal residence time of forty-five minutes. The bin is used to minimize irregularities in oil sand delivery rate from the mine since downstream equipment performs best under steady operating conditions.

Oil sand is retrieved from the base of the bin by six apron feeders which discharge onto three conveyors. At design through-put two conveyors operate; each conveyor delivers ore to a dedicated cyclofeeder where it is mixed with hot water in a high-shear vortex prior to discharge onto a system of primary screens. Caustic may be added to the hot water as required. Primary oversize from these screens is crushed in a small crusher and then screened to 50 mm on a small secondary screen. Any secondary screen oversize is discarded as reject. Underflow from both primary and secondary screens is combined in a sump. A slipstream of the slurry from the sump is recycled to the cyclofeeder while the remainder is delivered to the hydrotransport slurry pumps. There is a set of three slurry pumps for each cyclofeeder the pump sets are connected by manifolds to two pipelines which deliver the oil sand slurry to a distributor located adjacent to the existing Extraction plant on Lease 86.

Transfer of heat and mechanical energy to the oil sand during slurry preparation and transport is sufficient to both release bitumen from the oil sand matrix and to ready the slurry for bitumen recovery.

For current operations (depicted in Figure C5.0-2b) oil sand delivery is accomplished by overland conveyors from the sizers to the surge bin (located in the Extraction plant). Conditioning is accomplished in drums to which steam and hot water are added.

5.2.2 Bitumen Separation Circuit and Froth Handling

Figures C5.0-3a and C5.0-3b show process flow diagrams for the bitumen separation circuit and froth handling. Figure C5.0-3a depicts the process flow diagram for the five trains which are used in current operations while Figure C5.0-3b shows the process flow diagram for the sixth train (which will be built to augment Extraction plant capacity for accommodation of the Steepbank production rate). Suncor does not intend to alter the existing five trains since their performance is satisfactory; however the new, sixth train will be a simpler design (see later in this subsection).

Slurry from the two transport pipelines will be discharged into a distributor from which it will be sent (when operating at design through-put) to five of the six Extraction trains. Provision is made for adding water to the slurry at the distributor.

In each of the five existing trains the principal engine of recovery is the separation cell. The surface area and residence time in these cells are sufficient for:

- a layer of bituminous froth to separate from the feed slurry; and
- the bulk of the sand in the slurry to settle to the bottom of the vessel.

Most of the bitumen recovery occurs in the separation cell; its froth is sent directly to a primary heater/deaerator. A relatively dense sand slurry is withdrawn from the base of the vessel and sent to tailings. A third stream (the middlings) is withdrawn from the side of the separation cell and sent to a bank of flotation cells; it comprises a dilute suspension of sand, fines and residual bitumen. The bulk of residual bitumen is recovered as a dirty froth in the flotation cells, then delivered to a froth cleaner where (after a settling interval) the froth product passes to a secondary heater/deaerator. Hot secondary froth is combined with primary froth in the feed to the primary deaerator. Froth settler underflow is recycled to the separation cells while underflows from the separation cell and the flotation cells are combined and pumped to the final tailings pump house.

As noted the sixth train planned for Extraction is a simpler version of current operations. The biggest change is the direct recycling of flotation cell froth into the separation cell where it is combined and recovered with primary froth. Hence, there will be only one froth stream destined for heating and deaeration so only one deaerator required for this purpose. A second improvement in the sixth train is better hydraulic isolation of the separation cell contents from the middlings and underflow streams. This will aid in maintaining steady conditions in the separation cell, enhancing bitumen recovery.

5.2.3 Froth Treatment

This process flow diagram is summarized in Figure C5.0-4. An interstage tank stores hot, deaerated froth issuing from the heater/deaerators. Froth from the tank is combined with hot diluent and sent for two-stage centrifugation. Demulsifiers are 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. The product stream from the disc centrifuges is diluted bitumen which is pumped to storage. Waste streams from the centrifuges are combined and sent to a diluent stripping tower.

5.2.4 Overall Balance

Figure C5.0-5 shows a simplified flow diagram for Extraction. Section C7.0 and Appendix III details extraction material balances at production rates of 79.5 kbpcd and 107 kbpcd upgraded crude oil respectively.

5.2.5 Tailings Management

a) Separation Circuit Tailings

Suncor anticipates that the following two processes for handling separation circuit tailings will be implemented by the time Steepbank operations commence:

- consolidated tailings (CT), a new technology that promises to eliminate the existing inventory of fine tailings by using it to form stable landfill; and
- tertiary bitumen recovery from a CT process stream.

The first commercial demonstration of CT technology began on half of Extraction tailings in November/December 1995. Full commercial operation by the end of 1996 is anticipated.

The process flow diagram for separation circuit tailings (which are divided with a hydrocyclone into high-mineral and low-mineral content overflows) is shown in Figure C5.0-6. Key parameters in the separation 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 by-product of Flue Gas Desulphurization at Suncor's Utilities plant. The calcium ion renders the mixture non-segregating - i.e., the sand and the clay in the fine tailings now settle together, rather than the sand settling out with the clay remaining in suspension. This aggregation is the basis for the CT technology. The chemically-treated tailings mixture is pumped to a tailings pond where it consolidates to a stable deposit.

Tertiary bitumen recovery, is planned to be accomplished in the hydrocyclone overflow, shown by a process flow diagram in Figure C5.0-7. The overflow would be sent to a set of flotation cells which scavenge residual bitumen for return to the separation circuit prior to pumping overflow to storage in a tailings pond.

Tailings sand will not be used exclusively for CT. About 15 % will be used for dyke construction in the period 2000 to 2008 on Lease 86/17. Dykes on Steepbank Mine will be constructed of overburden.

The tailings pumps, hydrocyclones and pipelines will be designed to incorporate sufficient flexibility to meet all operational demands.

b) Froth Treatment Tailings

Froth treatment tailings are routed to a naphtha recovery unit where most of the 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.

5.3 TECHNOLOGY INITIATIVES

Suncor has participated in a number of Extraction process and tailings management initiatives over the years, some in preparation for new mine development. The more significant of these initiatives are discussed in this section.

5.3.1 Fundamental Tailings Research

Tailings management technology is a common feature of the Extraction process options considered by Suncor. The company's tailings management activities have included efforts to determine improved means of storage and reclamation of tailings waste with an emphasis on the reduction/elimination of fine tailings. In addition to evaluating proposals developed by others Suncor has itself sought alternative methods to reduce or eliminate accumulation of difficult-to-manage tailings waste.

Suncor supported a long-standing research program (conducted by McGill University scientists in the 1970s) that sought to increase understanding of the origins and properties of the fine tailings which were rapidly accumulating in tailings ponds. The work culminated (in the early 1980s) with the development of a process to treat mature fine tailings using acid lime and polyelectrolyte; this product would then be combined with tailings sand to form a mixture from which the sand would not separate. Consolidation behaviour of pilot-scale volumes (125 m^3) of this mixture was then measured. Ultimately, the process was not commercialized because of its perceived high cost.

There was a hiatus in Suncor's tailings research until the late 1980s, when the company's plans for site reclamation and new-lease operation were undergoing development. It was apparent that retaining in perpetuity large volumes of tailings waste behind a dyke adjacent to the Athabasca River was both highly undesirable and impractical. Needing to search out other alternatives, Suncor initiated activities that led to commercial implementation of consolidated tailings technology.

It is noteworthy that CT technology is the culmination of work performed by many individuals and groups over an extended period of time. In 1989 a rather unique step was taken in the industry with formation of the Fine Tailings Fundamentals Consortium (chaired by Suncor). This began a five-year co-operative effort (involving industry, government and university personnel) to study the fundamental properties of fine tailings.

Significant large-scale pilot efforts are underway to investigate processes which emerged from the Consortium collaboration. It is anticipated that essential scientific work will be continued within the Canadian Oil Sands Network for Research Development (CONRAD).

5.3.2 AOSTRA Taciuk Process (ATP)

Suncor was a participant in the most recent industry/AOSTRA study of the ATP. This process approaches oil sand processing and tailings management from an entirely different perspective than conventional technology and thus provides improvements over existing practice. In particular:

- partial upgrading of bitumen is achieved simultaneously with its recovery, accomplishing two processing steps in one operation;
- the principal source of process heat comes from burning heavy ends of the bitumen, minimizing consumption of more valuable fuel such as natural gas;
- tailings can be delivered dry to their deposition site, eliminating fine tailings; and
- the partially-upgraded product from the major process unit (the Taciuk processor) is transportable via pipeline.

Despite these merits the process is burdened both by its novelty and by the perceived technical and economic risks associated with its progression to a commercial scale.

Suncor concluded that the ATP process is best considered in the context of new, small, grassroots facilities that have no existing infrastructure and no upgrading capability. (Suncor is currently evaluating the application of the Taciuk Process to oil shales in Australia).

5.3.3 OSLO Processes

Suncor held preliminary discussions with the OSLO New Ventures group on a joint venture to build and operate a demonstration oil sand dredging/bitumen recovery project. The initiative was abandoned because of poor economics at the anticipated scale of operation.

Another OSLO innovation, the use of mineral flotation chemicals in place of caustic to enhance bitumen recovery, has been investigated by Suncor. The principal attraction of the OSLO approach was the claim that generation of fine tailings is eliminated with no loss in bitumen recovery. A thorough assessment of the OSLO process was completed as part of the work of the Fine Tailings Fundamentals Consortium; their research confirmed the benefits to tailings of a non-caustic environment for oil sand processing. As a result Suncor completed a commercial-scale test in its Extraction plant in December 1995, using OSLO chemical aids to bitumen recovery rather than conventional caustic. A 1500 m^3 sample of fine tailings was collected for the first large-scale settling and consolidation testing on OSLO process tailings; this work is still in progress.

With the successful start-up of consolidated tailings technology in Suncor's current operation there is no incentive to convert to the OSLO process.

5.3.4 Canadian Occidental Sand Reduction Technology

Suncor accessed data from Canadian Occidental pertaining to its sand reduction technology, which uses hydrocyclones and proprietary chemical aids in a process intended to remove at least 90% of the mineral from an oil sand slurry at the mine site. The Canadian Occidental intent was to simplify and reduce the cost of processing ore mined at a site remote from existing facilities in two ways: by eliminating the need to transport sand long distances and by generating an essentially-dry tailings stream. The data did not quantify the amount and properties of the fines in the bitumen slurry, suggest means by which dilute bitumen slurry might be processed for bitumen recovery or elaborate on the quantity and properties of the tailings stream. Suncor did not pursue sand reduction technology because Steepbank Mine proposes to use the existing Extraction plant and consolidated tailings technology. In the decades ahead, as ore transportation distances increase, sand reduction technology may be reconsidered.

5.3.5 Bitmin Process

The Bitmin Resources Inc. process was developed jointly by Kilborn Western Inc. and Fording Coal Ltd. It is intended to maintain or enhance bitumen recovery while reducing external thermal energy requirements and eliminating fine tailings formation. The process includes:

- a novel conditioning method to minimize dispersion of clays contained in the oil sand;
- recycling of process water within the plant, thereby conserving heat; and
- water removal from fine and coarse mineral, using clarification and filtration technology to produce "dry", stackable tailings.

Suncor made available a site on its lease for Bitmin to construct a 20 t/h demonstration plant. A variety of ores was provided by Suncor and the bitumen product was delivered to Suncor's

Extraction plant. Bitmin stored the tailings in an impoundment where geotechnical data were collected.

Suncor assessed the Bitmin process and decided not to use it for the following reasons:

- The conditioning process is not applicable since Suncor chose hydrotransport for oil sand delivery and conditioning;
- The additional cost of recycling warm water is not warranted since available low-grade heat is used in the Steepbank Extraction process; and
- Consolidated tailings is a cost-effective way to eliminate existing fine tailings inventory.

5.3.6 Oil Sand Hydrotransport

After completion of an extended research program Syncrude Canada Ltd. concluded that slurry transport of oil sand is an effective means of:

- transporting oil sand long distances, and
- conditioning oil sand for bitumen recovery provided sufficient mechanical and thermal energy is imparted to the slurry.

As a consequence of this work Syncrude constructed a 610-mm diameter, 2.5-km-long pipeline to augment delivery of conditioned oil sand slurry to the Extraction plant; the facility is called the Extraction Auxiliary Production System (EAPS). Output from the EAPS pipeline is discharged directly into separation cells. EAPS commenced operation in fourth quarter 1993 and its performance has exceeded expectations.

Suncor purchased the right to use this technology by entering into a technology development agreement with Syncrude in 1994. The Steepbank Mine project uses oil sand hydrotransport to economically deliver ore from the mine to the Extraction plant, benefitting also from the simultaneous conditioning of the ore during its transport.

5.3.7 Modified Hot Water Process

In 1991 Suncor performed a suite of tests on one of the lines in the Extraction plant to measure the effect on recovery of running the plant at lower temperatures. The objective of the test was to demonstrate the feasibility of reducing SO_2 emissions by burning less coke to create steam for extraction heat. While that particular SO_2 initiative was not pursued because better solutions were found, tests did show that separation circuit recoveries were unaffected by temperature over the range of temperatures studied.

A more comprehensive set of plant tests was conducted on one line in the Extraction plant (during 1995) in order to determine the impact of different operating conditions on separation circuit recovery and equipment performance. Principal line test parameters were:

- oil sand feed rate: 1350 t/h, 1800 t/h and 2200 t/h;
- ore grade range: 9.4 wt% bitumen to 12.2 wt% bitumen;
- water/ore ratio (wt/wt): normal = 0.6 to 0.65 and low = 0.45; and
- separation circuit temperature: normal = 75°C and low = 52°C.

The test program was designed so that Suncor could assess:

- the upper limit of existing plant capacity, in anticipation of higher production rates forecast for 2000 and beyond;
- sensitivity of bitumen recovery to process variables; and
- the potential for reducing the quantity of thermal energy input to Extraction.

Ancillary experiments on froth flow and froth heating/deaeration were carried out in parallel with the main program.

Results of this work demonstrated that for the ores tested:

- separation circuit capacity for each extraction line is at least 2000 t/h oil sand; and
- recovery is unaffected by either water/ore ratio or separation circuit temperature over the range of testing.

As a result of the test program the separation circuit process for Steepbank Mine operations will be a modest extension of existing practice. The most significant change is to operate at temperatures about 50°C which is about 25°C lower than currently. Present operations temperatures have not been lowered because the conditioning drum requires steam injection to operate properly.

5.4 PROCESS SELECTION CRITERIA

Suncor's Extraction process selection method has evolved from preliminary evaluation of alternatives in the early 1990s to a more thorough assessment in 1994/1995 that resulted in the current design basis.

The Extraction and tailings management process selected by Suncor for its Steepbank Mine operation is discussed in terms of the following process criteria:

- capital and operating costs,
- technical risk,
- bitumen recovery,
- thermal energy efficiency,
- fine tailings generation, storage and reclamation,
- water balance, and
- naphtha losses and atmospheric emissions.

The last four criteria relate to environmental impact. This list also includes relevant objectives set forth by the AEUB for integrated, mining-suitable oil sands projects.

5.4.1 Capital and Operating Costs

Additional Extraction plant capacity is required for oil sand transport and conditioning. These functions are accomplished simultaneously in the hydrotransport process which moves oil sand from the east side of the Athabasca River to the existing plant on Lease 86. Existing facilities replaced by hydrotransport are the ore feed conveyors from the mine to extraction, and the conditioning drums and reject screens in the Extraction plant. Conversion to the hydrotransport process is less expensive than upgrading, relocating and extending existing facilities.

Proposed equipment changes are summarized in Table C5.0-1.

The slurry distributor will partition discharge from the two hydrotransport lines so that it can be delivered to the separation cells available for operation.

A sixth line in the separation circuit will be constructed, requiring a new froth heater and deaerator. Owing to the possibility of 50 mm rocks in the oil sand slurry pipeline discharge, separation cell underflow pumps in the plant will be converted to all-metal construction.

New equipment will be installed in the froth treatment plant. Expansion to 107 kbpcd capacity is a continuation of the earlier changes implemented to achieve 87 kbpcd capacity.

TABLE C5.0-1

EQUIPMENT CHANGES FOR EXTRACTION FACILITIES AT 107 kbpcd

Activity or Process	Change Required
Slurry Distribution	One slurry distributor
Primary Extraction	One separation cell Flotation banks One deaerator All-metal separation cell underflow pumps in current plant
Froth Treatment	One first-stage centrifuge Improved conveyor mechanism on all first-stage centrifuges Additional second-stage feed drum One filter Three second-stage centrifuges
Naphtha Recovery Unit	Increased capacity
Primary Extraction Tailings	One tailings line, consistent with requirements of consolidated tailings technology

The means to achieve increased capacity in the NRU stripper are being designed. The amount of diluent discharged to tailings ponds at 107 kbpcd will not exceed the amount currently discharged.

Planning studies currently indicate that a sixth tailings line will be required to sustain operations at 107 kbpcd. A definitive design for primary Extraction tailings will be established once the operating scenarios associated with consolidated tailings are better-defined.

These changes (which include the assumption that full use will be made of existing plant capacity) are sufficient to extend Extraction production capability to the equivalent of 107 kbpcd. They represent the minimum-cost option for Steepbank Mine Extraction facilities.

Absolute Extraction operating costs are expected to increase owing to the higher tonnage being processed; however, unit operating costs on a per tonne basis will decrease. Operating uncertainty is restricted to that part of the process which is new (i.e., the slurry transport system).

5.4.2 Technical Risk

At issue here is the potential to fail to meet expectations. Technical risk is associated entirely with the hydrotransport system. Loss of production may be experienced until sufficient operating experience is gained or until equipment fix-ups have been completed. Areas of particular interest include:

- rejects processing and extent of bitumen loss to rejects,
- uniformity of slurry distribution to any five of six separation cells, and
- ease of maintaining steady, optimal flow conditions in the slurry lines.

Suncor judges these uncertainties to be typical, acceptable risks when new technology is introduced into an existing commercial operation. Also, sufficient time exists to incorporate risk mitigation strategies in the final design. The following strategies relevant to the listed concerns are being pursued:

- It is believed that a particle size limitation for hydrotransport and subsequent treatment in the separation cells is <50 mm. To reduce reject volume, it is proposed to crush to <100 mm and then screen to <50 mm. This solution will require further investigation of crusher and reject circuit designs. (See also bitumen recovery later in this section.)

- Hydrotransport product will be distributed to on-line separation cells at the Extraction plant through the feed distributor. Uniform feed distribution is desirable but may be hard to achieve. Currently, a number of gravity-feed and pressure-feed distributor designs are being considered in conjunction with physical Extraction plant layout constraints.

- Large-volume slurry pipelining of tailings is well-understood at Suncor. Mathematical design models have been developed over the years that satisfactorily reflect operating performance. It is known, however, that a slurry containing significant amounts of bitumen will behave differently. Also, in order to reduce water transfer Suncor is pushing the limits of slurry technology by pumping as dense a slurry as possible. Additional testing and modelling of hydrotransport of oil sand is underway. The key results required are system design parameters and operating procedures that will both avoid plugging and provide steady feed to Extraction.

A key factor in facilitating adoption of hydrotransport technology at Suncor's operations has been the conversion to truck and shovel mining, which has provided the reliable, uniform ore feed that the technology requires to be successful.

5.4.3 Bitumen Recovery

Suncor is committed to achieve an average of 91.1% bitumen recovery from the Steepbank Mine. Suncor is also committed to a program of improvement initiatives. Suncor believes these initiatives will overcome the impact of higher fines from the Steepbank Mine and add in the order of 2% to bitumen recovery.

For current plant operations, calculation for bitumen recovery is based on a procedure developed in collaboration with the AEUB. The calculations proceed sequentially upstream from Plant 4 (secondary extraction) and the NRU using selected stream assays and flow rates to estimate bitumen content in the oil sand feed. Results of these calculations for 1995 are summarized in Table C5.0-2.

Bitumen losses to rejects, separation circuit tailings and froth treatment tailings are discussed in the following subsections. Bitumen recovery improvement initiatives are discussed in Subsection C5.4.7.a

a) Losses to Reject

As Syncrude gained experience with hydrotransport, the proportion of reject as a percentage of oil sand feed decreased from about 15% to about 8%, where it remains; bitumen content of the reject is estimated at about 8 wt%. A $1.3 million project was undertaken during the summer of 1995 to assess different reject screening options. While the intent was to demonstrate that bitumen losses could be reduced to a lower level using a better reject screening arrangement the work did not

TABLE C5.0-2

SUNCOR EXTRACTION PLANT RECOVERIES IN 1995

Month	Calculated Recovery (wt%)
January	91.9
February	93.2
March	93.1
April	91.8
May	92.3
June	91.9
July	92.1
August	92.1
September	91.1
October	91.4
November	91.9
December	93.2

achieve its objective. Hence (in the Steepbank Mine slurry preparation process) oversize in the cyclofeeder product is crushed, reducing the quantity of reject. It is estimated that bitumen loss to reject will be about 1.3 wt%; this compares with about 2 wt% to 3 wt% in current operations.

b) <u>Losses to Primary Extraction Tailings</u>

In recent years Suncor has reduced bitumen loss to Plant 3 (primary extraction) tailings by achieving relatively constant, high densities in the separation cell underflow streams. The improvement is attributed to both the conversion to truck and shovel mining (which provides a more uniform feed rate) and modifications made to the separation cell rake mechanisms.

It is conservatively estimated that bitumen loss to Plant 3 tailings will be about 5.3% for Steepbank Mine operations. There is potential to reduce these losses if hydrocyclone overflow from consolidated tailings is processed through a flotation circuit.

c) **Losses to Secondary Extraction Tailings**

Bitumen loss to Plant 4 (secondary extraction) tailings in current operations averages 2.3% of oil sand feed bitumen. Even though the same equipment will be used for Steepbank Mine operations a modest reduction in losses is anticipated owing to steadier operations after construction of intermediate storage between Plants 3 and 4 and better performance from new, second-stage centrifuges to be added to the existing plant.

The preceding discussion suggests total bitumen losses will be about 8.9%, resulting in overall recoveries of about 91.1%. Recovery will be increased through the use of tertiary recovery in Plant 3 and improved performance of Plant 4.

d) **Impact of Increased Fines**

Fines content (less that 44 microns) in Steepbank Mine ore will be higher than that from the present mine. Core hole evaluation is continuing; present indications are that fines content from Steepbank Mine may average about 17% (expressed as % of mineral in ore) compared to about 12% in the present operation.

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.

There is reason to believe these losses can be counteracted using the following means:

- Introduction of consolidated tails technology presents an opportunity for tertiary recovery of bitumen at the tailings cyclone overflow. This is under active investigation.

- Syncrude has achieved acceptable recoveries from higher-fines material. Suncor is participating in a technology exchange with Syncrude; areas of promise are in separation cell froth under-wash and centrifuge modifications and operations. (Froth under-wash involves introduction of a layer of clean water in the separation cell interface between middlings and froth layers. Any froth passing through this layer is cleaned. The benefit is most significant for high-fines ore).

5.4.4 Extraction Process Thermal Energy Demand

The dominant consideration affecting energy efficiency in bitumen production is the amount of thermal energy consumed by the Extraction process. In Table C5.0-3, the thermal energy balance for Extraction is summarized; data are presented for calendar day and stream day production rates. A calendar day rate is determined by averaging a quantity of interest over one year. A stream day rate is the design rate (i.e., the estimated maximum rate at which the quantity is processed on a sustained basis).

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 are stated at the top of the table. Note that:

1. A higher proportion of water is assumed for Steepbank Mine owing to the higher fines content of Steepbank Mine ore.
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 (55°C versus 72°C) for Steepbank Mine 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 is 18% lower (219 MJ/tTS versus 265 MJ/tTS) for Steepbank Mine operations.

Thermal energy is supplied by live steam, by recovering waste heat and by condensing steam as follows:

- Live steam consumption is reduced by more than 50% for Steepbank Mine operations because oil sand is no longer conditioned in a drum;

- The main waste heat item is the 97 MW of low-grade heat recovery from the expanded Upgrading facilities. Credit for low-grade heat recovery has been taken only for the

TABLE C5.0-3

EXTRACTION THERMAL ENERGY DEMAND

PARAMETER		**Calendar Day Rates**		**Stream Day Rates**	
		79.5 kbpcd	**107 kbpcd**	**79.5 kbpcd**	**107 kbpcd**
Oil Sand Rate	t/h	5708	7775	6273	10 000
Process Water/Oil Sand	wt/wt	0.54	0.66	0.54	0.66
Temperatures:	°C				
Oil Sand Feed		5-10	5-10	5-10	5-10
Make-up Water		10	10	10	10
Diluent Feed		54	54	54	54
Separation Circuit		72	55	72	55
Diluted Bitumen		84	84	84	84
Thermal Energy Required:					
Total	MW	420	472	461	608
Per tonne of Oil Sand	MJ/t	265	219	265	219
Thermal Energy Supply:	MW				
Live Steam		174	75	191	96
Waste Heat:					
- Cooling Water		30	10	30	10
- Low-Grade Heat Recovery		0	97	0	0
- Miscellaneous		4	5	4	9
Condensing Steam		212	285	236	493
Total Process Steam:					
Energy Rate	MW	386	360	427	589
Mass Flow	t/h	587	582	650	961
Total Steam Supplied:					
Mass Flow	t/h	646	640	715	1057

calendar day Steepbank Mine calculation. Under normal circumstances this amount of heat will be available when Extraction is operating at stream day rates. However, no credit is taken in the Steepbank Mine stream day calculation to ensure that the steam plant can make up any deficit in low grade heat recovery; and

- Condensing steam supplies the balance of Extraction heat.

Total process steam is the sum of the live and condensing steam requirements.

Total steam supplied is 110% of the process steam. The additional 10% accounts for miscellaneous heat sinks such as losses, heating, ventilating and steam tracing.

It is noteworthy that Extraction's calendar day steam demand for Steepbank Mine operations at 107 kbpcd is the same as for operations at 79.5 kbpcd. This is a consequence of lower operating temperature, lower live-steam consumption and the credit for low grade heat recovery. This has a positive influence on greenhouse gas emissions (see Subsection C8.1.2).

5.4.5 Fine Tailings Generation, Storage and Reclamation

Tailings fines consist of mineral (< forty-four microns) released from oil sand during conditioning and suspended in the fluid phase of the tailings stream. Upon deposition in the 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. The 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 the start of operations in 1967 Suncor has accumulated about 100 million m^3 of MFT. This fluid is stored in ponds whose perimeter walls are constructed of overburden and tailings sand.

Factors which affect the amount of fine tailings generated are:

- amount of clays and extent of their dispersion in the oil sand;
- temperature of conditioning process (high temperatures create more fines); and

- chemical environment during oil sand processing (the high alkalinity required in current operations increases creation of fine tailings).

Consolidated tailings 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 suspended sand will accelerate the consolidation process, permitting significant shear strength to be achieved in two to three years.

There is sufficient flexibility in the consolidated tailings recipe so that (once the technology is fully implemented) Suncor's inventory of MFT can be gradually drawn down. In the steady-state operation storage would be necessary for about three years' inventory of maturing fine tailings. Pond water storage would of course also be required.

The Extraction process (including tailings management) which Suncor proposes for Steepbank Mine operations will generate fine tailings at a slightly higher rate than at present. Dominant factors are the quantity and characteristics of fine minerals in the oil sand and the chemical environment during conditioning. Preliminary data suggests that fines content in Steepbank ore averages about 17 wt% of mineral, about 5% higher than current ore. A caustic-assisted process will be sustained. Although, the lower temperature during conditioning in the slurry pipeline (versus in the existing drums) will tend to reduce fine tailings generation, no credit is being assumed for this change in process conditions.

Steepbank Mine 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 consolidated tailings technology. Over twenty to thirty years of operations MFT inventory will be reduced to a low amount. Thereafter, MFT will be consumed at the same rate they are created.

Reclamation of consolidated tailings is discussed in Section D3.0.

5.4.6 Water Balance

The current Extraction operation is a net importer of water which accumulates in tailings ponds and in MFT.

The application of CT technology results in large volumes of water released from the MFT as they are consolidated and the inventory of MFT is drawn down. Calculations show that this water can be stored in existing and planned ponds for a period of five to ten years.

Management of Extraction recycle water is discussed in Subsection D3.4.4, where Suncor addresses opportunities to maximize the use of the CT release water, thereby reducing water demand from the Athabasca River.

Ultimately some water (meeting quality standards) will be discharged into the Athabasca River.

5.4.7 Extraction Performance Criteria

Anticipated bitumen losses to the waste streams in Extraction are summarized in Table C5.0-4. These losses correspond to anticipated overall recoveries of 91.3%, 91.3% and 91.1% at upgraded crude production rates of 79.5 kbpcd, 87 kbpcd and 107 kbpcd respectively. Discrepancies in the final significant figure are caused by rounding error.

a) <u>Methods of Improving Bitumen Recovery</u>

Suncor has identified several means by which bitumen recovery might be improved. Some of these are currently in various stages of implementation while others require further assessment. Suncor believes that these means will overcome the impact of higher fines from the Steepbank Mine and add in the order of 2% to bitumen recovery.

i. New Second-Stage Centrifuge

This new unit has recently been commissioned. Performance assessment will be complete by June 1996. Anticipated benefits include:

- Improved recovery (i.e., better than 97.5% of input bitumen to the centrifuge plant) because the design of the new unit incorporates several improvements over existing machines (which were designed thirty years ago); and
- Reduced loading on existing machines, which may result in improved recovery.

TABLE C5.0-4

ALLOCATION OF BITUMEN LOSSES IN EXTRACTION

(wt% of bitumen in oil sand feed)

	79 500 (12 639 m^3/cd)	**87 000 (13 832 m^3/cd)**	**107 000 (17 012 m^3/cd)**
Bitumen Recovery (%)	91.3	91.3	91.1
Bitumen Losses (%):			
- Reject	2.0	2.0	1.3
- Separation Circuit Tailings	4.3	4.3	5.3
- Froth Treatment Tailings	2.3	2.3	2.3
Total (%)	99.9*	99.9*	100.0

* Discrepancies in the total percentages are the result of rounding.

ii. Upgraded First-Stage Centrifuge

A joint program with Syncrude is in progress, to assess changes to the centrifuge feed mechanism recommended by its manufacturer. It is anticipated the capacity of the machines can be raised by 25% and there is also potential for recovery improvement. The test program and data analysis will be complete by third quarter 1996.

iii. Larger Drum Slurry Screens

Existing drum slurry screens measure 1.8 m x 4.9 m and have openings of 3 cm x 7.6 cm (on the top deck) and 0.8 cm x 3.2 cm (on the bottom deck). There are five of these double-deck screens, one for each drum. Suncor intends to replace one of these screens with an 2.4 m x 6.1 m double-deck screen which has larger openings. Assessment of new screen performance should be complete by fourth quarter 1996. It is anticipated the larger screen will reduce losses to reject even at the higher oil sand feed rates for 87 kbpcd production (at 107 kbpcd these are by-passed).

iv. Naptha Recovery Unit Enhancements

The Naptha Recovery Unit recovers hydrocarbon (diluent) from plant waste streams that are en route to storage in tailings ponds. In addition to centrifuge plant tailings feed to the column includes wastewater streams from the Upgrader. On the basis of a recently-completed study of the Naphtha Recovery Unit Suncor will improve the feed box design so that higher feed stream temperatures (which will result in higher hydrocarbon recovery) can be run without danger of particulate carry-over into the overhead condenser system. This change will be completed by 1997 and is judged sufficient to accommodate production rates of up to 87 kbpcd.

Suncor will modify the NRU so that diluent losses to the ponds at a rate of 107 kbpcd are no higher than at 79.5 kbpcd.

v. Froth Underwash

Froth underwash refers to the introduction of a layer of clean water beneath the froth-middlings interface in the separation cell. Syncrude has added a froth underwash to each of their separation cells. Beneficial effects of this technolgy are particularly pronounced when difficult-to-process ore is arriving at Extraction. In particular, separation circuit froth quality does not deteriorate with poorly-processing ore, which means that centrifuge plant feed rate does not need to be reduced in order to maintain quality in the diluted bitumen product sent to Upgrading. A more steady operation in the centrifuge plant will improve recovery although the benefit cannot be easily quantified.

Suncor has acquired the right to use froth underwash technology and is currently assessing the best time to introduce the technology into its Extraction operations.

vi. Bitumen Recovery From Hydrocyclone Overflow

The consolidated tailings process described in Subsection 2.2 requires removal of moist sand from the separation circuit tailings stream, accomplished with hydrocyclones. Moist sand from the cyclone underflow is used to produce consolidated tailings. Fluid overflow from the hydrocyclones contains most of the bitumen in the original tailings stream and is a candidate for a tertiary bitumen recovery operation.

Pilot tests have been completed on a flotation process for bitumen recovery from cyclone overflow and promising results were obtained. A decision to apply the process has been made. The expected recovery improvement is in the order of a rate of 2 kbpcd when the total separation circuit tailings are hydrocycloned.

vii. Bitumen Recovery From Mature Fine Tailings

Another opportunity for incremental recovery involves the bitumen in mature fine tailings. Bitumen content in existing fine tailings inventory ranges from about 1% to 6% by weight. When consolidated tailings are manufactured it may be attractive to recover bitumen from fine tailings which are in transit from the tailings pond to the final tailings pump house. Prior work has identified several areas that need further clarification before a decision to initiate commercial-scale operation is made including:

- fraction of fine tailings inventory that has high bitumen content;
- bitumen recovery as a function of bitumen concentration;
- properties of recovered bitumen stream and disposition of this stream; and
- variability of bitumen production rate as influenced by consolidated tailings schedule, seasonal constraints and accessibility of high-bitumen-content fine tailings.

A pilot program to assess bitumen-recovery-from-fine-tailings process parameters is in progress and will be completed by fall 1996. The next step will depend on the outcome of this work and further analysis of the above-mentioned issues.

viii. New Tailings System for Froth Treatment Plant

Suncor's existing tailings system is at its limit during normal operations. Variations in the flow to the NRU are frequent. Work is underway to replace the centrifuge plant tailings collection and pumping system; the new design anticipates requirements for a 107 kbpcd production rate. With completion of this work (by the end of the 1997 turn-around) a more stable NRU feed rate will be achieved which will contribute to increased diluent recovery.

ix. Interstage Tank

The interstage tank (between deaerators and centrifuges) has been discussed in Subsection 5.2.3. It is projected that the tank will improve both production and recovery by reducing hydraulic interference of the separation circuit with froth treatment and vice versa.

x. Diluent-to-Bitumen Ratio in Froth Treatment Plant Feed

Work has begun to assess the feasibility of reducing the diluent/bitumen ratio in the centrifuge and will be completed by fall 1996. If feasible, reduced losses of diluent in NRU tailings would be expected.

5.5 ORE TRANSPORT TECHNOLOGY SELECTION

Development of Steepbank Mine to support an increase in production rate (from the 1995 level of 79 kbpcd to 107 kbpcd upgraded crude oil) requires a proportional increase in ore transport capability. Suncor has the opportunity to consider a transportation alternative to its current conveyor technology. The practical alternative available is hydrotransport (also known as slurry transport).

This section compares conveyor transport with hydrotransport in terms of economics, technical risk and environmental impact.

5.5.1 Economic Considerations

a) Capital

Because the distance from Extraction to Steepbank Mine is shorter than to current in-pit ore sizers, Suncor will have redundant conveyor capacity once Steepbank Mine is established. However, in the transition period (2000 to 2001) Suncor would need to operate parallel systems, necessitating capital outlay for conveyor capacity. Initial capital cost for a conveyor system is less than that of the proposed hydrotransport system; however the hydrotransport system provides ore conditioning as well as transportation. Current plans call for use of the redundant conveyor capacity in Steepbank Mine beyond 2008 to shorten ore haul distances.

b) Operating Cost

Suncor has operated both hydrotransport and conveyor systems in its operations since start-up (albeit for different purposes). Operating costs for hydrotransport are about one-third that of conveyors, a significant advantage resulting from reductions in maintenance costs and energy input. The proposed hydrotransport system will replace conditioning drums in Extraction.

5.5.2 Technical Risk

Suncor considers the use of hydrotransport as a means of moving ore to be an extension of proven technology currently used for tailings transport. A key requirement for use of the technology is the assurance of a steady, reliable feed rate, which is provided by conversion to truck and shovel mining from the large, single-purpose bucketwheel excavator system of mining. Technical risks of the hydrotransport system are judged to be acceptable.

5.5.3 Environmental Impact

The hydrotransport system is determined to have important environmental benefits compared to the conveyor system particularly with respect to the bridge crossing of the Athabasca River. These advantages include the following:

- The hydrotransport system is an enclosed system which (under normal operation) spills no ore along the transport route unlike the open conveyor system, which can spill materials, including diesel fuel and glycol, along its entire length.
- The hydrotransport system provides energy savings compared to the conveyor system because it pre-conditions ore during transport and at lower temperature, thus reducing greenhouse gas emissions from Suncor's operations.
- A shorter, more direct route to Extraction is possible with the hydrotransport system.

Abnormal operating conditions with hydrotransport include line plugging and line leaks. Unplugging of lines is accomplished by using drain points and containment basins which have been established along the line route, thus carrying out the operation under controlled conditions. The containment pools are earth structures located to provide isolation of their contents from both the Athabasca River and natural surface drainage.

Pipeline leaks may occur; they are expected to be infrequent and contained, requiring minor clean-up. Based on experience from the Syncrude hydrotransport system the wear rate in hydrotransport lines is expected to be low.

The following design and operating strategies will be implemented to reduce the incidence of leaks (and their resulting environmental impact) to an acceptable level:

- Those sections of pipe which can be expected to experience higher wear or which are positioned where a failure would have high environmental impact (e.g., on the bridge over the Athabasca River) will have additional wear protection in the form of chromium carbide lining in a spiral-wound pipe. Suncor experience indicates that such wear protection extends pipeline life by a factor of four.
- The pipelines will be appropriately supported to contain movement.
- The pipelines over the bridge will be located in a containment trough with collection basins on both ends of the bridge.

- A quality assurance program will periodically assess wear on the total line, more frequently for critical sections.
- Visual inspection will be conducted formally on each shift and randomly by nearby traffic.

The possibility of catastrophic failure occuring with the above mitigation strategies in place is remote. A pressure transmitter control system will also be installed to detect significant leaks in tthe line and to respond immediately by shutting down and draining the system, and immediately activating the emergency response procedure.

5.6 TRANSITION PLAN

Transition from current operations to full rates from Steepbank Mine will take place over approximately fifteen months in 2000 to 2001 as current Lease 86/17 reserves are exhausted.

Details of the transition operations have yet to be developed. Every attempt will be made to minimize production interruption and operational risk without sacrificing recovery. Installation and commissioning of the hydrotransport system (from the feed crushers to the Extraction feed distributor) will not present a major difficulty. There will be challenges with changeover in Extraction due to space and layout constraints. The transition will be managed by appropriate sequencing and some temporary routing.

5.7 PROCESS DESIGN RATES

Design through-put	105 kbpcd upgraded crude oil net product for market 107 kbpcd upgraded crude oil gross product
Upgraded crude oil/ bitumen ratio	0.81 (nominal)
Overall recovery factor	91.1%
Bitumen in feed	145 kbpcd 23 000 m^3/cd 23 260 t/cd (density 1.009 t/m^3)
Ore grade (Pits 1 and 2)	11.9 %
Ore feed required	195 kt/cd 8100 t/ch
Hydrotransport design rate	10 000 t/h (nominal)

FIGURES SECTION C5.0

FIGURES

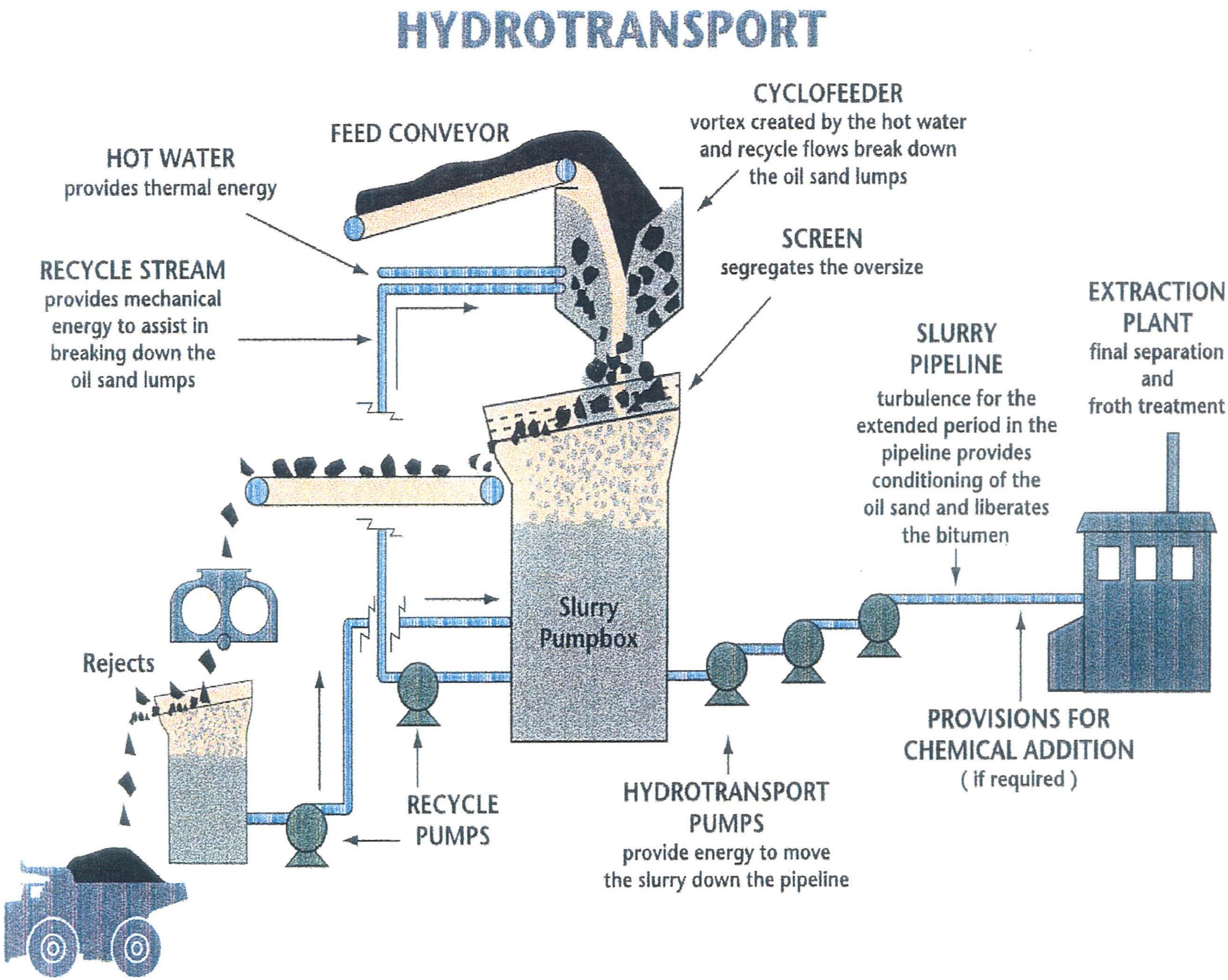


Figure C5.0-1 Hydrotransport

Oil Sand Conditioning and Transport

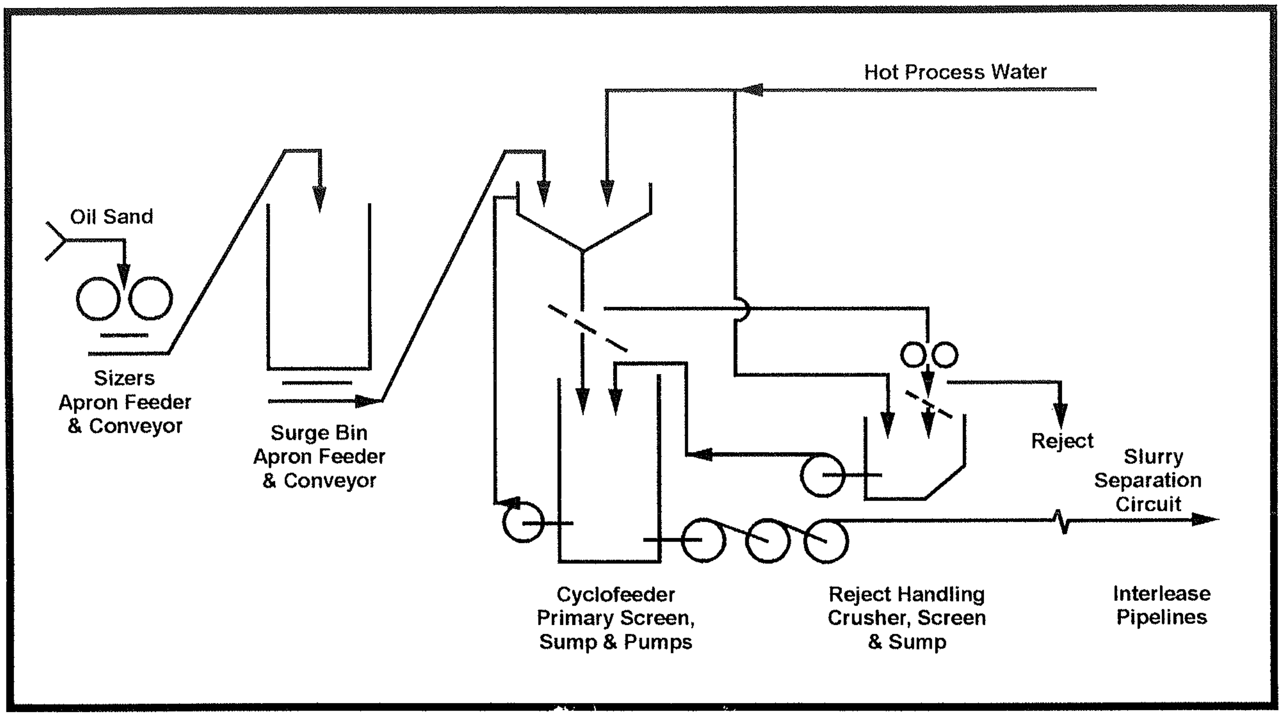


Figure C5.0–2a at 107 kbpcd

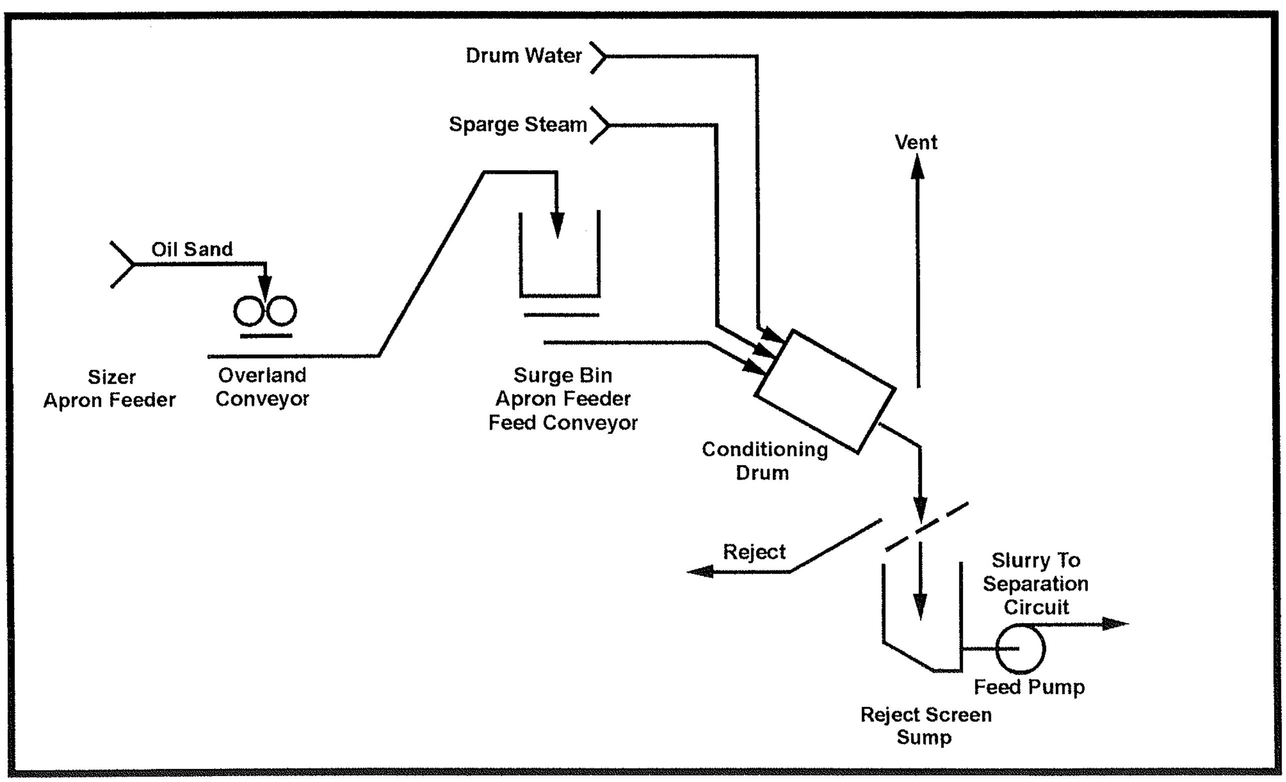


Figure C5.0–2b at 79.5 and 85 kbpcd SCO

Separation Circuit and Froth Heating/Deaeration

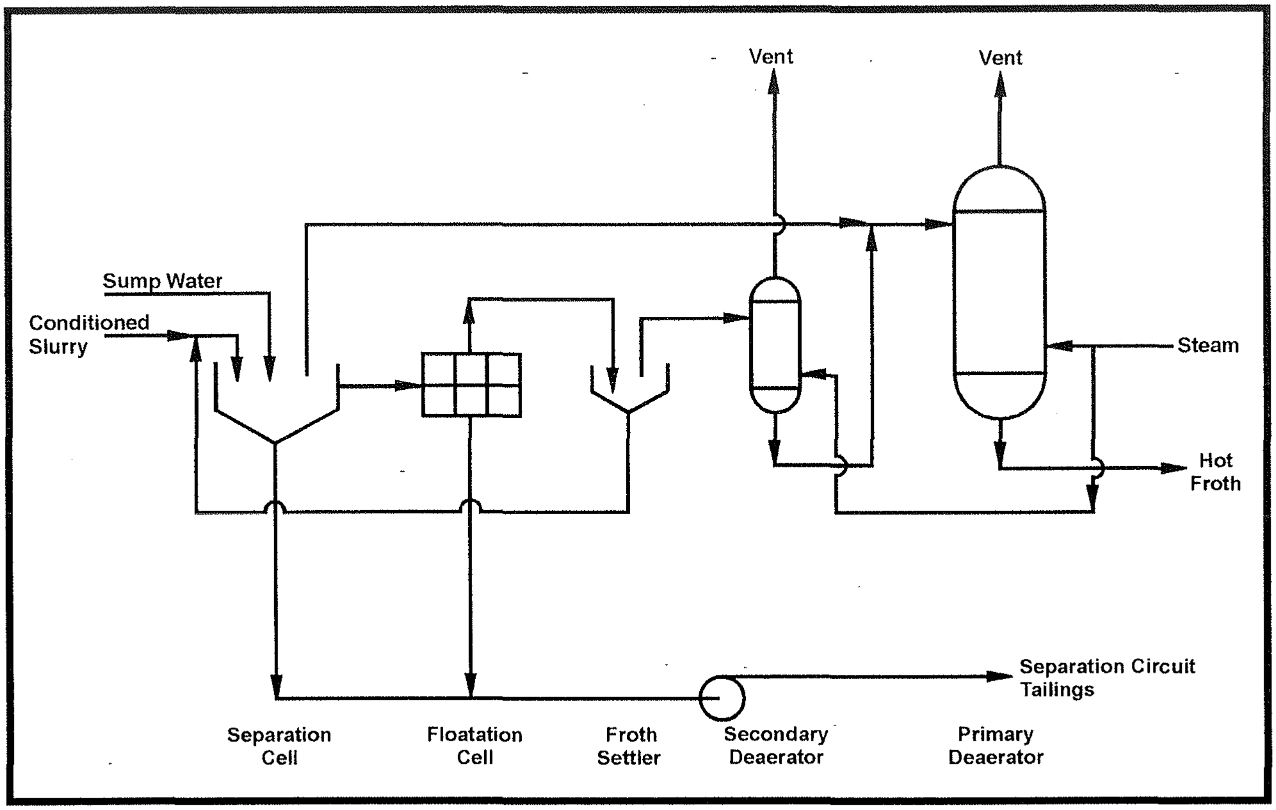


Figure C5.0-3a Current Operations

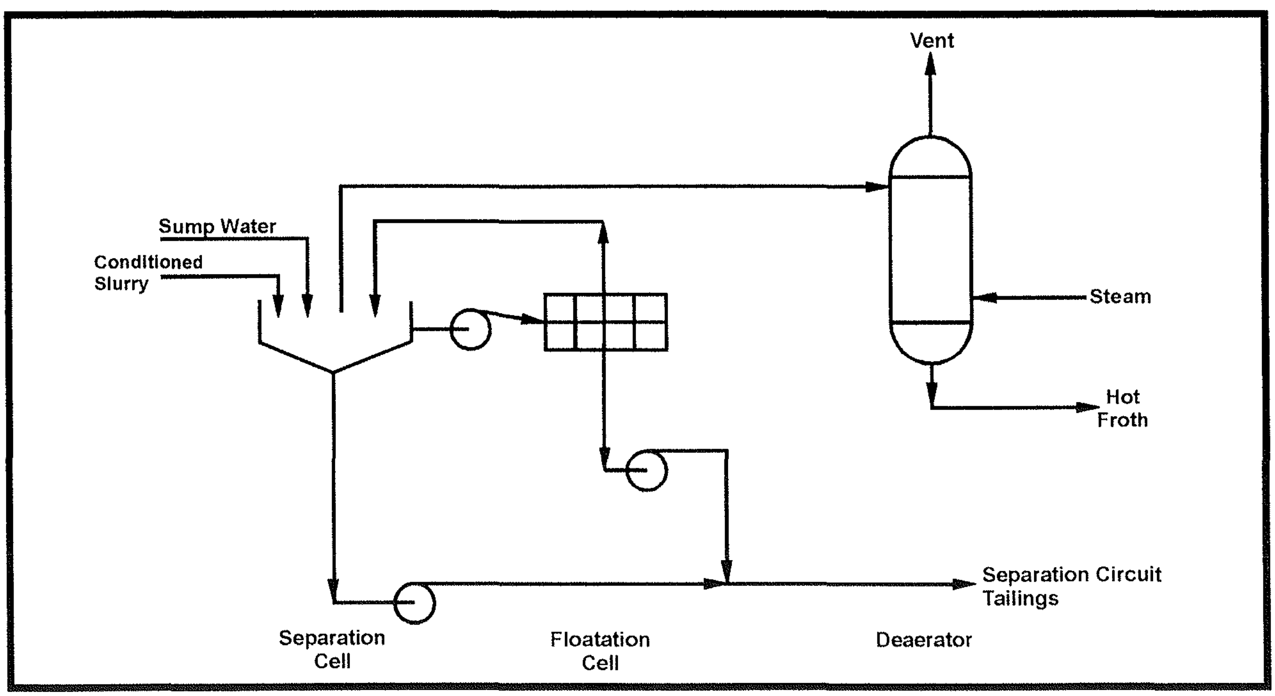


Figure C5.0-3b Sixth Line

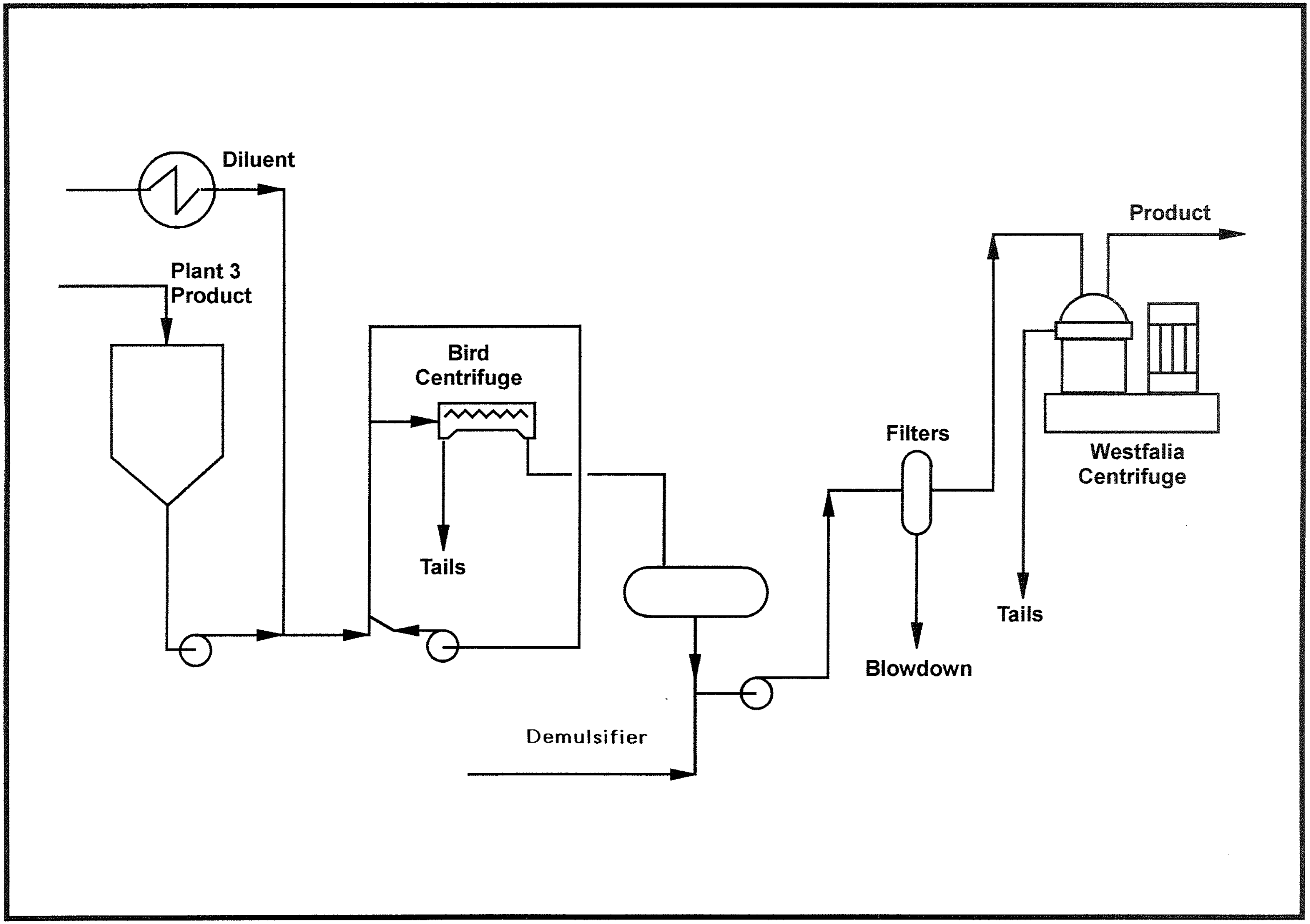


Figure C5.0-4 Froth Treatment Process

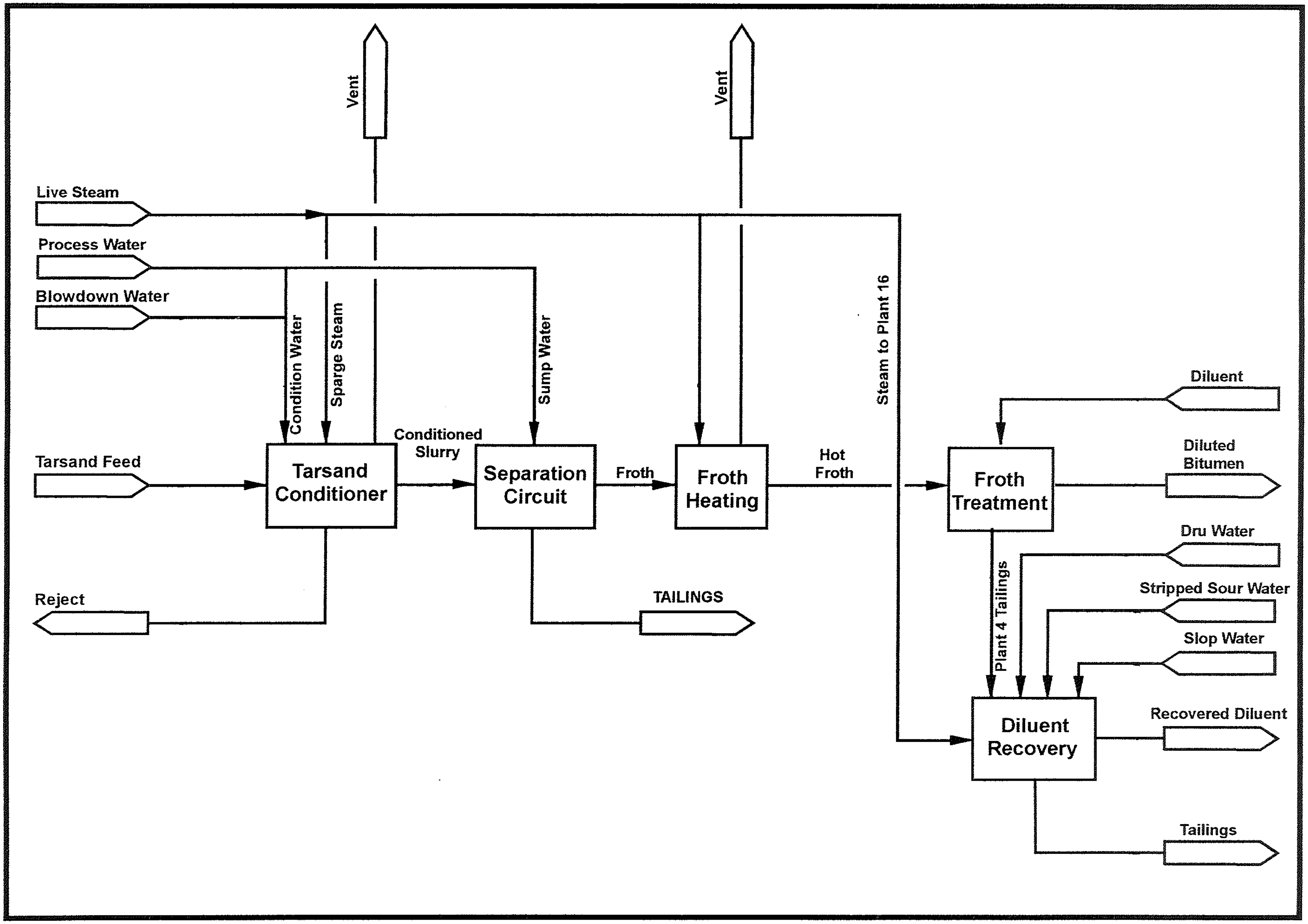


Figure C5.0-5 Extraction Flow Diagram

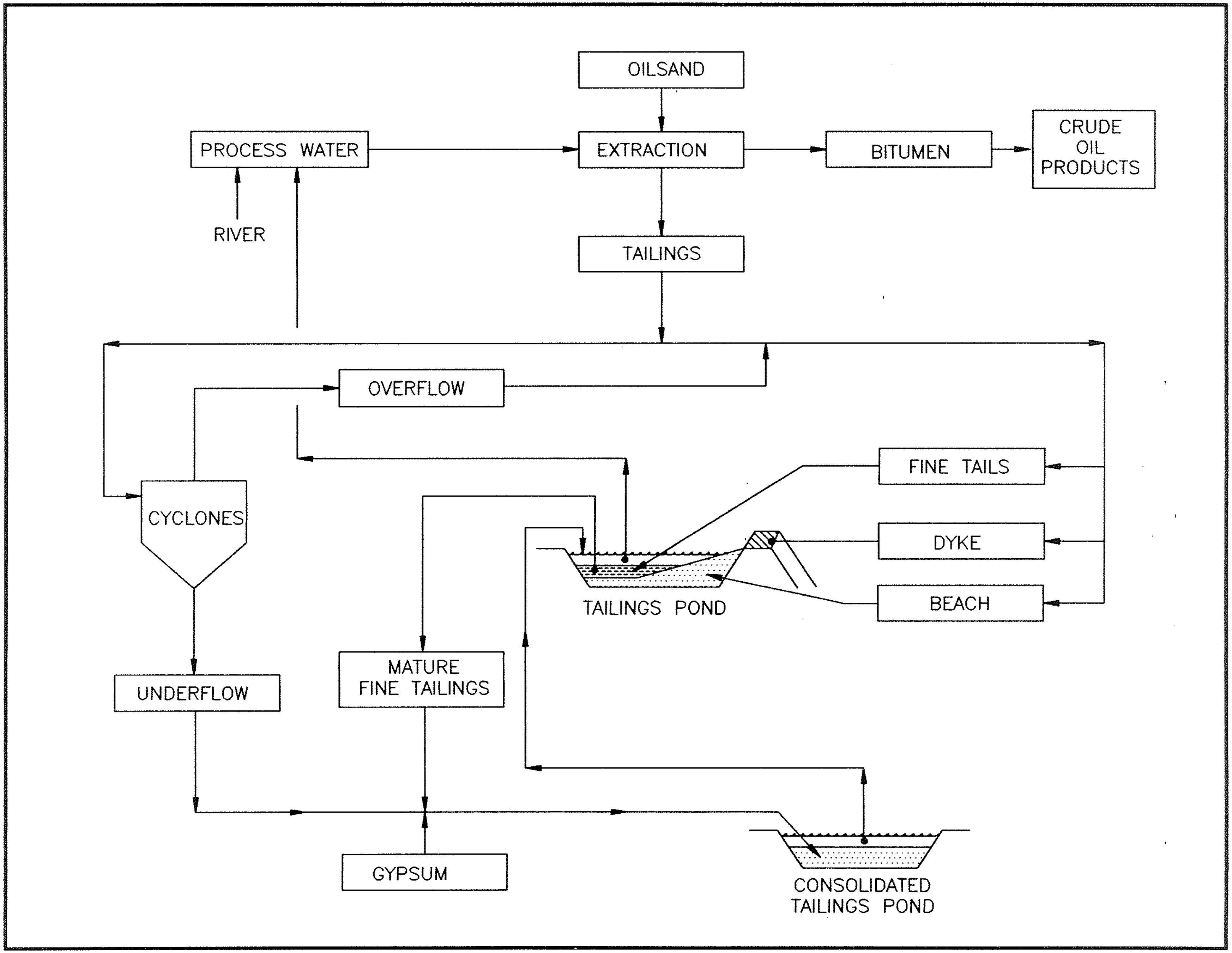


Figure C5.0-6 Consolidated Tailings Flow Diagram

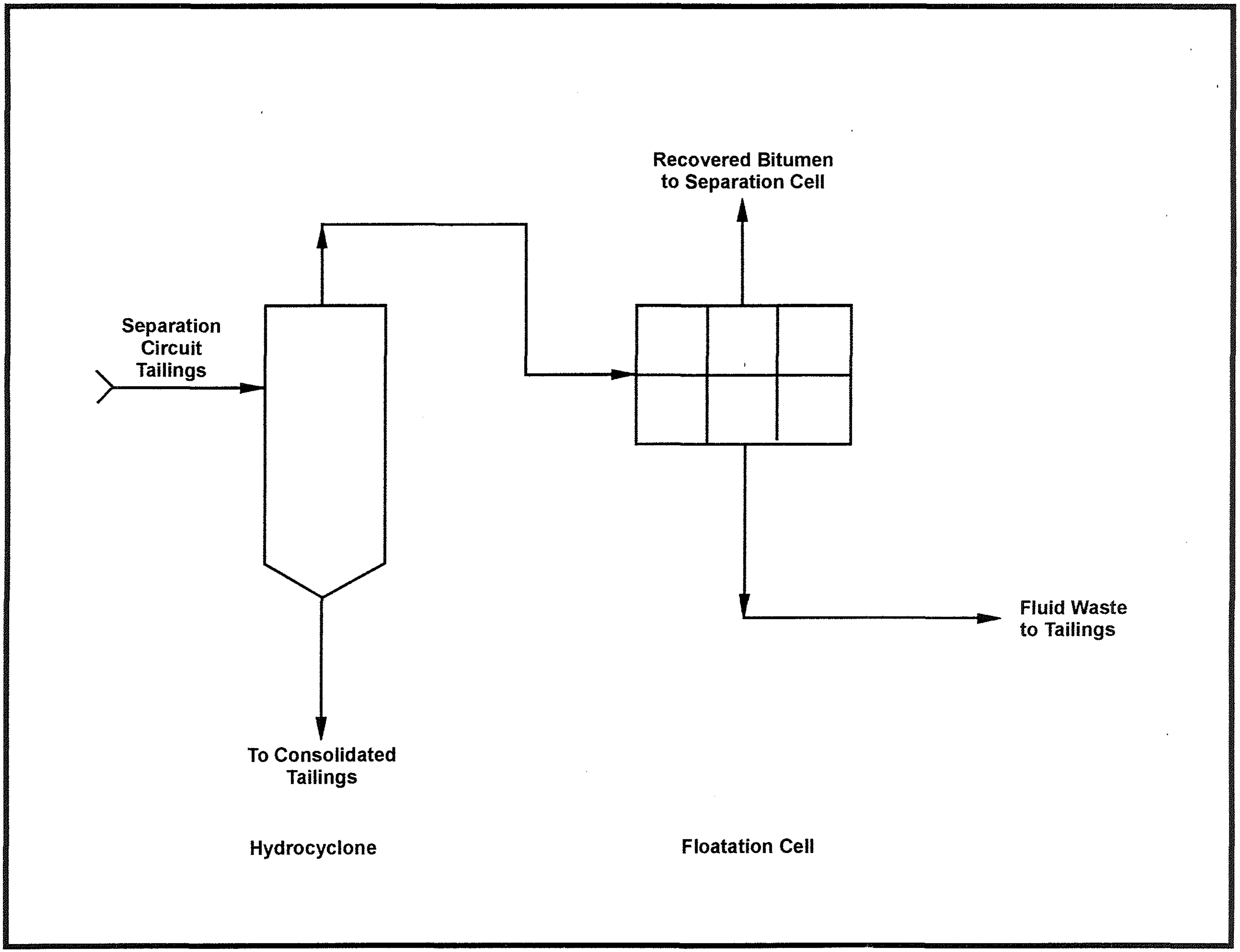


Figure C5.0-7 Candidate Flow Diagram for Tertiary Recovery

C PROPOSED STEEPBANK MINE

6.0 BOUNDARY ASPECTS

The boundary of the Steepbank Mine project is considered to be the inlet to the diluted bitumen transfer line. Bitumen operations will require energy, water, fuel and diluent from outside the boundary. This section describes boundary modifications which will be made to accommodate Steepbank Mine.

Material and energy transfers are quantified in Section C7.0. Changes and upgrades to the fixed plant which will be required to process the higher volume of bitumen from Steepbank Mine and to serve the mine's utilities needs are detailed in the Application for Fixed Plant Expansion.

Heat Energy: Hydrotransport and the Extraction plant need large quantities of heat to raise the temperature of recycle pond water which is used in the process. Most of this heat will be supplied by condensing 50 lb. steam in heat exchangers. Currently, two 50 psig steam lines run from Upgrading to Extraction:

- a 915-mm line which sometimes has contaminated steam; and
- a 41-mm line which has clean steam.

At present, these lines combine and then join a 1370-mm steam line from Utilities. In future the 915-mm line will be routed separately to increase steam transfer capacity. As well, the Fixed Plant Expansion project proposes to recover additional low-grade heat from the Upgrading by routing pond recycle water through heat exchangers in Upgrading.

Electric Energy: About 58 MW of the total 67 MW of electrical power currently needed to operate the Mine, Extraction, Upgrading and Utilities plants is supplied by Suncor's in-plant generators. The remaining 9 MW is purchased from Alberta Power Limited and is accessed via two incoming 72-kV lines.

The Fixed Plant Expansion project proposes to ensure an adequate electrical supply to support operations safely and reliably by introducing the following changes to existing systems and facilities:

- installation of three 13.9-kV switchboards, each rated for 1000 MVA;
- revamp of the load-shedding sequence to improve reliability of the electrical supply and to reduce the probability of cascading failures; and
- planned installation (a separate strategic project) of a third turbo-generator which would generate power by condensing 50 psig steam using pond water as the cooling medium.

Water: Water is transferred to the Extraction plant and its recycle water system from the Upgrader and Utilities in a number of forms including as steam, utility water, blowdown water and process water. Net water demand ultimately is sourced from the Athabasca River. The water balance in Appendix III details water flow volumes.

Diesel Fuel: Diesel fuel for Steepbank Mine will be pipelined from the Upgrading diesel-loading station in a 100-mm pipeline operating at approximately 140 psig.

Natural Gas: Peak natural gas consumption for building heat at the Steepbank Mine facilities is estimated to be 1300 GJ/d. A 100-mm line operating at 90 psig at the inlet will be constructed from the Utilities plant to Steepbank Mine facilities.

Diluent: This will continue to be provided from Upgrading via the current system.

Diluted Bitumen: The transfer line will be debottlenecked by twinning the existing 41-mm line with a 61-mm line.

C PROPOSED STEEPBANK MINE

7.0 MATERIALS AND ENERGY BALANCE

7.1 OVERALL BALANCE

Bitumen production operations are physically coupled to Upgrading and Utilities at Suncor's oil sands plant with transfers of heat (in water and steam), electricity, diluent, diesel and natural/process gases and bitumen occurring among the entities.

It is useful to examine the impact of increasing plant production rate (from 79.5 kbpcd to 107 kbpcd) on inputs and outputs to the bitumen production operation and on overall energy efficiency. Appendix III presents overall balances for the plant at 79.5 kbpcd, at 87 kbpcd and at 107 kbpcd production rates. Hydrocarbon, mineral, water, sulphur and energy balances are also detailed.

Key indicators of overall plant performance are shown in Table C7.0-1.

These balances (based on a model of the overall plant site) are a representation of bitumen production operation. Balances may differ from actual operating data due to possible inaccuracies in model assumptions, design expectations or measurements. Although total CO_2 and NO_x are not determined in the balances they are shown as key indicators of performance.

A commentary on the key material balance indicators follows:

<u>Product to Market</u>
The difference between plant capacity and product to market is due to internal consumption of diesel and fuel gas, and diluent losses to tailings.

<u>Sulphur Recovered</u>
Sulphur recovered will increase 12.4% while production capacity will increase 34.8%. Recovery of sulphur is not proportional to the rate of increase because the product slate sent to market contains more sulphur for downstream removal at the refinery level.

TABLE C7.0-1

OVERALL PLANT BALANCE, KEY INDICATORS

Key Indicator and Unit	At 79.5 kbpcd Rate	At 107 kbpcd Rate	% Increase (Decrease)
Product to Market kbpcd	77.9	105	34.8
Sulphur Recovered t/cd	485	545	12.4
Electricity Import (Export) MW	16.5	(7.3)	(144)
Coke to Stockpile Kt/y	433	606	40.0
Natural Gas Import 10^6 scf/d	23.2	25.1	8.2
Net Water Retention m^3/d	28 900	40 700	40.5
Overall Energy Efficiency %	73.1	74.6	1.5
SO_2 Emissions t/d	223.6	51.0	(77.2)
CO_2 Emissions kt/d	9.3	9.8	5.4
No_x Emissions t/d	37.1	35.9	(3.2)
Bitumen Recovery %	91.3	91.1	(0.2)

Electricity Import

Electricity imported at 79.5 kbpcd is 16.5 MW. This will move to a position of surplus capacity of 7.3 MW with the planned installation of a third generator at the Utilities plant. This surplus would be generated from coke in a co-generation mode.

Coke to Stockpile

Coke transferred to stockpile will increase 40%, more than the production increase, because of improved overall energy efficiency.

Natural Gas Import

Natural gas import will increase only 8.2% as a result of energy efficiencies and reduced hydrogen consumption per barrel of product (used to remove sulphur and improve quality).

Net Water Retention

Net water retention from the Athabasca River will increase by 40% due to an increase in tailings at higher production rates. Some water will be available for return as consolidated tailings release water (see Section D3.0).

Overall Energy Efficiency

Overall energy efficiency (outputs as a percent of inputs) will improve as a result of utilization of hydrotransport and warm-water extraction; fixed plants waste heat recovery project; and other energy improvements in Upgrading and Extraction.

SO_2 Emissions

These emissions have been reduced 75% plant-wide with the commissioning of the Flue Gas Desulphurization unit (in Utilities) in 1996.

CO_2 Emissions

CO_2 emissions will increase significantly less than would be expected for the increase in upgraded crude oil production as a result of improved plant energy efficiency. This number includes indirect emissions which accrue to power generated elsewhere. Suncor has the opportunity to increase its on-site electrical power generation with only a small increase in energy input; this will result in a CO_2 emission credit when compared to the use of power generated elsewhere. Further decreases in CO_2 emission levels are expected post-2002.

NO_x Emissions

NO_x emissions will decrease by 3.2% as a result of higher efficiency of revamped Utilities boilers; provision of over-fired air in the coke-fired boilers; installation of low-NO_x burners in Upgrading; and a flare gas recovery project.

Bitumen Recovery

Bitumen recovery is expected to remain relatively unchanged. This does not include any credit from potential tertiary recovery.

7.2 BITUMEN PRODUCTION OPERATIONS

Another approach to assess the performance of Steepbank Mine is to consider bitumen production operations as a separate entity from the remainder of the plant site and then to examine its inputs of electricity, water, heat, natural gas/process gas, diluent and diesel. This analysis is presented in Table C7.0-2 which shows that overall energy efficiency (outputs as a percent of inputs) increases from 85.2% to 85.9% as production increases from 79.5 kbpcd to 107 kbpcd. A calculation based on the table shows that energy consumed per unit of bitumen production is reduced by nearly 14% for Steepbank Mine (from 3.12 GJ/t to 2.70 GJ/t).

TABLE C7.0-2
BITUMEN PRODUCTION OPERATIONS - KEY MATERIAL BALANCE INDICATORS

Indicator	79.5 kbpcd Rate		107 kbpcd Rate	
	Usual Units	Energy Units (GJ/h)	Usual Units	Energy Units (GJ/h)
Bitumen Mined	685 t/h	27 860	910 t/h	37 000
Energy Consumed:				
Electricity	36.6 MW	130	46.7 MW	170
Heat Demand	420 MW	1500	472 MW	1700
Diesel	575 bpcd	140	775 bpcd	185
Diluent Loss	4 t/h	180	4 t/h	180
Production:				
Bitumen to Storage	625 t/h	25 400	829 t/h	33 700
Energy Efficiency		85.2%		85.9%

7.3 BITUMEN PRODUCTION ACCOUNTING

The present Suncor Extraction material balance is expressed as a complex series of calculations (based on component ratios in the various process streams) developed in collaboration with the AEUB in 1991. Bitumen recovery and production has been calculated back to January 1990 using this method. Changes in the process (which result in changes in the material balance results) are difficult to identify and address. In order to make monitoring of the material balance an easier process, a simpler material balance is calculation required. This section describes a proposed new calculation procedure that has been discussed with the AEUB and which Suncor is developing in collaboration with the AEUB.

7.3.1 Proposed Material Balance

A material balance calculation for Extraction has been proposed that uses only Extraction input and output streams (oil sand feed is not used). The balance then would account for only the bitumen and diluent components of relevant process streams. Figure C7.0-1 is a simplified flow diagram that shows the streams which will be used to calculate the material balance. Recoveries will be

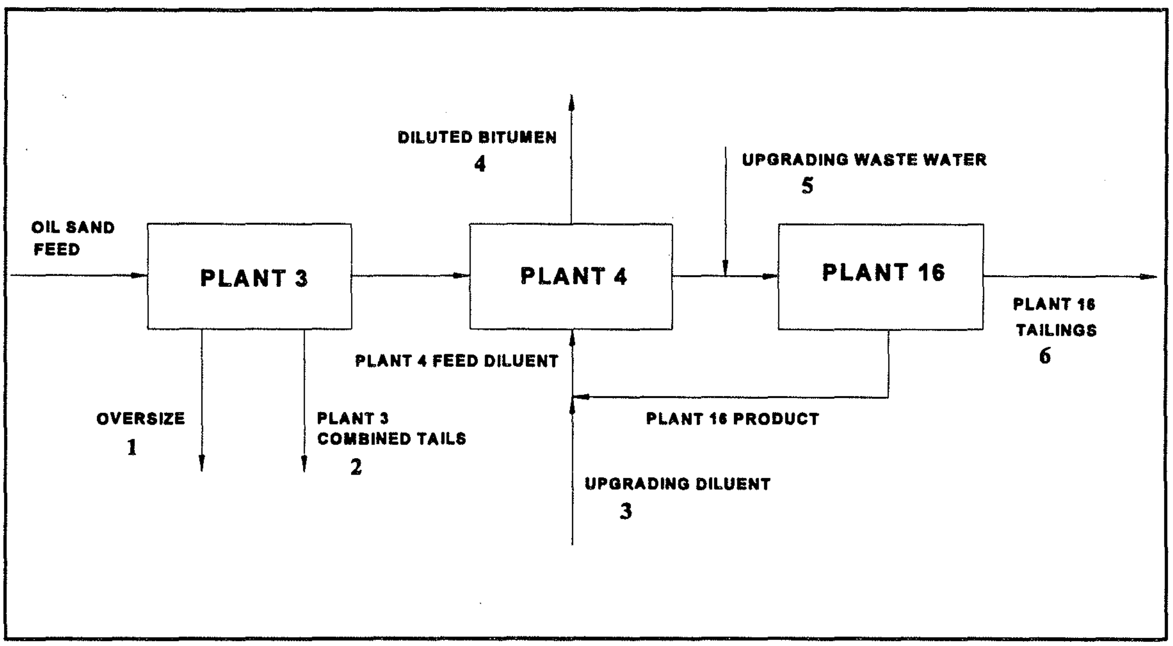


Figure C7.01 Extraction Hydrocarbon Streams

calculated based on the amount of bitumen or diluent in diluted bitumen produced by Extraction over total bitumen or diluent in Extraction.

With reference to the figure:

Bitumen Recovery = $B_4/(B_1+B_2+B_4+B_6)$

Diluent Recovery = $D_4/(D_3+D_5)$

Where B is the quantity of bitumen in the particular stream and D is the quantity of diluent in the stream.

7.3.2 Flows and Definition

The following is a description of the streams indicated in Figure C7.0-1.

Oversize- Stream 1

Plant 3 oversize (reject material from the oversize screens) is disposed of in the mine. This stream contains unrecovered bitumen.

Plant 3 Combined Tailings - Stream 2

Plant 3 combined tailings stream includes separation cell tailings and scavenger circuit tailings. This stream contains bitumen that is pumped to tailings ponds via the final tails pump house.

Upgrading Diluent -Stream 3

Upgrading diluent is supplied to Extraction by Upgrading. This stream is combined with Plant 16 product (diluent stripping tower) to form the Plant 4 feed diluent stream.

Diluted Bitumen Product - Stream 4

Diluted bitumen is the Extraction product stream transferred to the Upgrader. All amounts of recovered bitumen and diluent leaving Extraction are in this stream.

Upgrading Wastewater Product - Stream 5

Upgrading wastewater is a combination of process water and slop tank drainage water that is pumped to Plant 16 from Upgrading. Process water contains a small amount of diluent and slop tank drainage water contains a mixture of hydrocarbon. Due to the small amount of hydrocarbon this will be stated as diluent for the purpose of this balance.

Plant 16 Tailings - Stream 6

Plant 16 tailings contains all tailings from Plant 4, the secondary Extraction process. The stream contains bitumen and diluent not recovered in Plants 4 and 16.

7.3.3 Sample Calculation

A sample calculation is shown in Table C7.0-3. While numbers used in the sample calculation are representative of the process the numbers themselves are not process data from the same time period and they are only to be used as an example. Stream numbers refer to numbered locations illustrated in Figure C7.0-1.

Sample analyses were varied through a reasonable range of calculations to determine sensitivity of bitumen and diluent recovery to the specific variation. It was concluded that inaccuracies in bitumen or diluent content (particularly in Streams 1 to 4) can have an important impact on calculated recovery. Additional sensitivity analysis is being conducted.

TABLE C7.0-3

SAMPLE CALCULATION - BITUMEN AND DILUENT RECOVERY

	Plant 3 Oversize	**Plant 3 Combined Tailings**	**Upgrading Diluent**	**Diluted Bitumen Product**	**Upgrading Waste - water**	**Plant 16 Tailings**
STREAM	**1**	**2**	**3**	**4**	**5**	**6**
Bitumen (wt %)	3.20	0.35	00.0	57.74	0.00	1.44
Diluent (wt%)	0.00	0.00	99.8	37.26	0.06	0.39
FLOW						
Total (USgpm)		22 500	2454	6300	782	4200
Density (kg/l)		1.65	0.87	0.90	1.00	1.16
Total (t/h)	500	9281	534	1417	195	1218
Bitumen (t/h)	18.50	32.48	0.00	818.45	0.00	17.54
Diluent (t/h)	0.00	0.00	532.67	528.16	0.12	4.69
RECOVERY *						
Bitumen (%)	-1.8	-3.7		92.5		-2.0
Diluent (%)			100.0	99.1	0.0	-0.9

* Negative numbers indicate a loss of bitumen or diluent.

7.3.4 Sample Points and Instrumentation

Oversize - Stream 1

Bitumen losses to the oversize stream will be calculated using a fixed bitumen content (to be determined). Attempts to core-hole the oversize dump (to establish bitumen content) have been unsuccessful. Other methods of sampling the oversize dump are being investigated; the best alternative will be selected and used to determine average oversize bitumen content. Oversize weight will be measured using the weightometer installed on the oversize conveyor.

Plant 3 Combined Tailings - Stream 2

Bitumen losses in Plant 3 combined tailings will be calculated using analysis of a representative stream sample and a flowmeter. Tailings will continue to be sampled with an auto-sampler at discharge of the separation cell bottoms pump. The autosampler (Isolok) will remain in its present location unless sample verification indicates it should be relocated. Flowmeters will be installed to measure tailings flow for each process line, initially one flowmeter will be purchased and tested (to ensure accurate measurement), prior to their installation on all other lines.

Upgrading Diluent - Stream 3

Upgrading diluent to Plant 4 will be calculated using the flow rate, density and sample analysis of Plant 4 Feed diluent less Plant 16 product (determined by a flow rate and a calculated assay).

The Plant 4 Feed diluent stream will be sampled using the present auto-sampler and shift composite samples will continue to be taken. Due to the relatively-low volume and small component variance of Plant 16 product a fixed analysis will be used for it. A sampling program will be employed to determine average composition of the diluent supply to Extraction by taking the Plant 16 product out of the Plant 4 diluent feed stream.

Flows will be measured for three diluent streams. Current Plant 4 diluent and Plant 16 product flowmeters will continue to be used while a new flowmeter will be installed on the diluent piping from Upgrading (during the 1997 turn-around). Prior to its installation diluent flow to Extraction will be determined by calculation of difference.

Diluted Bitumen Product - Stream 4

Bitumen and diluent content of the diluted bitumen will be calculated using flow rate, sample analysis and density, the same method as is used at present. Diluted bitumen will continue to be sampled as a shift composite using the existing auto-sampler on the pump-around loop and diluted bitumen flow will be measured using existing flowmeters.

Upgrading Wastewater Product - Stream 5

Diluent content of the Upgrading wastewater stream will be calculated using flow rates, densities and sample analyses for the two streams making up the combined stream. Upgrading wastewater streams will be sampled (using auto-samplers) and will be analyzed on a shift composite basis with existing flowmeters used to measure flow of wastewater streams.

Plant 16 Tailings - Stream 6

Bitumen and diluent losses in Plant 16 tailings will be calculated using flow rate, density and sample analysis. Samples of Plant 16 tailings will be collected as a shift composite sample using auto-samplers located on the horizontal sections of tailings lines outside Plant 4. The flowmeters presently in use will be replaced with new flowmeters. Initially a new flowmeter will be selected and installed on one line for testing prior to their installation on the other lines.

7.3.5 Program to Develop Sample Points, Instrumentation and Verification

All sample points associated with the material balance will be studied to ensure their accuracy. Intricacy of the study will vary with type of material being sampled and the effects sample results variance have on the material balance. Results of all sample and instrumentation verification will be filed for auditing purposes.

Oversize - Stream 1

Data from the oversize sampling program will be assessed to determine statistical validity of the bitumen content estimate. This will either ensure that the sampling method is accurate or will identify the need to develop another method of measuring bitumen content.

The sampling program to determine bitumen content of Plant 3 oversize material will be repeated annually or semi-annually to ensure the estimate is representative. Calibration of the oversize weightometer will be performed semi-annually, unless re-calibration is indicated (by a difference in results between the weightometer and the oversize truck count). To re-calibrate the weightometer trucks will be weighed.

Plant 3 Combined Tailings - Stream 2

Testing of the Plant 3 combined tailings auto-sampler has been completed, the data are being analyzed and a report will be issued. A testing program at the Saskatchewan Research Council is planned for 1996. After the two test programs are completed optimum placement of the auto-sampler will be well-defined. A new flowmeter will be selected and tested to measure Plant 3 combined tailings flow.

The Plant 3 combined tailings auto-sampler will be checked semi-annually by using the separation cell bottoms density metre. This density will be compared with the sample density to ensure the autosamplers are continuing to give representative samples. Re-calibration and inspection of the tailings flowmeters will be performed on a bi-monthly basis.

Upgrading Diluent - Stream 3

Accuracy of the existing Plant 4 feed diluent auto-sampler has never been in doubt because it samples a homogeneous stream. However, a short-duration program will be implemented to confirm its accuracy.

Plant 4 feed dilution stream auto-sampler results will be compared to those from a series once a year to ensure accuracy is maintained. The fixed analysis to be used for Plant 16 product will be checked using a short-duration sampling program semi-annually.

Diluted Bitumen Product - Stream 3

Diluted bitumen sampling will be checked by implementing a short-duration sampling program. Diluted bitumen auto-sampler results will be compared to those from a series of manual samples semi-annually to ensure accuracy is maintained.

Upgrading Wastewater Product - Steam 5

Upgrading wastewater streams have little or no effect on the material balance so no work on them is recommended. Samples taken after implementation of the South Tank Farm Dewatering Project will identify stream composition.

The streams will be sampled using existing auto-samplers. If there is a change in analysis the Upgrader will be contacted to determine whether the change is process-related. Auto-samplers will be checked if the change cannot be explained by a process change.

Plant 16 Tailings - Stream 6

The Plant 16 tailings auto-samplers do not require any development work. The hydrocarbon analysis will be examined and (if required) changes will be developed. The present venturi flowmeters (used to measure flow of Plant 16 tailings) wear quickly, resulting in inaccurate measurement. Consequently, a new flowmeter will be selected and tested for reliability. Upgrading wastewater streams will be sampled using existing auto-samplers. If there is a change in analysis the Upgrader will be contacted to determine whether the change is process-related. Auto-samplers will be checked if the change cannot be explained by a process change.

Plant 16 tailings sample results will be compared to Plant 16 tailings density metre to ensure sample accuracy is maintained. The flowmeter will be re-calibrated and inspected on a bi-monthly basis.

7.4 WATER BALANCE

Site-wide water process water balance is presented in Appendix III. Subsection C3.4 describes Steepbank Mine wastewater management and water diversion.

7.5 ENERGY SOURCES

Suncor's fixed plants will supply the energy needed by Steepbank Mine. These needs include heat (in water and steam), electric power (from Utilities) and diesel (from the Upgrader) for the mine fleet. The Suncor Application for Fixed Plant Expansion (Suncor 1996a) describes the Utilities plant facilities required to support a production rate of 107 kbpcd.

C PROPOSED STEEPBANK MINE

8.0 ENVIRONMENTAL STREAMS AND CONTROL SYSTEMS

This section describes the new and incremental atmospheric and aqueous streams resulting from the proposed Steepbank Mine, hydrotransport and the modified Extraction plant. Included is discussion of the management of petroleum coke, sulphur, landfill waste, domestic sewage, gypsum (from the FGD plant) and emergency response. For detailed information about current emissions, and mitigative or control practices and initiatives refer to the Application for Renewal of Environmental Operating Approval, February 1995 (Suncor 1995a).

8.1 EMISSIONS TO AIR

8.1.1 Volatile Organic Compounds

Volatile Organic Compounds (VOCs) or light hydrocarbons are the major pollutants of concern in bitumen production. Continuous improvement in control of VOCs and the introduction of consolidated tailings are expected to contribute to a reduction in VOCs released over the next several years.

Table C8.0-1 indicates potential sources of VOC emissions in bitumen production.

In 1995 Suncor installed a Vapour Recovery Unit (VRU) to condense and recover VOC emissions from secondary Extraction vents, the Naphtha Recovery Unit and diluted bitumen storage tanks. The VRU is designed to remove 99% of H_2S and 99 wt% of incoming hydrocarbon.

Also in 1995 Suncor designed and implemented (on a test basis) a VOC recovery scheme for a primary froth deaerator. Modifications to the unit were made in January 1996. A recovery system (planned for installation by the end of 1996) will collect VOC emissions from the remaining froth deaerators and froth storage. Conditioning drums will no longer be used with the hydrotransport system eliminating that source of VOCs. Remaining sources of uncollected VOCs in the Extraction plant are the separation cells and the flotation cells. Because these operate at modest temperatures with heavy hydrocarbons (and at lower temperatures in the future with use of the hydrotransport system), their contribution to VOC emission is low.

TABLE C8.0-1

VOLATILE HYDROCARBON EMISSIONS

Emission Source	Operating Temperature (°C)	VOC Emissions-Current Operations	VOC Emissions-(Proposed) Steepbank Operations
Cyclofeeder	55 - 60	Not applicable	Low
Conditioning Drums	70 - 80	Not collected	Not applicable
Separation Cells	Current 70 - 75 Steepbank (proposed) 50 - 55	Not collected	Not collected
Primary Froth Deaerator	95	All collected by end of 1996	Collected
Flotation Cells	Current 70 - 75 Steepbank (proposed) 50 - 55	Not collected	Not collected
Froth Settler	Current 70 - 75 Steepbank (proposed) 50 - 55	To collect via Plant 3 vent by end of 1996	Collected via Plant 3 vent
Secondary Froth Deaerator	95	To collect by end of 1996	Collected via Plant 3 vent
Froth Storage	95	To collect via Plant 3 vent by end of 1996	Collected via Plant 3 vent
Plant 4 Vent	Ambient	Collected	Collected
Diluted Bitumen Tanks	80 - 85	Collected by VRU	Collected
Plant 4 Emergency Pond	Ambient	Normally nil	Normally nil
Diluent Stripping Tower	65	Collected by VRU	Collected
Plant 3 Tailings Pond	Ambient	Low	Reduced with CT
Plant 4 Tailings Pond	Ambient	Being reduced	Reduced with NRU and other improvements

Introduction of a hydrotransport system for Steepbank Mine presents the possibility of VOCs released at the cyclofeeders, which are open vessels. Based on the fact that cyclofeeders operate at a relatively-low temperature (55°C to 60°C), VOCs released at that location are expected to be very low. Their character would be similar to those from the Extraction separation cells.

Site wide VOC emissions are expected to be reduced at the 107 kbpcd production rate to 33% of 1995 levels (Table C8.0-2).

TABLE C8.0-2

COMPARISON OF CURRENT AND FUTURE VOC EMISSIONS

Year		1990	1995	1998	2001
Gross Production Rate	**(bbl/cd)**	**58 900**	**77 500**	**87 000**	**107 000**
	(m^3/cd)	**9 364**	**12 321**	**13 832**	**17 012**
Tailings Ponds[a]	(t/cd)	2.3	3.5	3.9	4.6
Tank Storage[b]	(t/cd)	5.8	6.9	0.3	0.3
Extraction[c]	(t/cd)	18.2	25.6	14.1	0.3
Upgrading[d]	(t/cd)	4.6	6.3	6.9	7.7
Cyclofeeder[e]	(t/cd)	0.0	0.0	0.0	1.0
TOTAL	(t/cd)	30.9	42.3	25.2	13.9
VOC Per Unit of Production		.00329	.00318	.00182	.00082

a Primarily Pond 1
b North and south tank farms.
c Primary extraction Plant 3 and extraction centrifuge Plant 4
d From fugitive sources
e Estimate

Field measurements of pond emissions have indicated that ponds are a much-less significant contributor to current VOC emissions from the plant site than originally thought (less than ten percent of total VOCs release in 1995). The NRU will be modified so that diluent losses to the ponds at 107 kbpcd are no more than at 79.5 kbpcd.

Application of consolidated tailings (CT) technology may introduce odours at two locations: the CT mixing tank and the deposition site. No noxious vapours have been detected in spot checks of the commercial CT trial at these locations. Mitigations (if required) could include collection of the mixing tank vapours and underwater deposition of CT.

In the longer term it has been suggested that anaerobic production of noxious vapours or volatization of hydrocarbons from the CT deposits might occur. Suncor believes that this will contribute an insignificant impact to the environment. The field demonstration test will be monitored for this occurrence.

8.1.2 Greenhouse Gas Emissions

Greenhouse gas (GHG) emissions from bitumen production operations are largely due to energy use. With the introduction of hydrotransport technology and warm-water extraction energy consumption and emission per unit of bitumen production is projected to decrease site-wide. As production capacity increases (from the current 79.5 kbpcd to 107 kbpcd, a 35% increase), carbon dioxide, the largest component of GHG, emissions will increase (from an estimated 9.3 kt/d to 9.8 kt/d, a 5% increase).

Suncor Oil Sands Group (OSG) acknowledges its environmental stewardship responsibilities with respect to climate change and seeks to manage this environmental concern on a voluntary basis in accordance with the precautionary principle. OSG has established, as a key goal, the stabilization of greenhouse gas emissions from its operations at or below 1990 levels by 2001. OSG is committed to achieving this goal through the actions described below.

Without a reduction strategy, OSG's GHG emissions would increase 79.4% between 1990 and 2001 (from approximately 3.4 to 6.1 megatonnes/year). As disclosed in Suncor's 1995 Voluntary Challenge Action Plan, actions taken and committed projects to date reduce the projected emissions at 2001 to 4.0 megatonnes/year (a 17.6% increase over 1990 levels). A further reduction of 600 000 tonnes/year is required to reach the stabilization goal.

OSG will achieve approximately 90% of that required reduction in GHG emissions through modifications to its facilities and implementation of new technology as a part of its Fixed Plant Expansion and Steepbank Mine Projects (see Section C5.0).

An additional 5% reduction is expected to be realized through projects currently under consideration, including a third turbogenerator and hot water surge tank installed in its Utilities plant. These projects still require further assessment, engineering and financial approval.

Currently, OSG has not identified specific improvements which would provide the final 5% reduction in GHG emissions. OSG is confident this will be achieved by measures developed through implementing a comprehensive GHG reduction management strategy which includes such elements as:

- establishment of clear GHG goals and targets;

- senior management stewardship;
- mobilization of technical and research resources;
- use of internal financial signal and price mechanisms;
- employee education and motivation;
- GHG emissions and eco-efficiency indicator measurement and reporting;
- GHG sensitive procurement practices; and
- ongoing consultation with external experts and concerned publics.

OSG will maintain an ongoing and effective GHG reduction effort beyond the point that projects are implemented to achieve the 2001 stabilization goal.

Success will not only be measured by the actual outcome of any initiative, but by the dedication of OSG to work toward achieving the goal. This commitment provides the opportunity to achieve the stabilization goal and positions Suncor to realize further reduction opportunities beyond 2001.

8.1.3 Oxides of Nitrogen

Bitumen production operations will contribute less than 15% of the total NO_x generated from Suncor's plant site. Almost all of these emissions are from the mine vehicle fleet which utilizes diesel engines. NO_x emissions will increase (from 3.1 t/d to 5.2 t/d) with the expanded mine vehicle fleet required for Steepbank Mine. Selection criteria for the vehicle fleet includes emission performance.

Site wide NO_x emissions are predicted to be reduced from 1995 levels of 37.1 t/cd to 35.9 t/cd at the 107 kbpcd rate.

8.1.4 Sulphur Dioxide, Hydrogen Sulphide and Fugitive Emissions

There are insignificant emissions of SO_2 from bitumen production operations. With commissioning of the Vapour Recovery Unit H_2S emissions are now also insignificant.

Fugitive emissions are defined as those which occur from leaks in valves, flanges, packing seals and previously-discussed tailings ponds. Other than ponds, the only potential fugitive emission source is Plant 4. Any possible fugitive emissions are believed to be minor.

Site-wide SO_2 levels are predicted to be reduced from 1995 levels of 233.5 t/cd to 51 t/cd in 1980 with flue gas desulphurization.

8.1.5 Particulate Emissions

Particulate emissions from bitumen production operations may occur from three main sources:

Mine Operations

Both vehicle traffic on corridor and haul roads and wind erosion on cleared areas scatter particles of sand (silica dust) into the surrounding environment. Haul roads and corridor roads are wetted to minimize this dust. Overburden stripping operations precede mine operations by about six months, limiting the area exposed.

Tailings Beaches and Dykes

At Steepbank Mine dykes will be constructed of overburden materials and will be revegetated promptly to reduce erosion. Consolidated tailings will be placed underwater, reducing dust concerns for beach areas.

Coke Pile

Temporary vegetative cover on the stockpile is used as part of routine dust suppression activities.

The current coke pile is expected to reach capacity in 1999. Suncor is evaluating the transfer of coke after that time to a site to be determined.

Site wide particulates are also generated by the combustion of coke in Utilities. Ninety-eight percent of these are removed by electrostatic precipitators. When the Flue Gas Desulphurization unit is operating, 85% of the remaining particulates will be removed.

8.1.6 Current and Proposed Monitoring Design

Current air and environmental quality monitoring practices are discussed in more detail in the Application for Renewal of Environmental Operating Approval, February 1995 (Suncor 1995a).

a) Air Quality Monitoring

Current ambient air quality monitoring in the region is accomplished by three separate systems. Suncor and Syncrude each maintain a network of five monitoring stations and Alberta Environmental Protection maintains a network of two stations.

In addition both Suncor and Syncrude maintain a network of static exposure stations (40 and 30 respectively) and AEP operates a further six static exposure stations.

Suncor has been collecting continuous ambient data in the vicinity of its oil sands plant since 1975. All five of its continuous ambient monitoring stations collect SO_2 data, four of the stations also collect H_2S data and two of the stations measure hydrocarbon. Syncrude has been collecting continuous readings from its five ambient monitoring stations since 1979. Both H_2S and SO_2 are measured at all five of its stations, and NO_x and THC are measured at one station. AEP has been observing ambient air quality at its stations in Fort McMurray and Fort MacKay since 1977 and 1983 respectively. Both of the AEP ambient stations collect data on SO_2, H_2S, and total hydrocarbon. Emissions data on NO_x, ozone, CO, NO_2 and co-efficient of haze are also collected at the Fort McMurray station. All continuous ambient monitoring stations record wind speed and direction.

An enhanced air quality monitoring network has been proposed. Technical details for this network are not currently available as various options are under consideration by the Air Monitoring Subcommittee of the Regional Air Quality Co-ordinating Committee (RAQCC). This committee is a multi-party group of individuals representing community interest groups, regulatory bodies and industry participants.

Suncor's Fina Air Quality Monitoring station is located within the Steepbank Mine area along with three static stations. The elimination of these will be considered in the RAQCC review of the regional network.

b) Environmental Effects Monitoring

Biological observation in the region has been undertaken in the past by government agencies as well as oil sands operators and the Alberta Oil Sands Environmental Research Program (AOSERP). The current approach is toward a co-ordinated effort with input from all members of RAQCC. Typical projects either completed or continuing to date include :

- lichen studies,
- infrared photography (vegetative stress),
- small mammal studies,
- animal census,
- visible foliar studies (of trees in the region),
- berry studies, and
- soil acidification studies.

Another sub-committee of RAQCC is currently addressing a regional bio-monitoring program.

Final design of the bio-monitoring program is not completed but the program is likely to focus on a number of selected boreal forest plots, analyzing changes in vegetation and soils over time. Observation of selected parameters will be carried out to detect any changes or trends in the plots; this will be followed by relating these changes or trends to changes in regional air quality. As a result there is expected to be some linkage between the networks proposed by both the air quality monitoring and bio-monitoring subcommittees.

8.2 WASTE MANAGEMENT

Suncor's waste management systems have been designed incorporating the assertion that effective waste control is achieved by an approach that takes into account waste at both its generation and disposal stages (life cycle approach).

To help control waste generation, a Chemical Product Approval System has been implemented. All chemical products used on the plant site must first be approved by the Environmental Health and Safety department of Suncor. Products are reviewed to ensure that they do not contain any banned substances or (in the case of certain pesticides) that they are handled only by certified employees.

Product users are provided with information about approved disposal practices and reportable release regulations. Approved products (over 2000) are each assigned a unique identifier number and catalogued with entries including identification of their chemical ingredients. Suncor has also commissioned detailed waste inventories that identify, classify and quantify process and chemical waste streams generated in the course of operations.

In addition to the Industrial Wastewater Treatment System Suncor has three primary systems for handling its waste streams: the Class II Industrial Landfill, the Hazardous Waste Storage Yard, and the Tailings Pond Liquid Waste Disposal Site. Current practice with respect to these four systems is discussed in detail in the Application for Renewal of Environmental Operating Approval, February 1995 (Suncor 1995a).

Management of the wastewater system when production is at the rate of 107 kbpcd is an Upgrader issue and is discussed in the Application for Fixed Plant Expansion (March 1996) to the AEUB and AEP. The impact of Steepbank Mine on the remaining three waste stream-handling systems is discussed in the following subsections.

8.2.1 Industrial Landfill

Suncor currently maintains a Class II Industrial Landfill at its operations on Lease 86/17 in an area on the south shore of Pond 4. Rising water levels in Pond 4 will require establishment of a new landfill by the end of 1996: its location has not yet been determined. This new landfill will be the subject of a separate approval application to Alberta Environmental Protection.

Since 1 September 1993 the Industrial Landfill has been operated in accordance with the requirements of both the Waste Control Regulation and Section 8 (Hazardous and Solid Waste) of the current AEP Environmental Operating Approval. In areas where the two documents are not in agreement the more stringent requirement is applied. Suncor does not dispose of any liquid waste into its landfill. As well, restrictions (Section 14 of the Waste Control Regulation and Suncor's Environmental Operating Approval) prohibit burial of selected hazardous wastes.

The Industrial Landfill is staffed eight hours per day, five days per week. Although access to the Landfill is not controlled, primary utilization of the site occurs during the hours it is staffed. Landfill operations are audited internally by Suncor staff and externally by AEP inspectors.

Only one facility associated with Steepbank Mine will generate significant waste: the new integrated service complex. All industrial waste generated on the east side of the Athabasca River will be collected in dumpsters and transported to the Industrial Landfill on Lease 86/17. If a landfill becomes necessary on the east side after start-up it will be limited to acceptance of non-hazardous solid waste only. Other wastes will be directed to the Hazardous Waste Storage Yard, the Tailings Pond Liquid Waste Disposal Site or the Upgrader Hydrocarbon Recovery Basin.

8.2.2 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 is targeted for recycling. This Yard is operated in accordance with standards set out in the Waste Control Regulation of AEPEA and it is regularly inspected by AEP.

An accumulation or staging area will be designated at Steepbank Mine for temporary, short-term storage of drums of hazardous waste pending their transport to either the Hazardous Waste Storage Yard or the Industrial Landfill. Bulk volumes of liquid waste will be moved by tanker trucks as they are generated, either for disposal (at the Tailings Pond Liquid Waste Disposal Site) or for recycling (at the Upgrader Hydrocarbon Recovery Basin). Hazardous waste drum inventory at the staging area will be limited to sixteen oversize drums. Provision for secondary containment will be made in this staging area.

All drums of hazardous material to be moved across the river will be packed into heavy-gauge, oversize drums prior to loading for transport: thus, each drum will have its own secondary containment. Drums will be secured onto trucks for transport across the river and trucks moving hazardous waste will be equipped with hazardous material spill containment and response supplies.

8.2.3 Tailings Pond Liquid Waste Disposal Site

Selected bulk liquid waste streams from tanker trucks are currently deposited into tailings ponds at a designated location. The present location is close to the Industrial Landfill on the south shore of Pond 4. Disposal criteria and systems to control and monitor disposal are established in a Suncor internal standard.

Waste oil and waste glycol generated at the Steepbank Mine service complex will be segregated at source and will be transported across the river in secure containers. Waste oil will be recycled while waste glycol may be either recycled externally or used internally.

8.3 COKE STORAGE

Coke handling and storage are the responsibility of bitumen production operations at Suncor.

At current rates of production about 0.37 Mt/y of coke is stockpiled in a coke storage area (north of the Upgrading plant). Another smaller coke storage area accommodates the daily needs of the Utilities plant.

The current coke stockpile is expected to reach capacity in 1999 after which a new coke stockpile (its location currently under consideration) will be established. Repeated efforts over the years have failed to develop a market for the product. Current and projected inventories of coke (assuming no other use develops) are as follows:

- Coke stockpiled at 1 January 1995: 4.6 Mt
- Coke stockpiled at 1 January 2002: 6.9 Mt
- Coke production to stockpile at 107 kbpcd: 0.6 Mt/y

8.4 GYPSUM

After Suncor commissions the Flue Gas Desulphurization (FGD) unit in 1996 gypsum will be generated as a by-product. Gypsum from the FGD unit will be in a slurry and will be pumped for disposal initially to a section of Pond 4. Because of its low solubility in water gypsum will settle out quickly. A long-term disposal site will be selected after the FGD commences operation, when the volume and quality of gypsum are established. Estimated production of gypsum at 107 kbpcd upgraded crude oil is about 0.36 Mt/y; a portion of this output will be used in the formulation of consolidated tailings. It is possible that gypsum may be marketed.

8.5 AQUEOUS STREAMS

Management of all waters associated with Steepbank Mine is discussed in Subsection C3.4 and current water management practice is described in Suncor's application for Environmental Operating Approval (Suncor 1995a).

8.6 DOMESTIC SEWAGE

All domestic sewage from Suncor's offices, plants and the camp facility at its present operation is directed to the Sewage Treatment System for retention and natural treatment with final treated effluent discharged to the Athabasca River. The system was upgraded in 1995 with the addition of aeration treatment cells and a final treatment polishing cell.

Effluent from the sewage treatment system is discharged to the Athabasca River at the Mid-Plant drainage outfall. The upgraded sewage treatment system meets all AEP treated sewage discharge standards on a year-round basis.

A sewage treatment facility is required for Steepbank Mine to treat grey water and sanitary sewage from various facilities within the hydrotransport and integrated service complexes. Sanitary sewage from these facilities will be directed to a 19 m^3 underground storage tank then pumped to the sewage treatment facility. Wastewater from the shop areas will be separated into oily-water and grey-water streams. Oily waste will be temporarily stored in two 38 m^3 underground tanks at the main shop area and a 19 m^3 underground tank at the light-vehicle shop. The tanks will be emptied as required with their contents transferred to the liquid disposal site.

The sewage treatment facility is composed of a septic/surge tank, a rotary biological contact treatment plant and a wastewater disposal field. The facility will accommodate a daily through-put of about 110 m^3/d (30 000 gallons per day). Treated water from the sewage treatment facility will be discharged to the Athabasca River via the Steepbank Mine interception drainage outfall, similar to the current arrangement (at the Mid-Plant drainage outfall) on Lease 86/17.

8.7 EMERGENCY RESPONSE

Emergency response procedures at Suncor are well-established; they are described briefly in Subsection B2.1 and in more detail in the Application for Environmental Operating Approval (Suncor 1995a). Existing procedures for Bitumen Production Operations will apply to Steepbank Mine. Slurry transport of ore and tailings in pipelines installed on the bridge over the Athabasca River presents an incremental risk potential. As previously discussed design features, frequent inspection and monitoring, and built-in spill containment makes the likelihood of a spill from the bridge remote.

Detailed emergency response procedures equal in quality to those already in place for Suncor's current operations will be developed prior to operation of the new facilities proposed in this Application.

Suncor's emergency response plan already includes preparation for the scenario of an oil spill into the Athabasca River. During the open water season boom equipment and absorbents at the plant site would be promptly deployed. Suncor personnel are trained to respond to such emergencies and they will continue to be trained to deal specifically with incidents on the Athabasca River.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

TABLES

FIGURES

(located at end of each section - where applicable)

LIST OF TABLES AND FIGURES

FIGURES **PAGE**

D AEPEA APPROVAL REQUIREMENTS

This section along with associated sections of this Application constitutes Suncor's request for approval for the construction and operation of the Steepbank Mine and associated Extraction plant modifications as well as the integrated reclamation plan for Lease 86/17 and Steepbank Mine, in accordance with AEPEA.

Specifically, this section will request amendments to the current Environmental Operating Approval.

Information about current operations is found in both Section B of this Application and the Application for Renewal of Environmental Operating Approval, February 1995. The proposed Steepbank Mine and resulting modifications to bitumen production facilities are described in Section C; specific environmental atmospheric and aqueous streams are described in Section C8.0.

Amendments to the current Environmental Operating Approval attributed to the proposed expansion of the fixed plant capacity are requested in the Application for Fixed Plant Expansion (Suncor 1996a). The Fixed Plant Expansion Application included Extraction modifications to increase capacity to 87 kbpcd. This Application includes modifications to the existing Extraction facilities required to reach 107 kbpcd capacity and the associated Naphtha Recovery Unit upgrade.

1.0 WASTE

Solid and liquid wastes generated from Steepbank Mine activities and processes are similar to those from the current operation, so present waste management practices will apply.

Suncor expects to submit a separate application in 1996 requesting approval for a new industrial landfill site on Lease 86/17, which will receive Steepbank Mine wastes suitable for disposal in this facility.

2.0 SUBSTANCE RELEASE

2.1 AIR EMISSIONS

Only one new source of air emissions is associated with Steepbank Mine produced from the hydrotransport cyclofeeder at the Hydrotransport Complex, on the east side of the Athabasca River. While emissions from this facility are expected to be low, Suncor nonetheless requests that the facility be listed as an approved emission point.

Suncor's Fina Air Quality Monitoring Station and three Sulphation Stations will be eliminated because of the Steepbank Mine development. Suncor recommends that the removal of these be acknowledged in annual reporting during the 10-year approval period. The replacement of these monitoring stations should be considered within the RAQCC current re-assessment of the regional system.

2.2 WATER EMISSIONS

2.2.1 Surface Drainage

Water diversions and wastewater management for Steepbank Mine are discussed in Subsection C3.4.

Suncor requests approval for discharge of all mine intercept drainage streams to the Athabasca River as described and quantified in Subsection C3.4. Water discharge to the Athabasca River will be through various existing natural watercourses (Unnamed Creek, Shipyard Lake, Leggett Creek and Wood Creek) as follows:

- period 1997 to 2003: via Unnamed Creek and Shipyard Lake
- period 2003 to 2009: via interception channels through Shipyard Lake; and via Leggett Creek from 2008
- period 2009 to 2015: via a diversion channel through Shipyard Lake; and via a diversion channel to Leggett Creek
- period 2015 to 2020: via Shipyard Lake and Wood Creek

2.2.2 Sewage

Suncor requests approval for an additional sewage treatment facility to be located at the Integrated Service Complex on the east side of the Athabasca River. The system is described in Subsection C3.4.4. Treated water from the facility will be discharged via Shipyard Lake.

2.2.3 Consolidated Tailings Release Water

The implementation of consolidated tailings technology will result in the need to discharge consolidated tailings release water to the environment. This is discussed in Subsection 3.4.4. Suncor will apply for approval of this release prior to 2000, which is the conservative estimate of the timing of storage limitation.

2.3 GROUNDWATER

Groundwater conditions for Steepbank Mine are discussed in Subsections C3.4 and E7.0. In 1995 twelve standpipes were installed in Lease 97 and Fee Lots 1 and 3 to monitor groundwater quality and pressure, located in limestone (2), the basal aquifer (5) and in overburden aquifers (5). In addition, sixteen pneumatic piezometers were installed to measure pressure heads.

Groundwater wells on the Steepbank Mine site will be sampled semi-annually as part of the Suncor groundwater monitoring program. In 1997 the status of these wells will be reviewed to determine if either the sampling frequency or the sampling parameters requires modification. Any wells for which monitoring frequencies or sampling parameters change will be returned to the original semi-annual, full-parameter monitoring program as mining advances into proximity of the well.

Suncor requests approval for the additions to the groundwater monitoring program associated with Steepbank Mine.

3.0 CONSERVATION AND RECLAMATION

3.1 INTRODUCTION

The Conservation and Reclamation section is the basis of Suncor's request for reclamation approval under AEPEA Approval Regulation, Division 3.

Suncor commenced production on Lease 86/17 in 1967 and bitumen reserves on that lease will be exhausted in 2001. Over the last few years Suncor has acquired Leases 19, 23, 97 and 25 and Fee Lots 1 to 6. These properties contain sufficient resources to allow bitumen production operations to extend past the middle of the next century. Therefore conservation and reclamation planning assumes continued production operations well beyond the twenty-year mine plan for Steepbank Mine project submitted here.

3.1.1 Purpose of Conservation and Reclamation Section

Suncor intends to progressively reclaim its disturbed lands to a certifiable state and capability equivalent to pre-disturbance conditions. This section includes an explanation of Suncor's vision for reclaimed landscapes; a description of the strategy to realize that vision within each step of the full- project life cycle; and a demonstration of the means by which the project will diligently meet the criteria for environmental acceptability and regulatory requirements.

3.1.2 Overview of the Conservation and Reclamation Section

Information presented in this section follows the project through its natural life cycle (shown in Figure D3.0-1), consisting of the following seven steps:

- Project Goals - Project goals, design criteria and assessment techniques provide the basis for design of the project. An overview is provided in Subsection D3.2.

- Project Design Considerations - The project design phase incorporates determination of reclamation objectives including end use; assessment of pre-disturbance conditions; and selection of technologies best-suited to achieve both operating and reclamation objectives. Subsection D3.3 reviews this phase including a detailed examination of the consolidated tailings technology that provides the means to achieve an essentially dry reclamation landscape.

- Approvals - A project plan proposal is submitted for regulatory and community approvals: this Application provides documentation for this step.

- Operation Phase - This phase involves mine site preparation, oil sands mining and bitumen extraction, physical reconstruction of landforms, surface contouring, subsoil placement; and establishment of major hydrologic systems as discussed in Subsection D3.4. Landforms reconstruction will progress towards a dry landscape by applying new consolidated tailings (CT) technology, in which coarse and fine tailings are combined to form a stable deposit. Following this subsoil construction techniques will produce a trafficable surface for the CT deposit prior to soil reconstruction and revegetation.
- Reclamation Phase - The reclamation phase involves soil reconstruction, revegetation, and establishment of wetlands and watercourses as discussed in Subsection D3.5. Soil reconstruction and revegetation will commence as early as is practical following the operation phase. On Lease 86/17 most overburden storage areas and dyke slopes have already been reclaimed to healthy ecosystems inhabited by a number of wildlife species. Reclamation of tailings storage areas was not possible because of the need for active tailings storage during mining. Implementation of the CT process will eventually allow reclamation of disturbed areas to keep pace with new mining disturbance. The reclamation phase also includes Suncor's field demonstrations of components of its reclamation plan.

- Reclamation Performance Assessment and Monitoring - Full reclamation of an oil sands operation has not yet been completed. There are unique reclamation aspects which have not been demonstrated at full field scale. Because of this, performance projections of reclamation are attempted based on results from pilot-scale testing. Subsection D3.6 establishes the basis for Suncor's confidence that fully-successful reclamation can be achieved.

  Once active reclamation is complete and vegetation has been re-established Suncor will continue to monitor progress toward maturation of landscapes and ecosystems to provide the basis for its submission for reclamation certification as discussed in Subsection D3.6. During this phase, Suncor will also carry out any required maintenance activities on its reclamation areas. It is important to establish practical criteria which can serve as milestones in the maturation process (to determine whether long-term goals are likely to be achieved).

- End Uses and Reclamation Certification - Projected end uses for the reclaimed landscape are discussed in Subsection D3.7. The proposed reclamation plan provides considerable flexibility and opportunities to address specific future land uses including wildlife habitat, traditional land use, recreation and possibilities for commercial forest production. It is anticipated that future large-scale demonstrations followed by monitoring of fully-reclaimed areas will establish the basis for reclamation certification.

3.2 CONSERVATION AND RECLAMATION GOALS, CRITERIA AND ASSESSMENT TECHNIQUES

3.2.1 Goals

Suncor's vision for reclamation includes the construction of stable landforms and re-establishment of productive, self-sustaining ecosystems which will provide land use capabilities equivalent to those of the pre-mining environment. About 65% of the reclaimed area will be returned to upland forest; the remaining 35% will consist of shallow wetlands with some open-water areas. These tasks will be undertaken with minimal impact on the surrounding environment. The following general operational and reclamation criteria 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 River, must be controlled to an extremely-low probability.
- Discharge of earth materials through surface erosion processes will be controlled to rates which are acceptable to the environment.
- Discharge of surface and seepage waters will be managed to ensure an acceptable level of impact on the Athabasca River.
- The ecosystems re-established on disturbed lands will be fully self-sustaining and will mature naturally without presenting significant risk to resident or migratory species.
- Fully reclaimed lands will be maintenance-free, thereby justifying reclamation certification. Various end uses will be possible for the reclaimed landscape, with end-use decisions made based on input from the regional communities.

3.2.2 Specific Guidelines and Criteria

These specific criteria and guidelines which follow are based on the broad goals just outlined.

a) <u>Landform Security</u>

Suncor will continue to ensure that its earth structures will meet or exceed applicable Canadian standards for geotechnical security. Over the past thirty years the company has developed considerable expertise in construction with local oil sand materials; the basis for design, construction and operation is the Observational Approach (see Subsection D3.4.5), which comprises extensive monitoring during project construction and operation. Fluid-impounding structures are patrolled several times a day to confirm acceptable performance. As well, instrumentation is placed within each structure to monitor internal behaviour. An annual Performance Report is submitted to regulatory agencies detailing actual performance (and providing comparisons with expected performance) for the structures.

In the final reclamation phase, all structures will be "maintenance-free". At this point current fluid-impounding structures will be transformed to landforms with the consolidated tailings process producing a non-fluid infill material of soft soil consistency. The landforms must be stable under both static and anticipated earthquake loadings.

b) Rates of Erosion

Erosion of slopes along the Athabasca River is a natural process which has created the Athabasca Valley and sculpted local topography. Similar processes currently occurring on Suncor's tailings impoundment structures are monitored and appropriate remediation is applied. Small, localized movements of earth materials are to be expected but the movements must be at a sufficiently low rate to allow for self-healing of the vegetative cover.

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 or to overloading of systems receiving the erosion solids or to permanent disruption of vegetative cover.

c) Water Management

In accordance with the terms of its current Environmental Operating Approval Suncor discharges surface water and certain process waters to the Athabasca River at four locations: North, Mid-Plant, and South Mine drainage; and the Wastewater Treatment System / Cooling Pond E outfall. Water at these outfall locations is monitored daily for volume and quality, allowing Suncor to maintain control of these discharge streams. The Approval stipulates that dyke seepage streams are to be collected and returned to tailings ponds. Groundwater is to be monitored to improve understanding of its quality, flow paths and discharge locations. Drainage from the Steepbank Mine is discussed in Section C3.4.

In 1995 a joint industry/government task force the Oil Sands Water Release Technical Working Group - (OSWRTWG) - was created to address issues associated with oil sands waters. The group defined oil sands water releases as either operational or from reclamation (OSWRTWG 1996).

Operational waters are those waters that are characteristically:

- discharged from a channel or outfall;
- discharged over the life of the project or a shorter period;
- controllable;
- treatable in a managed treatment system;
- amenable to comparison with ambient water quality criteria; and
- potentially of concern when considering regional off-site impacts.

Sources of operational waters include:

- consolidated tailings release water,
- collected dyke seepage water,
- mine drainage water,
- upgrading process water,
- cooling water, and
- sewage treatment facility discharge.

Under final reclamation conditions discharge streams will not be controlled through human intervention. Reclamation waters are characteristically:

- non-point source, diffuse waters that may be directed through wetlands, streams or lakes prior to discharge off-site;
- released at slow rates over large areas for extended periods of time;
- non-controllable;
- non-treatable (but may be altered through natural systems or constructed wetlands);
- not amenable to comparison with ambient water quality criteria; and
- managed primarily with on-site water management systems which are components of maintenance-free reclamation landscapes.

Sources of reclamation waters include surface run-off and groundwater seepage from:

- sand dumps and dykes;
- consolidated tailings deposits;

- coke piles, gypsum storage facilities and landfills;
- overburden dumps and dykes; and
- wetland treatment systems.

The OSWRTWG developed a protocol (Figure D3.0-2) for assessing water discharge to ensure that impact on the Athabasca River is environmentally acceptable. 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 reclamation discharges; constructing facilities to provide required long-term controls; and monitoring the impact of these streams through the post-operation and reclamation periods. These efforts provide the basis for assurance that its maintenance-free final reclamation discharges will be environmentally acceptable.

d) <u>Ecosystem Re-Establishment</u>

About 65% of the reclaimed land area will be returned to upland forest while the remaining 35% will be shallow wetlands with some shallow, open-water areas. Suncor has developed and successfully demonstrated its reclamation techniques for overburden and tailings sand deposits over the last twenty-five years. Soil reconstruction of disturbed lands provides the basis for a variety of self-sustaining ecosystems capable of supporting a number of end uses.

Suncor's reclamation protocol calls for spreading 15 cm to 20 cm of muskeg soil amendment (wherever possible containing live native vegetation) on reconstructed landforms. Prior to the amendment, subsoil base materials (e.g., one or more of tailings sand, overburden and consolidated tailings) and a capping layer where required (e.g., on oversize and consolidated tailings deposits) are placed and levelled.

Prepared reclamation areas then undergo a single seeding of barley which serves as a nurse crop for out-planting nursery seedlings and other natural vegetation. Area fertilization is also undertaken for two to four years to establish adequate nutrient levels.

Woody-stemmed species are planted in reclamation areas with species mix and planting densities defined by the specific ecosystem-type goals for the reclamation area and the variable terrain features of the area. Average planting densities are 2500 stems per hectare. The mix of woody-stemmed species selected for planting will consist of a variety of native species suitable for prescribed area end uses. This revegetation mix will undergo natural succession processes and become a mature biological community providing habitat for wildlife as well as areas for traditional land use and recreation. Specific areas on the reclaimed site will have possibilities for timber production.

Suncor will ensure that for reclamation of river valley areas of Steepbank Mine, pre-disturbed ecosystem types are re-established as quickly as possible. Suncor will develop a report detailing its specific plans for reclamation of the Steepbank Mine-Athabasca River valley area by July 1996.

e) <u>End Uses and Reclamation Certification</u>

Suncor will reclaim disturbed lands to an equivalent or better capability than the pre-disturbed area. End-use decisions for the reclaimed areas will be determined through discussions with the regional land users and communities.

The length of time required for development of mature ecosystems within the Boreal Forest Eco-region means that reclamation areas will typically be assessed for certification long before the areas have fully matured. Therefore, Suncor will establish criteria and monitoring programs (acceptable to all parties) demonstrating that clear progress toward environmentally-sound and fully-mature ecosystems is being achieved as the basis for its application for reclamation area certification.

3.2.3 Reclamation Assessment Techniques

While reclamation practices in other industrial settings provide guidance for planning, there are many unique features related to oil sands. Reclamation performance has to be predicted decades or even centuries into the future. This frequently requires extrapolation of pilot test data and current experience as the basis for prediction of future performance. Suncor and Syncrude jointly sponsored the development of the Oil Sands Reclamation Performance Assessment Framework (OSRPAF) to assist in this process. A detailed generic description of framework concepts is given in Golder 1994. Figure D3.0-3 shows the relationships among key framework components which are also discussed briefly below.

a) <u>Reclamation Plan Alternatives</u>

The framework can be used at any point throughout the project life cycle but it may have greatest benefit in the early project planning stages. In these stages the location and compositions of landforms are still to be decided. Later (when landforms are designed or actually constructed) its use facilitates decision-making among surface contouring measures and corrective initiatives under consideration which could improve surface drainage, decrease erosion or enhance revegetation performance.

b) Performance Analysis

This activity predicts future behaviour of elements in the reclamation plan to enable identification of potential adverse effects. Elements include landform performance, impact of chemical contaminants and ecosystem sustainability as follows:

i. Landform Performance

Future performance of various reclamation landforms is predicted (see Figure D3.0-4) based on knowledge of their construction history and operating performance combined with estimates of future conditions. Reclaimed landforms will be subject to natural processes experienced in the region including earthquake loading, river flooding and adaptation of systems after the operating phase. For example, while gully formation is retarded by a thriving vegetation cover, various threats to the cover (such as fire, drought, disease and high precipitation) must be considered. Reclamation design must recognize the potential for these events, incorporate appropriate protection and estimate consequences of failure.

ii. Environmental Performance - Impact of Contaminants

Changes to the chemistry of the environment and the consequences of those changes (induced by disturbance and operations) must be evaluated (Figure D3.0-5). For a chemical to have an adverse impact it must be present in significant concentrations; there must be a pathway leading to chemical exposure of biota; and there must be receptors sensitive to those chemicals. The evaluation process includes examination of chemical concentration data for air, waters, soils, plants, aquatic invertebrates, fish and other animals. A comprehensive list of organic and inorganic chemical species forecast to be present in the reclamation landscape has been initially identified.

Chemical Screening

Figure D3.2-5 shows the process for determining which chemical species require detailed consideration. Chemicals in disturbed ecosystems are primarily associated with various materials which have gone through the oil sands mining and extraction process. These materials contain varying concentrations of chemicals which originate in the parent oil sands. The screening process incorporates several conservative assumptions to ensure that all chemicals of concern are considered. This process has not been fully applied to air emissions because chemical identification and speciation within various emissions is incomplete.

Exposure Pathway Screening

The objective of screening exposure pathways includes identification of all potential routes through which humans and ecological receptors could be exposed to chemicals and determination of the relative significance or importance of operable exposure pathways.

Exposure pathways examined included:

- inhalation - including volatilization of chemicals into the air and fugitive dust generated from soils;
- dermal - including direct contact with air, water or soils; and
- ingestion - including ingestion of fugitive dust, surface water, soil/sediments, plants and animals.

Receptor Screening

Biota that will live in reclaimed landscapes have the potential to accumulate oil sands-related chemicals within their tissues. For example, there is potential for uptake of soluble chemicals through plant roots and of volatile chemicals through the foliage of plants that grow on consolidated tailings deposits. Animals may accumulate chemicals as a result of incidental ingestion of CT soils (e.g., in erosional areas, where CT might be directly exposed to the surface), drinking affected surface water, or eating affected prey (i.e., food chain effects).

The process to assess impacts of the chemicals within various environmental media includes detailed screening of potential receptors. This screening process, which is described in more detail in (Golder 1996c), includes consideration of human and ecological receptors; the human receptors included both future on-site and off-site users.

iii. Environmental Performance - Ecosystem Sustainability

Sustainability of ecosystems developed on reclaimed oil sands landscapes is a primary consideration in assessing suitability of the reclamation plan. Primary factors to be considered (as indicated in

Figure D3.0-5) include: soil reconstruction, soil moisture and nutrient availability, revegetation species selection, wetland development, landform configuration and wildlife utilization, as well as threats to sustainability such as fire, drought, disease and erosion. About 65% of reclaimed lands will be forest ecosystems with the remainder being wetlands.

Dry Landscape Sustainability

Land Capability for Forest Ecosystems. Suncor recently participated in an industry-government committee (Tailings Sand Reclamation Practices Working Group) whose mandate was to develop a land capability classification system suitable for application to forest ecosystems in the oil sands region. This system evaluates pre-disturbance and post-reclamation land capability for forest production. It was designed to aid in both the planning of soil-handling procedures and in measuring land capabilities. Details of this land classification system are provided in a document released by the working group (Land Capability Classification for Forest Ecosystems in the Oil Sands Region). Major components of the classification system are summarized below.

The capability classification approach to the rating of reclaimed lands (CAN-AG 1996a) includes assessment of:

- **Land Capability**: the ability of the land to support a given land 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 forest production (commercial forestry).
- **Land**: comprising terrestrial, semi-aquatic and aquatic landscapes when the term is used in definitions of "land capability" and "equivalent land capability".

Major components of the reclaimed area (i.e., soil and landscape) are considered separately and each is assessed a value between 0 and 100. The reclamation land rating system provides flexibility: either the soil or landscape index can be used to determine the Capability Class; or the most limiting soil and landscape components can be used to attain the equivalent capability rating. Regional climate and eco-region are determined by nature but soils and landscape features can either be upgraded or trade-offs can be negotiated through specific management strategies. The result of the assessment process is that lands are assigned with Capability Classes based on the number of index points. Defined capability classes and their characteristics are detailed in Table D3.0-1.

While the developed classification system applies directly to forest ecosystems in the oil sands region it does not apply directly to other ecosystem types such as grasslands and wetlands. For example, forest capability Class 3 areas are considered as Low Capability (lands having limitations which in aggregate are severe for sustained forest production) while Class 4 areas are considered as currently non-productive (lands with limitations which may be surmountable in time, but which cannot be corrected with existing knowledge at currently acceptable cost). However, both Class 3 and Class 4 areas may contain highly-productive wetlands systems or productive grassland areas suitable for raising range animals.

Terrain Based Classification. It is recognized that, as an initially revegetated landscape matures and evolves, it will 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 was applied to this final surface and the vegetation was classified appropriately. The results are summarized in Golder 1996c.

Wetlands Sustainability

Reclamation areas will include surface water drainage systems to collect and channel water from the reclaimed area for eventual discharge to the environment. The quality of water from these various sources will vary, from relatively high quality surface run-off to dyke drainage water (which is known to contain chemicals of site origin). Within this drainage system a treatment pond-wetlands system (i.e., constructed wetlands) will be situated to ensure a high level of water quality before these drainage waters are discharged to the receiving environment. Designs of the wetland systems are based on complete removal of acute fish toxicity from oil sands wastewater.

Suncor, working with members of the Tailings Sand Reclamation Practices Working Group and other specialists will begin the development of a reclamation landscape capability classification system which will include consideration of wetlands and grasslands. These efforts are expected to commence following completion of development of the forest capability classification system.

TABLE D3.0-1

LAND CAPABILITY CLASSIFICATION FOR FOREST ECOSYSTEMS IN THE OIL SAND REGION (FROM CAN-AG, 1996a)

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 increase inputs to the extent that the overall cost-benefit will still be attractive but appreciably inferior to that expected on 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 the overall advantage to be gained from the use will be low.
4	21-40	Currently Non-Productive - land having limitations which may be surmountable in time but which cannot be corrected with existing knowledge at currently acceptable cost thereby precluding successful sustained forest production.
5	0-20	Permanently Non-Productive - Land having limitations which appear so severe as to preclude any possibility of successful sustained forest production.

c) **Risk/Effects Analysis**

The probabilistic assessment process is becoming a standard tool in North America when dealing with environmental impacts. This activity estimates magnitudes and probabilities of potential adverse effects on reclaimed sites.

Concentrations of selected chemicals are estimated in reclamation soils and waters, and the probability of achieving critical concentrations in plant and animal species (either through direct contact or through food chain effects) is estimated. With knowledge of the probability of a critical impact decisions can be made as to its environmental acceptability.

d) **Decision Analysis**

In this phase predicted level of risk and cost of remediation are examined and (where necessary) modifications are recommended to design alternatives. This iterative process identifies the optimum reclamation plan that takes into consideration corporate, regulatory and community need.

e) **Implementation Decision**

Following the "Decision Analysis" phase choices will be made to either implement specific reclamation alternatives or return to the planning stage for identification of other remedial actions.

3.3 PROJECT DESIGN CONSIDERATIONS

3.3.1 Project Design

The Steepbank Mine project design is detailed in Section C of this Application. The project description for the current Suncor operation on Lease 86/17 was reviewed in detail in the February 1995 Application for Renewal of Environmental Operating Approval (Suncor 1995a).

3.3.2 Pre-Disturbance Baseline

a) Lease 86/17

Pre-development site analysis for Lease 86/17 (including information on Lease 86/17 pre-development land capability for soils, vegetation, forestry, wildlife and recreation) is discussed in detail in the February 1995 Application for Renewal of Environmental Operating Approval (Suncor 1995a).

b) Steepbank Mine

Pre-development site analysis (including land capability for soils, vegetation, forestry, wildlife and recreation) for Steepbank Mine is described in Section E and supporting documents.

c) Suncor Local Study Area

Forest types that develop on reclaimed Suncor leases are related to the parent material, topography and drainage of the area. An estimate of potential forest capability for the Suncor local study area (which includes both Lease 86/17 and Steepbank Mine area) was completed as a component of Suncor's Steepbank Mine EIA by applying the capability classification system discussed in Subsection D3.2.3 and (CAN-AG 1996b). These classes are approximately equivalent to Classes 3 to 7 respectively of the Canada Land Inventory Forestry Capability. The system was previously used for Suncor's assessment of forestry capability (including the February 1995 Application for Renewal of Environmental Operating Approval, Suncor 1995a).

Results of the assessment show that less than 20% of the Suncor local area has a high or moderate potential forest capability (i.e., Classes 1 and 2); capability classes average 4 for the Suncor local study area (detailed in Table D3.0-2). Suncor's reclamation goals include the restoration of formerly-organic soils to moderately-productive forest and shrub lands capable of supporting wildlife habitat and limited forestry production. By improving local soil drainage conditions for existing poorly-drained organic soils, the reclamation plan increases the opportunity for a greater variety of land uses such as wildlife habitat, traditional land use, recreation or forestry.

TABLE D3.0-2

FORESTRY CAPABILITY CLASSES FOR SUNCOR LOCAL STUDY AREA

Soil Series	Hectares / % of Area	Soil Class [a]	Landscape Class [a]	Combined Class [a]	Capability-Limiting Factors
Algar	26 / 0.1	4	1	1	wetness
Firebag	157 / 0.5	4	1	4	prone to drought
Horse River	2881./ 8.8	2, 3	1	2, 3	moisture regime
Kinosis	3101 / 9.5	2, 3	1	2, 3	moisture regime
McMurray	414 / 1.3	2, 1	1	2, 1	soil reaction
Mildred	6860 / 21.0	5	1	5	organic, wetness
Muskeg	13 596 / 41.5	5	4	5	organic, wetness
Ruth Lake	1357 / 4.1	5	1	5	prone to drought
RB1	382 / 1.2	4	1	4	prone to drought
RB2	738 / 2.2	3, 4	2	3, 4	prone to drought
RB3	2604 / 8.0	3, 4	4	4	steep slopes, erosion
Total Area	32 116				

[a] Classification system from: Land Capability Classification for Forest Ecosystems in the Oil Sands Region (CAN-AG 1996a)

3.3.3 Dry Landscape Reclamation Technology

The production and accumulation of large volumes of fine tailings from the Clark hot water extraction process has been a concern for the oil sands industry since it began operations. Construction of the Tar Island dyke was carried out on a priority basis to forestall plant closure shortly after commencement of operations. The required containment of fine tailings produced incremental 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.

The long search for solutions (over twenty years) has resulted in the basis for a Dry Landscape Reclamation Plan. Principal technologies now available are the consolidated tailings process;

surface stabilization techniques; and various water treatment options to handle seepage and discharge waters.

Prior to discussing the new technologies used to achieve the dry reclamation landscape it is useful to briefly review the procedure of generating of fine tailings from the Clark hot water extraction (CHWE) process.

a) Fine Tailings Generation and Properties

Suncor has used the current caustic-based Clark hot water extraction process and hydraulic tailings disposal technology 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 Fine Tailings Fundamentals Consortium 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 behavior 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.

b) Prediction of Fine Tailings Volumes

Suncor uses a semi-empirical model to forecast accumulation of fine tailings. This model utilizes fundamental data on the water-holding capacity of fine 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 in Figure D3.0-7. The model has provided an adequate basis for tailings containment planning but it would require modification for considerably different ore types or changes to extraction chemistry.

c) Alternatives Considered in the Selection of Dry Landscape Reclamation Technologies

For over twenty years the oil sands industry has studied, tested and piloted many methods which claimed to be able 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 in FTFC 1993. Together, the Fine Tailings Fundamentals Consortium and the University of Alberta, focused on resolution of major problems associated with commercial implementation of calcium-based consolidation techniques. Their efforts produced the consolidated tailings process (described in the Consortium's Final Report, FTFC 1995).

d) Consolidated Tailings Technology

Suncor is proposing to eliminate permanent storage of fluid fine tailings from Leases 86/17 and Steepbank Mine through utilization of consolidated tailings (CT) technology. The CT process results in recombination of coarse and fine tailings into a stable deposit with a reclaimable surface. CT process implementation began in November 1995 when Suncor initiated a six-month commercial trial. Full implementation is forecast to commence in August 1996. It is projected that continued implementation of CT will eliminate future fine tailings accumulation and consume the current fine tailings inventory of about 100 Mm^3 by about 2015 to 2020. A minimum operating mature fine tailings volume of around 25 Mm^3 is required to thicken fresh extraction fine tailings in preparation for CT utilization. At the same time the surface area required for water clarification will be reduced to about 30% of that used today.

i. CT Process Description

As shown in Figure D3.0-8 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 using gypsum, which is a by-product of the new Flue Gas Desulphurization plant. It has been demonstrated through pilot plant trials that this mixture is readily pumpable (using existing tailings pumping systems) yet dewaters relatively rapidly to a stable deposit (Caughill 1994).

CT mixtures of plant tailings and fine tailings have several minimum process requirements:

- The final mixture density must be above 50 % solids by weight.
- The clay fines concentration must be above 15 % by weight of the solids.

- A chemical additive must provide a source of soluble calcium to interact with the clay and sand solids. A minimum level is required to generate consistent CT product: initially 0.9 kg of gypsum per cubic metre of CT will be used. It is expected that this quantity can be reduced as CT discharge water (containing elevated levels of calcium) is returned to the Extraction recycle water inventory.
- Deposition needs low-energy conditions, providing quiescent conditions for initial settling in relatively thin layers.

Selection of CT Composition

Consolidated tailings behavior is exhibited over a range of initial solids concentrations, chemical treatment species and quantities, and coarse-mineral to fine-mineral ratios. Typical behavior is illustrated in Figure D3.0-9, which summarizes extensive laboratory and field pilot testing conducted over several years (AGRA 1996a). Note the "segregation boundary" dividing segregating and non-segregating behavior. 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 its fundamental goal. Operational issues further constrain selection of CT composition as described below.

Selection of the course-sand-to-fine-mineral ratio (SFR) is driven by two objectives. The first 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. The second objective is to reduce the existing inventory of fine tailings; this would suggest a lower SFR than 6:1. Incorporation of the existing inventory of fine tailings into CT deposits can be done most economically prior to establishing a remote desanding operation, which could be as early as 2020. 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 4:1.

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 most of these treatments due to the very large volumes of fine tailings which require processing. For instance a treatment cost of as little as $1 per cubic metre 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 was chosen because of the proven effectiveness of the treatment, and the availability of gypsum (calcium sulphate) as a low-cost by-product of the Flue Gas Desulphurization process. Gypsum obtained from FGD pilot testing has been used successfully to produce CT materials at a laboratory scale.

e) Techniques to Stabilize the Surface of CT Storage Areas

Surfaces of consolidated tailings deposit areas (Ponds 5 and 6 on Lease 86/17) do not spontaneously become trafficable: a number of processes which can be employed to facilitate CT deposit surface reclamation are discussed below. These processes have been individually pilot- tested to different scales (FTFC 1995) but an integrated demonstration of stabilization of a large CT deposit has not been conducted. Subsection D3.5.1 delineates the pilot testing necessary for such a demonstration. Topography development on the deposit surface is discussed in Subsection D3.5.2.

i. 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 thickened Extraction tailings. Following a period of further dewatering, revegetation activities can proceed as they would for other sand areas (see Subsection D3.5.1).

ii. 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. This process will occur naturally on the surface of CT deposits. Placement of fresh materials in relatively-thin layers on the deposit surface during the winter facilitates the process by allowing rapid frost penetration. Up to 3 m of material can be freeze/thawed each winter in this way.

iii. Aggressive Drainage

Once a deposit surface cap is established its strength can be rapidly enhanced by techniques employed around the world (for example, in Holland river sediments are pumped across large tracts of land). Drainage channels are established on the deposit surface to carry away precipitation and run-off 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.

iv. Surface Revegetation

Established surface revegetation techniques (discussed in Subsection D3.5.1) will be used to return the stabilized surfaces of CT deposit areas to a revegetated condition.

3.4 OPERATING PHASE

This section focuses on those aspects of the operating plan which affect the reclamation plan; other aspects of the operating plan can be found in Section C.

3.4.1 Mine Site Preparation and Soil Salvage

a) Land Clearing

Land clearing on Lease 86/17 is essentially complete. Details on remaining areas are contained in Suncor's February 1995 Application for Renewal of Environmental Operating Approval (Suncor 1995a).

The preparation of the Steepbank Mine site will commence in 1997 with clearing activities for the access roads, plant facility and office and shop areas. Clearing of the mining area will begin in 1998 and continue through 2020. Waste dump areas will also be cleared commencing in 1998. Table D3.0-3 summarizes the total areas of Steepbank Mine cleared (based on a preliminary mine plan) on a yearly basis between 1997 and 2006, then for the periods 2007-2010, 2011-2015 and 2016-2020. Land area cleared for Steepbank Mine between 1997 and 2020 will total 3852 ha.

Timber salvage will be conducted as part of site-clearing activities in accordance with, Alberta Lands and Forests guidelines. The Steepbank Mine site is within Alberta Pacific Ltd.'s (Al-Pac's) Forest Management Agreement Area. A technical report of the EIA gives more detail on locations of merchantable tree stands while the mine plan specifies when these stands are to be cleared.

b) Drainage

Drainage for Lease 86/17 is described in Suncor 1995a and in Section C3.4. Drainage plans for Steepbank Mine are discussed in Section C3.4.

c) Soil Salvage

Subsection D3.5.4 discusses soil salvage.

3.4.2 Landform Construction

The Long-Range Mine Plan defines the intent of and construction schedule for a particular structure as well as its expected service conditions and service life. Prior to reclamation certification Suncor will be present on-site to monitor performance of its structures and to take corrective actions as necessary.

TABLE D3.0-3

STEEPBANK MINE - SITE CLEARING PROGRESSION

Year	Land Clearing (ha)	Total Land Cleared (ha)
1997	150	150
1998	358	508
1999	139	647
2000	68	715
2001	347	1062
2002	276	1338
2003	113	1451
2004	80	1531
2005	88	1619
2006	127	1746
2007-2010	993	2739
2011-2015	679	3418
2016-2020	434	3852
Total		**3852**

a) <u>Construction and Monitoring for Landform Security</u>

During construction and operation, Suncor will follow current practices (which are based on the Observational Method, Figure D3.0-10) to ensure the geotechnical stability of all of its earth structures. Steps followed include:

- To determine the pre-existing conditions and type of construction materials which must be considered in the design, a comprehensive site investigation has to be conducted.
- The most-probable and the worst-case service conditions are identified as are potential failure modes.
- Geotechnical design is developed based on the most-probable service conditions but monitoring programs and contingency plans are developed to detect and remedy conditions which do not fall within the most-probable conditions.

- The design is prepared through use of a combination of in-house and consultant resources. For the design process static loading, and dynamic loading from potential earthquakes. Then the design is reviewed by Suncor's Mine Development and Reclamation Review Board (an external expert review panel) prior to its submission to regulatory authorities.
- Monitoring of the construction phase consists of selection of construction materials to meet the design specifications, and determination that construction materials are placed in the structure according to design specifications. Geotechnical instrumentation is installed to allow assessment of the structure's performance during construction and its service life.
- For all containment structures an annual Performance Report is prepared, subjected to external review and submitted to regulatory agencies. This report summarizes the status of construction and results of the monitoring programs and assesses structural stability. Recommendations included revised monitoring requirements and any anticipated remediations.

b) <u>Overburden Handling Plans</u>

Overburden materials are used in construction of major landforms. Volumes, schedules and utilization are covered in a number of sources (Suncor 1995a, Suncor 1996c, Section C3.0 and Appendix IV).

c) <u>Tailings Management</u>

Previous tailings plans proposed by Suncor utilized a combination of overburden and tailings sand for dyke construction, with tailings sand also used as a pond infill material. The final dyke (Dyke 8) was to be constructed entirely with overburden and was to contain the inventory of fine tailings (accumulated during operations) under a water cap in perpetuity. A decision to open Steepbank Mine on property adjacent to Lease 86, combined with adoption of dry reclamation technology (using consolidated tailings as the basis for tailings planning), has had a significant impact on this plan.

i. Constraints and Opportunities in Plans to Achieve Dry Reclamation

The following constraints and opportunities have guided development of the modified tailings plan:

- East Bank ore bodies have sufficient resources to support bitumen recovery beyond the middle of the next century. Therefore, Suncor will be present to monitor reclamation success and provide any required corrective actions for decades.

- The inventory of fine tailings (currently about 100 Mm^3) which has accumulated over the past twenty-eight years will be reduced to a minimum working level of about 25 Mm^3 by 2020. This working volume is required to thicken fresh Extraction tailings fines to the density required for preparation of future CT mixtures.
- Pond 2/3 will be used to thicken fresh fine tailings in preparation for CT disposal as long as ore is hydrotransported to the current Extraction plant. The pond will be infilled prior to changeover to remote desanding (likely beyond the 2020 time frame).
- As much tailings sand as possible (approximately 75% immediately and rising to more than 95% in the future) will be diverted to disposal as consolidated tailings. However, since suitable overburden dyke construction materials are in short supply on Lease 86/17 there is still a requirement to construct portions of Dykes 8 and 9 from tailings sand. All dykes planned for construction on Steepbank Mine prior to 2020 will utilize overburden only.
- Selection of the average sand to fines ratio used in CT (approximately 4:1) balances the desire to re-incorporate the fine tailings inventory into stable deposits by 2020 with the desire to minimize surface settlement of the deposits in the reclamation time frame (when "topping up" the deposit is no longer feasible). The natural sand to fines ratio in ore is about 5:1.
- The CT sand to fines ratio combined with the rate of fresh tailings sand production which can be diverted to CT disposal establishes the consumption rate for existing fine tailings inventory.
- Pond 2/3 is currently at its maximum operating level. In the future (and critical for the next few years) thickened fine tailings must be removed from the pond and incorporated in CT at a rate at least equal to the accumulation of fresh fine tailings to prevent loss of the recycle water required for Extraction operations.
- Removal of fine tailings and decommissioning and reclamation of Pond 1 will be done as early as is practical (the schedule addressed later in this section). However, the priority must be to control fluid levels in Pond 2/3.

ii. Implementation Plan

The following modifications to the Extraction plant tailings system are required to implement the CT process. Hydrocyclones will be installed to increase the density of plant tailings from 35% solids by weight to 70% solids by weight. Water, fines and bitumen removed in the hydrocyclone overflow from plant tailings will be pumped directly to Pond 2/3, where recycle water will be recovered and fine tails will thicken in preparation for later incorporation in CT. Gypsum addition facilities will be installed to store and add the appropriate amount of gypsum to the mixed stream. Pumping and pipeline systems will be configured to deliver and deposit CT mixture in Pond 5 and future deposition areas. Water released from the CT mixture deposit will be used primarily as recycle water. As existing fine tailings are consolidated in the CT process surplus water volumes will be generated; this water may eventually be treated and returned to the natural environment (see Subsection D3.4.3).

Conversion to consolidated tailings will be in stages. Initially, facilities have been constructed to convert half of the Extraction plant tailings to CT. A commercial trial (conducted during the winter of 1995/96) will highlight any opportunities for improvements in the technology. Thereafter, CT technology will be the primary means of tailings deposition, with the exception of some tailings required for dyke construction. Additional hydrocyclones will be installed to convert the remainder of Extraction tailings into CT. Flexibility in equipment operation will be provided to produce CT, high-density sand tailings for dyke construction or both.

The implementation phases are described below:

- Phase I - Hydrocyclones (to densify half of Extraction tailings to about 70% solids) were installed in spring 1995. The stream was used to construct Dyke 8 during 1995. Water recycling facilities were installed to return the transport water to Pond 2/3.

- Phase II - A full-scale commercial trial of CT technology is underway during the fall/winter of 1995/96 to prove the process. About half of the Extraction tailings are being used to create a 4 Mm^3 deposit in Pond 5.

- Phase III - Hydrocyclones for the remaining half of Extraction tailings will be installed in 1996 to allow simultaneous CT mixture deposition in Pond 5 and continued construction of Dyke 8.

- Phase IV - Facilities to recover Extraction process recycle water will be installed in Pond 5 in 1997.

iii. Suncor's Long-Range Tailings Plan

Details of the integrated Lease 86/17 and Steepbank Mine tailings plan (which ultimately supports a dry reclamation landscape) are given in Suncor 1996c. An overview is presented below. Associated reclamation activities are described in Subsection 3.5.

Figure D3.0-11 shows the 1997 layout of Lease 86/17 and the proposed Steepbank Mine property. Activities as of 1997 are listed below:

- Clearing has progressed to near the north edge of the property as shown.
- Dyke 8 is under construction using a combination of overburden and tailings sand.
- Preparation for construction of Dykes 8 and 9 abutment is in progress.
- Pond 5 is being infilled with CT as part of the consolidated tailings commercial trial.
- Dyke 7 is under construction as Pond 4 is being infilled. A portion of Pond 4 has been segregated to contain the FGD recycle water pond and store surplus gypsum.
- Pond 2/3 has been constructed to its design elevation; fluid is at its design level and will be used as a fine tailings thickener for the foreseeable future. Fine tailings transfer pumps have been installed to provide fine tailings for CT disposal to Pond 5.
- Fine tailings withdrawal from Pond 1 commenced in 1995 with about 2 Mm^3 being transferred to Pond 2/3 by the end of the year.
- Other than site investigation there is no activity on the Steepbank Mine site.

Figure D3.0-12 shows activities as of 2000 summarized below:

- Clearing has progressed for Steepbank Mine as shown.
- Mining is essentially complete on Lease 86/17; ore production has begun from Steepbank Mine.
- Dyke 9 is under construction while Dyke 8 is essentially complete.
- Pond 5 is being infilled with CT with filling to be complete by 2002.
- Pond 4 construction is complete and it is in use as a FGD recycle water pond.
- Pond 2/3 is in use as a fine tails thickener for CT preparation.
- Pond 1 has had about 7 Mm^3 of fine tailings withdrawn (to be used in CT) and infilling with Extraction oversize is progressing.

Figure D3.0-13 shows activities as of 2005 including:

- Clearing and mining is progressing at Steepbank Mine as shown.
- Construction of the north overburden waste dump is underway.
- Construction of Dyke 9 is nearly complete.
- Pond 6 is being infilled with CT.
- Pond 5 is completely filled with CT and is in the primary dewatering phase.
- Pond 2/3 contents are in use as a fine tails thickener for CT preparation.
- Removal of Pond 1 fine tailings (for use in CT) is essentially complete.

Figure D3.0-14 shows activities as of 2010 as follows:

- Mining advance and overburden construction is progressing at Steepbank Mine as shown.
- Primary CT production is directed to Pond 7.
- Ponds 5 and 6 are topped up with CT as dewatering continues.
- Pond 2/3 contents are in use as a fine tailings thickener for CT preparation.
- Pond 1 is infilled and revegetated.

Figure D3.0-15 shows activities in 2015 comprising:

- Mining advance and overburden construction is progressing as shown.
- Primary CT disposal is directed to Pond 8.
- Ponds 5, 6 and 7 are periodically topped up with CT as dewatering and consolidation continues.

Figure D3.0-16 shows activities in 2020 including:

- Mining completed at Steepbank Mine.
- CT Ponds 5, 6, and 7 have been capped with tailings sand and revegetated.
- CT Pond 8 is topped up with sand from extended mining on Lease 25 as dewatering occurs.

iv. *Infilling of CT Ponds*

<u>Re-Incorporation of Existing Fine Tails Inventory into CT Deposits</u>

It is Suncor's desire to capture into CT all fine tailings produced by future operations and to reduce current inventory of fine tailings to a working volume of around 25 Mm^3 before

2020. This means that CT deposits must contain higher fines content than ore mined in the same period. A target sand:fines ratio of about 4:1 has been established.

Figure D3.0-17 shows a projection of the consumption of fine tailings inventory, indicating that between 2015 and 2020 inventory will be down to the minimum required to thicken fresh fine tailings from Extraction.

Prediction of Dewatering Rates

The sand:fines ratio is a very important parameter as it indicates the time needed for a CT deposit to dewater and consolidate. During this period considerable surface settlements occur as excess water is expressed. As surface settlement proceeds excess water will be removed and the deposit "topped up" with new CT to re-establish surface. For Pond 5 this will take place several times prior to achievement of surface stabilization.

Projected filling of Pond 5 and subsequent dewatering of the CT deposit is shown in Figure D3.0-18. At present there is some uncertainty as to the release rate of water from CT; data to more precisely specify this rate are being collected as part of the CT commercial trial.

Both the projected rate of surface settlement and the development of strength within the CT deposit have been studied extensively for CT Pond 5 (AGRA 1996a). In this source the database required for these projections is also discussed as well as methods for composing the projections. For Pond 5 results are presented in Figure D3.0-18 which show that after final revegetation, surface settlements will measure about 13 m. Uncertainty in this projection arises from the range of uncertainty in laboratory and field test data. These projections had been made prior to any actual commercial experience. The first opportunity to correlate them with commercial experience will be in late 1996 when analysis is available of results from Suncor's consolidated tailings commercial trial is available.

v. ***CT Deposit Surface Stabilization***

The CT process does not immediately create a deposit with a trafficable surface, but it does produce sufficient strength at depth to support a trafficable surface within a ten to twenty-year time frame. Fine tailings deposits do not possess such strength and cannot support a trafficable surface. Such a trafficable surface will be constructed using techniques outlined in Subsection D3.3.3. These techniques have each been tested at minimum on a field pilot scale but not on the scale of the surface of a large CT deposit: such developmental work is planned (discussed in Subsection D3.5).

Surface stabilization for deposits 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 (shown in Figure D3.5-4), to facilitate revegetation as discussed in Subsection 3.5.

vi. Infilling of Pond 1

Pond 1 (Suncor's original tailings pond) commenced operation in 1967. It is enclosed by the Tar Island dyke (shown in Figure D3.0-19). The pond is currently receiving only a small tailings stream from the Extraction centrifuge plant and periodic flows from the Upgrader. At its deepest point it contains a deposit (about 30 m deep) of mature fine tailings and about 2 m of recycle water.

As the fine tailings currently in the pond will not settle to form a soil-like material for hundreds of years, these materials will be removed and replaced with stable infill. Pond 1 will thus be transformed into a stable, trafficable and revegetated landform.

As Pond 1 is currently at capacity, infilling cannot proceed faster than the rate of MFT withdrawal. However, for the next few years the opportunity to withdraw MFT from Pond 1 will be limited by the necessity to withdraw MFT from Pond 2/3 as a first priority. In the plan to integrate tailings management of the Steepbank Mine with Lease 86/17, Pond 2/3 assumes the role of a fine tailings thickening pond for the CT process. In order to maintain Pond 2/3 fluid levels below the design elevation, MFT for the CT process for the next 5 years must come from Pond 2/3.

The projected cumulative withdrawal of MFT from Pond 1 (shown in Figure D3.0-20) indicates that withdrawal will be complete by 2006 and infilling will be accomplished by 2010. Surface revegetation will commence at that time.

In order to increase the volume of sand available for CT production and accelerate Pond 1 reclamation, Suncor expects to infill a portion of Pond 1 with Extraction oversize commencing by

1997. This change in material accelerates Pond 1 infilling by up to two years. In addition higher erosion resistance of the clayey oversize will arrest the long-term development of erosion gullies in Tar Island dyke. Suncor is continuing to search for opportunities to advance the infilling of Pond 1.

d) Landfills

Since 1991 Suncor has operated two industrial landfills south of Pond 4. The company's previous landfills located at various sites across Lease 86/17 (Figure D3.0-21) are for the most part contained within tailings ponds and waste dumps, the surfaces of which will be reclaimed. There is currently no evidence of abnormal leaching into the groundwater associated with these landfills, primarily due to their location and hydraulic containment, with the possible exception of two landfills.

These two shallow landfills are located at the south end of Waste Area 8 and adjacent to Pond 1A. Groundwater in the area of the Pond 1A landfill has been monitored since 1984 and groundwaters near Waste Area 8 have been sampled several times since 1992. Around both of these landfills, groundwaters have low levels of organic constituents but elevated sulphate levels. Monitoring will continue at both sites as part of the overall groundwater monitoring program.

3.4.3 Erosion

a) Surface Erosion

Suncor's policy is to control surface erosion enhancing the stability of constructed landforms and controlling loss of soils to the environment. Reconstruction of a soil layer followed by revegetation is accomplished as soon as is practical following cessation of construction activities in the area. For instance, revegetation of dyke slopes proceeds while construction continues at higher elevations on the dyke. If erosion occurs prior to full re-establishment of vegetation corrective activities are employed.

b) River Erosion Protection

i. Tar Island Dyke

The Athabasca River is currently eroding the river bank adjacent to the north half the of the Tar Island dyke. There has been no erosion of the toe of the dyke, although several sections of the access road (known as the limestone road) along the toe of the dyke were undermined and required a number of repairs during 1995. Besides providing access along the toe of the dyke the limestone road (approximate elevation 239.6 m ASL) provides flood protection (for the toe of the tailings sand dyke) to an elevation corresponding approximately to the 1-in-20-year flood event.

In 1995 Suncor commissioned the following two studies to generate bank protection designs for the toe of the Tar Island dyke:

- a review of current river bank conditions along the toe of the Tar Island dyke to provide an operational bank protection design; and
- a geomorphological assessment of the Athabasca River between Fort McMurray and Fort MacKay, to provide a design for long-term bank protection for the Tar Island dyke (see Subsection 3.5)

The first study reviewed current erosion patterns and developed an operational bank protection design (i.e., a design that can be monitored through observation and repaired if required) to reduce erosion rate below the limestone road (AGRA 1996d). Construction of operational bank protection will provide an opportunity to evaluate both long-term bank protection requirements and the first stage of abandonment-level bank protection.

To develop an operational bank protection design the studies reviewed conditions along the toe of the Tar Island dyke including:

- flood frequency elevation, discharge and velocity;
- winter ice and spring break-up conditions; and
- bed scour.

Results of the review showed:

- the 1-in-20-year flood event has an elevation of about 238.6 m ASL, a flood discharge rate of about 4440 m^3/sec and a flow velocity of 1.4 to 2.1 m/sec;
- ice jams could result in local flow velocities of up to 3 m/sec, similar to 1-in-100-year open-water flood velocities; and
- total scour depth (local scour plus one half of observed dune height) along the north half of the Tar Island dyke will be 2.7 m to 3.6 m during the 1-in-20-year flood event.

The operational bank protection design includes riprap (erosion resistent materials) constructed to the 1-in-10-year flood elevation and sized for the 1-in-100-year flow velocity. Above the 1-in-10-year flood event elevation bank protection will be provided by vegetative cover. This type of protection will provide sufficient erosion resistance as flow velocities are reduced above the 1-in-10-year flood event elevation. The general design is shown in Figures D3.0-22 and D3.0-23; design details are also available (AGRA 1996d). Suncor will request approval to install operational bank protection along the toe of the Tar Island dyke during summer 1996.

Operational bank protection will shield the Tar Island dyke from the erosion which could lead to instability under all floods up to Probable Maximum Flood conditions. The Probable Maximum Flood elevation at the Tar Island dyke is between 247 m ASL and 248 m ASL. Under such conditions riprap bank protection would likely be removed from the bank and deposited on the apron; there might also be up to 5 m of sand removed from the toe of the dyke. However, this will not impair the dyke's stability in any way. Immediately following a flood Suncor would reconstruct the dyke toe and the bank protection and would replace any vegetation lost.

ii. Other Bank Protection Requirements

There are currently no areas on Lease 86/17 (other than the Tar Island dyke) that require bank protection from the Athabasca River. Suncor will continue to monitor the river bank along Lease 86/17 and will implement any approved measures necessary to ensure the required level of river bank integrity is maintained.

At present, no defined requirements for river bank protection exist for Steepbank Mine. These will be addressed as part of the final design of Steepbank Mine facilities (AGRA 1996g).

iii. Emergency Plan

Suncor monitors river level forecasts provided by Alberta Environment. In the event of a flood of any magnitude the company will have sufficient time to ensure all facilities along the toe of the dyke (e.g., pumping stations and electrical supplies) are protected from floodwaters. As outlined above no additional bank protection is required for a flood. Immediately following a flood event Suncor will evaluate conditions at the toe of the dyke and undertake any necessary repairs.

3.4.4 Site Water Management

The following section explains the management of operational and reclamation water streams during the operating phase of Lease 86/17 and Steepbank Mine. Subsection 3.5.3 describes water management after reclamation and abandonment.

a) Extraction Recycle Water

i. Impact of CT on Recycle Water Inventory

The introduction of CT technology has created the challenge of managing large volumes of released water. Suncor's goal will be to maximize recycling of water, however there will be a need for environmental discharge. The following discusses CT release water management.

The Clark hot water extraction process requires a supply of hot water to mix with the oil sands during processing. Most of this water is recycled from the tailings ponds; the remainder is drawn from the river. Suncor's tailings water balance is discussed in Ref D3.0-9. Fresh water input is required to replace water captured (in tailings sand dykes and beaches) and held in fine tailings. In typical fine tailings, water would be released over a period of centuries as the deposit slowly consolidates and eventually becomes a soft soil. The CT process dramatically accelerates water release from fine tailings as consolidation occurs, this changes the water balance resulting in a large increase in water input to the recycle water inventory. Figure D3.0-24 shows a projection of recycle water inventory to 2020. If the operation continues to import water from the Athabasca River at its current rate, recycle water inventory will grow from the current 25 Mm^3 to 130 Mm^3 . As an inventory of only 20 Mm^3 is required for the Extraction process, Suncor intends to reduce inventory volume so that reclamation can proceed as rapidly as possible. Additional inventory represents a direct cost in terms of containment structure construction and maintenance.

Storage of large volumes of water is not consistent with the intent of dry reclamation. Water storage is geotechnically less desirable than storing fine tailings due to its increased seepage potential. Suncor therefore has no provision in its reclamation plan for storage of large volumes of fluids following mining operations (i.e., abandonment storage).

There are two methods to control recycle water inventory:

- reducing river water inputs; and
- discharging excess capacity.

ii. Recycle Water Management by River Water Input Reduction

Reducing river water import to the Extraction plant can effectively manage the volumes of tailings pond recycle water. The current overall extraction/tailings water balance contains Athabasca River water input at a rate of about 200 l/s. A 50% reduction in imported water volume will reduce tailings pond recycle water volume to manageable levels but the intent is to use as much release water from CT as possible. Extensive modelling has shown that over the next five to ten years the FGD gypsum stream used to create consolidated tailings will alter the chemistry of tailings pond recycle water (Kasperski 1996). As two critical parameters in the model can be verified only by actual operation (the composition of the FGD stream and the release rate and quality of CT release water) these calculations must be considered preliminary.

There are known sinks for many of the dissolved ionic species that could appear in recycle water. Concentrations of calcium and similar ionic species are not expected to increase substantially since they tend be adsorbed onto clays present in recycle water. Some ionic species do not have obvious sinks and may build up within the recycle water system; in particular sulphate concentrations may increase in tailings ponds (Figure D3.0-25). In addition to sulphate there will likely be other ions in the FGD gypsum which (although at lower concentrations) will also tend to build up in the recycle water.

Suncor is currently analyzing the impact of alterations in recycle water chemistry on tailings pond performance (primarily odours), extraction recovery and downstream impacts within the bitumen Upgrading operation. In addition, longer-term impacts on reclamation vegetation are also under review. Surfaces of infilled ponds are unlikely to be affected as CT deposits will be capped by a layer of soil prior to revegetation. Downstream slopes of tailings sand dykes may experience elevated salt concentrations in groundwater emanating from CT particularly in the early years.

iii. Recycle Water Management by Environmental Discharge

The other method of managing recycle water volumes is to maintain Extraction fresh-water inputs near current levels and remove part of CT release water from the recycle water system. Current calculations suggest that about 20% of annual CT release water would have to be removed to manage remaining volumes adequately (Figure D3.0-24). As some of this water can probably be used elsewhere in the Suncor operation river water inputs may be reduced, but it is likely most of this water would be discharged to the Athabasca River.

CT release water may require treatment before operational discharge (based on OSWRTWG findings in Subsection D3.2.2) but the CT process appears to reduce CT water toxicity below that of current dyke seepage or recycle water, thus making it easier to treat prior to release (see below). Suncor will provide necessary treatment to CT water prior to its release.

Figure D3.0-24 shows that such discharge would occur around 2005 but this date is dependent on the release rate of water from CT and can only be confirmed through monitoring of Pond 5 performance. The quality of CT release water from Pond 5 will depend on the chemistry of the FGD by-product stream (to be introduced in late 1996). After that time a water treatment plan could be devised; possible treatment options are discussed in Subsection D3.4.4.c.

iv. Impact of Recycle Water Chemistry on Extraction Performance

The chemistry of the extraction recycle water inventory has been extensively investigated and modelled (Kasperski 1996); in particular, concentrations of calcium and magnesium have been projected. Based on criteria established through processibility testing (Munoz 1996) there is no indication that concentration of chemical species will rise to levels that will affect Extraction performance.

b) Operational Drainage and Seepage Control Measures

i. Surface Drainage Control Measures

Surface drainage on Lease 86/17 is controlled, permitting only licenced streams to discharge to the Athabasca River. Licenced streams include surface run-off and shallow aquifer water from the North and South Mine areas, and run-off from the south slope of Waste Area 8 (Mid-Plant drainage). Run-off from all areas of active mining or tailings disposal is collected by means of a series of channels and run-off retention basins from which it is pumped back into the Extraction/tailings recycle water system. A significant portion of rainfall landing on tailings sand structures infiltrates the tailings sand and enters the groundwater system (AGRA 1996b). Most of these waters are collected in seepage control systems and pumped back into tailings ponds.

In 1995, as a response to several localized seeps along the toe of the Tar Island dyke, Suncor upgraded the toe ditch collector system (for both seepage and surface run-off collection). The system includes an upgraded seepage cutoff beneath the ditch and a coke filter drain, to direct seepage and surface run-off to the pumping stations for return to Pond 1 (AGRA 1995a).

Surface run-off from plant site operating areas is divided into oily and non-oily streams, each handled differently. Non-oily streams are collected through a sewer system and discharged via the wastewater system outfall. Oily streams are directed though the API separator (where the hydrocarbons are stripped and returned to the Upgrader for processing); cleaned water from the separator is discharged through the wastewater outfall.

The only area of uncontrolled surface run-off is the east side of Waste Area 8. This structure is a former overburden dump which has been fully reclaimed for about fifteen years. Surface run-off from this slope is not expected to be different from that of other vegetated slopes along the Athabasca River and should therefore pose no environmental risk. Additional monitoring of surface water and groundwater conditions in Waste Area 8 will be undertaken.

The Steepbank Mine surface drainage plan is discussed in Subsection C.3.4.

ii. Seepage Control Measures

Suncor maintains seepage control measures in two areas of its current operation:

- within and around tailings sand dykes, and
- beneath the coke pile.

Dyke seepage is controlled using one of two primary methods:

- internally, through coke filter drains within dykes constructed primarily for geotechnical stability purposes; and
- externally, by collecting seepage water from the base of the dykes and directing it (either through pumping or gravity drainage) back to the Extraction/tailings recycle water system.

A third system is employed on Dyke 5, where a series of pumping wells have been installed to improve dyke stability.

These control measures allow Suncor to capture about 90% of all dyke seepage streams. Any seepage that currently by-passes the controls is lost primarily through the foundations of the tailings ponds (see Subsection D3.4.4.b). Current losses have been shown to have no measurable impact on aquatic life in the Athabasca River (see Subsection E5.4).

Seepage from the coke pile is collected by means of a drain beneath the west side of the pile and a toe ditch along the east slope of the pile; this water is then discharged into Pond D (in the plant wastewater treatment system).

At present, no specific seepage control systems have been identified for Steepbank Mine. Its impoundment facilities are designed to be constructed of low-permeability overburden materials that will not need engineered seepage control structures for stability. Any seepage that does pass through the dyke will be collected and contained in the mine drainage system.

Estimates of seepage losses (outlined above) through the foundation of the tailings ponds are based on recent assessment of Pond 5 (AGRA 1996c). Before start-up of tailings Ponds 6, 7 and 8, investigations will be undertaken to determine the necessity of foundation liners. If required, Suncor will engage in any necessary measures to ensure foundation seepage losses are limited and any adverse environmental impacts are acceptable. In addition, seepage quality will be monitored through the Suncor groundwater monitoring program as detailed in Suncor's 1995 Application (Suncor 1995a).

iii. Conventional Discharges

As discussed in Subsection D3.4.4.b Suncor maintains four licenced outfalls for discharge of certain operational waters to the Athabasca River. There are currently no plans to remove these outfalls, although water volumes from several of them will likely be reduced over time.

The three mine outfalls allow discharge of both precipitation run-off from unmined areas and groundwater from surface aquifer dewatering. Volumes discharged from the North mine drainage system will be reduced as mining on Lease 86 progresses northward. No run-off water from exposed oil sand slopes or basal aquifer waters will be discharged through mine outfalls. In 1996 these outfalls will be upgraded, to allow more accurate flow volume measurements and collection of more representative samples for water quality analysis. Suncor will continue to monitor these outfalls to ensure compliance with licence standards.

Discharge volumes of wastewater will also be reduced over the next five to ten years as water use within the processing area is conserved due to increased recycling and re-use initiatives outlined in the Suncor Expansion Application.

A new mine outfall will be required for Steepbank Mine by about 2000. The Steepbank Mine drainage plan requires an outfall near the shop facilities area (between Pits 1 and 2) for discharge from the interception drainage system (see Subsection C.3.4). This outfall will discharge into the wetlands area (Shipyard Lake) before entering the Athabasca River. Water quality in the interception drainage system is expected to be similar to water quality in the current North and South mine drainage systems. All mine run-off waters will be collected in a series of channels and run-off collection basins and will be contained either on-site or (by pumping back to the west side of the river) in the Extraction/tailings system. Discharge from the new Steepbank Mine weir will be monitored daily in conjunction with Lease 86 outfalls.

c) Operational Water Quality Assessment

During the past two years Suncor has carried out a number of assessments of seepage flow and water (quality focusing on the Tar Island dyke and the Devonian limestone beneath Pond 5) to gain a better understanding of on-site and off-site surface water and groundwater conditions. Other waters evaluated include seepage water from landfills, Plant 4 beach, the mine drainage systems and the wastewater system. Data from these assessments were used as input for Ecological and Human Health risk analyses (See Section E).

i. Background Surface Water and Groundwater Quality

The quality of much of the surface water and groundwater in the Suncor area is affected by exposure to oil sand. While the inorganic chemistry often reflects the geology of the surrounding or underlying formation, the organic chemistry is similar to the chemistry of fluids in oil sand pore spaces. Several natural waters (believed to represent background conditions on Lease 86/17) have been sampled including:

- seepage from an oil sand slope adjacent to the Athabasca River and upstream from Suncor, which contains naphthenic acid concentrations between 10 mg/l and 25 mg/l;
- basal aquifer water from Steepbank Mine, which contains naphthenic acid (in concentrations of between 8 mg/l and 36 mg/l) as well as low levels of PAHs, PANHs and phenolic compounds;
- upper Devonian limestone groundwater from Steepbank Mine, which contains naphthenic acid (concentrations ranging from 47 mg/l to 57 mg/l) as well as low levels of PAHs, PANHs and phenolic compounds; and

- sediment porewater beneath the Steepbank River, which contains naphthenic acids (up to 16 mg/l) as well as PAHs and PANHs.

Organic chemistries of these naturally-occurring waters are similar to that of process-affected groundwaters in the Tar Island dyke.

ii. Tar Island Dyke Seepage

In the February 1995 Application for Renewal of Environmental Operating Approval (Suncor 1995a), Suncor reported the results of a seepage analysis of the Tar Island dyke, examination of which showed that some seepage from the Tar Island dyke by-passes seepage collection systems and enters the Athabasca River. Seepage chemistry is similar to natural background seepage water quality as noted above. The Application also outlined results of a river bio-monitoring program and risk assessment which indicated that there is no measurable impact of seepage on aquatic biota and a negligible risk to all other potential receptors. Suncor will continue to monitor impacts of the Tar Island dyke seepage on river biota.

During 1995 Suncor conducted four additional programs aimed at addressing further seepage conditions and impacts as follows:

- a second, more detailed seepage analysis (AGRA 1996f);
- design and construction of a new toe ditch seepage collection system (AGRA 1995a);
- collection of additional river sediment porewater samples along the toe of the dyke (GOLDER 1996a); and
- an extensive river bio-monitoring program (as well as human health and ecological risk prediction calculations) as part of the Environmental Impact Assessment for the Steepbank Mine project (See Section E).

Results of seepage analysis are summarized below:

- The two main sources for seepage from the Tar Island dyke are:
  - precipitation infiltration, and
  - downward seepage through a zone of coarse Plant 4 beach tailings.

Phase I seepage analysis assumed that only 13% to 20% of precipitation falling on the Tar Island dyke became part of the groundwater system. However, results of an infiltration study (AGRA 1996b) showed that up to 35% of precipitation infiltrates the dyke and that it is a major contributor to collected and uncollected seepage streams.

- Four main discharge pathways for the Tar Island dyke seepage are:

  - the coke filters,
  - seepage at the toe of the dyke,
  - seepage through foundation clay, and
  - seepage through the Snye channel.

  Improvements to the toe seepage collection system were designed and partly constructed in 1995; construction will be completed in 1996. Seepage from the dyke toe is now collected in a toe filter (rather than in an open ditch) which is located behind a new cut-off wall.

- Together coke filters and the toe ditch collect about 1400 m^3/d of the Tar Island dyke seepage and surface run-off which is then returned to Pond 1.
- The probable volume of foundation seepage entering the Athabasca River is about 1700 m^3/day. (There is a 90% probability that the foundation seepage volume entering the Athabasca River is greater than 730 m^3/day and there is only a 10% probability that foundation seepage volume is in excess of 4200 m^3/day.)
- A majority of foundation seepage exits through the Snye channel (Figure D3.0-26) which (although covered by fine-grained materials) has a higher permeability than the remainder of the dyke/pond foundation.
- Seepage conditions at the Tar Island dyke are not yet at steady state: the phreatic surface (internal saturated water level) is dropping 1 m to1.6 m/y.
- Under steady-state conditions (when the phreatic surface has dropped to approximately elevation 244 m ASL), there will be about 325 m^3/d to 650 m^3/d of seepage exiting the structure primarily due to infiltration. Steady-state conditions will not be reached for about a century.

Results of the river sediment porewater study showed that, although process-affected chemistries (sodium bicarbonate water, naphthenic acids, PAHs) were found at several locations along the river bank, they were concentrated at the north end of the Snye channel (Figure D3.0-27). This supports the seepage analysis finding that the Snye channel is the focus for a majority of foundation seepage.

Based on these findings, Suncor evaluated corrective options including:

- a cut-off wall to the limestone, and
- pumping wells.

The cut-off wall is considered impractical as the depth to limestone in the Snye area is in excess of 16 m (and more than 40 m elsewhere along the dyke) and seepage will likely flow around the ends of the wall. Also considered impractical is the pumping well option as in order to "capture" the Tar Island dyke seepage, large volumes of river water would have to be pumped and contained. Suncor proposes that no additional corrective measures (beyond the new toe filter construction) be used for the Tar Island dyke seepage. Such measures are either impractical or unlikely to succeed and there is no evidence of any aquatic or human health impact from the seepage (See Section E).

iii. Athabasca River Monitoring Program

In addition to the above programs Suncor carried out both an extensive river bio-monitoring program and a risk assessment for aquatic and human health. Results of those programs are discussed in Section E and are summarized below:

- Compounds within the Tar Island dyke's seepage (at elevated levels these may cause health effects) have been identified in natural background waters including the Steepbank River sediment porewater and the basal aquifers in Steepbank Mine.
- Measurements of fish species diversity and population density showed that there is little or no impact from the Tar Island dyke's seepage.
- Tar Island dyke seepage poses a negligible risk to all potential users of the Athabasca River.

A proposed monitoring program for the Athabasca River is described in Section E.

iv. Pond 5 Seepage

As part of the Dyke 8 design Suncor carried out a foundation investigation for the Devonian limestone. Although the limestone was shown to be a competent foundation it was also found to contain high-permeability units which appeared to be fractured and which could cause seepage from the pond. A hydrogeological investigation was then carried out to determine the nature and extent of the fracturing.

Dyke 8 and Pond 5 are located within a channel in the Devonian limestone surface (Figure D3.0-28). Hydrogeological investigation showed that the limestone in the channel includes some hard, resistant, beds which have significant fracture porosity and are water- bearing. A pumping test affected water levels over a distance of 1500 m in a southwest-northeast direction. Units between the beds appear to have low permeability, resembling the limestone beneath Suncor's other tailings ponds (AGRA 1995b, 1996c). In order to prevent migration of MFT fines into the limestone fractures an overburden blanket "filter" (primarily lean oil sand) was placed across the entire pond bottom.

A detailed field investigation of the overburden blanket and upper limestone permeability was undertaken, to quantify seepage rates. Results of the field tests showed that the permeability of the overburden blanket is low (5 x 10^{-7} cm/s). The tests confirmed that the fracture limestone permeability is relatively high (100 x 10^{-7} to 30 000 x 10^{7} cm/s), while the intervening beds have low permeability (2 x 10^{-7} cm/s).

For seepage modelling purposes Pond 5 was subdivided into six sections, based on both overburden blanket permeability and thickness and limestone permeability. Predicted seepage volumes from Pond 5 are shown in Table D3.0-4.

In the future, additional seepage losses are predicted from tailings Ponds 6 through 8 via similar fractures in the Devonian limestone (AGRA 1996c). The discharge point for the seepage waters is unclear, however it is assumed that the seepage enters the Athabasca River. Various processes (dilution, dispersion, adsorption, chemical and biochemical reactions) probably reduce chemical concentrations in seepage water.

TABLE D3.0-4

PREDICTED SEEPAGE FLOWS FROM POND 5

Years After Start of Filling	Seepage Flow From the Pond Bottom (m^3/d)
0.5	202
1.0	405
2.0	475
4.0	376
10.0	248
20.0	128

No adverse impacts on Athabasca aquatic life due to seepage from Ponds 5 through 8 are predicted (Section E).

v. ***Other Seepage and Water Quality Assessment Projects***

As well as the above projects, Suncor carried out an assessment of water chemistry and toxicity for the following streams:

- mine drainage systems,
- wastewater system, and
- Plant 4 beach.

Results of these assessments, sampling protocols and laboratory data can be found in a number of references (Suncor 1996b, Golder 1996b/c/d).

vi. ***Summary Assessment***

Assessment of the cumulative impacts of the releases just described on the Athabasca River reveals that no adverse health effects are expected for either fish and wildlife populations or for human health (see Section E).

d) <u>Water Treatment Requirements and Options</u>

Suncor recognizes that methods of discharge of excess recycle waters must be environmentally acceptable; in most cases, this will require some form of water treatment. The type of treatment chosen will depend on the quality and type of water to be treated. Reclamation waters (which discharge at relatively low volumes over extended periods) are suitable to passive systems such as wetland bio-treatment. Operational waters (due to their volumes and controlled flow) are more suited to conventional water treatment options such as a water treatment plant.

i. Consolidated Tailings Water Toxicity

Recycle water from the current Suncor tailings ponds is toxic to aquatic biota (Table D3.0-5). While water will naturally detoxify over extended periods (if it is isolated from inputs of fresh tailings) it has been found that chemical treatment (i.e., acidification to pH < 5) immediately detoxified the water (Mackinnon 1991). The level of acute toxicity of CT release water was found to be lower than current recycle water, indicating that the creation of CT may also reduce water toxicity. Although acute toxicity of current recycle water will disappear in less than two years, low toxicity of CT release water offers an advantage when considering its further treatment and discharge to the environment (Kasperski 1995 and Alberta Environmental Centre 1994).

There are several outstanding issues that need to be resolved before Suncor can select its tailings recycle water management option:

- The rate at which CT consolidates will dictate both the rate of water release and the ultimate volumes of recycle water. Laboratory testing has shown a range of consolidation rates. Data from the CT trial will be used to determine actual field consolidation and water release rates.
- The chemistry of FGD gypsum will govern ionic concentrations within the recycle system, however the gypsum will not be available until later in 1996.

Current estimates suggest that sufficient storage for recycle water exists until between 2000 and 2005. Suncor will proceed with application for approval to discharge excess water prior to that time. Meanwhile Suncor will continue to collect data and carry out analyses to determine the best water management option(s) for continued operation and environmental protection.

ii. Water Treatment Options

As part of its overall reclamation research initiative Suncor has undertaken wetland research programs since about 1990. An overview of these programs through 1994 can be found in (Suncor 1995a, p 221). In 1995 Suncor expanded its research efforts to include CT waters.

TABLE D3.0-5

SUMMARY OF ANALYSES OF RECYCLE AND CT RELEASE WATER TOXICITY

Water Sample	*Daphnia magna* LC50, %	Microtox™ IC50, %	In Situ Stickleback and Fathead Minnow (% Survival at 6 Days)	In Situ *Ceriodaphnia magna* (% Survival)	Rainbow Trout	
					LC50, %	% Survival
Suncor Recycle Pond Water	25-50 [a]	25-50 [a]	---	---	---	---
Syncrude Recycle Pond Water	2 [b]	20-30 [a]	---	---	7 [b]	---
Syncrude Recycle (after 14 mo)	---	>100 [b]	---	---	90-100 [b]	---
CT Release Water (after 3 mo)	>100 [c]	---	---	---	71 [c]	---
CT Release Water (after 1 y)	>100 [c]	>100 [c]	---	---	>100 [c]	---
CT Release Water - Test Pits [d]	>100	---	80-100	0	---	0-70
CT Release Water - Pond Trench [d]	>100	---	0	0	---	0-100
CT Release Water - Wetlands [d]	>100	---	70-80	16-51	---	100

--- Not tested
a Boerger et al., 1986; MacKinnon and Boerger, 1991
b Nelson et al., 1993
c Kasperski and Mikula, 1995
d Bishay and Nix, 1996

Results of the 1995 work showed that:

- current dyke seepage waters and consolidated tailings release water are amenable to treatment in wetlands since the toxic components of these waters (e.g., ammonia, naphthenic acids, phenols) are biodegradable;
- based on relatively-small-scale field pilot tests, maintenance-free wetlands can be constructed to bio-treat surface streams prior to off-site release; and

- wetland efficiency can be enhanced by including shallow, upstream retention ponds, subsurface gravel beds and nutrient additions.

In addition to passive wetland water treatment systems Suncor has also been evaluating active treatment systems for operational release waters (Alberta Environmental Centre 1994, Wastewater Technology 1995), in particular CT release water. Suncor is currently evaluating systems for removal of inorganics from waters including:

- coagulation/precipitation processes,
- ion exchange,
- electrodialysis,
- reverse osmosis,
- ultrafiltration, and
- evaporation.

For organics removal from water streams the following processes are being evaluated:

- adsorption,
- distillation,
- stripping,
- solvent extraction, and
- up-flow filtration.

Suncor's application for release of excess water will likely include a choice of water treatment (from one of the above technologies). Regardless of the treatment alternative selected Suncor will ensure that any discharge (from operations or reclamation) is environmentally acceptable and complies with regulatory standards.

3.5 RECLAMATION PHASE

The goal of reclamation is to achieve maintenance-free, self-sustaining ecosystems with capability equivalent to their pre-disturbed condition. This section describes how Suncor intends to achieve that goal.

Suncor's reclamation strategy and short-term plan for Lease 86/17 was presented in the February 1995 Application for renewal of Environmental Operating Approval (Suncor 1995a). Guidelines and criteria which provide the basis for reclamation design are presented in Subsection D3.2; specific applications of these to Lease 86/17 and Steepbank Mine are presented below and details of this plan are provided in Appendix IV.

Maintenance-free means that human 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 the normal processes typical of the region leading to gradual reshaping of the landscape. Ecosystems will evolve in revegetated terrain, from new plantings toward mature systems typical of those in the region. Equivalent land capability refers to the capability of post-reclamation land to support various uses similar to that which existed prior to an activity being conducted on the land; these individual original and post-reclamation land uses will not necessarily be identical (AEPEA 1993).

Objectives of the Suncor reclamation program are:

- Disturbed lands shall be reclaimed with gentle slopes to primarily a forest use compatible with pre-disturbed terrain, providing a range of end uses including wildlife, traditional use and recreation; and
- Dyke slopes shall be revegetated primarily for erosion control providing natural end-use possibilities.

Suncor had to redesign its reclamation plan because of the company's proposal to continue its oil sands operation through the opening of another mine site and development of a consolidated tailings technology. Reclamation plans for Lease 86/17 and Steepbank Mine are integrated because of the transfer of materials between the mine sites. The following sections summarize the status of reclamation on Lease 86/17 as of 1996, as well as planned reclamation activities over the next twenty-four years. Development of reclamation landscapes, the integral drainage and groundwater systems associated with those landscapes, and the reclamation ecosystems which will develop or have developed on the landscapes is reviewed below.

Development of a design to achieve Suncor's reclamation goals and objectives (see Subsection D3.2) requires consideration of the principal processes influencing ecosystem development. The types of vegetation and soil that will develop on Suncor leases are dependent on climate, topography, parent material, drainage and time. In addition knowledge and experience gained from over twenty-five years of active reclamation work in the oil sands region provide specific design guidelines.

This section summarizes the specific design considerations which provide the basis for the reclamation plan (outlined in Subsection D3.5.2) required to satisfy the criteria established in Subsection 3.2. Figure D3.0-29 shows the classification of the site into distinct "reclamation areas" to facilitate discussion of specific issues.

3.5.1 Reclamation Landform Security

The relative stability of constructed landforms is important to the establishment of self-sustaining ecosystems. Suncor's dykes are all designed as fluid-retaining structures; all existing dykes meet accepted Canadian standards for such structures. Consolidated tailings technology allows a reclamation plan to be developed which does not require long-term storage of fluids behind constructed containment structures. Drainage occurs within these landforms, decreasing internal water pressures and improving their security. To ensure continued landform security through the reclamation time frame consideration must be given to design elements which either now require maintenance or can be expected to require maintenance in the future. Suncor has completed a full analysis of existing structures in this context (AGRA 1996e); a brief summary is provided below.

a) <u>Stability</u>

Water pressures within existing structures are controlled by a system of internal drains which can be expected to require maintenance in the future. Therefore, Suncor will design and install measures to construct maintenance free landforms as part of the reclamation process. Observations from future monitoring will provide guidance for final design.

b) Consolidated Tailings Demonstration Trials

Additional testing and monitoring of deposit performance is required to establish final design configurations.

The consolidated tailings process produces a deep deposit which gains strength as it dewaters and consolidates. Although the deposit quickly assumes the characteristics of a soft soil instead of a fluid, consolidation continues for many decades leading to settlement of the deposit surface. In order to prevent the formation of shallow lakes on the deposit surface, the deposit must be initially constructed to a higher elevation, to compensate for settlement. In addition, provision must be made to lower outlet control elevations in the final phases of reclamation.

In 1993 the process was demonstrated in field test pits (Caughill 1994) with a volume of about 5000 m^3. This was followed in 1995 by a larger test at the Syncrude site, with a volume of about 100 000 m^3. When complete in 1996 the Suncor Consolidated Tailings Commercial Trial will involve a deposit with a depth of over 15 m and a volume of about 5 Mm^3.

Stabilization and revegetation of the deposit surface have each been demonstrated in individual test series but not as an integrated system. Demonstration of freeze/thaw techniques (to stabilize the deposit surface) has been reported in FTFC 1995. Results of greenhouse and field test plots of various plant species grown in typical tailings and CT deposit surface materials are reported in Xu 1996.

Suncor intends to create a CT reclamation demonstration test site in 1996. The objective of this project is to demonstrate integration of the various steps in stabilization of the surface of a CT deposit in order to identify opportunities for performance improvement for full-scale CT deposits (such as Pond 5). This deposit will be allowed to dewater and experience two seasons of freeze/thaw conditions to strengthen the surface. After this time either additional lean CT mixtures or tailings sand will be used to create a hummocky surface layer as proposed for full-scale CT deposits. Test plots of various plant species will evaluate vegetation sustainability.

3.5.2 Erosion Control

a) <u>Surface Erosion</u>

In 1995 Suncor conducted a major study in 1995 on the erosion resistance of reclamation slopes (AGRA 1996b). Erosion rates on slopes populated with mature vegetation were determined to be within the spectrum of natural processes. Significant environmental consequences in reclamation areas are not anticipated, assuming that soil reconstruction provides the basis for development of healthy vegetative cover leading to the formation of a natural soil profile. Erosion rates were low, even in areas where vegetation was destroyed by a simulated forest fire followed by a simulated 1-in-10 000-year rainfall. Therefore, flattening of slopes to reduce erosion rates is neither necessary nor justifiable.

Performance data collected over the next two decades will enable specific determination of possible requirements for further necessary stabilization measures.

b) <u>River Bank Erosion Protection</u>

Before abandonment of the Tar Island Reclamation Area (Figure D3.0-29) bank protection must be provided in order to safeguard against unacceptable rates of river erosion. Future stability of the river channel must be determined prior to the design of long-term, maintenance-free bank protection measures; in particular the likelihood of channel shifts (leading to changes in erosion patterns) must be ascertained.

To determine the stability of the Athabasca River in the Suncor area a geomorphological assessment of the river was undertaken in order to understand the processes that have led to the current river course and to predict future river flow patterns (AGRA 1996g). This assessment was then used to develop a bank protection design that will provide Tar Island Reclamation Area with long-term, maintenance-free resistance to erosion from the Athabasca River.

i. Athabasca River Geomorphic Assessment

The assessment was conducted through a review of geological literature, visual observation, and comparison of river changes over time through examination of historical photographs of the area. Results of the geomorphic assessment showed that:

- In the Suncor area the Athabasca River is confined by extensive Devonian limestone outcrops.
- Although the river is presently considered to be in a down-cutting mode, the rate and extent of down-cutting is limited by the low river channel gradient and the elevation of Lake Athabasca (18 m over 265 km).
- Near Tar Island Reclamation Area the Athabasca River is classed as a single, sinuous, stable channel system with a shifting and migrating bed.
- The river is not susceptible to abrupt channel shifts and is becoming more stable with time.

Based on this assessment abandonment-level bank protection design can be based on current river morphology.

ii. Long-Term Bank Protection Design for Tar Island Dyke

Some form of bank protection is required for long-term protection of the Tar Island dyke (TID): a conceptual design is shown in AGRA 1996g and Figure D3.0-30. The design will be completed based on results from performance monitoring of the operational bank protection measures described in Subsection 3.4.3.i.

iii. Other Bank Protection Requirements

The only other structure within the Athabasca River flood plain that may require bank protection before abandonment is Waste Area 8. This structure is built of erosion-resistant overburden materials and has been extensively revegetated; in addition, there is natural vegetation between the toe of the waste area and the river bank. Thus, it has been determined that additional protection is probably unnecessary. Should future monitoring indicate erosion of the bank adjacent to Waste Area 8 this decision will be reviewed.

Currently there are no requirements for long-term river bank protection for Steepbank Mine: this situation will be reviewed as part of reclamation performance monitoring. The river geomorphic study has indicated low long-term erosion potential of the east bank of the Athabasca River in the area of 70 m set-back (AGRA 1996g).

3.5.3 Water Management

Section D3.2.2 provided the framework for establishing reclamation design criteria for water management. Section D3.4.4 discussed the operational management of water. This section discusses the long-term plan for the reclamation phase.

a) Introduction

A reclamation drainage system must re-create the stability, safety and sturdiness of the pre-development natural drainage system. This will be accomplished through development of a surface drainage system sustainable for hundreds of years patterned after natural models that are characterized by similar climate, topography and soil conditions. Although it will be impossible to fully replicate the original Lease 86/17 drainage system (because of the unique soil and topographic conditions of post-reclamation facilities) it will be possible to replicate the stability and sturdiness of the original natural systems.

The reclamation drainage plan must include consideration of three objectives including:

- Provision of a plan for conveyance of surface run-off water following mine closure which ensures long-term sustainability and requires no continuing maintenance.
- Minimization of the risk of excessive surface erosion (leading to catastrophic release of CT or tailings sand) through collection and channelling of surface run-off to a receiving water body.
- Assurance that the quality of water leaving the lease must have an acceptable environmental impact on receiving water bodies.

b) Design Criteria

Historically the approach to design of drainage systems for reclamation has been to supply rigid, erosion resistant drainage facilities configured to handle a specific extreme event. This approach may result in uniformity of design and construction but does not necessarily achieve the mine closure objectives of minimal erosion and long-term sustainability.

A major deficiency in conventional practice is the absence of a self-healing mechanism for the drainage system. Often, when man-made channels fail (due to overtopping, washout of erosion protection or channel degradation) the failure leads to either accelerated erosion or channel relocation (or both). These situations are unacceptable. Failures where underlying materials are highly erosive result in high sediment yield and loss of aquatic habitat.

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 designed self-healing capability. The recommended geomorphic approach to design of drainage systems and landscape for mine closure involves development of drainage channels which replicate natural drainage systems. This replication reduces the risk of accelerated erosion and enables provision of self-healing erosion control systems.

Reclamation drainage courses will alter over time and no attempt should be made to resist such change. Instead every attempt should be made to anticipate and accommodate such shifts by incorporating several lines of defence including boulder-strewn ground and deep riprap trenches within drainage channels.

c) **Lease 86/17 Drainage System**

i. General Routing of Major Drainage Channels

Eventually the Lease 86/17 area will comprise a number of reclamation areas (detailed in Figure D3.0-29). The proposed drainage scheme for Lease 86/17 (shown in Figure D3.0-31) routes 60% to 70% of the run-off from reclamation areas westward to Ruth Lake. This lake presently drains southward to Poplar Creek via the Poplar Creek spillway. However, after Syncrude Canada Ltd. commissions its mine closure drainage scheme Ruth Lake will drain northward (to Beaver Creek Reservoir) and then southward to Poplar Creek via a channel in a deep-cut engineered system which replicates natural processes.

Only one reclamation area on Lease 86/17 is not routed to Ruth Lake: Reclamation Area 6 (Figures D3.0-29 and D3.0-31). As its final surface elevation is too low to be discharged to the lake it is necessary to drain this area northward to the Athabasca River (via Horseshoe Lake).

The reclamation drainage plan (detailed in AGRA 1996h) is summarized in Table D3.0-6.

ii. Secondary Drainage Channels

While the major (primary) drainage channels provide surface water outlets from each reclamation area, secondary drainage systems will provide drainage within each of the reclamation areas.

The proposed secondary drainage system will be developed by creating a network of east/west-trending hummocks (ridges) through placement of sand infill. This will force drainage to travel along depressions between the hummocks which will be constructed to form a branched drainage

TABLE D3.0-6

RECLAMATION DRAINAGE CHANNELS

Channel	Year Opened (Approx)	Drainage Basins [a] (See Figures D3.0-29 and D3.0-31 for locations)	Drainage Outlet
1-2-3	2012	• collect drainage for the south end of Lease 86/17 including TIRA and the south slopes of RA2/3 • collect groundwater discharges along the south slopes of RA2/3 • will include drainage from RA1A after 2030	Ruth Lake
4-5-6	2030	• collect surface run-off from RA2/3 and overburden dumps west of RA2/3 • wetlands at west side of RA2/3 • flow into Crane Lake Reclamation Area	Ruth Lake
7-8	2030	• collect surface run-off from RA4 and RA5	Ruth Lake
9-10	2030	• collect run-off from the surface of RA6	Horseshoe Lake
11	2030	• collect surface run-off and groundwater discharge from the NERA including the NESSA and the north portion of Waste Area 8 • existing North Mine Drainage channel	Athabasca River
12	2030	• collects surface run-off from the Plant Site Reclamation Area including the north end of TIRA	Athabasca River

a. TIRA = Tar Island Reclamation Area; RA1A = Reclamation Area 1A; RA2/3 = Reclamation Area 2/3; RA4 = Reclamation Area 4; RA5 = Reclamation Area 5; NERA = Northeast Reclamation Area; NESSA = Northeast Sand Storage Area.

system, similar to many natural drainage basins in the area. The advantage of this configuration is it enables earlier planting of upland vegetation on the hummocks. Wetland vegetation types will be planted in the low areas between ridges.

A schematic layout of the secondary drainage system is shown in Figure D3.0-31. The hummocks, which are composed of tailings sand (cyclone underflow), will be approximately 5 m high with 50 m top widths and side slopes of about 15H:1V. Typical spacings of the ridges vary from 200 m to 400 m.

Drainage areas which develop between the hummocks are expected to evolve naturally, creating their own channel pattern and cross-sectional shape. The resulting secondary drainage system is expected to be stable over the long term.

d) Steepbank Mine Reclamation Drainage Plan

The drainage plan for Steepbank Mine is discussed in Subsection C.3.4. Reclamation drainage will be implemented after 2020 following the mining of Pit 2. The proposed final reclamation drainage scheme for Steepbank Mine is shown in Figure D3.0-31.

e) Wetlands Demonstration Trial

Wetlands are a key component of Suncor's reclamation strategy.

Suncor has completed four years of intensive research on the utilization of constructed wetlands systems for the treatment of oil sands wastewaters (Bishay and Nix 1996; Gunter et al. 1995; Nix et al. 1994; Nix et al. 1995). A 1995 pilot-scale study at the Suncor Wetlands Research Facility (constructed on-site in 1991) focused on investigation of a managed wetlands operation used for biological treatment of various process-affected wastewaters (Bishay and Nix 1996). Summary results of this research is provided in Suncor's 1995 annual Conservation and Reclamation report (Suncor 1996d).

Suncor will be continuing its investigation of the use of wetlands for biological treatment (of the types of waters which will be released from reclamation structures and systems) for many years after area reclamation activities have been completed. The focus of 1996 research will include consideration of:

- accumulation of chemicals within organisms using wetlands treatment systems;
- ecological health and sustainability of wetlands treatment systems;
- larger-scale field experiments to evaluate use of biological filter systems for the treatment of both CT release waters and dyke drainage waters;
- contaminant handling during low-temperature operational periods; and
- relative merits of ponds versus wetlands for water treatment.

Planned wetlands research will include use of the current Wetlands Research Facility (including both constructed wetlands trenches as well as a natural wetlands area) as well as use of the southwest drainage ditch (which channels discharge waters from the area of the Wetlands Research Facility to Tailings Pond 1A).

3.5.4 Ecosystem Re-Establishment

a) <u>Soil Reconstruction</u>

Some materials available for use in construction of reclamation landforms are less desirable as they contain concentrations of various chemicals. Where these materials are located near the surface of a structure a capping layer (of materials such as overburden, tailings sand or lean consolidated tailings) will be added prior to deposit of soil amendment material.

Reconstruction of soil for reclamation areas is one of the critical components of Suncor's reclamation plan. Ultimate capability of the reclaimed area is determined largely by the quality of reconstructed soil. Surfaces of reconstructed landforms are covered with a layer of soil amendment, primarily a muskeg soil that has been removed from areas to be mined and then either stockpiled or (preferably) transported directly to reclamation areas. Stockpiling is employed where surface disturbance has just begun on a site and where there are no areas yet available for reclamation. Soil-building materials available on Lease 86/17 are described in detail in Suncor's Application for Renewal of Environmental Operating Approval (Suncor 1995a).

Suncor's current soil reconstruction technique has been used on an operational scale since 1984. Reclamation sites are enhanced with quality soil-building material, using a technique which involves stripping muskeg to include 25% to 50% (by volume) of mineral overburden. The peat/till mixture is hauled, placed on prepared overburden, tailings sand or consolidated tailings areas and spread to an average depth of 15 cm to 20 cm over the underlying materials.

A detailed reclamation soils handling plan has not been developed for the Steepbank Mine because of the conceptual level of the mine plan.

For Lease 86/17, this information has been provided in the Environmental Operating Approval Application (February 1995) for 1995 to 1999 inclusive. Reclamation soil salvage at the Steepbank Mine would likely commence by 2000 with placement onto any reclamation area by 2002. Detailed annual soil handling plans will be provided through annual C & R reporting through the ten-year approval period.

Suncor will provide a more detailed soil reconstruction and revegetation plan for the Athabasca River valley area of the Steepbank Mine by July 1996. This will be based on EIA Ecological Land Classification (referenced in Section E) and more advanced mine planning in order to provide sufficient information to address Integrated Resource Plan (IRP) criteria.

b) Revegetation

i. *Revegetation Program Objectives*

The primary objectives of Suncor's revegetation program are to:

- provide an erosion-resistant plant cover on tailings dyke slopes and overburden dump slopes;
- focus on utilization of woody-stemmed reclamation species common to the region;
- strive to establish a diverse range of plant species to re-create the level of bio-diversity common to the pre-disturbed site; and
- establish a permanent, viable plant community capable of developing into a self-sustaining cover of forest species suitable for traditional land uses and for wildlife use and with possibilities for recreation and other end uses.

ii. *Revegetation Process for Overburden and Tailings Sand*

Typically, the revegetation process begins with excavation and hauling of undisturbed muskeg soils to the reclamation area. This method (which is completed in the winter whenever possible) enhances site revegetation because dormant, in situ native seed and root fragments are transferred with the soil. Spreading of the muskeg soil on the reclamation site is completed in early spring with the usual result an emergence of a variety of native, woody-stemmed species, forbs, wildflowers and grasses. Key chemical and physical properties of soil materials are detailed in Appendix IV (Table IV-3).

Revegetation objectives are achieved through implementation of a revegetation program which involves: seeding of reclamation areas with ground covers designed to control erosion; area fertilization; and establishment of appropriate, woody plant species.

Suncor currently uses barley as a ground-covering nurse crop on all reclaimed sites. Barley (an annual variety that does not reseed) provides erosion control without hindering development of native vegetation emerging from the muskeg soil by leaving stubble which traps snow, thus protecting out-planted shrub and tree seedlings during the winter.

Fertilizer is applied during initial years of revegetation; applications are made over two to four years, depending on results obtained from annual monitoring programs. Yearly fertilizer application is then discontinued so that developing herbaceous cover does not compete too vigorously with planted woody seedlings. Details of the typical fertilizer program for new reclamation sites are provided in Appendix IV (Table IV-6).

Establishment of woody plants on reclamation areas is integral to the reclamation process. Selection of species and the proportion of each species in the planting mix are based on the woody-stemmed species common to the eco-sites within the Suncor region; existing field conditions; the vegetation type expected to develop on the site (based on landscape terrain features); and the expected growth of woody-stemmed species from seeds and root fragments in the soil amendment layer. Suncor's woody-plant establishment methodology is designed to accelerate the process of natural succession towards desired vegetation types. As woody cover develops on a reclamation area the micro-environment modifies, providing favourable conditions for later successional and mature species. The planting program ensures these species are present, established and capable of taking advantage of condition changes. Types of woody-stemmed species which will be planted on the various reclamation areas of Lease 86/17 are detailed in Appendix IV (Table IV-4).

Woody plant seedlings are propagated either from seed or cuttings collected in the Fort McMurray area. Seedlings are planted in early spring and late summer, the choice depending on logistics and availability of reclaimed areas. Tree and shrub seedlings are planted at an average density of 2500 stems per hectare. This planting density is chosen to ensure sufficient seedlings are planted to permit establishment of volunteer plants and to provide adequate stocking of each species after initial mortality. The Suncor reclamation planting scheme (detailed in Appendix IV, Table IV-4) is summarized in Table D3.0-7 which shows the general composition of overburden planting which would be applicable to the escarpment area of Steepbank Mine. Variation in woody-stemmed species planting ratios will allow a return of the original forest ecosystem to the escarpment area in as short a time as possible. Suncor is currently developing a detailed planting plan for the Steepbank Mine development in the Athabasca River valley.

Suncor's revegetation program includes planting of woody-stemmed species which initiate the return of the area to ecosystems similar to others found in the region and which assist in creation of four primary vegetation types including:

- *Closed Mixed-Wood Forest - Coniferous Dominant (Pine Forest)* - This vegetation type will be established on the edges of tailings sand plateaus and slopes.

TABLE D3.0-7

SUMMARY OF RECLAMATION PLANTING SCHEME

Reclamation Landscape Type	Woody-Stemmed Species - % of [a]			
	Pine	Spruce	Poplar	Shrub
Tailings Sand	50	10	20	20
Overburden	10	50	20	20
Overburden (Escarpment Areas)	0	40	40	20
Consolidated Tailings	20	50	15	15

[a] The planting mix for woody-stemmed species tends to have a higher percentage of coniferous species because deciduous species are naturally returned to the area via the muskeg soil amendment.

- *Closed Mixed-Wood Forest - Deciduous Dominant (Poplar-White Spruce/Shrub)* - This vegetation type will be established on the moister areas of tailings sand plateaus and consolidated tailings deposits. It will also be established on overburden dykes used to re-establish Steepbank Mine escarpment areas within the Athabasca River valley.

- *Closed Mixed-Wood Forest - Coniferous Dominant (White Spruce-Poplar/Shrub)* - This vegetation type will be established on the overburden dumps, the lower portions of the tailings dyke slopes with northerly aspects and on reclaimed consolidated tailings deposits.
- *Wetlands Closed Shrub Complex* - This vegetation type will be established on poorly-drained areas of tailings sand plateaus and consolidated tailings deposits.

iii. Revegetation Process for Consolidated Tailings Reclaimed Storage Structures

Implementation of consolidated tailings (CT) technology allows Suncor to infill tailings ponds with a material which dewaters relatively quickly, permitting typical dry-landscape reclamation technologies to be implemented. As described in Subsection 3.5.1, surfaces of CT storage areas will develop secondary drainage channels as a result of the upward flow of CT release waters. Between these channels hummocks will appear on the area surface. Figures D3.0-32 through D3.0-35 show the relative change in proportions of dry and wet regions on the surface of Reclamation Area 5 (i.e., the CT-infilled Pond 5) for four time periods (2017, 2030, 2050 and far-future).

Reclamation activities on CT-reclaimed storage structures will involve several steps, beginning with the dewatering of the CT-filled area and its undergoing of freeze/thaw cycles (to strengthen the surface). After this initial dewatering period additional lean CT mixtures or tailings sand will be used to fill the upper layers of the area and to create the hummocky surface. Soil amendments will be placed over stabilized surface materials, primarily during the winter. Revegetation of the hummocky, CT-reclaimed storage area will follow, commencing with seeding the hummocks with barley to provide immediate surface stabilization. Shrubs and woody-stemmed species will be planted with the selection of species based on experiments conducted (starting in 1996) to identify those species which are most suitable to CT release water chemistry.

Figures D3.0-32 to D3.0-35 also show the progression of vegetation communities on the surface of the CT-reclaimed storage structure. The lower parts of the area will evolve from temporary wetlands to either dry upland areas or permanent wetlands. Upland areas will initially be dominated by forbs (non-grass herbaceous plants) with deciduous (poplar/willow/others) and coniferous (black spruce/others) woody-stemmed species planted throughout. Changes in relative areas of each of these habitat types is shown in Table D3.0-8.

This reclamation scenario will apply for those tailings ponds on Lease 86/17 which will eventually receive CT. Additionally Ponds 7 and 8 of Steepbank Mine will undergo similar reclamation processes.

iv. Steepbank Mine River Valley Development

Suncor has considered the environmental impact of the Steepbank Mine as required by the Integrated Resource Plan. The Integrated Resource Plan allows for development provided environmental criteria are met. Suncor will provide a detailed reclamation plan for the Steepbank Mine valley by July 1996.

3.5.5 Sequence of Reclamation Activities - Lease 86/17 and Steepbank Mine

a) Final Reclamation Landscapes

Final reclamation landscapes for Lease 86/17 and Steepbank Mine are shown in Figure D3.0-36.

b) Reclamation Activities and Progression

Planned reclamation activities for Lease 86/17 during the period 1996 through 2020 are detailed in Appendix IV (Table IV-4); such activities for Steepbank Mine during the period 2001 through 2020 are also detailed in Appendix IV (Table IV-5). Within Appendix IV, Figures IV-1 to IV-4 show the reclamation progression for both Lease 86/17 and Steepbank Mine.

TABLE D3.0-8
RECLAMATION OF CT STORAGE STRUCTURES

Habitat Type	Percentage of Area During:			
	Year 2017	Year 2030	Year 2050	Far-Future
Permanent Wetlands - Emergent vegetation and open water	10	10	10	20
Temporary Wetlands - Emergent vegetation	50	30	15	0
Uplands Areas (Hummocks)	40	60	75	80
Vegetation Composition on Hummocks:				
- Forbs	40	20	0	0
- Poplar/Willow	0	40	20	0
- Poplar/Spruce	0	0	55	80

3.6 RECLAMATION PERFORMANCE ASSESSMENT AND MONITORING

The intent of this section is to provide the basis for confidence that the reclamation criteria developed in Subsection D3.2 can be achieved by the reclamation plan outlined in the previous Subsection D3.5. The Performance Assessment Framework discussed in Subsection D3.2 provides the foundation for this discussion. Consideration is given separately to landform performance and to environmental performance (although they are interrelated) because different techniques are required for each.

It should be recognized that oil sand reclamation technology is an emerging discipline: although some aspects have already been demonstrated, other aspects require additional refinement and full-scale demonstration. Since Suncor envisions continuing operations on the east bank well past the middle of the next century there will be additional time to monitor progress and to evaluate the success of early reclamation activities. Future application for reclamation certification will be largely based on results of these monitoring programs.

3.6.1 Landform Performance Assessment

Assessment of landform security involves consideration of mass stability, surface and river erosion resistance, and long-term settlement.

a) Stability

Long-term post-reclamation landform stability (of all retention structures) is evaluated through a combination of current and forecast stability, recognizing that specific additional measures will be taken as part of the final reclamation plan (Subsection D3.5.1). In more than twenty-five years of lease operations Suncor has maintained the stability of all retention structures (including tailing dykes, waste dumps and other facilities). These structures have been designed and operated to accepted Canadian standards for fluid retention structures and their design and operating conditions safety have been both supported by an extensive monitoring program and reviewed by independent review boards and regulatory agencies.

Stability of all structures will improve with time due to two important factors. Firstly, removal of fluid-like mature fine tails and their replacement with consolidated tailings will assist in improvement of stability. Secondly, porewater pressure in the foundation and other structural elements will slowly decrease with time thereby further increasing structural stability from already-acceptable levels. When removal of fine tailings and infilling of ponds is complete these structures will no longer retain fluids. Seismic activity in this region is very low; thus, the risk from earthquakes to long-term stability of all lease components is also very low.

Any potential consequences of instability have been dramatically reduced by the replacement of fluid-like mature fine tails with soil-like consolidated tailings infill. Nevertheless, such material is subject to a degree of run-out in the unlikely event that retention structures are breached by long-term erosive forces. Therefore, there is a low residual potential of infrequent increases in solids loading to the regional drainage system, particularly the Athabasca River. Studies have indicated the potential increase in solids loading to the Athabasca River is in the order of one percent or less of actual background solids loading in the river. This amount is insignificant to the river (AGRA 1996b).

Suncor depends on results of extensive monitoring to evaluate the performance of tailings structures and deposits including visual inspections; analysis of data from instrumentation; annual structural performance reports; and surveys of pond contents and behaviour. Any need for correction of unacceptable situations is thereby identified and acted on. These activities will continue until reclamation certification is received. The frequency and level of monitoring will be optimized to meet the requirements for an effective program.

b) Erosion Control

As part of the reclamation plan Suncor will undertake to minimize the continuing impact of natural erosive forces that can act on the landscape. It is recognized that erosion is a natural process which will modify reconstructed landforms over extended periods of time but it is important to determine whether the reclaimed landscape will perform differently enough from surrounding terrain to pose a significantly elevated risk to the environment.

Detailed consideration has been given to the sustainability of the Tar Island dyke once it has been infilled (replacing its current fluid contents) and reclaimed. A comprehensive geomorphic study of the Athabasca River has been undertaken which indicates that many of the valley features date to a single catastrophic flood event about 9900 years ago. This event resulted in confinement of the river by extensive limestone outcrops that have likely remained stable from pre-Cretaceous times. Since this event the river has continued to become more ingrown and stable and is presently in a down-cutting mode (with the extent and rate of down-cutting limited by the low channel gradient and the level of Lake Athabasca). Geomorphic stability analysis of the Athabasca River in the vicinity of the Tar Island dyke indicates that the river is not susceptible to abrupt, dramatic channel shifts and will become more stable with time. Detailed examination of the facies of sediments found in and adjacent to the old Tar Island, coupled with geomorphic analysis, indicates that the Athabasca River already had begun to abandon the Snye between Tar Island and the valley wall to the west. In this context construction of the Tar Island dyke merely accelerated a natural process: the river's abandonment of a sub-channel.

While the river is unlikely to dramatically shift its channel (thus threatening the long-term stability of the Tar Island dyke) there remains potential for lateral erosion. Bank protection measures are proposed that will be capable of withstanding numerous extreme events that could be anticipated in the many centuries following reclamation. With the exception of the Tar Island dyke and the toe of an overburden waste dump (Waste Area 8) which intrudes slightly into a remnant channel north of the current plant site, all other lease structures are founded on limestone well away from the river and above flood levels.

The reconstructed surface drainage system incorporates several provisions for long-term maintenance of its integrity. An assessment of landscape stability includes the effects of surface erosion through interaction of the surface drainage network (required to safely conduct run-off to the regional drainage system) with lease landforms. Overall the lease drainage plan is designed to control surface erosion and to provide (as much as is practically possible) stable drainage networks. The reclamation drainage system is designed to re-create comparable levels of stability, safety and sturdiness found in natural drainage systems in the area that are subject to similar topography, soils and climate. As much as possible the reclamation plan replicates the self-healing characteristics of natural drainage systems. In this way potential requirements for long-term maintenance are reduced to an exceptionally low level since the landforms will function as natural systems.

Rainfall simulation experiments have demonstrated that surface erosion of tailings sand slopes can be effectively controlled through revegetation: testing (including simulation of forest fires followed by 1-in-10 000-year rainfall events) did not initiate significant erosion.

A system of shallow secondary drainage will be constructed to intercept surface runoff. These channels feed a series of wetlands in the primary system which act to reduce the impact of high-precipitation events. All systems support dense vegetative and root structures, which will be effective in erosion retardation. Wherever possible low channel gradients are used and where this is not practical constructed and hardened basin outlets are used to control erosion.

Based on this assessment it is concluded that constructed drainage systems will respond to natural erosion processes in a manner which does not pose significant incremental risks to the environment relative to regional background performance. There will be an extended period of monitoring of drainage systems performance following revegetation which will allow an evaluation of this conclusion and provide opportunity for any necessary corrective actions.

c) Long-Term Consolidation

Long term consolidation of CT deposits does lead to long-term settlement, thus potentially creating small lakes on the reclaimed landscape. It will be possible, to predict these settlements (based on monitoring of CT deposits) and to construct the deposits to compensate for this settlement. As well discharge outlets can be lowered as settlement occurs reducing the tendency for lakes to form. This is a design issue which can be effectively resolved prior to reclamation certification (AGRA 1996h).

d) Summary

Suncor concludes that performance of the reclaimed landforms will be acceptable relative to the regional background performance for the next 100 to 200 years and that there is a high probability of attaining the criteria established in Subsection D3.2. In the millennia following reclamation extreme conditions might give rise to a local loss of landscape integrity. The reclamation design proposed will produce a landscape which will respond to extreme events in a manner which does not pose incremental risks to the environment relative to natural regional background landscapes.

3.6.2 Environmental Performance Assessment

Environmental performance assessment for human and ecological health considers the following:

- quantities and qualities of all primary chemicals associated with oil sands materials;
- potential receptors of chemicals including both current and future on-site and off-site receptors;
- pathways by which chemicals could leave reclamation areas and affect receptors, as well as the rates at which these processes may occur; and
- potential impacts for receptors (if they are exposed to the chemicals) as well as their degree of severity and likelihood of occurrence.

a) **Reclamation Release Water Quality**

This section presents the assessment of risks associated with release of long-term reclamation surface and groundwater to the receiving environment (particularly the Athabasca River) relative to regional natural discharges.

Suncor has a well-documented program which monitors regional and on-site surface water and groundwater qualities. Analytical models required to predict future process water quality, (including the impact of conversion to consolidated tailings) have been developed. Comprehensive modelling of surface water and groundwater flow rates from reclaimed lands has been completed. Also the distribution, fate and environmental risks of specific chemical species within reclamation streams have been detailed, incorporating extensive field pilot-scale test programs.

Full particulars on the assessment process and results are provided in the documents "Suncor Reclamation Landscape Performance Assessment" (Golder 1996c) and "Athabasca River Water Releases - Impact Assessment" (Golder 1996b). A summary is presented below:

- Existing operating and regional background water streams have been subjected to extensive chemical analysis. The first step in the assessment process, chemical screening (Figure D3.0-6), shows that most chemical species present no risk to current or future on-site and off-site users and do not require more detailed analysis. The four remaining species (benzo(a)pyrene, benzo(a)anthracene, naphthenic acids and manganese) have similar concentrations to those in the natural background; therefore, there is insignificant incremental risk associated with these chemicals.

- Current operational and future reclamation releases to the Athabasca River are very unlikely to have an adverse effect on either aquatic biota (including fish and other organisms) or other wildlife users of the Athabasca River. Potential risks to current or future human users (associated with those four chemicals) from drinking river water are very low (one in ten million or lower).

- Wetlands have been shown to treat process-affected oil sands wastewaters (such as dyke drainage water or consolidated tailings release water) thereby removing acute toxicity to fish. While partial removal of chronic toxicity has been demonstrated further assessment is required. Based on field-scale testing it will be possible to design constructed wetlands to treat specific drainage basin inflow rates and compositions.

The risk assessment establishes that reclamation plans (which allow groundwater and surface run-off water to be released to the environment) are safe to human health and environmentally acceptable. However, while the consequences of conversion to the CT process have been forecast to pose low environmental risk, comprehensive monitoring as the process is implemented is required to verify this projection. The monitoring will involve observing process recycle water quality followed by field treatment tests using Suncor's natural and constructed wetlands (as has been done for dyke seepage and preliminary CT analyses). When reclamation of the Tar Island Reclamation Area is complete (in about 2010) run-off waters will be channelled into test wetlands to assess future reclamation release water quality.

b) <u>Ecosystem Sustainability</u>

Assessment of the sustainability of re-established ecosystems requires consideration of soil reconstruction, evaluation of revegetated areas, forecasts of evolution of revegetated areas to mature systems and re-entry of wildlife. These elements will be considered below.

An assessment of the success of ecosystem re-establishment for reclaimed lease areas was completed using Oil Sands Reclamation Performance Assessment Framework (Subsection D3.2.3). This performance assessment, as well as human and ecological risk assessments, were carried out for both Lease 86/17 and Steepbank Mine reclamation scenarios. Details are provided in the document "Suncor Reclamation Landscape Performance Assessment" (Golder 1996c), while information on the human and ecological risk assessment process is provided in the document "Athabasca River Water Releases - Impact Assessment" (Golder 1996b). A summary is presented below.

i. Soils

Performance of topsoils and subsoils is a key parameter for ecosystem sustainability, and erosion control. Assessment of risks associated with plants growing on reclaimed tailings sand and overburden areas (as well as to the users of those plants) indicates no risk for human or wildlife users. The risk associated with plant uptake of chemicals is effectively mitigated by Suncor's proposed practice of capping less-desirable materials (e.g., CT solids) with better-quality materials. If an event causes a failure of the capping system (e.g., severe gully erosion), then plants growing in contact with poorer-quality materials may accumulate some chemicals. Human health risk assessment showed a low level of concern for two chemicals (manganese and molybdenum) encountered by ingestion of materials grown in areas where the typical capping layer was removed. Wildlife risk assessment shows potential concerns relating to ingestion of plants growing on these same areas. However, this concern specifically relates to the growth of plants directly in CT materials: the effect will be mitigated by capping of CT materials, a process which is part of Suncor's reclamation plan.

Suncor has monitored and assessed its reclaimed soils by comparing trends of key parameters to reference soils. A new approach has been developed using a Capability Rating system (Subsection D3.2.3). This soil rating system includes consideration of various surface and subsurface factors such as physical parameters including moisture, structure, organic carbon and surface peat; and chemical parameters such as acidity/alkalinity, salinity, sodicity/saturation percentage and nutrient retention capacity. The final step in the soil rating procedure involves linkage of moisture and nutrient values with the interim soil rating based on the above evaluations.

Two typical Lease 86/17 reclamation soils have been evaluated: 20 cm of Type 1 muskeg over 80 cm of two different types of overburden materials (see Appendix IV, Table IV-8). This soil evaluation resulted in final soil ratings of 56 and 53 (Class 3). Two additional soils, which were selected based on the soils inventory of Steepbank Mine site (L. Leskiw, personal communication 1996), were also evaluated, including a 20 cm peat/mineral mix over 80 cm of two types of sandy clay loam overburdens (see Appendix IV, Table IV-9). These evaluations resulted in final soil ratings of 63 (Class 2) and 59 (Class 3).

It is forecast that reclamation areas to be developed on both Lease 86/17 and Steepbank Mine will typically have a soil class of 3 (Appendix IV) which means the capability of these reclaimed areas would be greater than that which was typical for the area prior to development. Therefore these soils will meet the criterion of providing the foundation for sustainable ecosystems. As additional areas are reclaimed monitoring of topsoil's performance will continue with particular emphasis on CT deposits, where little experience is currently available. Field-scale demonstrations of reclamation of CT deposits will continue in 1996 following laboratory and greenhouse studies initiated in 1995.

ii. Vegetation

Suncor's reclamation monitoring program assesses achievement of its reclamation objective of "returning the disturbed lands to a forested use compatible with pre-disturbed terrain, providing habitat for wildlife and with possibilities for recreation". The plant communities expected to evolve on reclaimed lands were evaluated for both pre-disturbance and post-disturbance wildlife utilization; they will be used by a variety of wildlife as the vegetation develops towards final forest condition.

Results From Monitoring Reclaimed Areas

Since 1976 Suncor has conducted programs to monitor ecological development on its reclaimed sites. These programs include an annual Reclamation Monitoring Program specifically to assess herbaceous vegetation growth as well as physical and chemical properties of soil. The Suncor Reclamation Program includes a routine maintenance component involving fertilization of revegetated areas, erosion repair and control, and reseeding of areas with poor performance. The typical maintenance fertilizer program employed by Suncor is detailed in Appendix IV (Table IV-7). Annual assessments of tree and shrub survival and growth have been conducted in areas where known numbers of seedlings were planted out; results of these programs are reported to AEP in annual Conservation and Reclamation reports.

Suncor recently summarized results of its reclamation monitoring program in its February 1995 Application for Renewal of Environmental Operating Approval (Suncor 1995a). Specific studies were initiated in 1995 to assess vegetation and soil characteristics of both reclaimed sand structures and natural forested areas on Suncor and Syncrude mining leases. The objective of these studies was to continue assessment of methods used to establish vegetation species suitable for erosion control and which develop into self-sustaining communities compatible with surrounding ecosystems. Summarized below are the results of the 1995 study which was detailed in the report Vegetation Development and Sustainability on Reclaimed Tailings Sand Structures (AGRA 1996i):

- Most of the areas surveyed had originally been seeded to agronomic mixtures of grasses and legumes. These species dominated the herb/ground cover even in areas that were twenty or more years old. Native herbaceous species were only common in areas that had not been seeded to grasses and legumes. Pine and poplar were the dominant trees at Suncor although substantial areas of sparse trees were found. Willows, red-ozier dogwood and caragana were the dominant shrubs.

- Vegetation development was projected over one hundred years using basic assumptions of growth characteristics of individual species and their competitive interactions. During the first fifty years tree communities will increase, especially deciduous-dominated (poplar or aspen) stands. Shrub communities are projected to increase during the first fifty years but then decline during the next fifty years due to shading from developing tree communities. Herb/ground communities are projected to develop into native, forb-dominated stands during the first fifty years while non-vascular species (e.g., mosses) increase throughout the one-hundred year projection period.

- Characteristics of reclaimed sites were compared with those of nearby natural forest stands. Thickness of the surface organic layer ranged from 16 cm to 33 cm for most of the reclaimed sites; these values were comparable to the range of 14 cm to 22 cm found at natural mixed-wood forest stands and much greater than the average of 2 cm to 4 cm found at natural jack pine and aspen stands. The litter layer of natural stands ranged from 2 cm to 8 cm, much higher than the maximum 1 cm found on reclaimed sites. Rooting depth of herbaceous species at both natural and reclaimed sites averaged close to 50 cm. With respect to species composition there was little similarity between the reclaimed sites and natural stands, most apparently for herbaceous species. This lack is attributed to seeding of competitive grasses and legumes on the older reclamation areas, a practice which restricted the invasion of native species. Sites that were not seeded were generally more similar to natural forests even though they were younger than seeded sites.

- The number of tree stems per hectare was highest on sites reclaimed without seeding to grasses and legumes. Non-seeded sites averaged 1500 to 3000 stems/ha while seeded sites averaged less than 1000 stems/ha. By comparison natural forest stands had from 1200 stems/ha (jack pine forest) to almost 5000 stems/ha (spruce-dominated mixed-wood forests). The most obvious difference between reclaimed and natural forest stands was the relative areal cover of various vegetation groups: trees accounted for 55% to 90% of cover in the natural stands compared with an average of 20% to 30% in the best-treed reclaimed areas (older non-seeded sites).

- Comparison of vegetation cover among varying slope aspects at older seeded sites revealed relatively few significant differences. Where differences did occur, results generally indicated better growth on the northern to northeastern aspects compared with southern aspects. A comparison of vegetation cover on Suncor's Tar Island dyke revealed that the lower slopes had better growth of trees, shrubs and native vascular species compared to the upper slopes, where grasses and legumes tended to perform best. These differences are likely a result of more favourable moisture conditions on the lower slopes.

- Site rating tables (developed for the forestry industry) were used to predict future forest productivity on the reclaimed slopes of tailings sand structures. Site ratings and heights were calculated for both natural (pre-mining) and reclaimed sites. Where possible ratings were also determined for sites seeded with cover crops (versus those left unseeded), to compare the influence of site preparation technique on tree growth. Lastly ratings for natural and reclaimed sites were used to predict tree height at twenty-year intervals for each of the dominant tree species.

  - Ratings for reclaimed sites at Suncor fell in the poor/fair/low class for all species except white spruce which was classified as good. These ratings were slightly lower than those for natural sites except for white spruce which was slightly higher. Poplar had a good rating on unseeded sites compared with its poor/fair/low index on seeded sections: this difference, however, may have been the result of site conditions other than seeding versus non-seeding.

  - Predicted forest growth calculated from site ratings reflects the slower growth rate estimated for reclaimed sites. Trees in these areas would be expected to be slightly smaller than similarly-aged trees in the surrounding native forest.

- Vegetated species in reclaimed areas were evaluated on the basis of their long-term sustainability; most were considered to have either a moderate or high sustainability rating.

Impact of Forest Fires

Forest fires are a natural phenomenon in Northern Alberta and the impacts that wildfires of varying severity might have on the sustainability of plant communities has been considered in the report The Effects of Fire on Reclaimed Sites of the Oil Sands Region of Alberta (Silvacom 1996). A summary is provided below:

- If forest fires occur in the next thirty to forty years, they are most likely to be of low severity. Currently, grasses and herbs dominate (most common ground cover) all reclaimed areas and the shrub cover in most sites is too low to yield higher severity fires. Most plants are fairly resistant to burning or have protective bark and will be able to survive the effects of burning (or regenerate after it). Low intensity fires leave much of the organic layer and the root structure intact. Rainfall simulation testing following test burns has demonstrated that tailings sand slopes will be well protected from erosion under these conditions.

- As the reclaimed sites mature, soil organic layers will thicken, tree canopies will close, and downed and roundwood fuels will dominate in the surface litter layer. As a result of these changes, the probability that fires will be more severe increases. The probability of containing these fires burning under high hazard conditions will be much lower. However, under the relatively low soil moisture conditions present on tailings sand slopes, the root structure penetrates well into the mineral zone and continues to provide erosion protection. High intensity burn testing followed by rainfall simulation experiments has demonstrated little subsequent erosion. The use of natural species in reclamation, combined with invasion of local species, will ensure normal recovery of vegetation following a fire.

  Steep sandy slopes present on sections of the Firebag River provide a natural analogue to tailings sand slopes. Fires have historically passed through the forested steep sandy slopes without resulting in serious erosion. This has been attributed to the high infiltration rate of these sandy materials which reduces slope run-off. Studies on Tar Island dyke support this observation.

Based on the above it is concluded that there is a low probability that even high severity fires will lead to unacceptable erosion rates on tailings sand slopes, or which would be significantly different from natural terrain.

Prediction of Long-Term Sustainability

Results of these studies indicate that Suncor's reclamation sites are developing into sustainable ecological units comparable to nearby natural forest areas. Evaluations indicate that Suncor's new soil reconstruction practices are moving reclamation sites toward natural conditions faster than former methods.

A model based on landform geometry was developed as part of the biophysical evaluation of the proposed Steepbank Mine (Golder 1996e). This model was applied to the current landscape of Lease 86/17, to predict long-term vegetation distribution and to examine whether or not the revegetation plan is sustainable (based on characteristics of existing local vegetation). Modelling of the final Lease 86/17 surface (including final land contouring of CT-reclaimed storage structures) expressed the dendritic drainage pattern. The results are shown in Figure D3.0-36.

Results from application of a landform geometry model to planned reclamation ecosystem development gave rise to the conclusion that the reclamation strategy planned by Suncor will achieve long-term, sustainable, mature communities.

iii. Wetlands

Reclamation areas on Lease 86/17 and Steepbank Mine will include surface water drainage systems to collect and channel water from reclaimed areas for eventual discharge to the environment. The quality of water from these various sources will vary from relatively high (for surface run-off) to dyke drainage (water which is known to contain chemicals of site origin). Within this drainage system a treatment pond-wetlands system (i.e., constructed wetlands) will be created to ensure that water is of high quality before discharge to the offsite receiving environment. Designs of the wetland systems specify complete removal of risk of acute fish toxicity and oil sands wastewater chemicals.

Constructed wetlands offer an attractive alternative to conventional wastewater treatment approaches by providing:

- a self-sustaining treatment system utilizing natural microbial populations (capable of degrading complex chemicals) and with a large surge capacity;
- a flexible response to variable chemical loadings;
- a natural surge capacity for episodic rainfall events;
- aesthetically-attractive vegetated areas, which incorporate important ecological features such as small bird and mammal habitat; and
- a treatment system with relatively low capital and operating costs.

Results From Monitoring Wetland Pilot Test Systems

Since 1991 Suncor has conducted research into the use of wetlands systems for treatment of oil sands release waters. Results of research conducted to the end of 1994 were recounted in the February 1995 Suncor Application for Renewal of Environmental Operating Approval (Suncor 1995a) with further information provided in Biological Treatment Options for Consolidated Tailings Release Waters (Gunter et al. 1995) and Constructed Wetlands for Treatment of Oil Sands Wastewater: Technical Report #5 (Bishay and Nix 1996). Summarized below are the results of these wetlands studies.

Research on Lease 86/17 over the past four years has amassed significant information pertaining to the ecological characteristics and sustainability of constructed wetlands and their efficiency in handling process-affected oil sands wastewater (such as dyke drainage water or consolidated tails release water). Ecological data from this field research has indicated that these wetlands will function as viable and productive ecosystems although some of their ecological characteristics will differ from those of nearby natural wetlands (Nix et al. 1995).

The input of specific organic and inorganic chemicals to these wetlands will result in differences in the community structure of micro-organisms and planktonic organisms when compared to nearby natural wetlands. For example an acclimatized bacterial community will develop which will be capable of bio-degradation of many chemicals associated with oil sands wastewater (such as ammonia, hydrocarbons and naphthenic acids; Nix et al. 1993). Rates of bacterial respiration will be elevated (compared with nearby natural wetlands) indicating both an increase in overall bacterial numbers and a positive response to input of chemicals (i.e., the initiation of bio-degradation processes). This difference would be expected since these constructed wetlands are treatment systems and would logically show a biological response to input of contaminated wastewaters. Absence of alteration in biological structure would be evidence that the wetlands are not transforming wastewaters into non-toxic effluent.

Next in level of complexity in the aquatic food web, planktonic communities such as phytoplankton (algae) may differ by small reductions in diversity (i.e., taxa) and increases in abundance; zooplankton may show small decreases in both diversity and abundance (Nix et al. 1994). However, no strong relationship has been established between plankton richness and chemical levels: any identified differences may have been due to indirect (such as decreased oxygen levels) or general such as increased total organic loading effects. Even if differences in chemical concentrations are large, variations in planktonic community structure between treatment wetlands (i.e., dyke drainage) and reference wetlands will be small.

There are no substantial differences in benthic invertebrate communities (i.e., sediment dwellers) between treatment and control wetlands; this result may have reflected the small size of these experimental wetlands which did not permit exact comparisons with nearby natural wetlands. Preliminary findings of hydrocarbons within larval insects (chironomids) did suggest that bio-accumulation of organic chemicals in insect larvae may occur (Nix et al. 1993). For emergent insect concentrations of inorganic compounds (aluminum, iron and zinc) tended to be higher in the dyke drainage wetlands compared with controls but these trends are not statistically significant (Nix et al. 1994).

After wetlands construction a macrophyte community (i.e., aquatic plants) was established in both control and treatment wetlands. A weak trend was shown for hydrocarbon accumulation within cattail (*Typha* spp.) roots in treatment wetlands. Metal uptake into plant tissue was also demonstrated but metals were present to a greater extent in plants sampled from nearby natural control wetlands (Nix et al. 1994). Aluminum was elevated in macrophyte shoots from some treatment wetlands (i.e., dyke drainage) compared to controls but the difference was not statistically significant. In general there was no trend of increasing accumulations of chemicals resulting from increases in system loads. Overall a thriving plant community is established in treatment wetlands although both the growth and species diversity of aquatic plants is reduced slightly in comparison to control wetlands and nearby reference wetlands.

Investigations began for biota at a still higher level of the aquatic food web in 1995. In an experiment (Wolfe and Norman. In: Bishay and Nix 1996) mallard ducklings (*Anas platyrhynchos*) were exposed to various consolidated tailings and dyke drainage constructed wetlands; the principal route of their exposure during the study was by water ingestion. After a period of four weeks no differences were noted in growth rates either within treatment groups or between treatment and control groups. There was no signs of organ abnormality on autopsy; all ducklings had moderate to heavy body fat. After exposure to both dyke drainage and consolidated tailings waters there was no uptake noted of metals in amounts sufficient to present a health risk to young mallards. Also through analysis of bile PAH metabolites no uptake of PAHs (polycyclic aromatic hydrocarbons) was observed.

Sustainability Predictions

Based on these results and observations it can be concluded that there will be a thriving ecology within constructed wetlands. Further study (to assess long-term sustainability of constructed wetlands) will be conducted using larger field-scale test systems.

Wetlands created to treat process-affected oil sands wastewaters (such as dyke drainage water or consolidated tails release water) have been demonstrated to function as viable and productive ecosystems. The ecological characteristics of treatment wetlands, although different from those of nearby natural wetlands, will not prevent their use by wildlife species.

Examination of risks associated with reclamation wetlands and drainage systems indicates that there is a low degree of concern about impacts on resident or migratory species.

iv. Wildlife

Suncor's current method of reclamation and tree planting means a diverse herbaceous cover usually develops within a year of soil amendment application providing erosion protection along with a source of cover and food for wildlife. Animal utilization of reclamation areas (which becomes more noticeable as the extent of reclaimed land grows) increases as food and shelter become available (via maturing vegetation) on the reclamation sites. Some mammalian species are routinely observed on the reclamation sites while others frequent fringe areas adjacent to undisturbed stands. Increases in rodent populations on reclaimed areas have attracted coyotes, wolves, foxes and many birds of prey to the areas.

Results From Monitoring of Wildlife Use of Reclaimed Areas

The 1995 study of reclamation area vegetation, detailed in the report Vegetation Development and Sustainability on Reclaimed Tailings Sand Structures (AGRA 1996i), also evaluated use of reclaimed areas by wildlife species. Habitat suitability for wildlife was assessed during this study by evaluating the food or cover usefulness of vegetation communities. Suitability of individual tree, shrub and ground cover species was established for seven wildlife species groups (including deer, moose, small mammals, fur-bearers, songbirds, game birds and raptors). Key findings included the following:

- Two key tree species are balsam poplar and aspen which were used for food, cover or both by all seven species groups. Fruiting shrubs (saskatoon and chokecherry) are important for forage as well as for nesting habitat and escape cover. Although many of the grasses are highly-palatable they are used by relatively few species groups (mainly deer, moose and small mammals).

- Predicted vegetation communities (for 2095) were used to make qualitative assessments of habitat value for three selected species groups: ungulates, birds and large fur-bearers. Future habitat value at Suncor was high for all species groups across a majority of tree communities. Mixed deciduous and coniferous forests scored high with all species groups examined mainly because of the variety of food and cover niches available in this community. Similarly the mixed-wood community had high value for most wildlife species. Introduced species communities (e.g., Manitoba maple) and sparsely-treed areas had lower ratings due to unknown or lack of suitability of introduced (dominant) species and lack of strata respectively. As sparsely-treed areas (conifer/deciduous and deciduous communities) are predicted to predominate on reclaimed areas in 2095, future habitat value of these areas is expected to be good.

Other wildlife studies conducted in the oil sands area have shown that the most numerous terrestrial fur-bearers in the Suncor area are snowshoe hare, red squirrel, Canada lynx and fisher. Lynx, fisher and red squirrel prefer mature coniferous forest with a high degree of crown closure, numerous deadfalls and a few openings where shrubs can develop. Reclamation forests (which provide this habitat type as they mature) will increasingly be utilized by these animals.

Moose prefer early successional stages of mixed-wood and deciduous forests which offer a mosaic of vegetation types for both cover and food (i.e., browse). Favoured browse species include saskatoon and willow followed by aspen, red-ozier dogwood, white (paper) birch, balsam poplar, pincherry and chokecherry. Most of these species are included as part of Suncor's revegetation program while the remainder are expected to naturally invade reclamation areas.

Post-reclamation land capability for waterfowl will be higher than before development. The major factor limiting waterfowl use prior to development was the presence of topographic features that limited pond development. Permanent ponds on reclaimed areas will have gentle edge slopes to encourage growth of emergent plants. Pond shorelines (modified to maximize shoreline to pond surface area ratio) will enhance the ability of the ponds to be used as waterfowl and aquatic mammal habitat.

3.7 POTENTIAL RECLAIMED LAND END USES

Based on the Performance Assessment outlined in Subsection D3.6 reclaimed landscape will have the flexibility to accommodate a number of end uses and it will exhibit the following characteristics:

- Reclamation landforms created will meet or exceed stability requirements. Implementation of the consolidated tailings process eliminates the requirement for fluid-retaining structures. Planned landform modifications will both eliminate future maintenance requirements and satisfy long-term stability requirements.

- The effects of erosion on reclaimed landscapes will be controlled through a combination of drainage design and ecosystem re-establishment. Reclaimed areas will experience natural erosive processes; however, the extent of gullying will be limited by natural means with self-healing processes consistent with those of undisturbed areas.

- Drainage systems developed on reclaimed landscape will function effectively in channelling area waters to off-site environments. These waters, which will be treated naturally within the wetlands systems developed as components of the drainage network, will have acceptable impacts on the receiving environments.

- Ecosystems re-established on reclaimed sites will be self-sustaining and will function in a similar manner to ecosystems on undisturbed areas adjacent to the Suncor development. Individual components of re-established ecosystems have been evaluated as follows:

    - Reconstructed soils have been shown to be equivalent to or better than original soils.
    - Results of field monitoring indicate that Suncor's reclamation sites are developing into sustainable ecological units comparable to nearby natural forest areas. These results together with those from terrain modelling show that Suncor's reclamation strategy will achieve long-term, mature communities sustainable under current topographic and climatic trends.
    - Successful development of a viable reclamation area vegetative cover together with establishment of reclamation drainage systems means that reclamation ecosystems will become viable wildlife habitats. Assessment of risks associated with plants

growing on reclaimed tailings sand and overburden areas, as well as risks to users of those plants, indicates no risks for human or wildlife users.

The characteristics and ecological diversity of reclamation areas as presented in this Application provide the flexibility to accommodate a number of end uses. Selection of specific end uses from the spectrum of opportunities will be done in conjunction with regional land users and communities. Suncor believes that the reclamation plan as presented will meet the criteria for reclamation certification. The following subsections provide examples of end uses.

3.7.1 Traditional Uses

There will be a return to a land capability which can support traditional uses. Wildlife habitats will be recreated to enable trapping and the revegetation plans promote the growth of native species to provide plant-gathering opportunities.

3.7.2 Forestry

Baseline forestry conditions for Suncor lease areas have been shown to fall primarily in the low-productivity or non-productive capability classes (CAN-AG 1996b). Suncor's assessments of currently-reclaimed areas show an improvement in capability of post-reclamation potential (compared to pre-disturbance potential). This change is primarily due to alterations in topography which improve drainage patterns and establish productive lakes and ponds. Suncor's reclamation program has been successful in establishing a forest-type ecosystem that is evolving in harmony with undisturbed forest ecosystems adjacent to the lease.

3.7.3 Wildlife

Habitats developed on reclaimed Lease 86/17 areas include a variety of both drainage systems and ecosystems. These habitats will be well-used by a variety of wildlife species; therefore, as habitats mature opportunities for trapping and hunting will increase.

3.7.4 Recreation

There will be an overall increase in the recreational capability of upland portions of the lease area due to conversion of muskeg areas to better-drained, forest-type habitats which are more accessible to recreational users. These areas may sustain extensive recreational activities such as hiking, hunting, snowshoeing and snowmobiling. In addition post-mining topography on lease abandonment will provide a source of recreational interest. Areas of the Suncor leases adjacent to the Athabasca River will still retain moderately-high recreation capability by providing access for angling and boating as well as vantage points for nature viewing.

Areas of the reclaimed lease will require restriction of some forms of recreational activities; for example slopes of reclaimed tailings sand dykes will not sustain activities involving the use of all-terrain vehicles. Such activities will almost certainly disturb the developing ecosystem and lead to increased potential for erosion.

FIGURES SECTION D3.0

FIGURES

PROJECT LIFE CYCLE

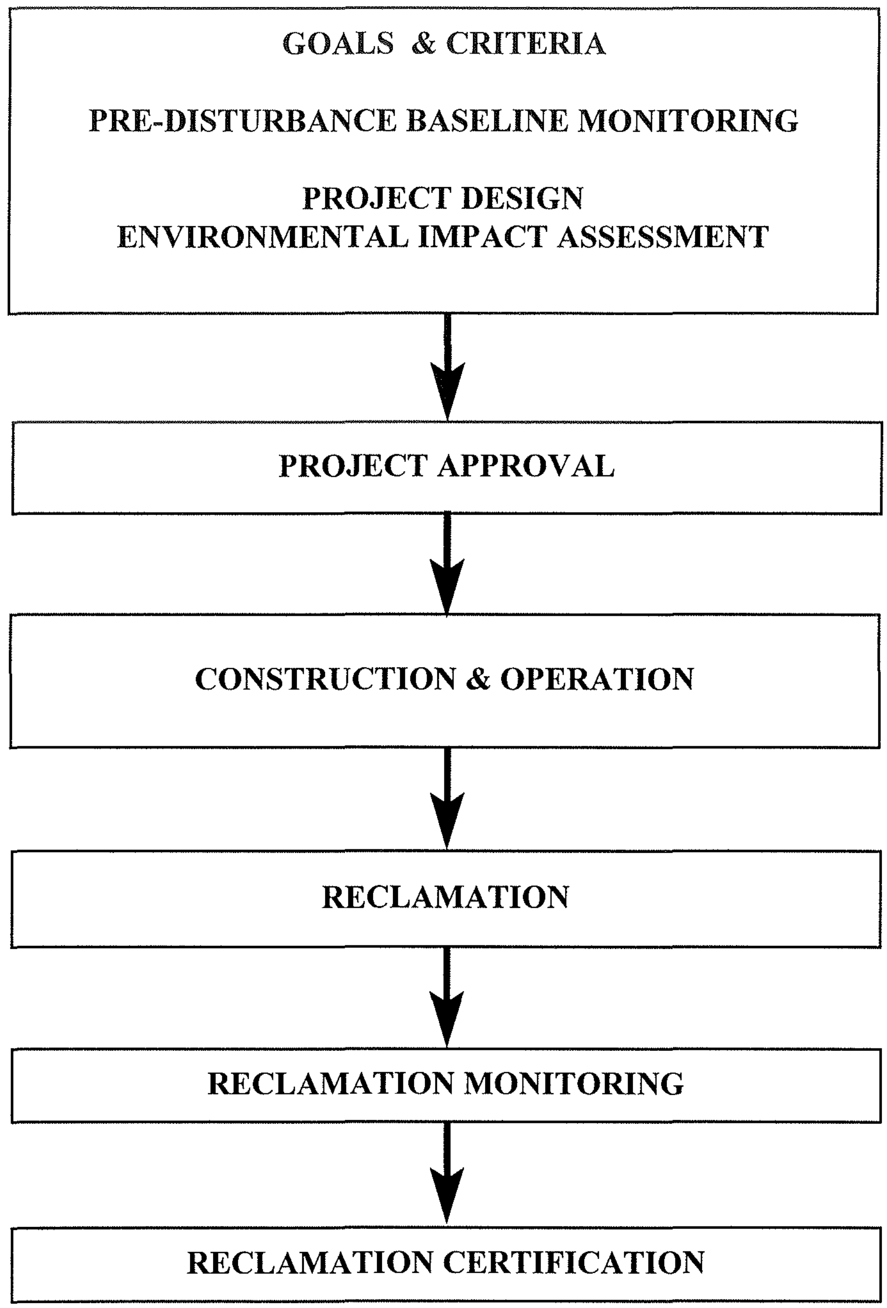


Figure D3.0-1

PROTOCOL FOR SCREENING EFFLUENT QUALITY FOR ATHABASCA RIVER IMPACT ASSESSMENT

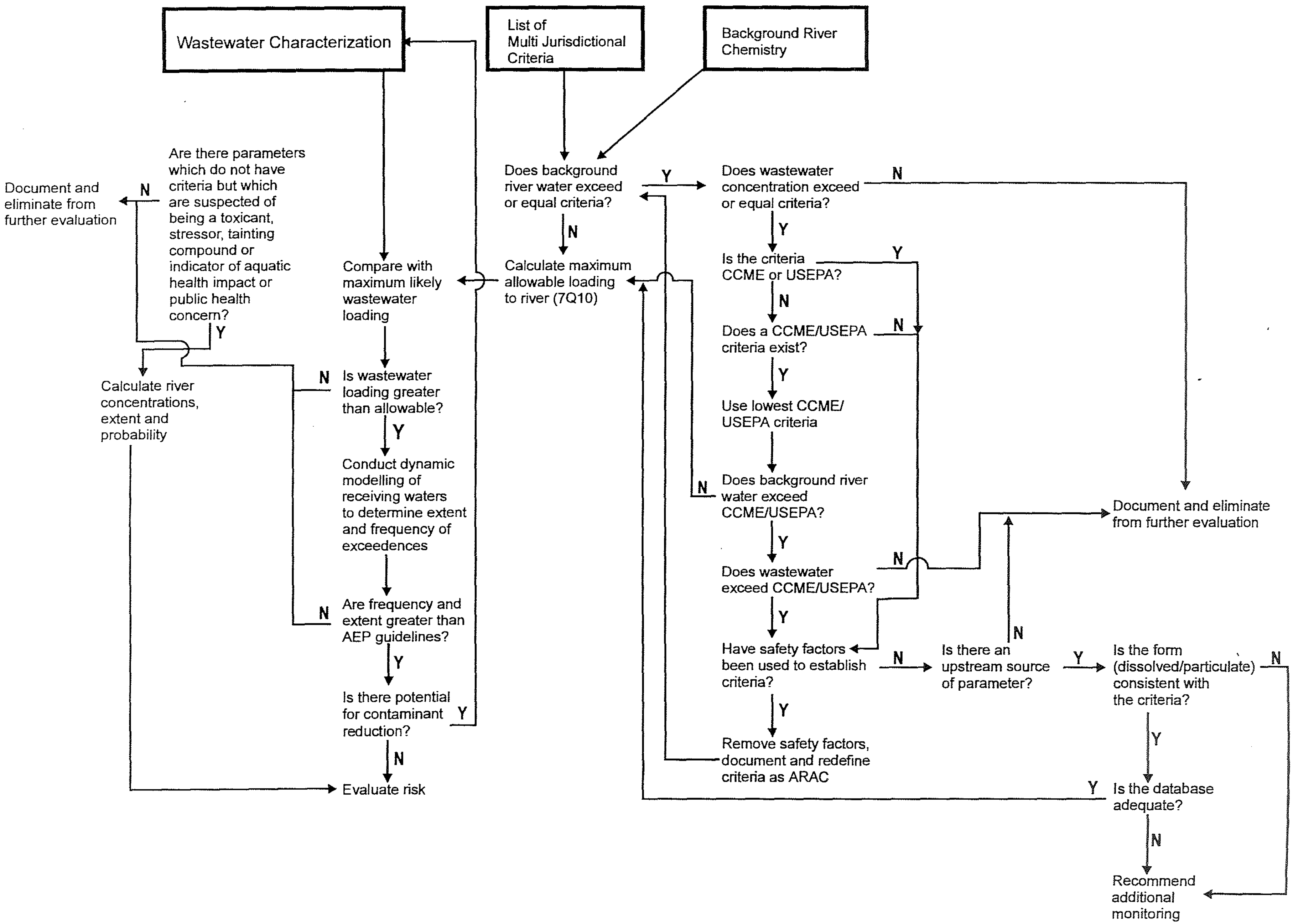


Figure D3.0-2

OIL SANDS RECLAMATION PERFORMANCE ASSESSMENT FRAMEWORK

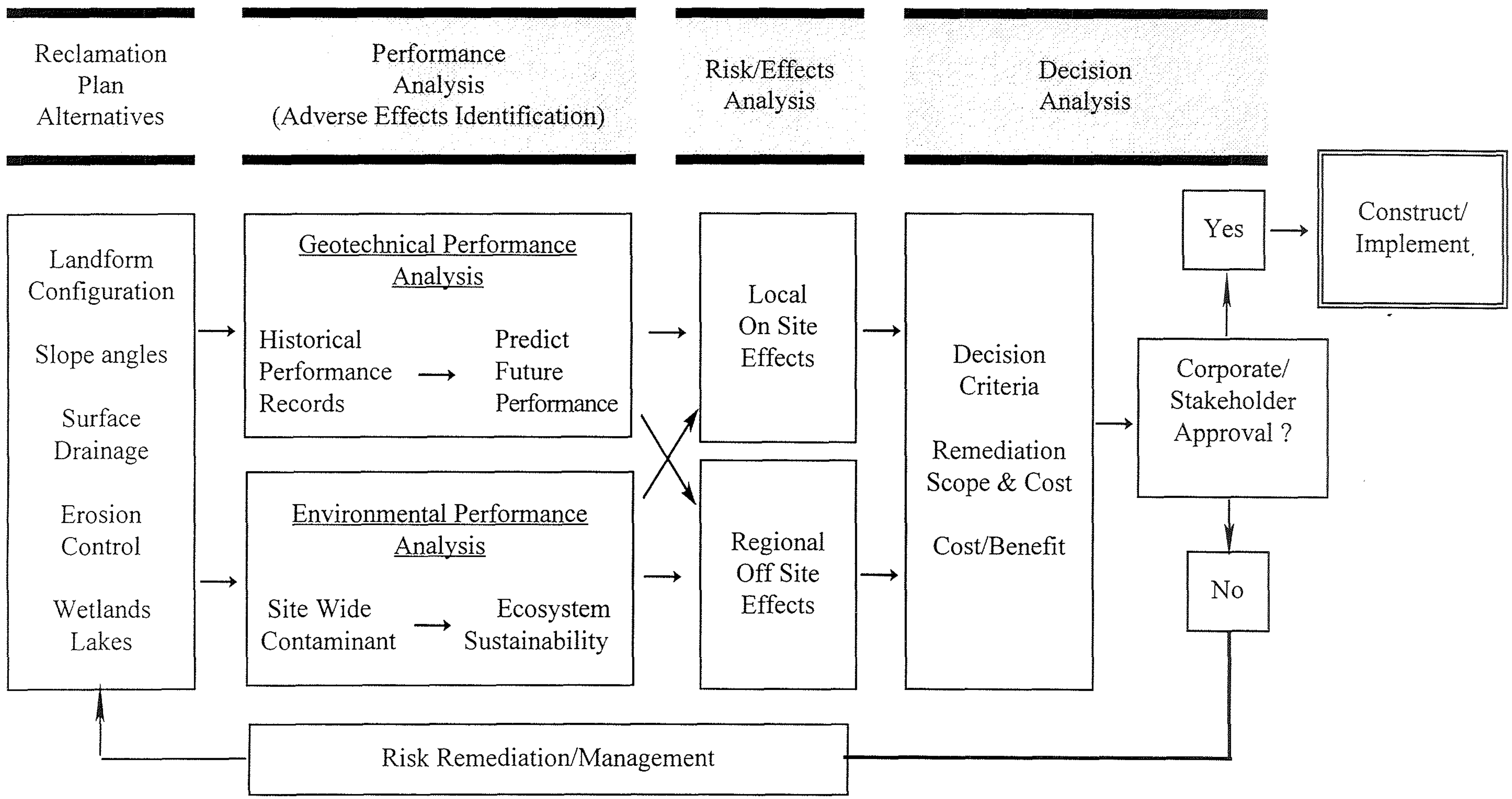


Figure D3.0-3

LANDFORM PERFORMANCE ANALYSIS

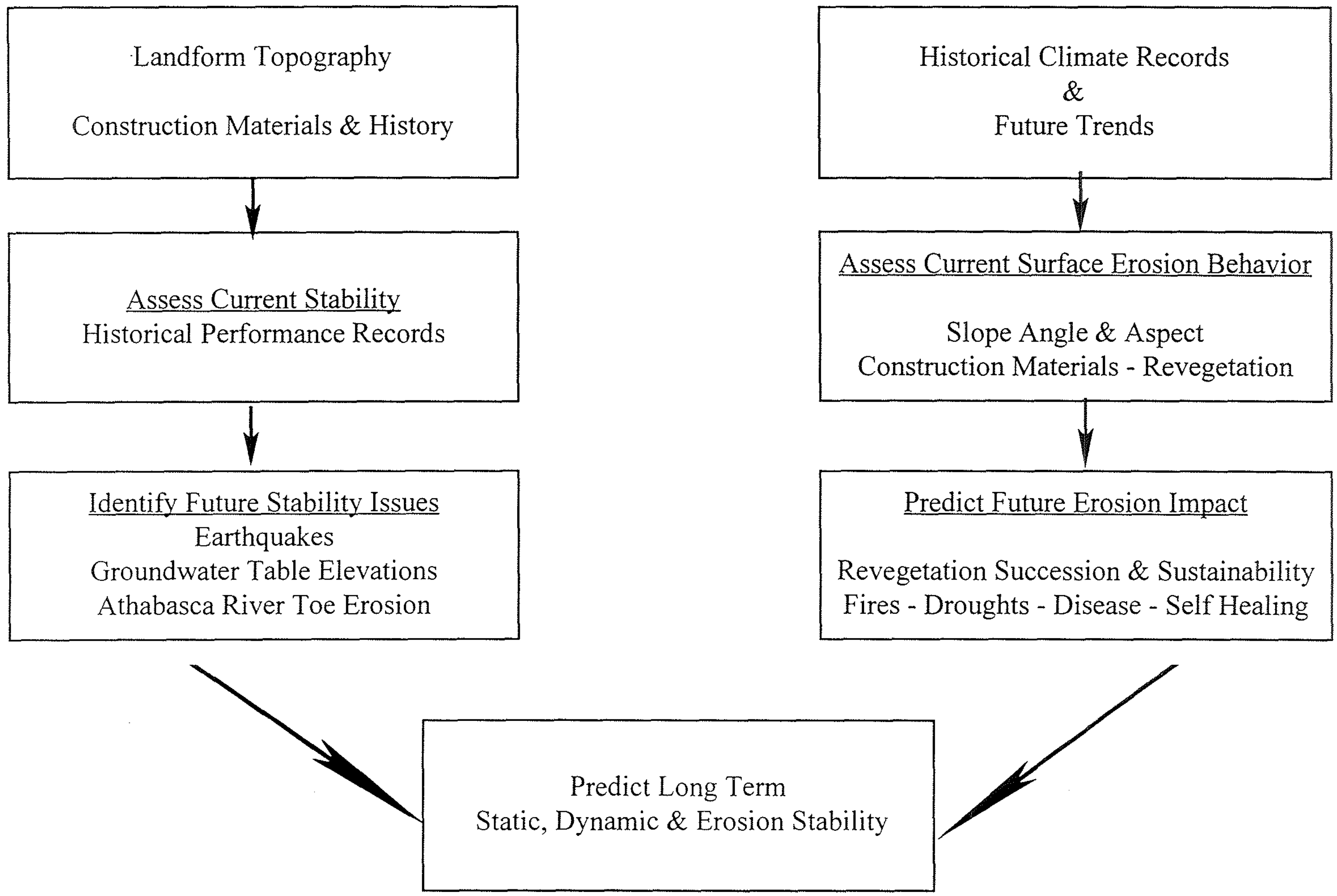


Figure D3.0-4

ENVIRONMENTAL PERFORMANCE ANALYSIS

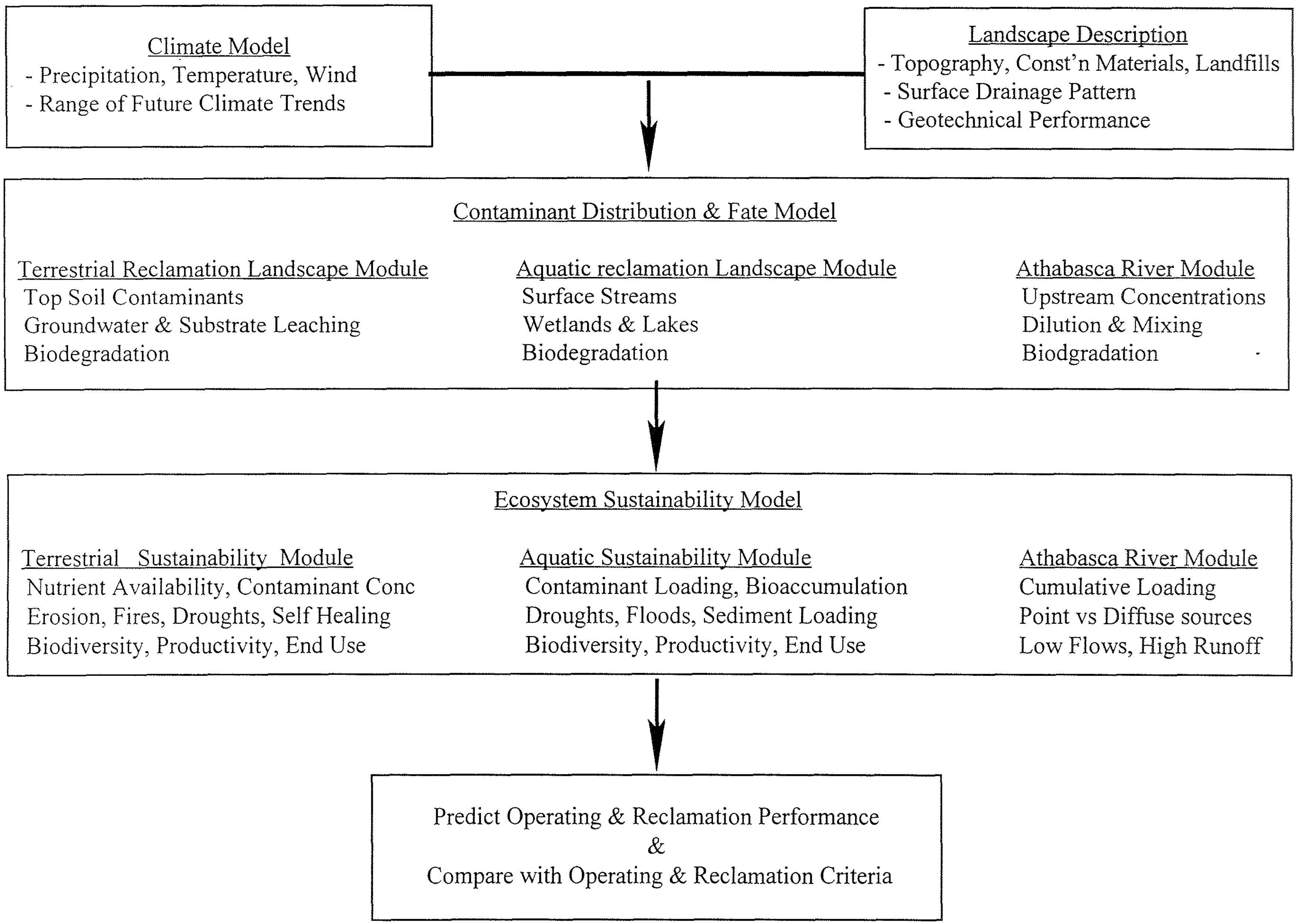
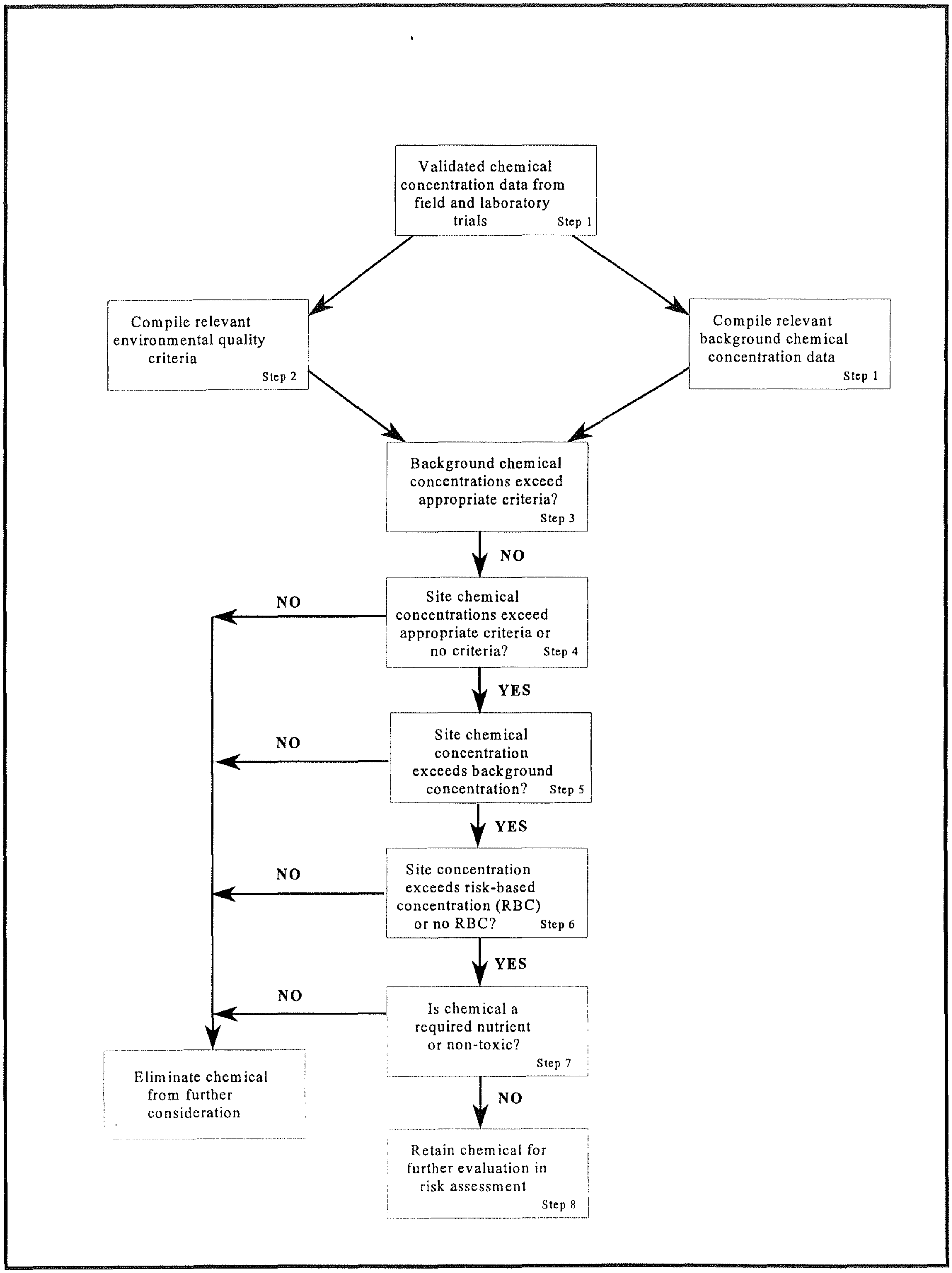


Figure D3.0-5



Process for Chemical Screening

Figure D3.0-6

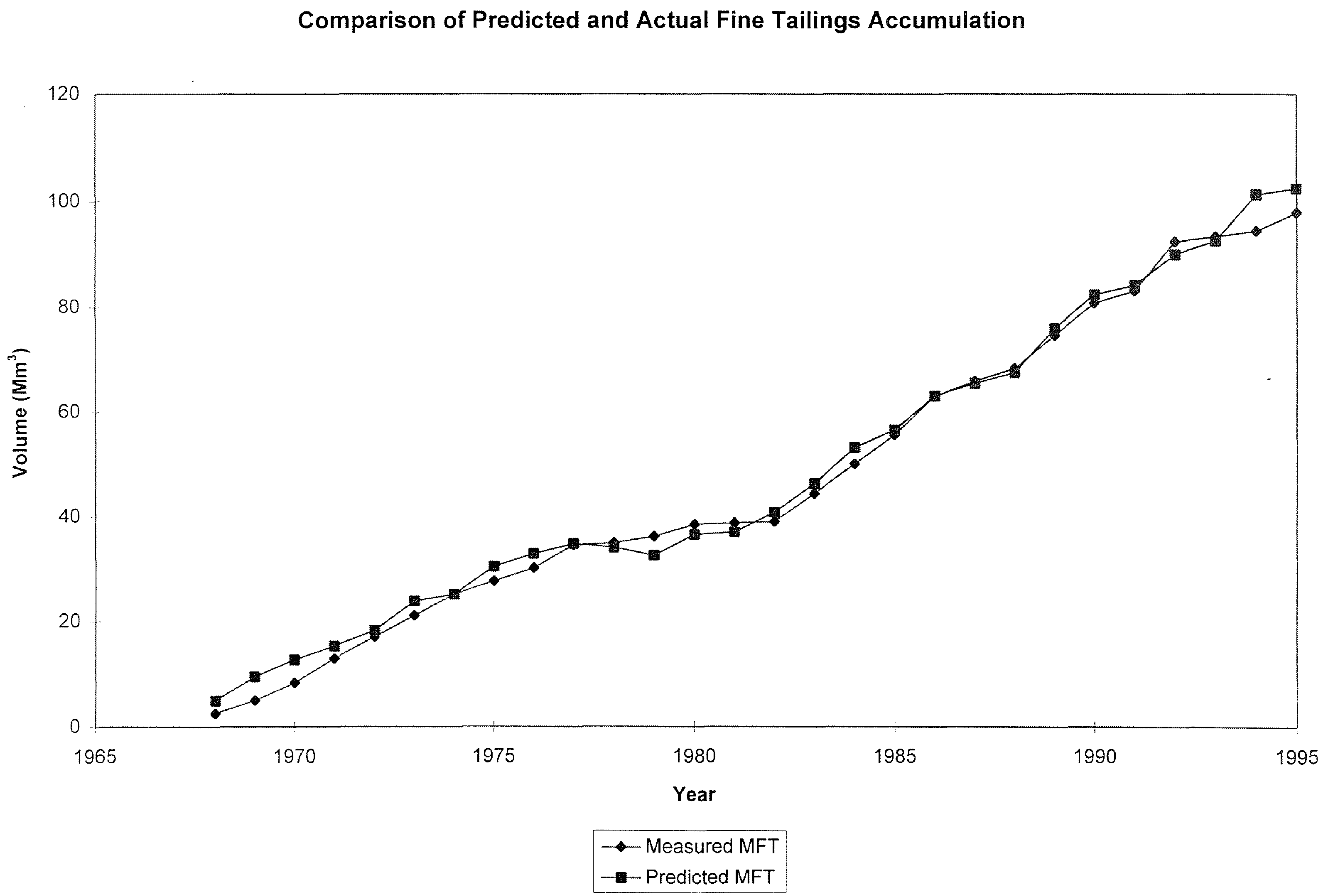

Comparison of Predicted and Actual Fine Tailings Accumulation
Volume (Mm³)
120
100
80
60
40
20
0
1965
1970
1975
1980
1985
1990
1995
Year
Measured MFT
Predicted MFT

Figure D3.0–7

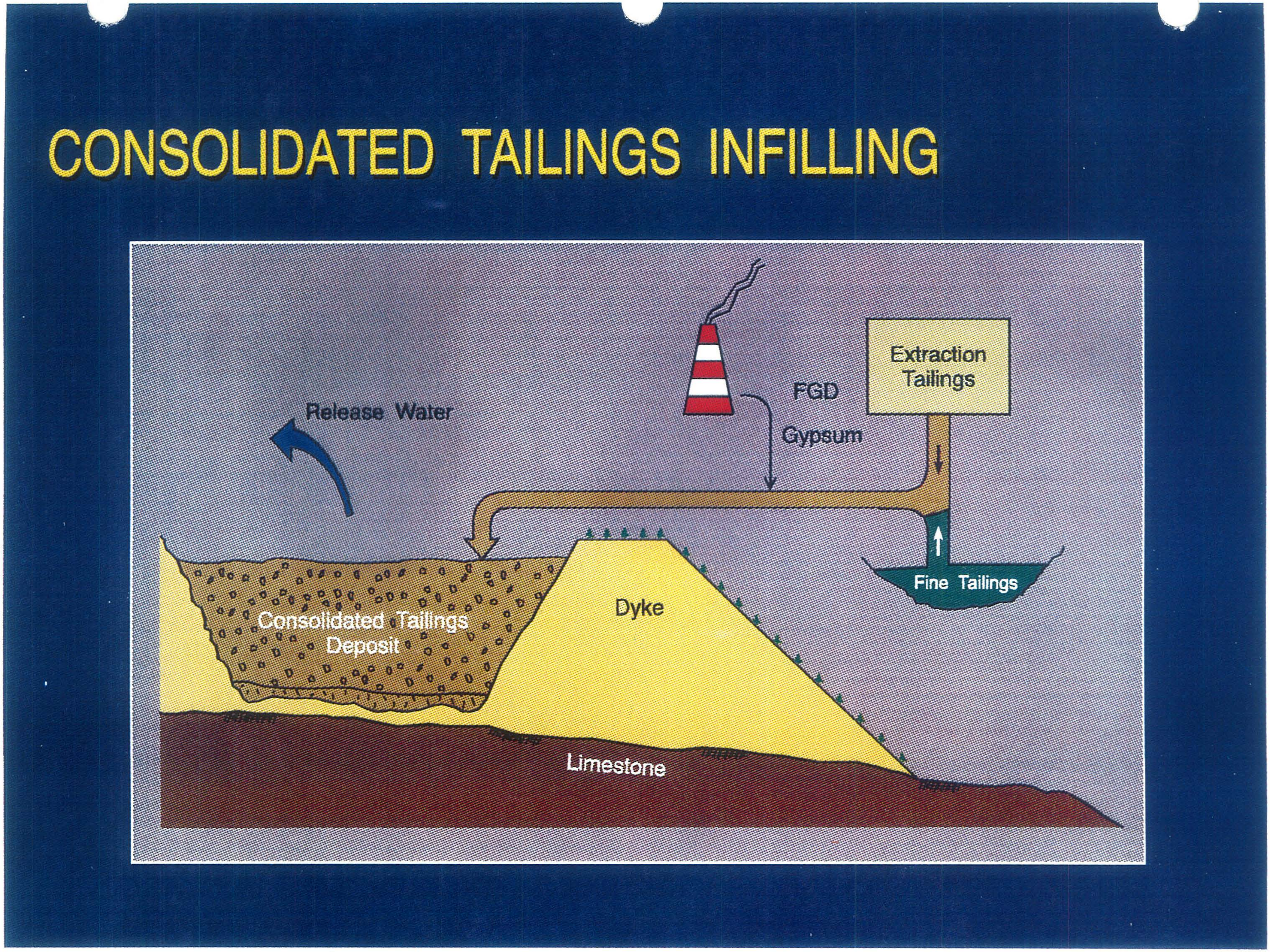
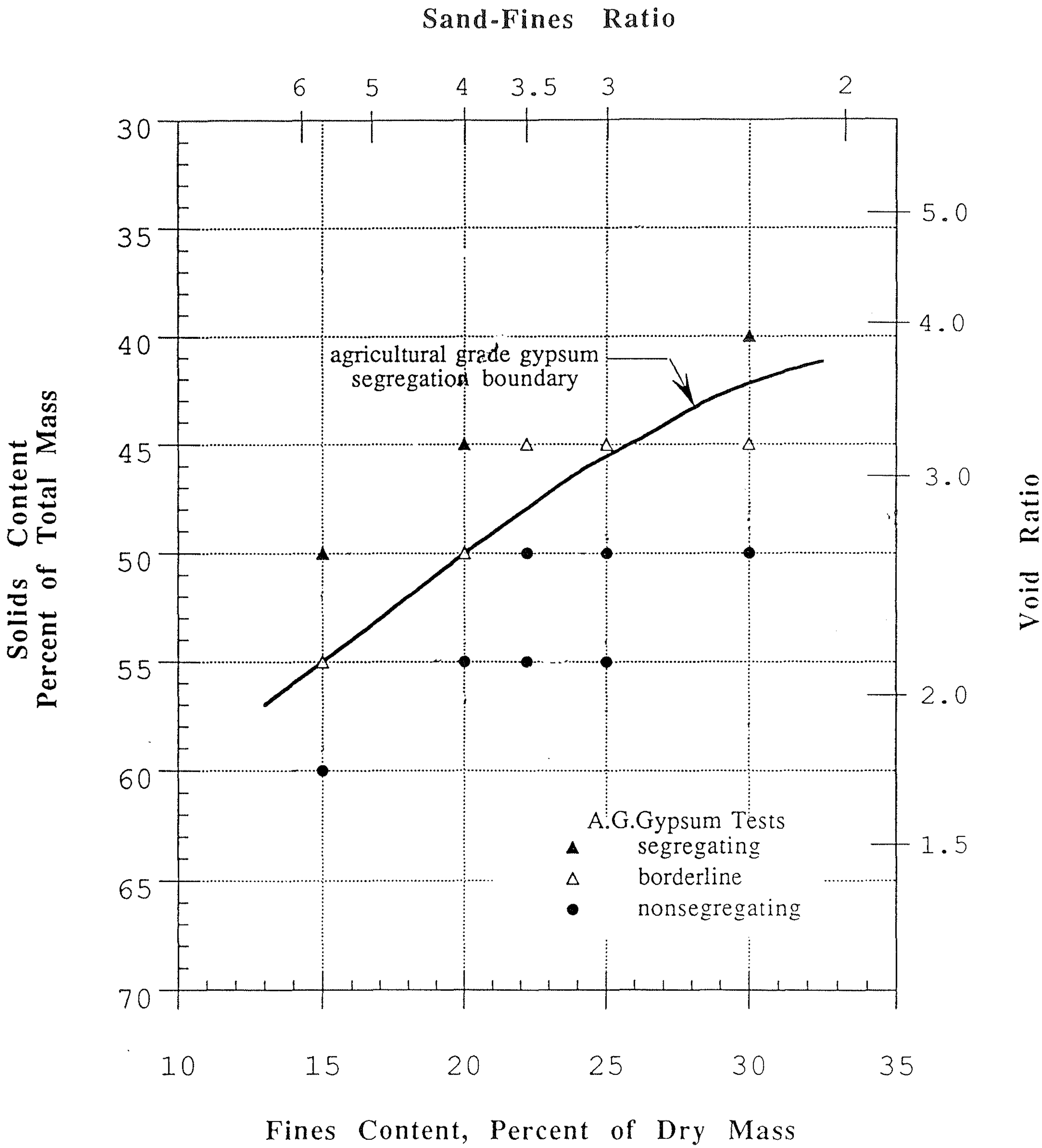

CONSOLIDATED TAILINGS INFILLING
Extraction Tailings
FGD
Gypsum
Release Water
Fine Tailings
Dyke
Consolidated Tailings Deposit
Limestone

Figure D3.0–8



Consolidated Tailings Segregation Boundary

Figure D3.0-9

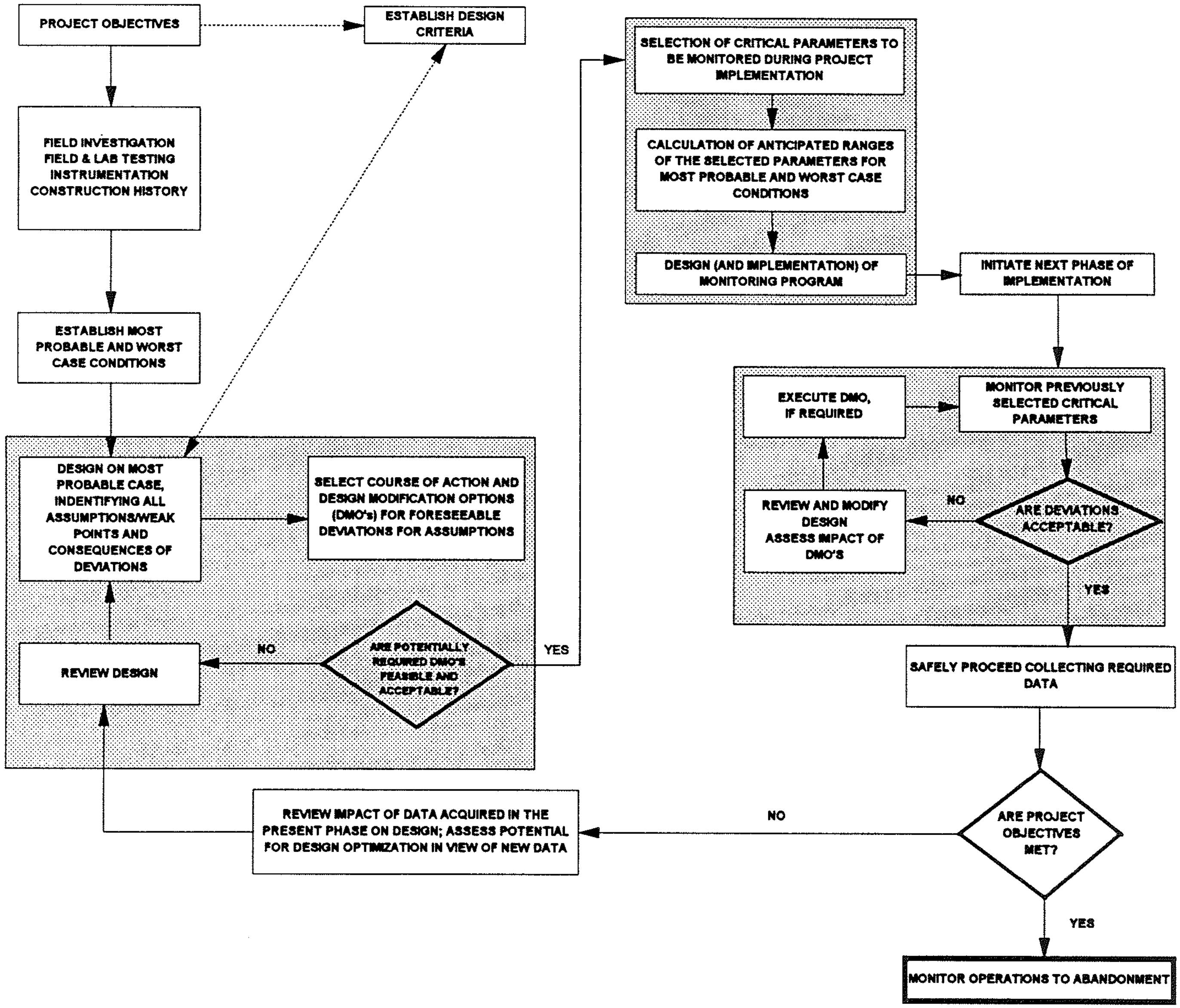
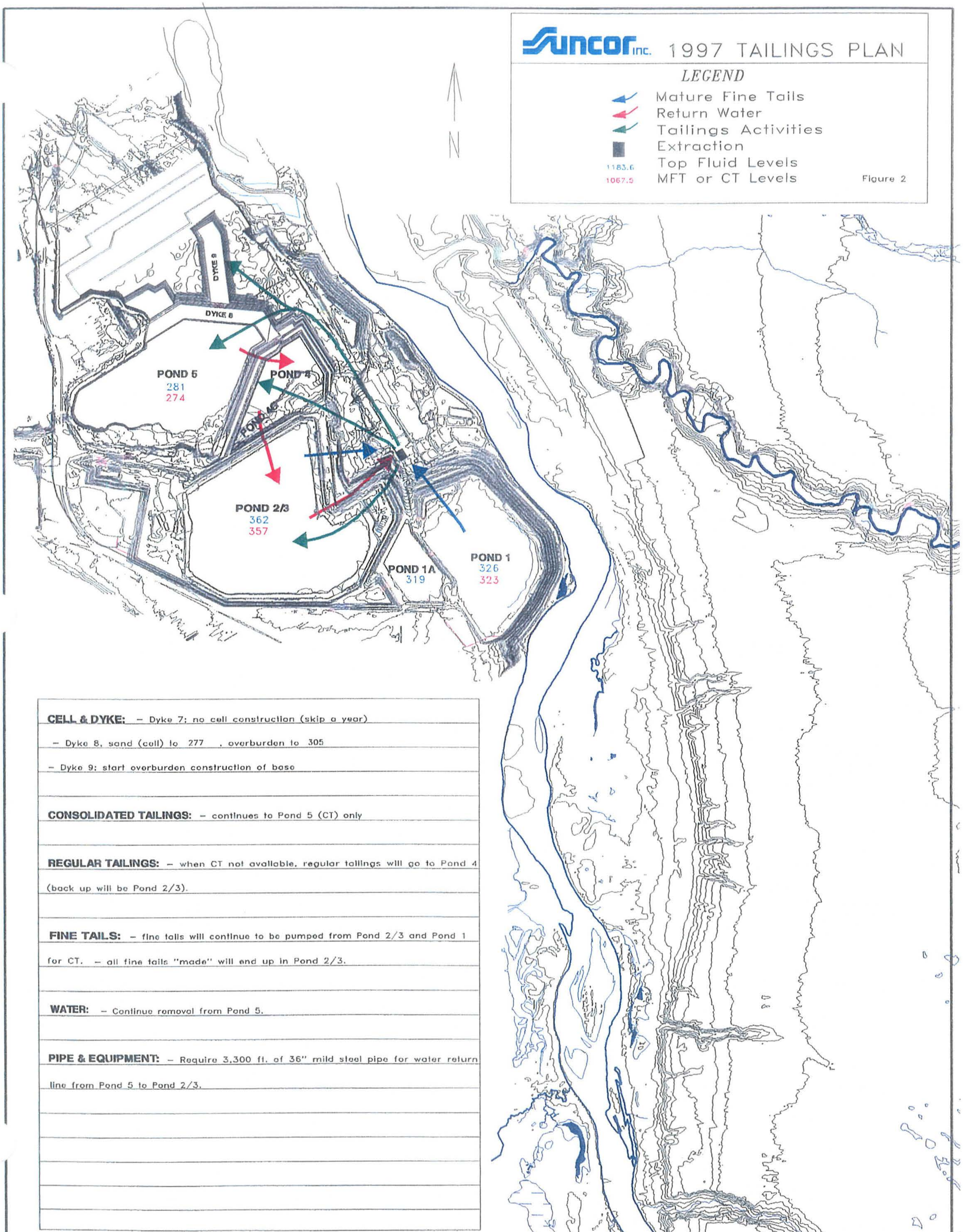


Figure D3-10 Observational Method



CELL & DYKE: – Dyke 7; no cell construction (skip a year)

– Dyke 8, sand (cell) to 277 , overburden to 305

– Dyke 9; start overburden construction of base

CONSOLIDATED TAILINGS: – continues to Pond 5 (CT) only

REGULAR TAILINGS: – when CT not available, regular tailings will go to Pond 4 (back up will be Pond 2/3).

FINE TAILS: – fine tails will continue to be pumped from Pond 2/3 and Pond 1 for CT. – all fine tails "made" will end up in Pond 2/3.

WATER: – Continue removal from Pond 5.

PIPE & EQUIPMENT: – Require 3,300 ft. of 36" mild steel pipe for water return line from Pond 5 to Pond 2/3.

Figure D3.0–11 Integrated Mines Tailings Plan – 1997

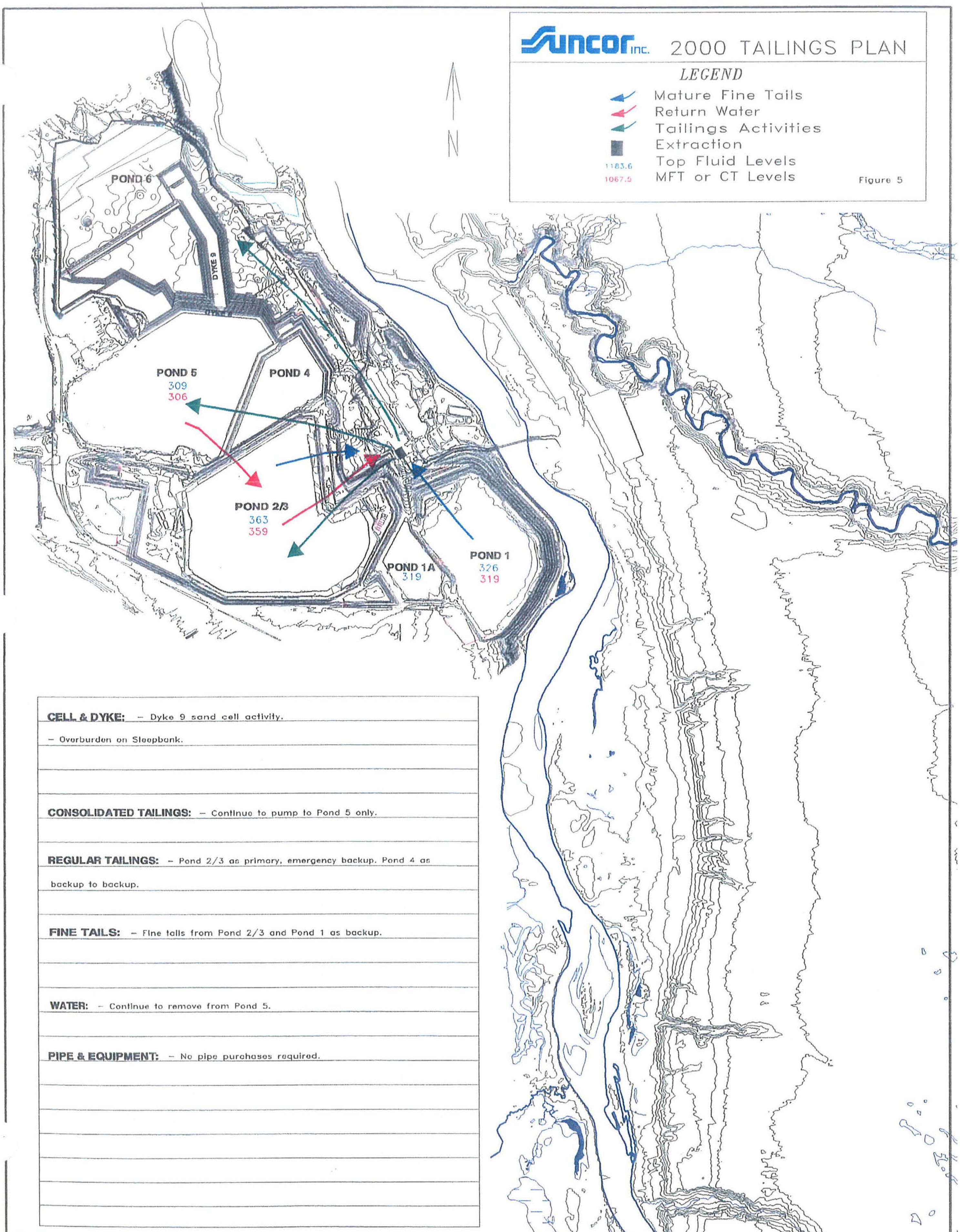


Figure D3.0-12 Integrated Mines Tailings Plan - 2000

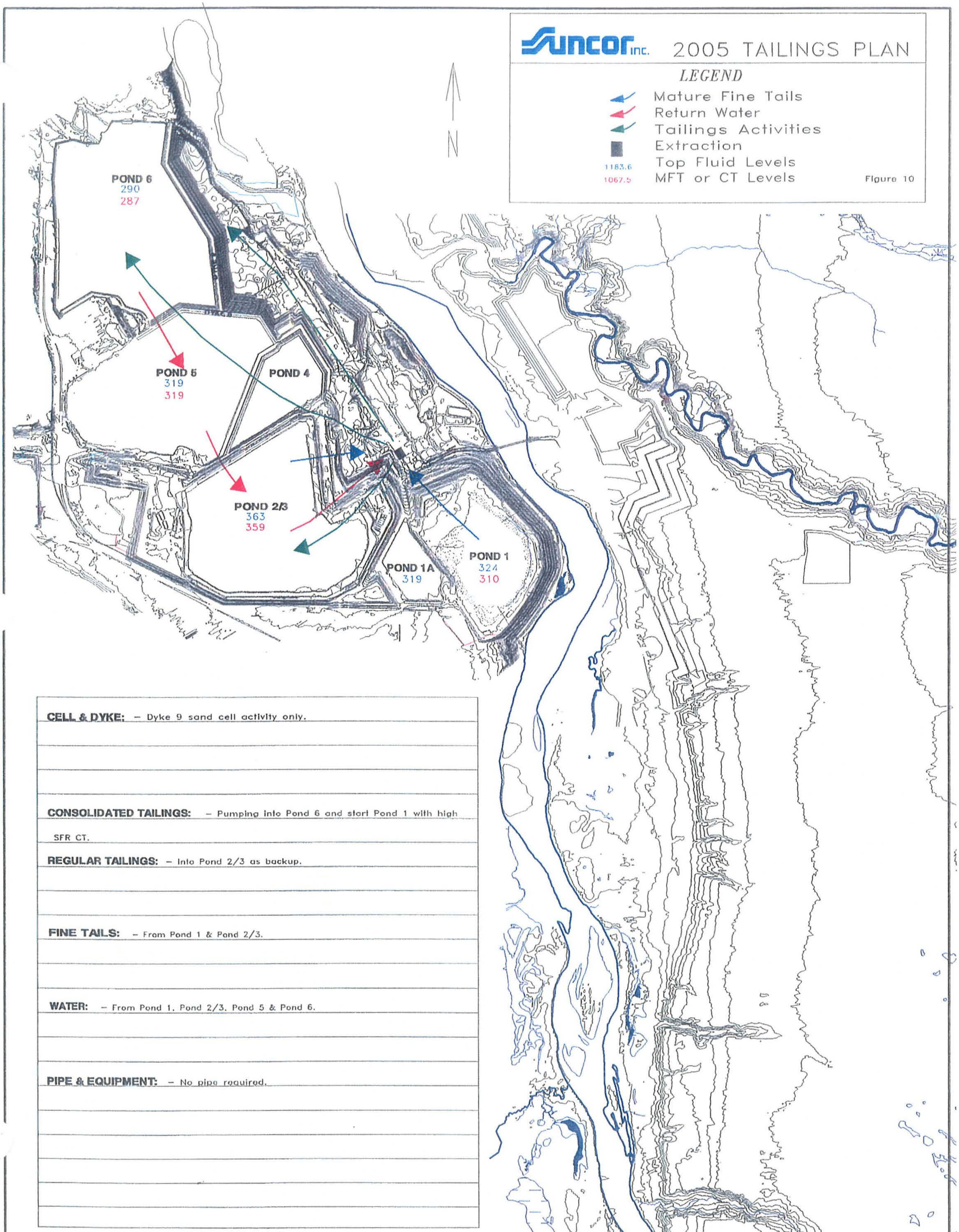


Figure D3.0–13 Integrated Mines Tailings Plan – 2005

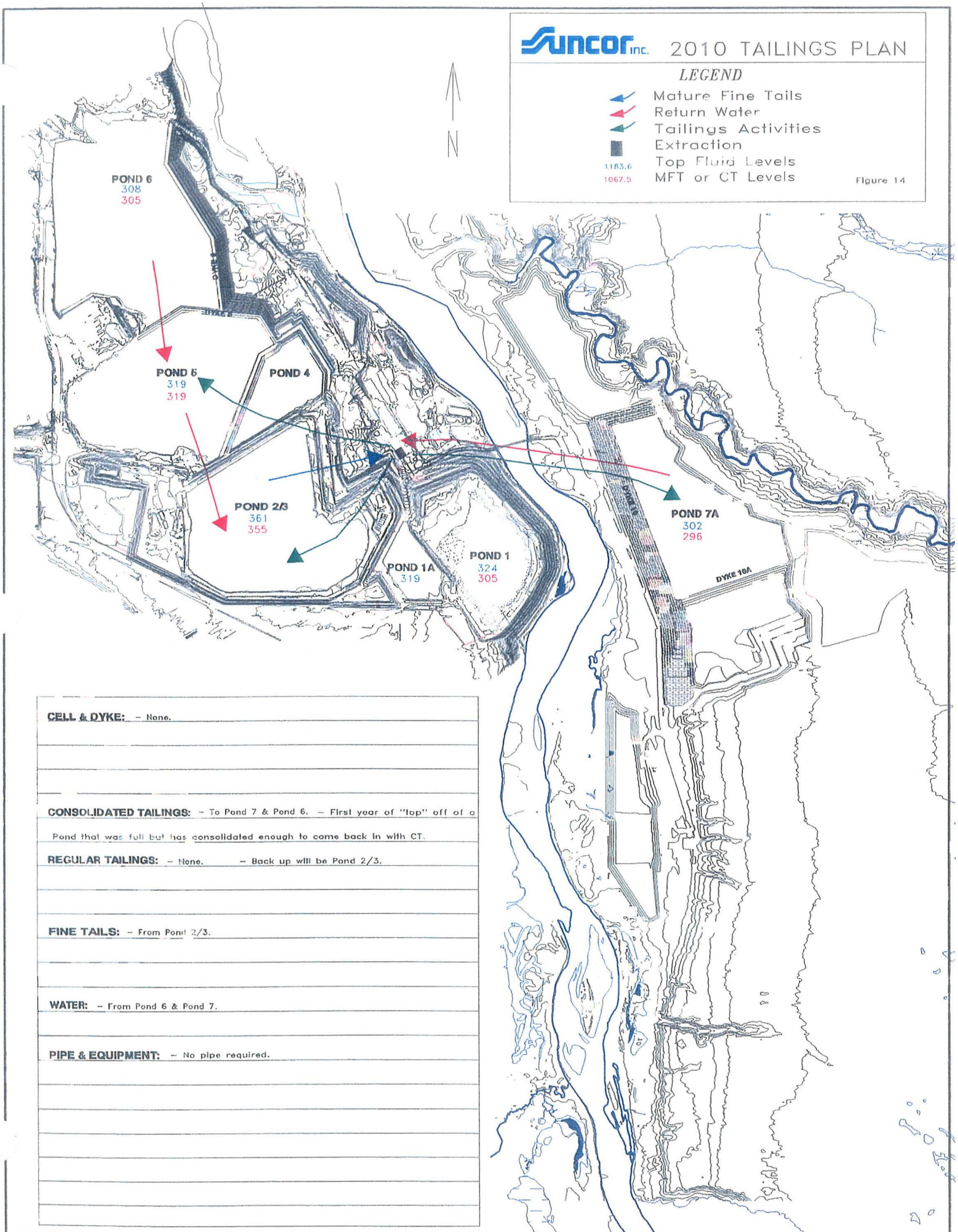


Figure D3.0-14 Integrated Mines Tailings Plan - 2010

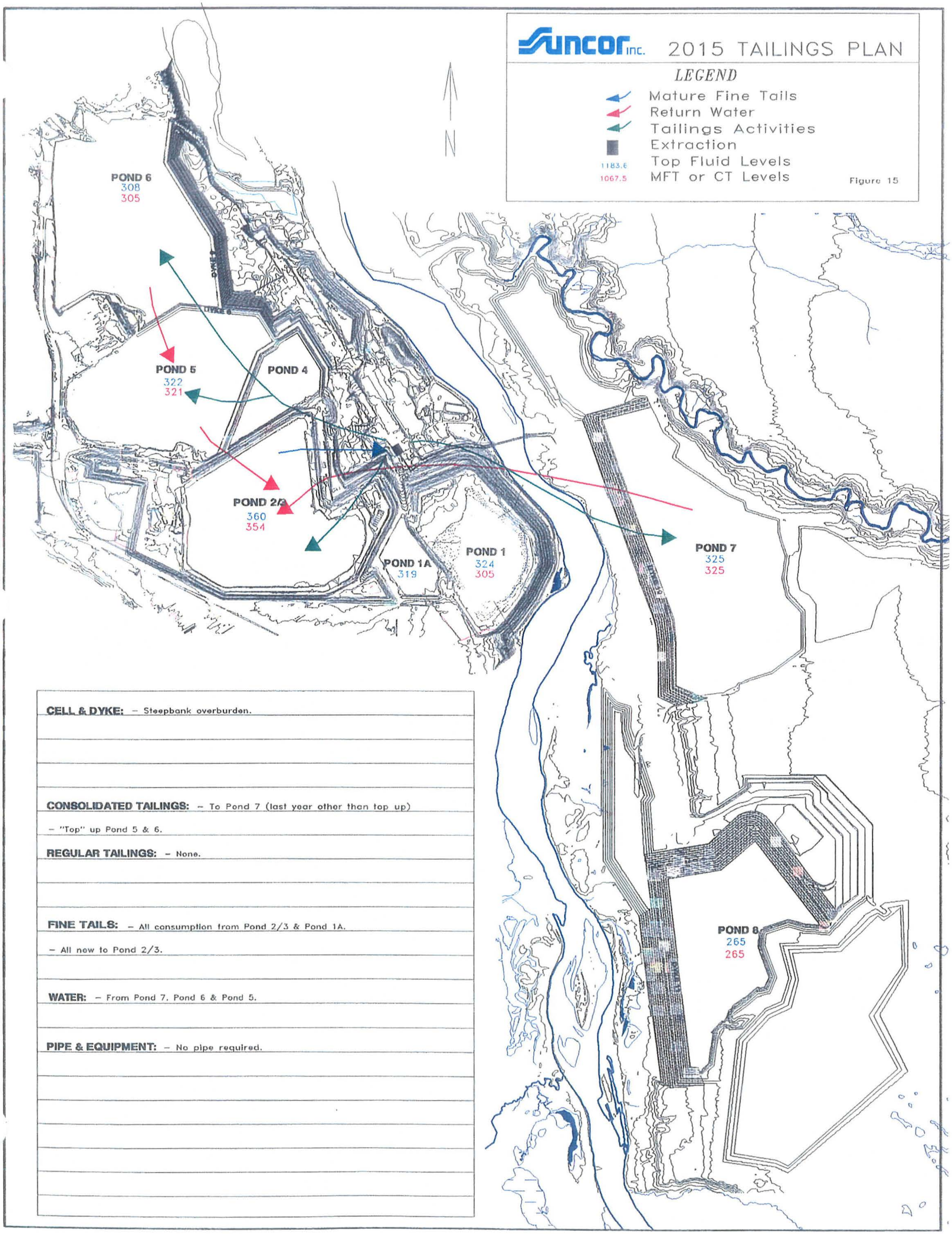


Figure D3.0–15 Integrated Mines Tailings Plan – 2015

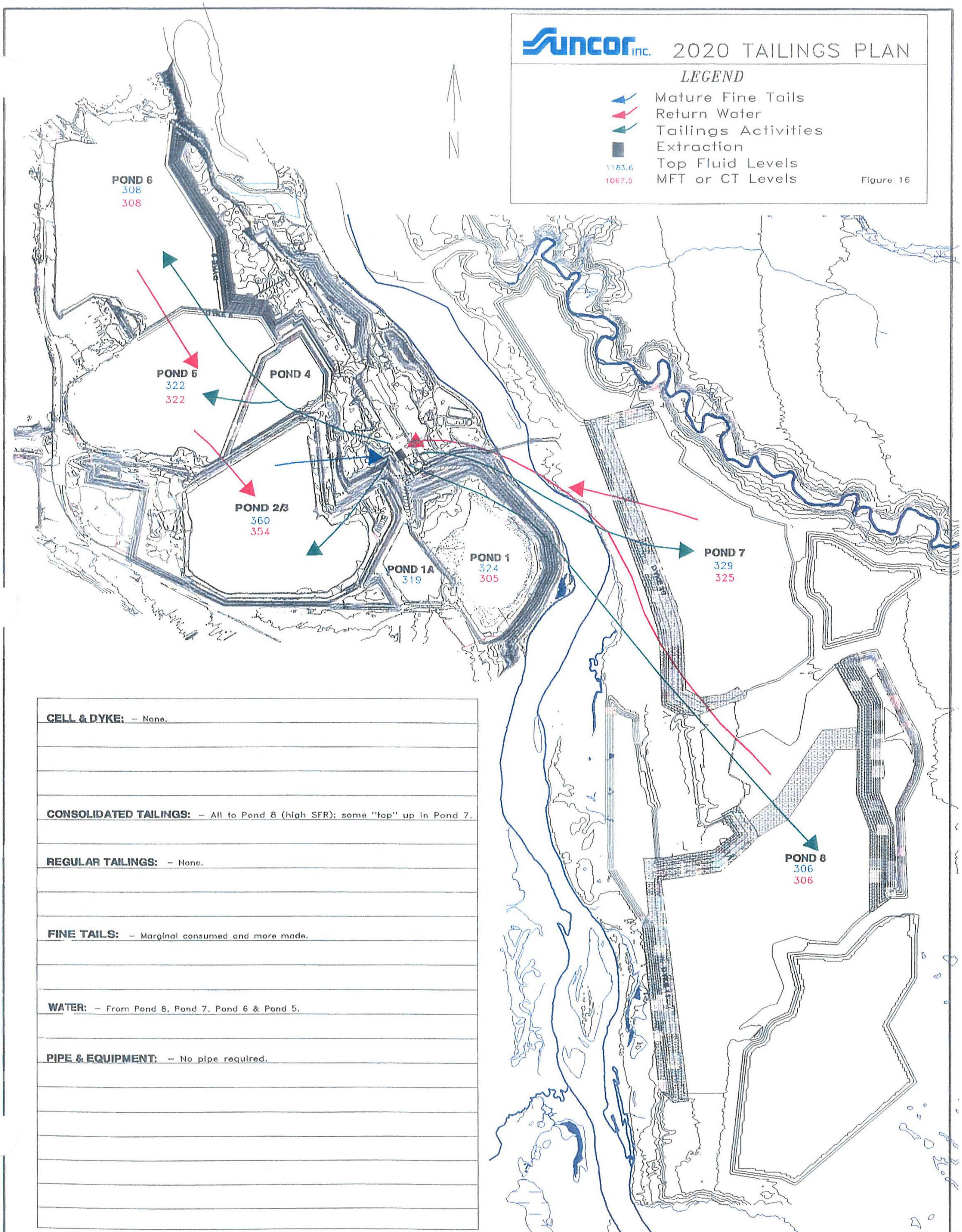


Figure D3.0–16 Integrated Mines Tailings Plan – 2020

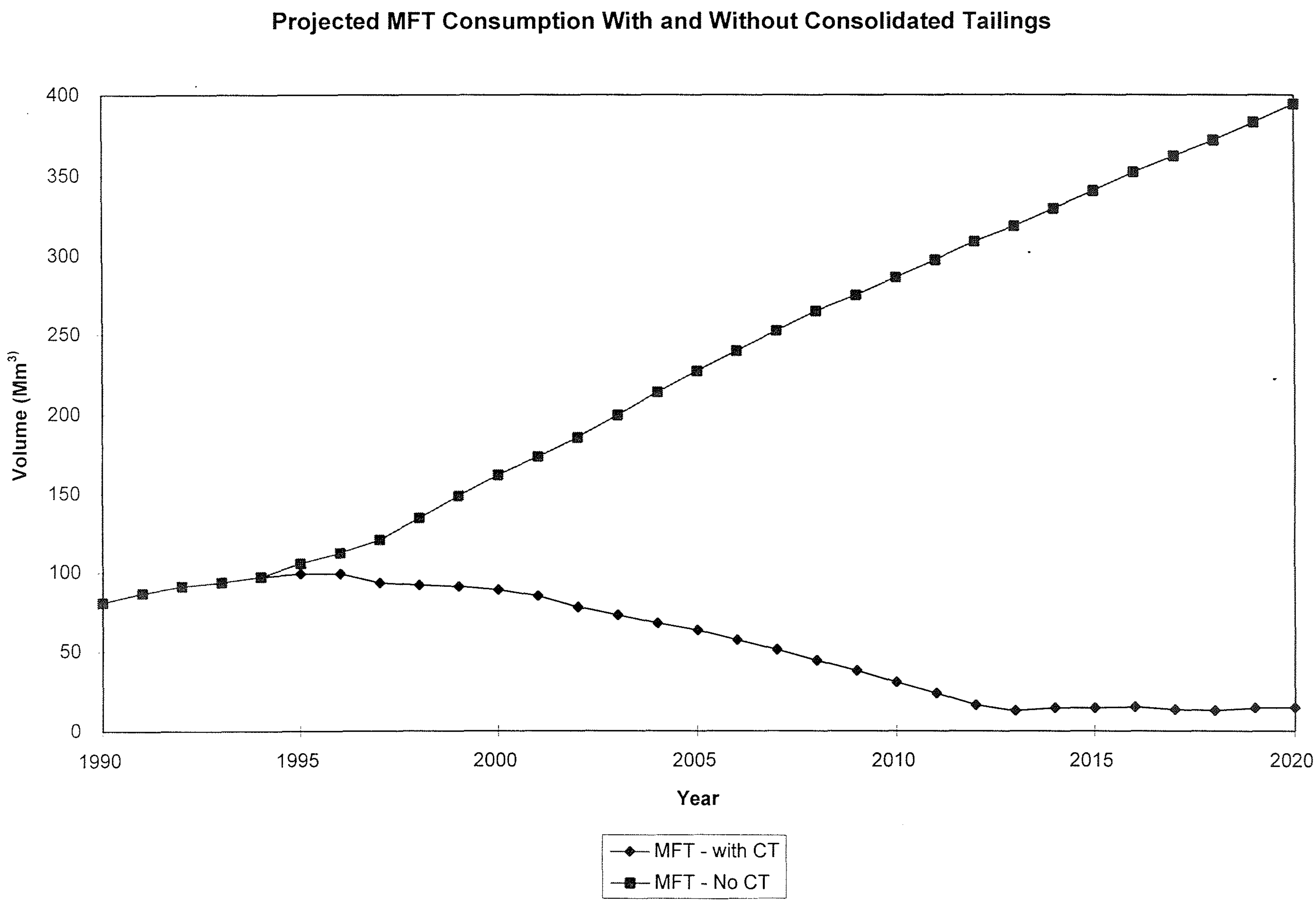


Figure D3.0–17

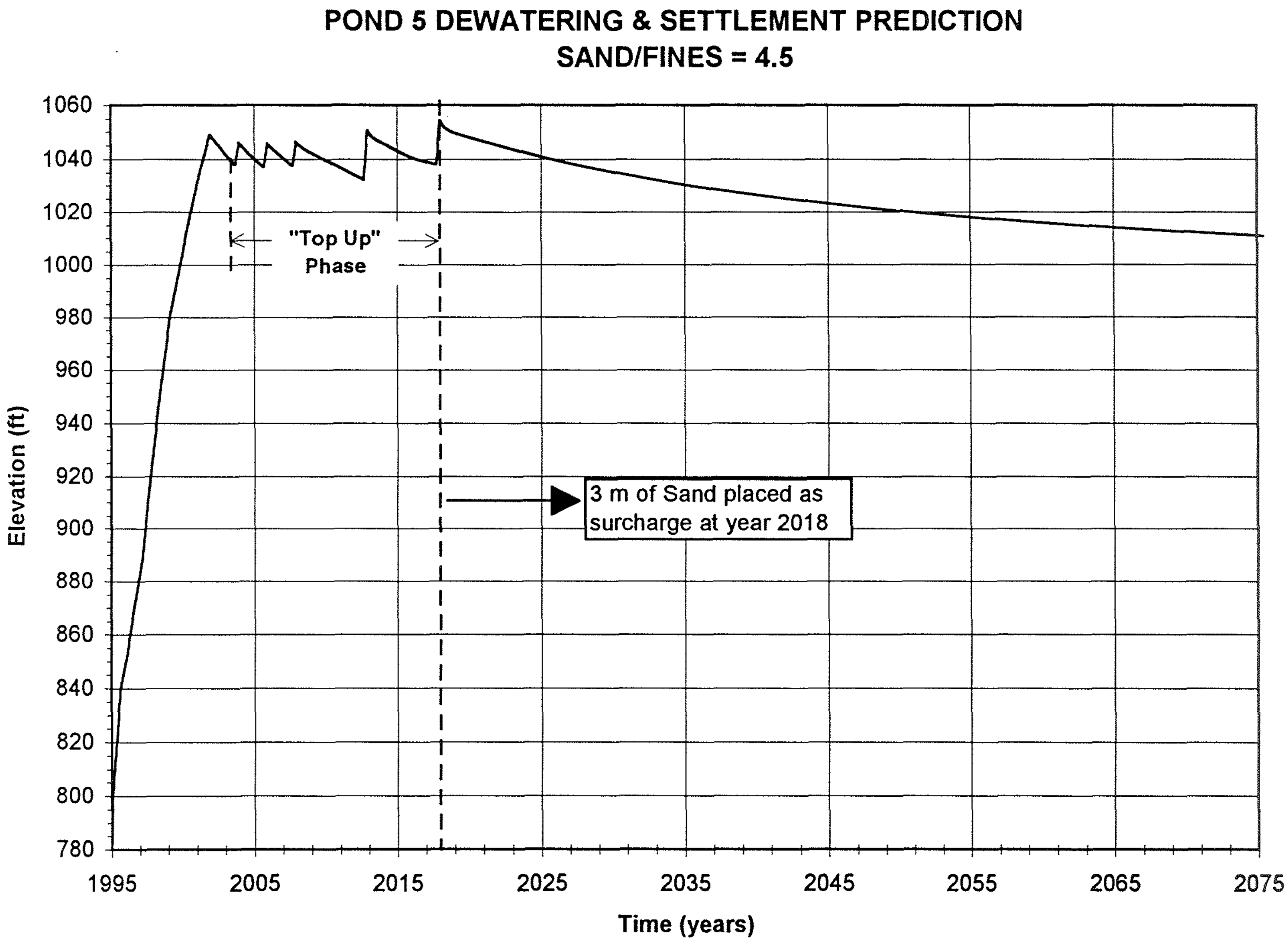
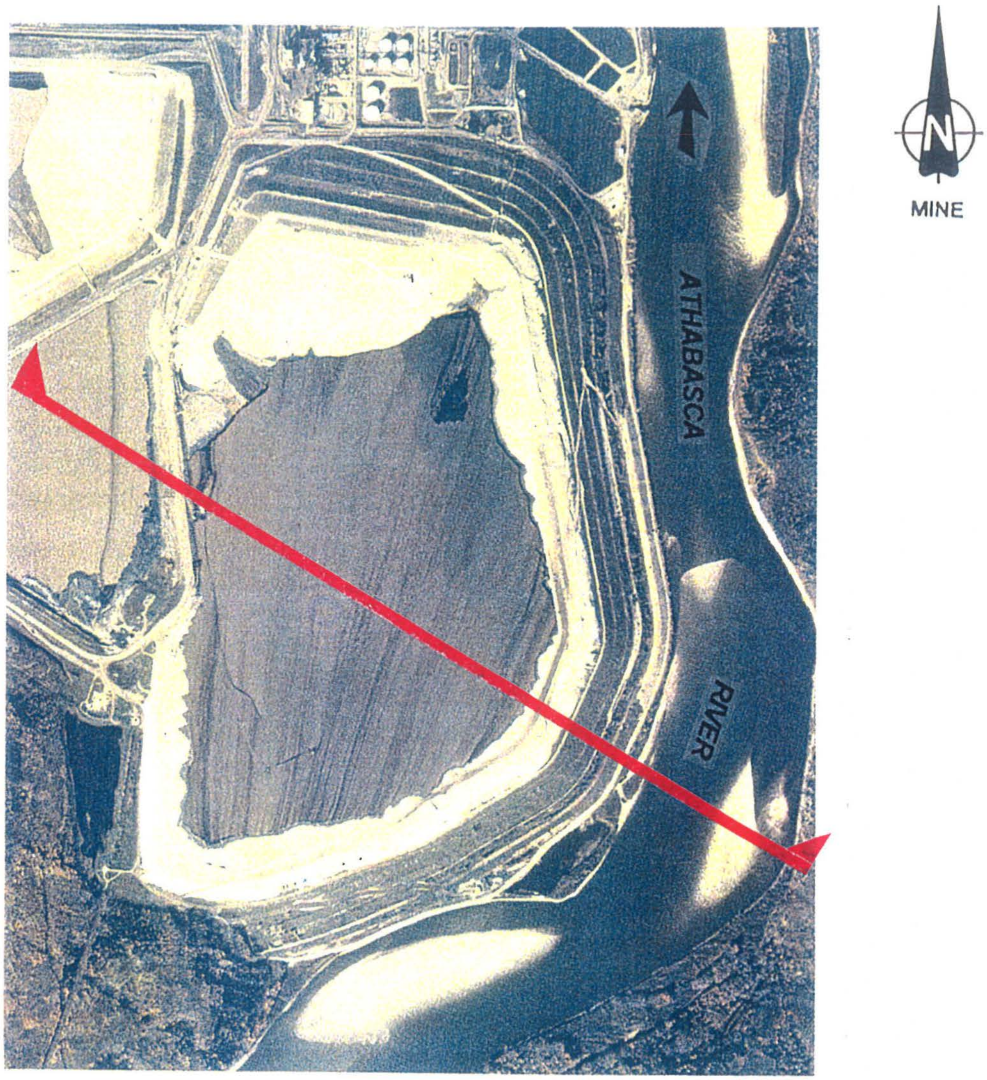
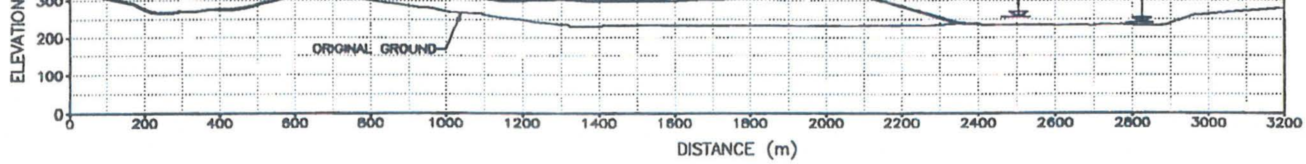


Figure D3.0-18





1459-300 1:1=8.5x11

Figure D3.0-19 Pond 1 and Tar Island Dyke

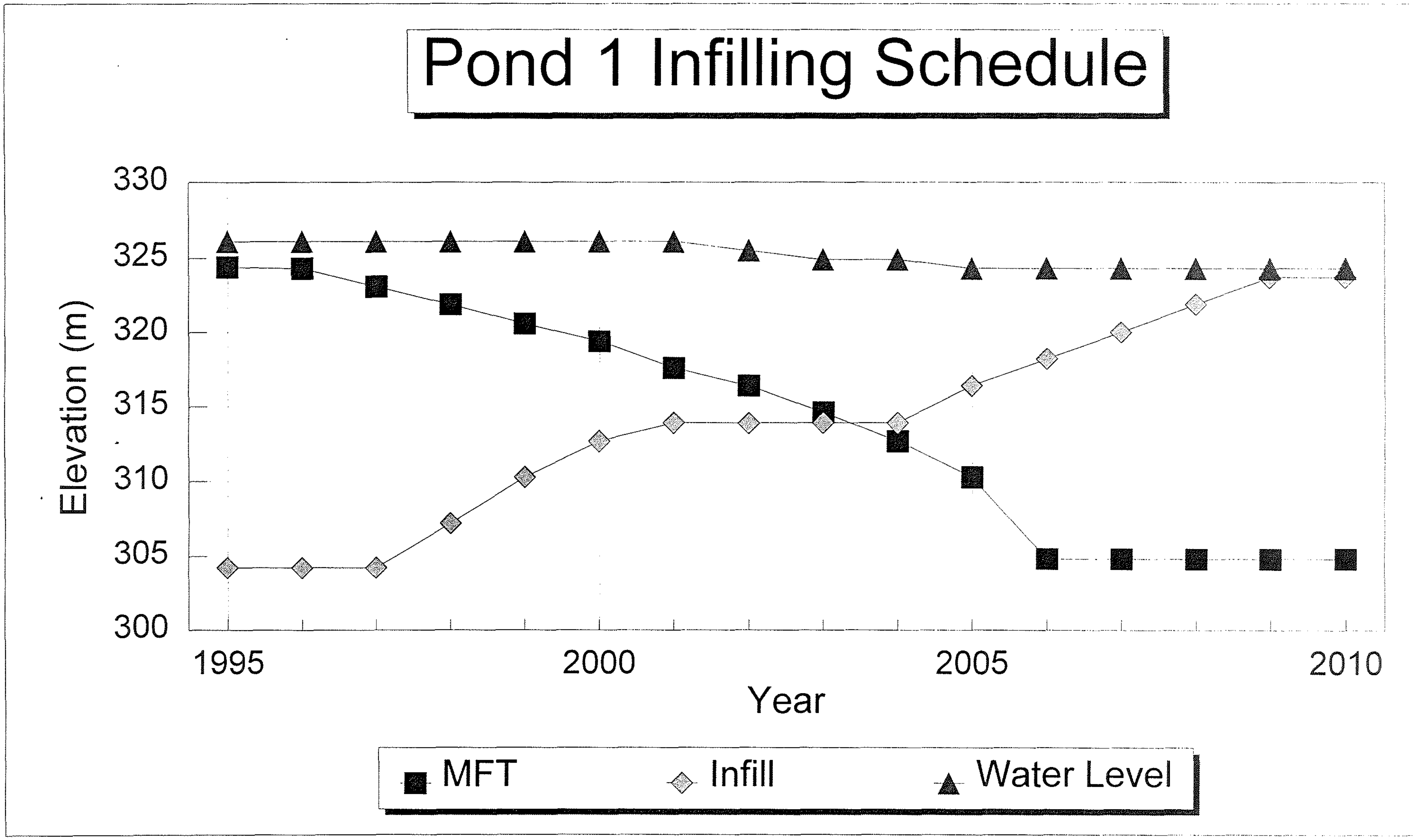
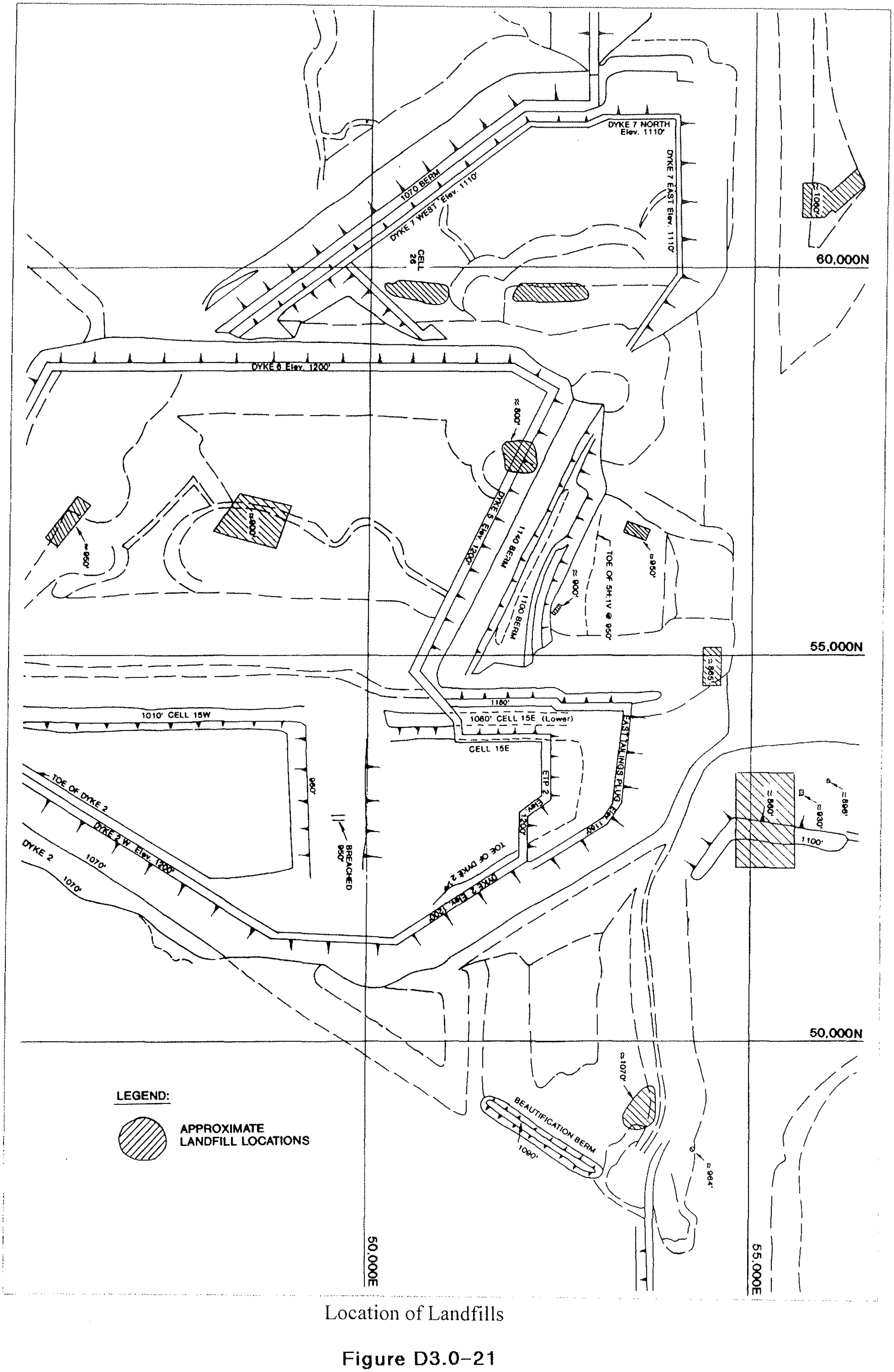


Figure D3.0-20



Location of Landfills

Figure D3.0–21

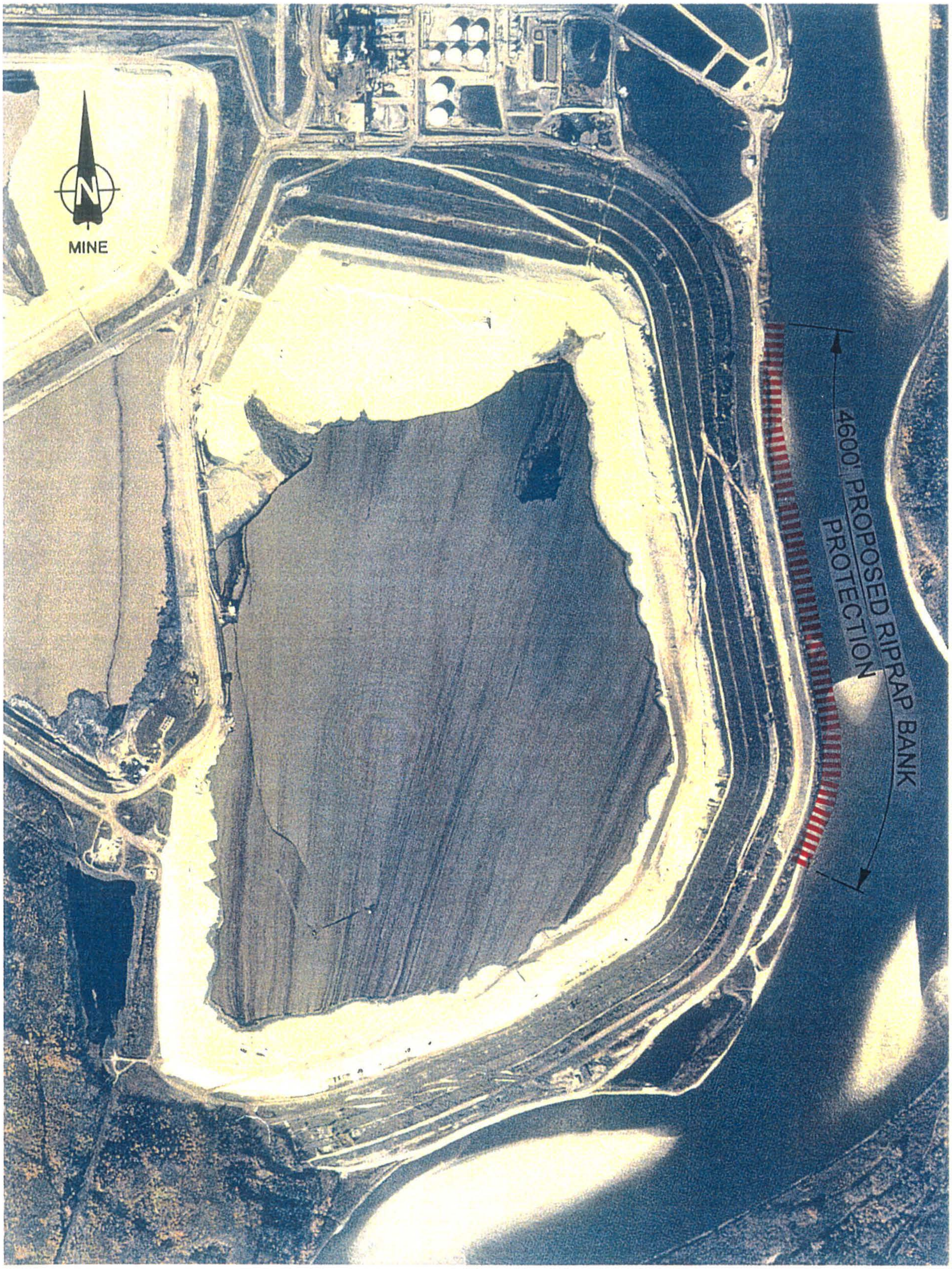
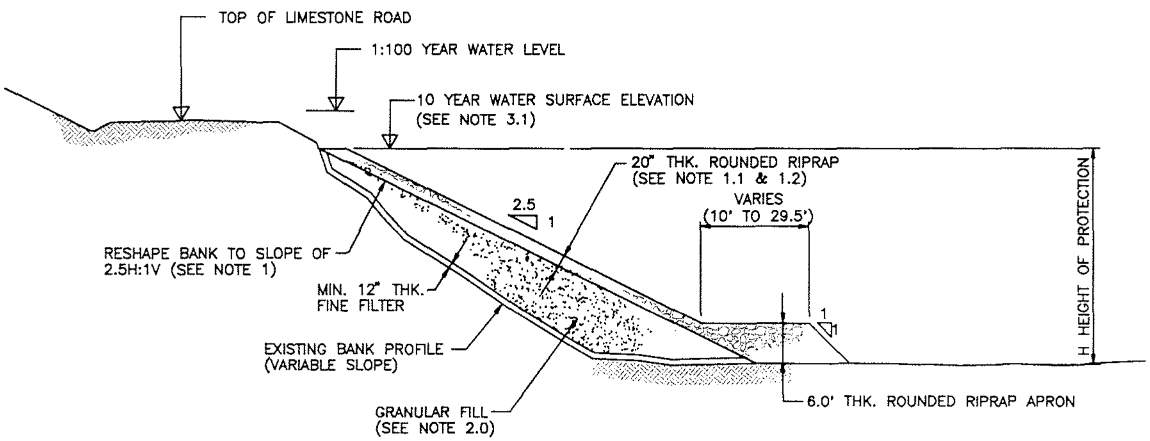


Figure D3.0-22 Tar Island Dyke Operational Phase Bank Protection



TYPICAL RIPRAP PROTECTION

N.T.S.

NOTES:

1.0 RIPRAP

1. IT IS ASSUMED THAT ROUNDED ROCK WILL BE USED WITH A THICKNESS OF 20" AND PLACED AT A 2.5H:1V SLOPE. THE ROCK SHALL BE SIZED AS FOLLOWS:

PERCENT PASSING BY MASS	(SIZE in)
100	12
30–80	10
20–50	8
5–20	4

2. ANGULAR ROCK, WITH THE SPECIFICATIONS GIVEN ABOVE, CAN BE PLACED AT A 2H:1V SLOPE.

3. SIZES QUOTED ARE EQUIVALENT SPHERICAL DIAMETERS. WHERE RELATIVE DENSITY IS IN THE RANGE OF 2.4–2.9.

2.0 GRANULAR FILL

1. GRANULAR FILL SHALL CONSIST OF MEDIUM TO COARSE GRAVEL SIZED MATERIAL. D_{50} SHALL EXCEED 2 INCHES.

2. RESHAPING THE BANK TO A SLOPE OF 2.5H:1V WILL REQUIRE BACKFILLING (SLOPE REDUCTION) AT SECTIONS 4,5,6,7,8 AND 10 AND SLOPE EXCAVATION (SLOPE STEEPENING) AT SECTIONS 6,9,10 AND 11.

3.0 BANK PROTECTION DIMENSIONS AT SURVEYED CROSS–SECTIONS

1. THE FOLLOWING ARE TYPICAL BANK PROTECTIION DIMENSIONS AT THE SURVEYED CROSS–SECTIONS.

CROSS–SECTION	10 YEAR WATER SURFACE ELEV. (ft.)	TOE OF BANK ELEVATION (ft.)	HEIGHT OF PROTECTION H (ft.)
04	782.7	768.2	15.8
05	782.7	759.5	24.4
06	782.4	761.2	22.4
07	782.2	760.9	22.5
08	782.1	760.0	23.2
09	782.0	762.9	20.2
10	781.9	763.3	19.7
11	781.8	763.3	19.8

2. SEE FIGURE 3 FOR LOCATION OF CROSS SECTIONS AND EXTENT OF PROTECTION LOCATIONS.

Figure D3.0–23 Section of Tar Island Dyke Operational Bank Protection

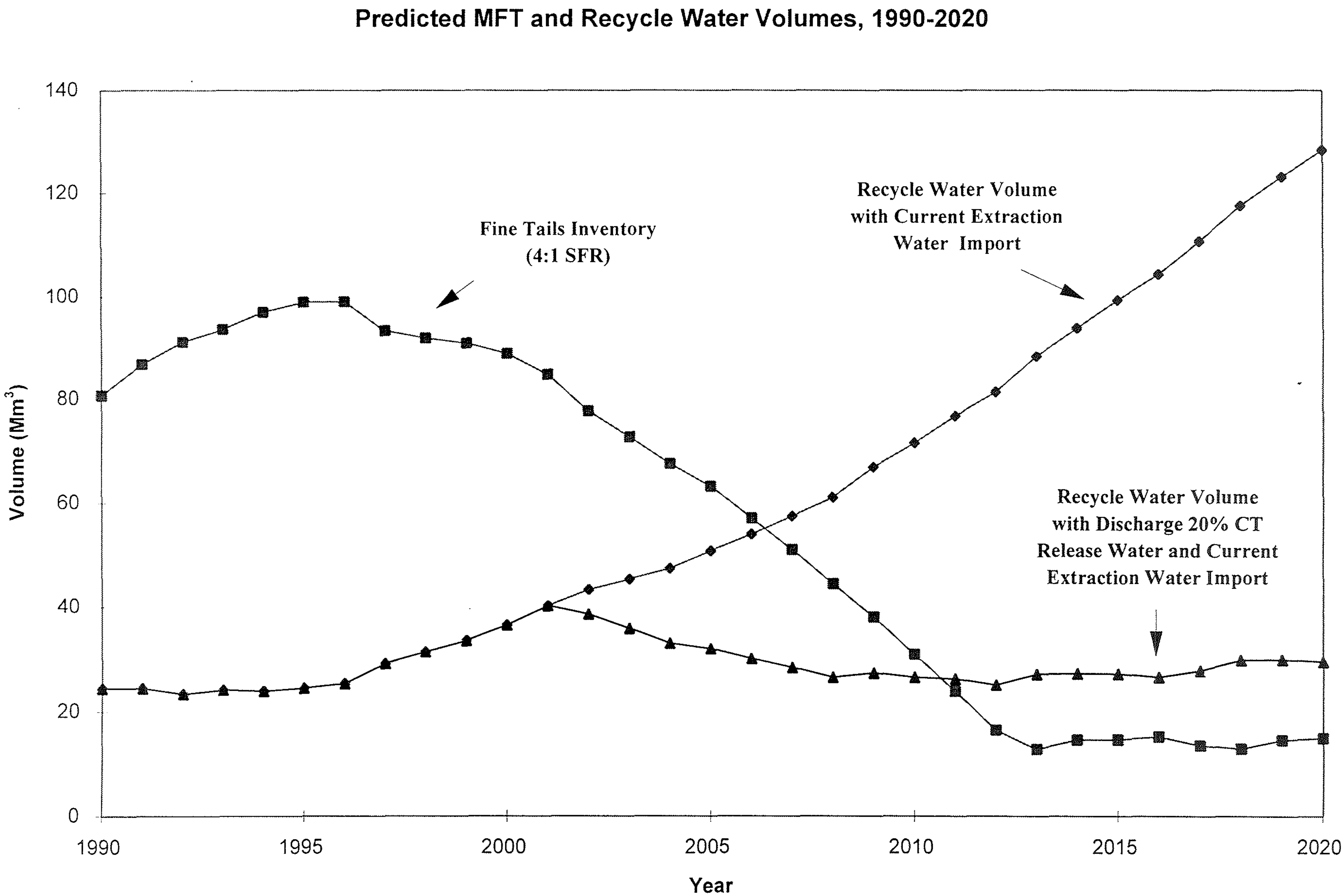


Figure D3.0-24

Predicted SO_4^{2-} Concentration in Recycle Water under CT Water Release and Reduced River Water Intake Water Management Scenarios

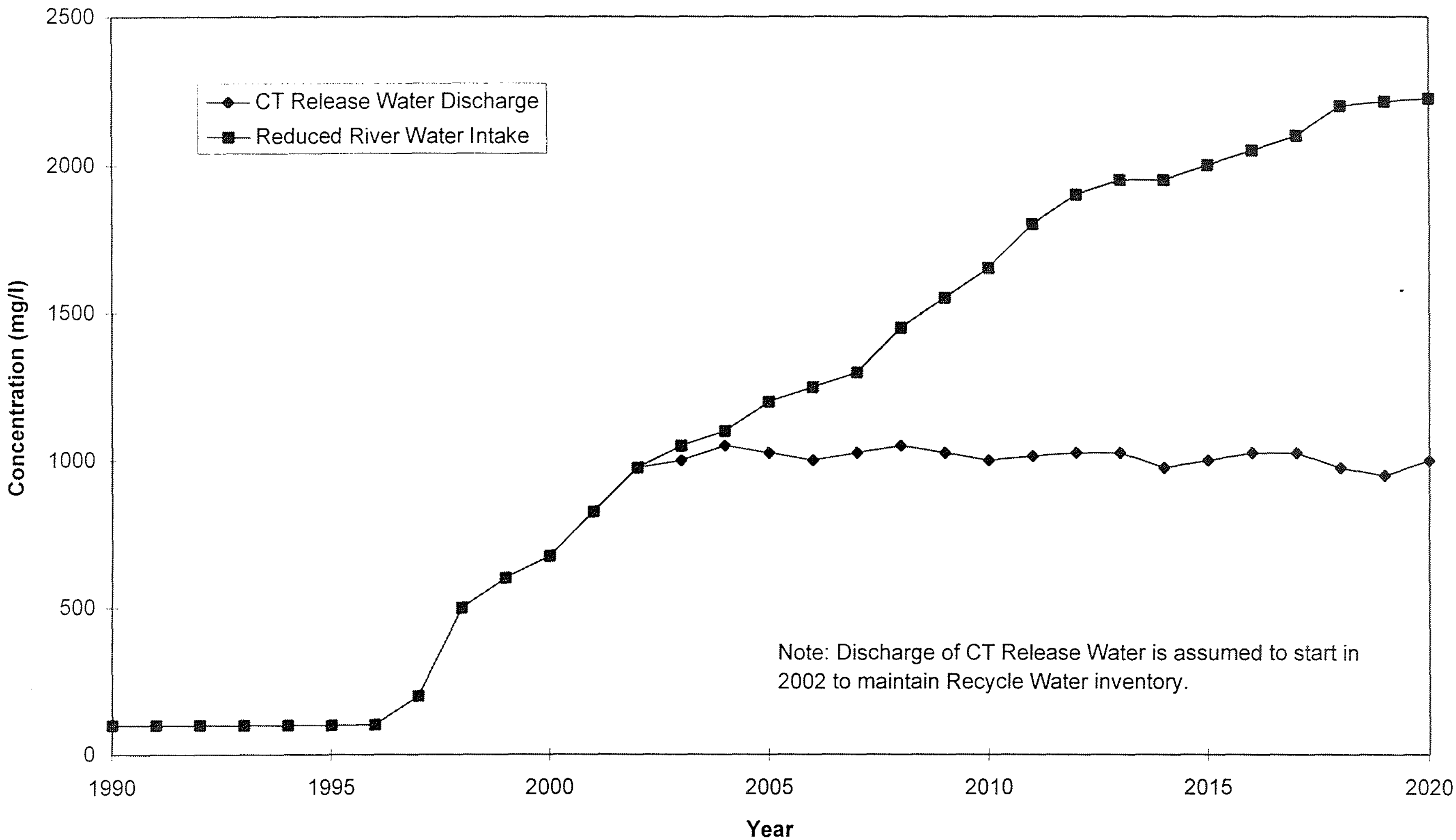
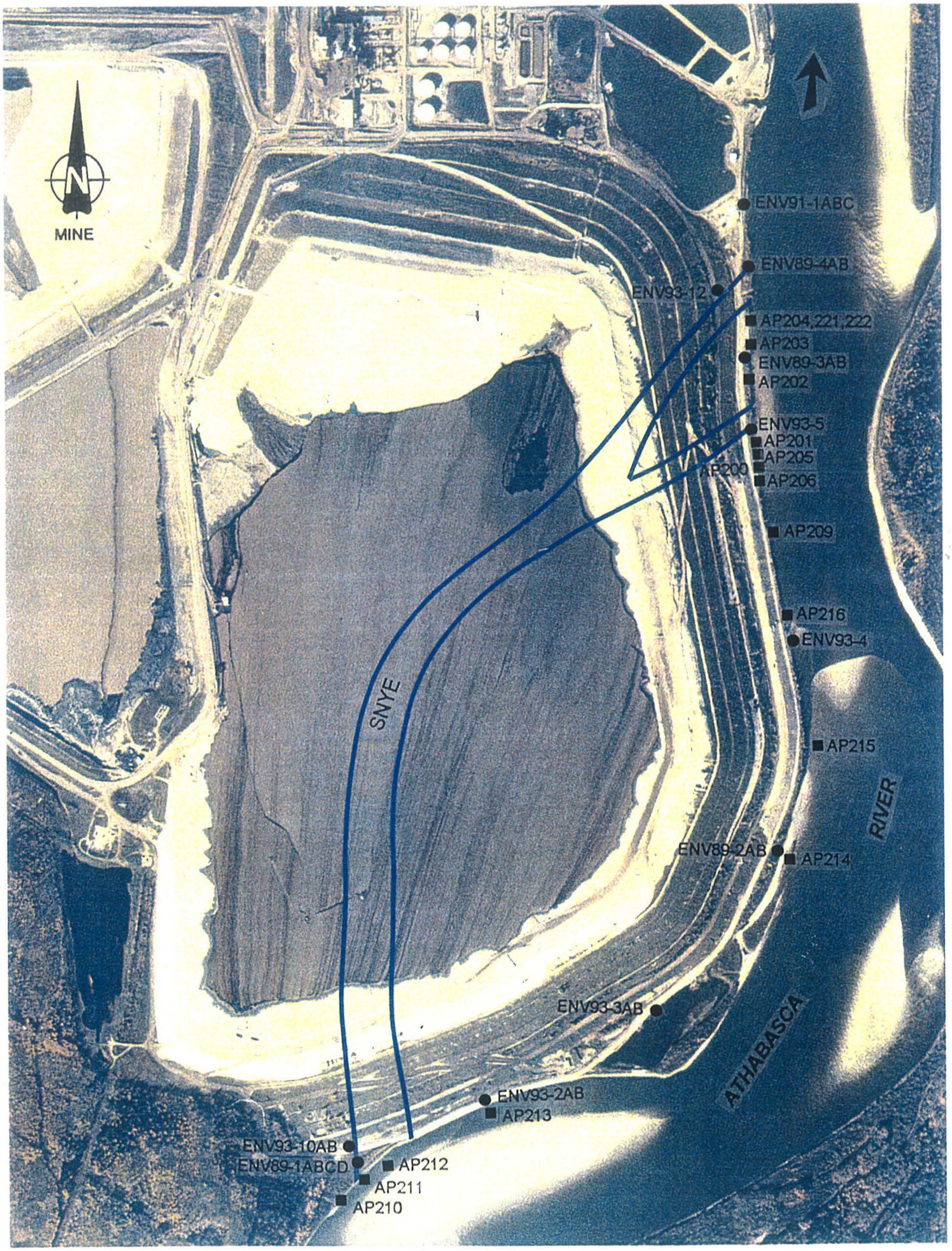


Figure D3.0–25



LEGEND

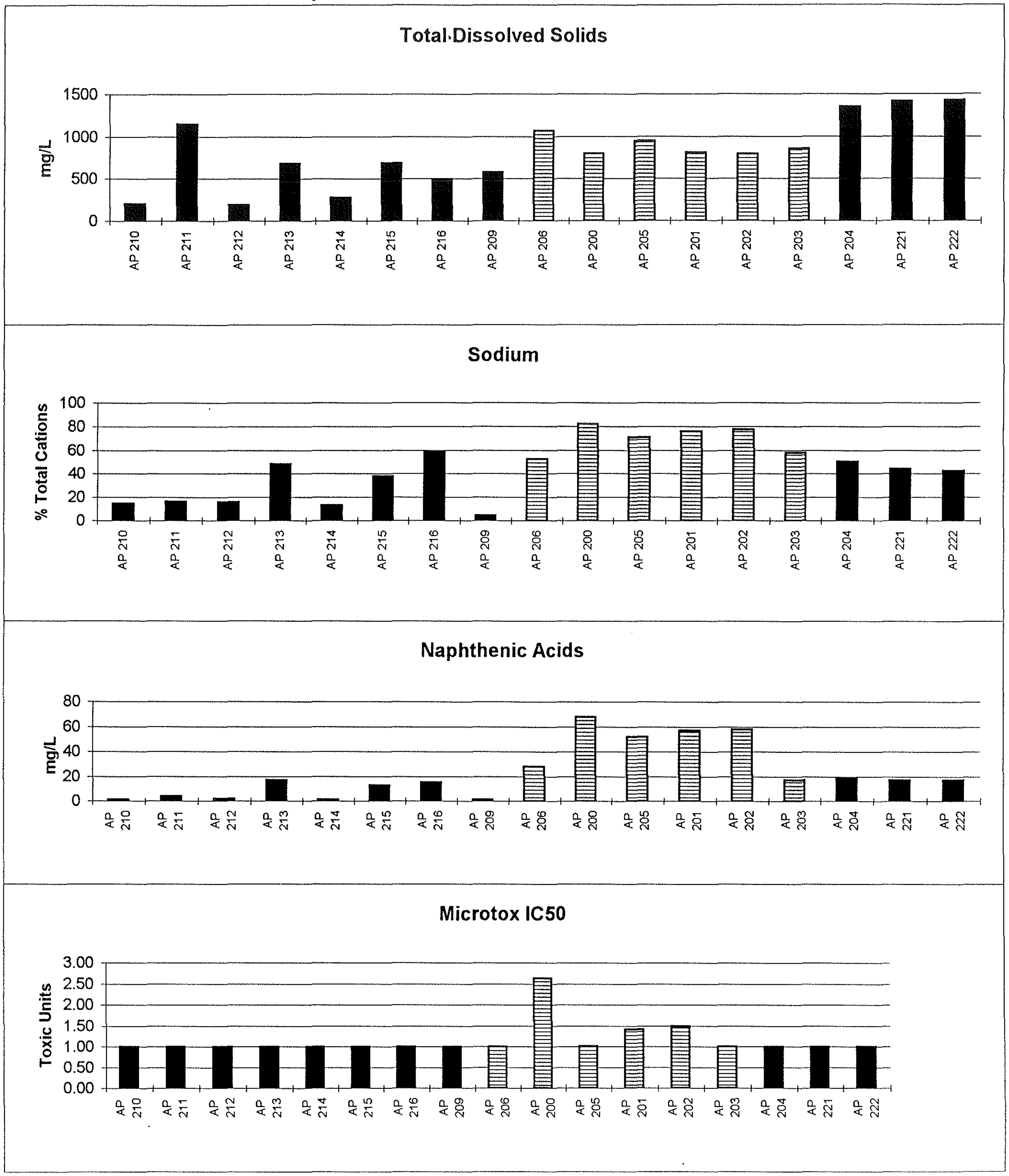
● GROUNDWATER WELLS

■ POREWATER SAMPLING LOCATIONS

1459-300 1:1=8.5*11

Figure D3.0-26 Tar Island Dyke Pore Water Sampling Sites

Porewater Chemistry - October 1995



Other sites along TID

Snye outlet sites

Figure D3.0-27

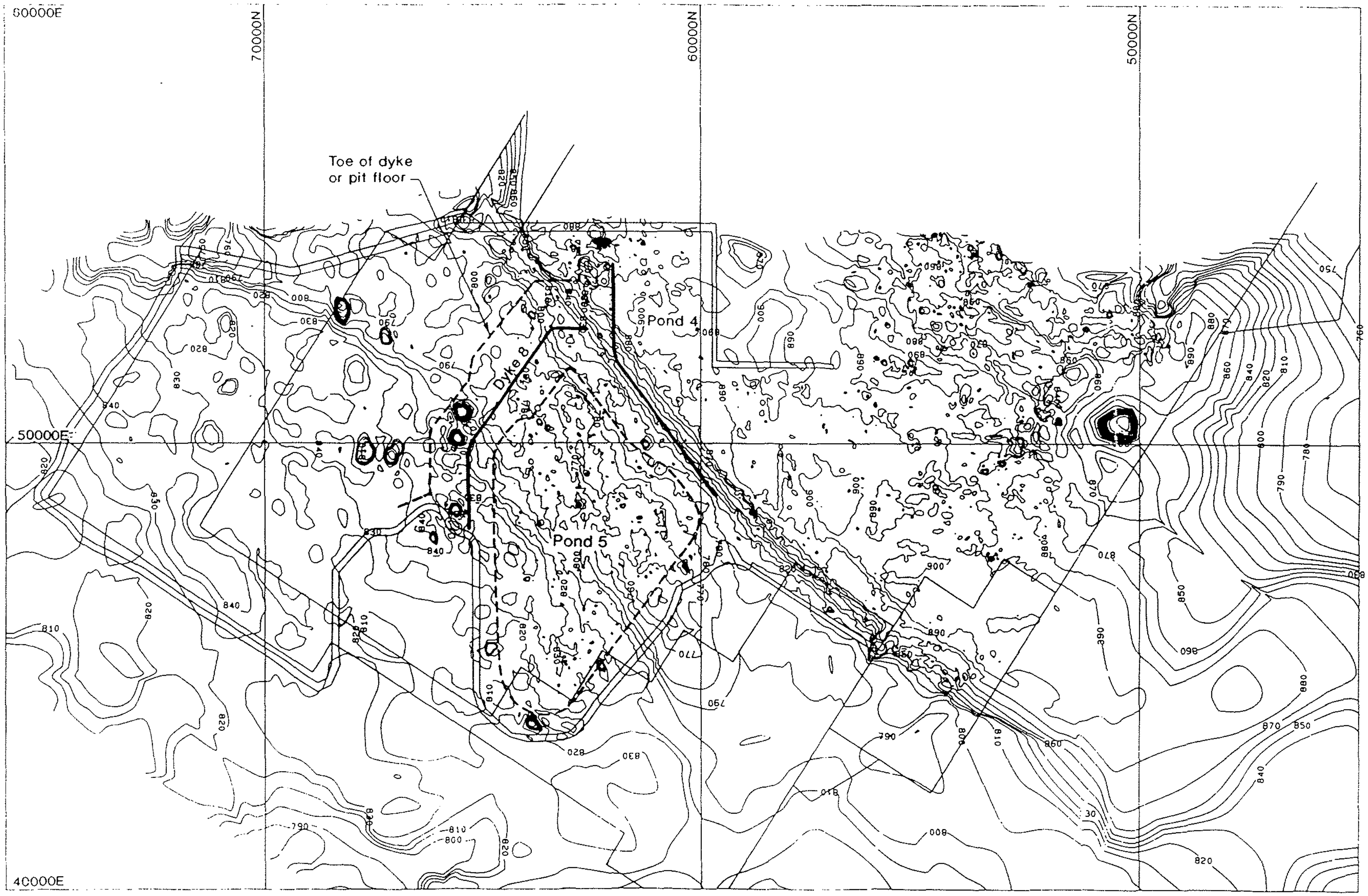


Figure D3.0-28 Devonian Limestone Surface under Pond 5

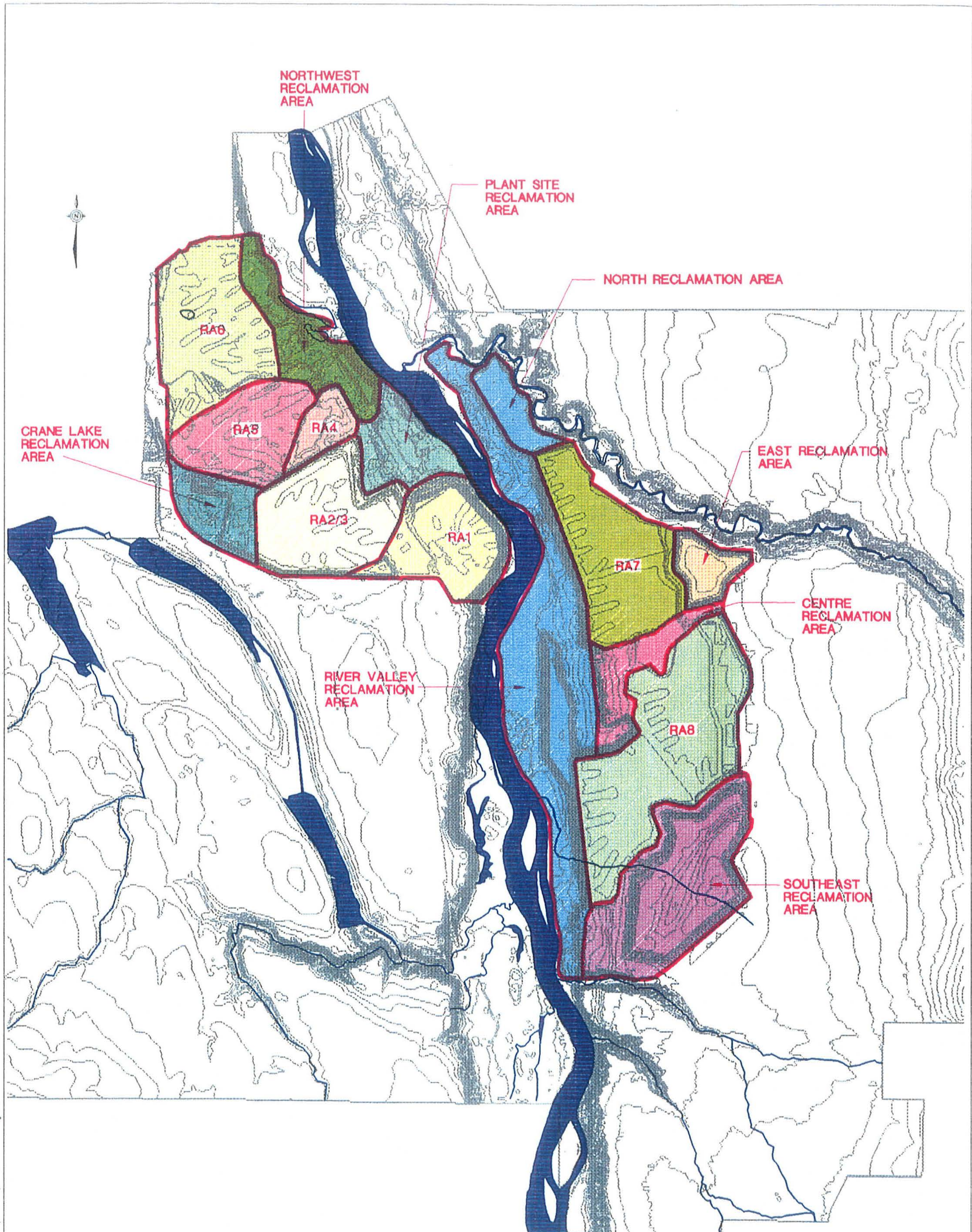
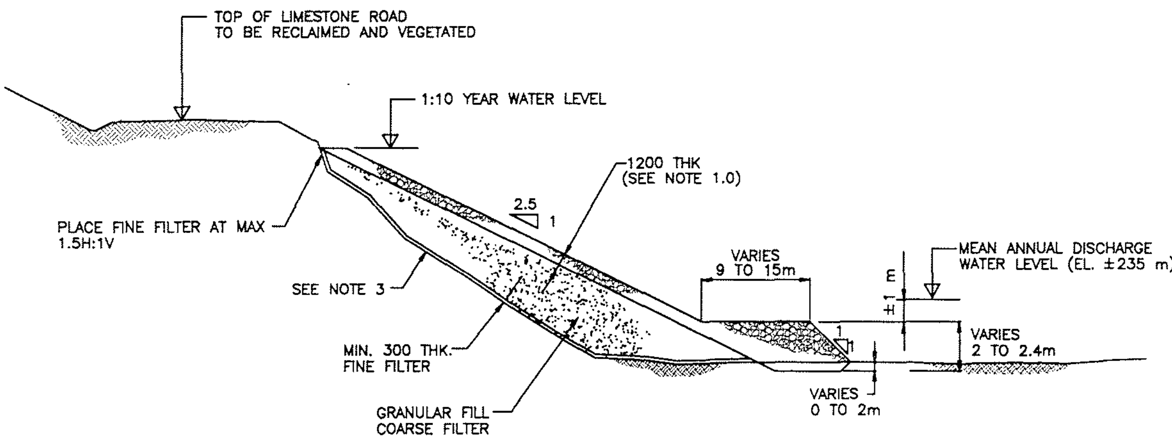
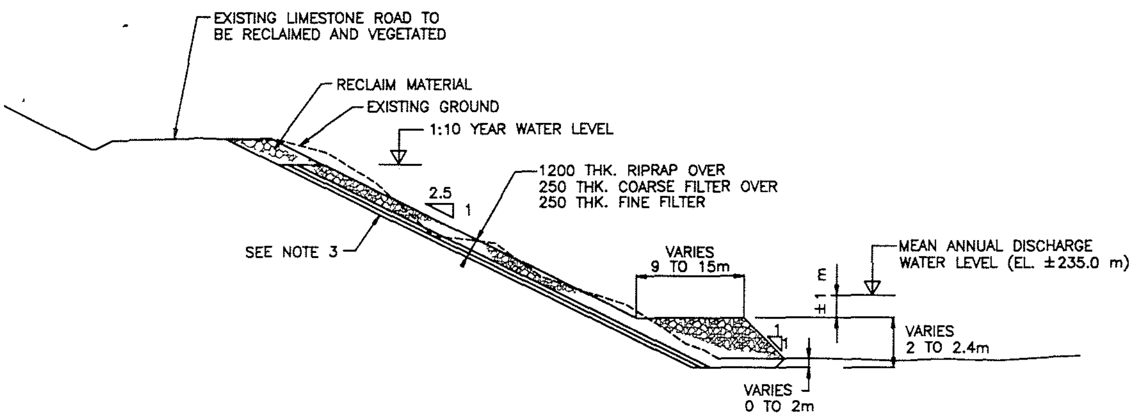


Figure D3.0-29 Map of Reclamation Areas



TYPICAL RIPRAP PROTECTION OVER GRANULAR FILL

N.T.S.



TYPICAL RIPRAP PROTECTION OVER ORIGINAL GROUND

N.T.S.

NOTES:

1.0 RIPRAP

a) IT IS ASSUMED THAT ANGULAR ROCK IS UNAVAILABLE. THEREFORE RIPRAP SIZES ARE BASED ON ROUNDED STONE WITH A LAYER THICKNESS OF 1200 mm AND PLACED AT A 2.5H:1V SLOPE. THE ROCK SHALL BE SIZED AS GIVEN IN TABLE A.

b) ANGULAR ROCK, WITH THE SPECIFICATIONS GIVEN IN TABLE A, CAN BE PLACED AT A 2H:1V SLOPE.

c) SIZES QUOTED ARE EQUIVALENT SPHERICAL DIAMETERS. WHERE SPECIFIC GRAVITY IS IN THE RANGE OF 2.6–2.9 IN ACCORDANCE WITH ASTM C127 AND CSA A23.2–12A.

d) THE RIPRAP SHALL CONSIST OF CLEAN, WELL GRADED, HARD AND DURABLE FIELD STONES, COBBLES AND BOULDERS OR QUARRY ROCK, AND SHALL NOT CONTAIN SOFT OR FRIABLE ROCK TYPES OR ROCK PIECES THAT HAVE A MAXIMUM DIMENSION MORE THAN FOUR TIMES A MINIMUM DIMENSION.

INDIVIDUAL RIPRAP SIZES SHALL HAVE NOT MORE THAN THIRTY (30) PERCENT PERCENT LOSS WHEN TESTED FOR ABRASION RESISTANCE IN ACCORDANCE WITH ASTM C535 OR CS 123.2–17A.

SULFATE SOUNDNESS TESTING IN ACCORDANCE WITH ASTM C88 OR CSA A23.2–9A SHALL HAVE NOT MORE THAN TEN (10) PERCENT LOSS. ABSORPTION IN ACCORDANCE WITH ASTM C127 OR CSA A23.2–12A SHALL BE LESS THAN OR EQUAL TO TWO (2) PERCENT.

2. RIPRAP, INTERIM ARMOUR AND FILTER MATERIAL SIZE GRADATIONS SHALL BE AS SPECIFIED IN TABLE A AND FIGURE 7.1.

TABLE A
MATERIAL SIZE GRADATIONS

PERCENT PASSING BY MASS	(SIZE mm)			
	RIPRAP	INTERIM ARMOUR	GRANULAR FILL/ COARSE FILTER	FINE FILTER
100	600	400	200	25
30–80	350	250	50	5
20–50	300	200	–	–
15–60	–	–	30	3
5–30	–	–	20	2
5–20	200	100	–	–

3. THE NEED FOR A FILTER MATERIAL OVER EXISTING ARMOUR MATERIAL SHALL BE DETERMINED ON A SITE SPECIFIC BASIS. ZONES OF EXPOSED, CLEAN EXISTING RIPRAP OR ARMOUR MATERIAL THAT DO NOT SHOW ANY INDICATIONS OF SLUMPING SHALL NOT REQUIRE ANY FILTER MATERIAL PRIOR TO RIPRAP PLACEMENT.

CW\1460\chuck\1460e100.dwg

Figure D3.0–30 Tar Island Dyke Conceptual Reclamation Phase River Erosion Protection Design

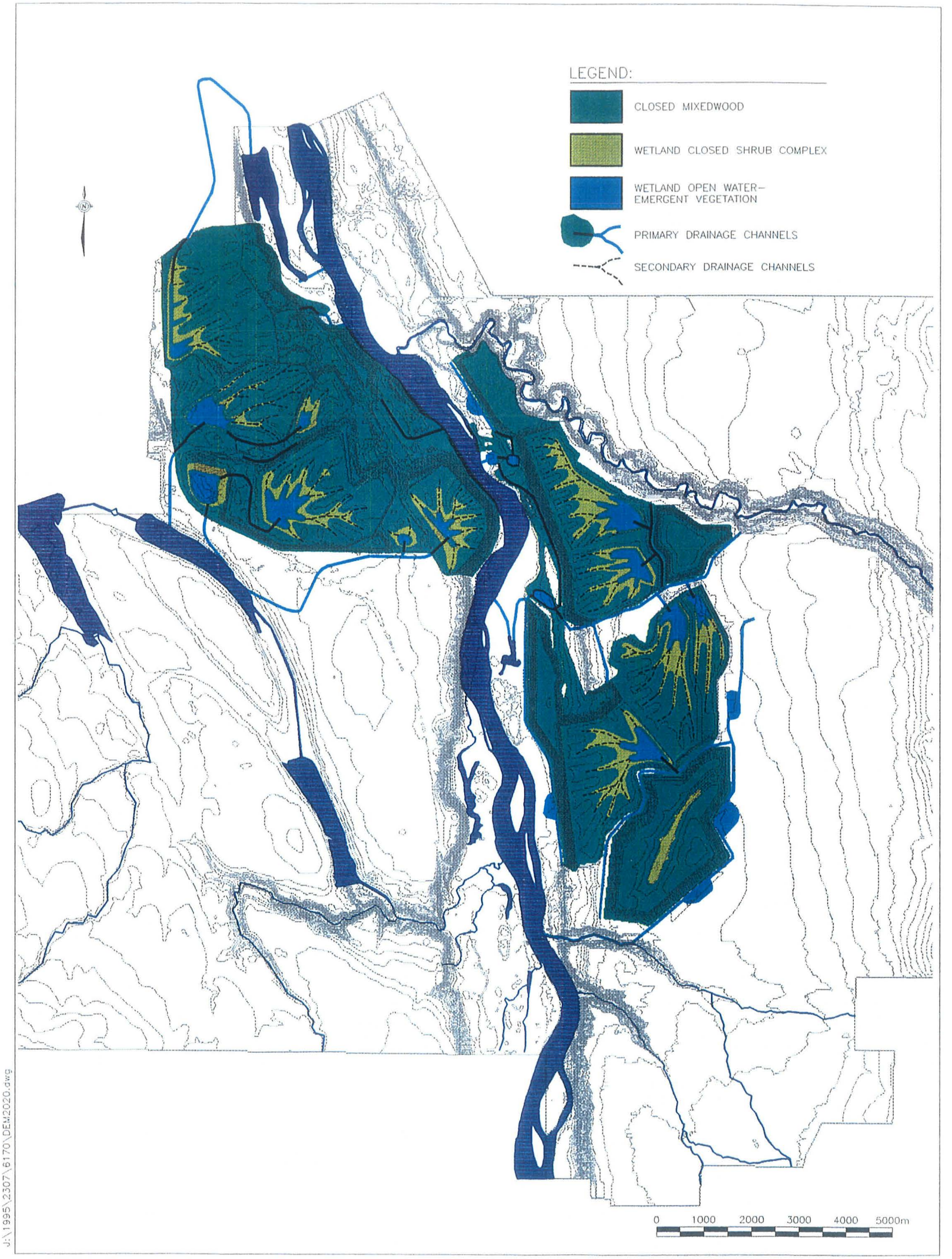
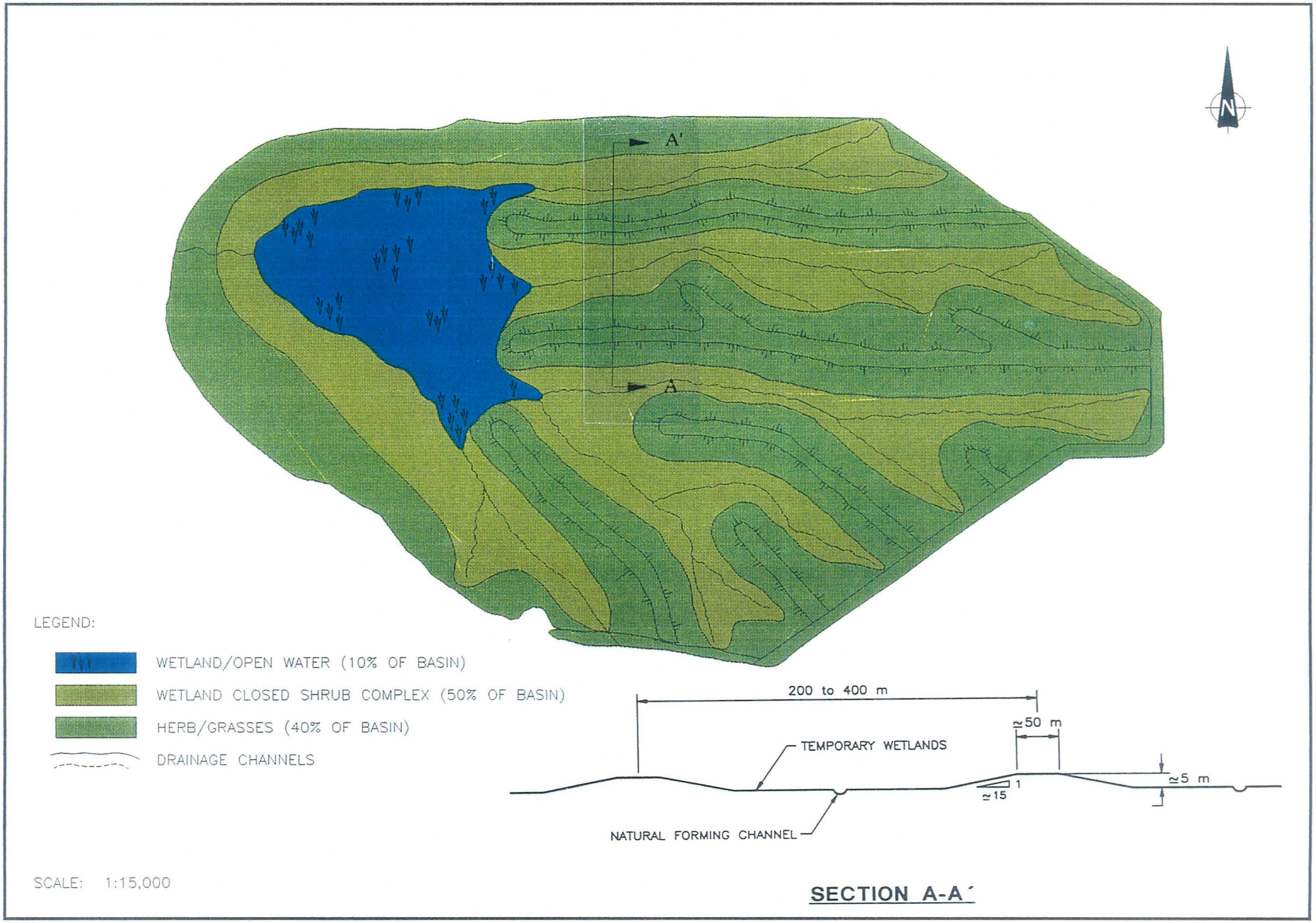


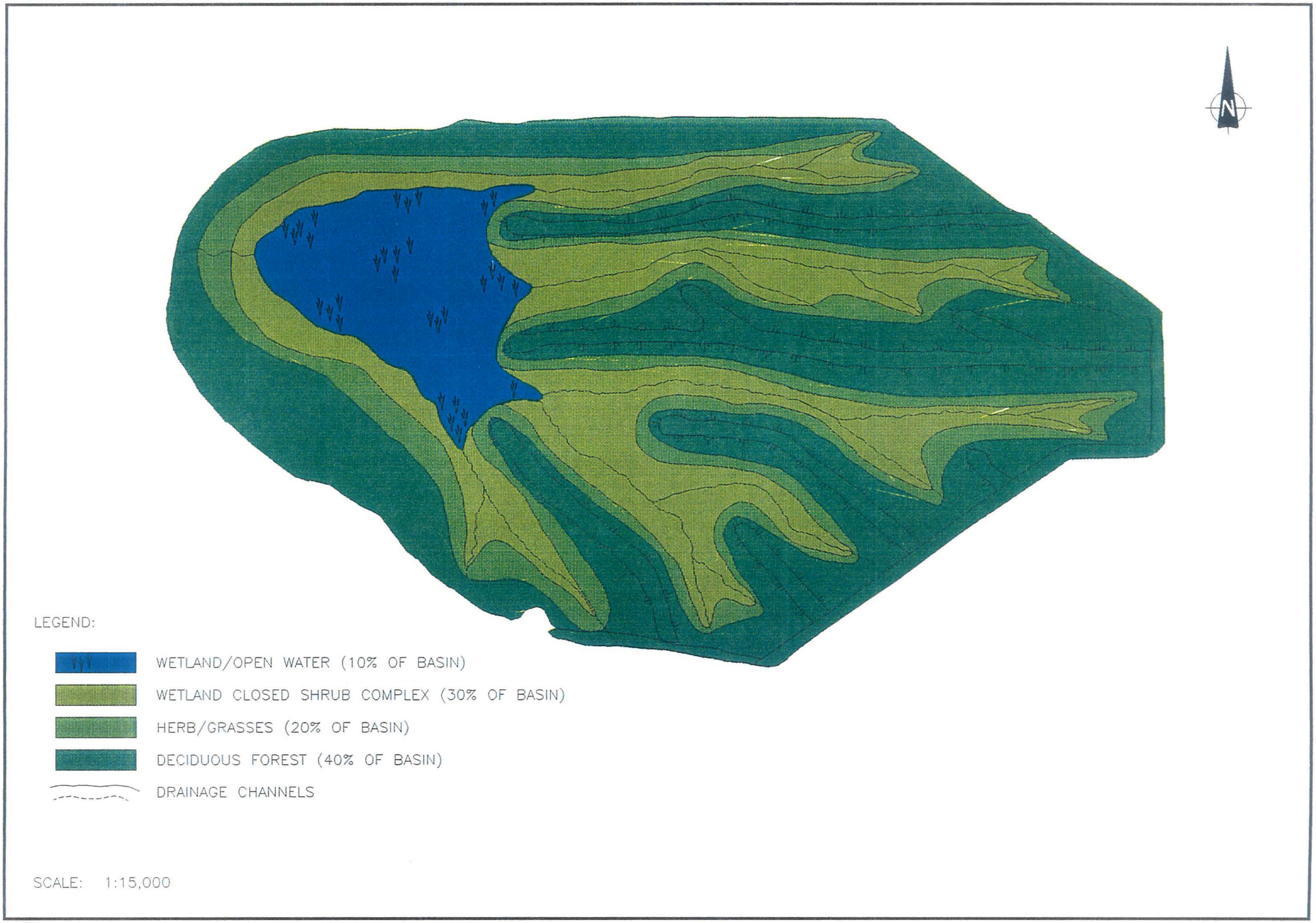
Figure D3.0–31 Reclamation Drainage Systems



2017

DUKGACLR.dwg 11=13970

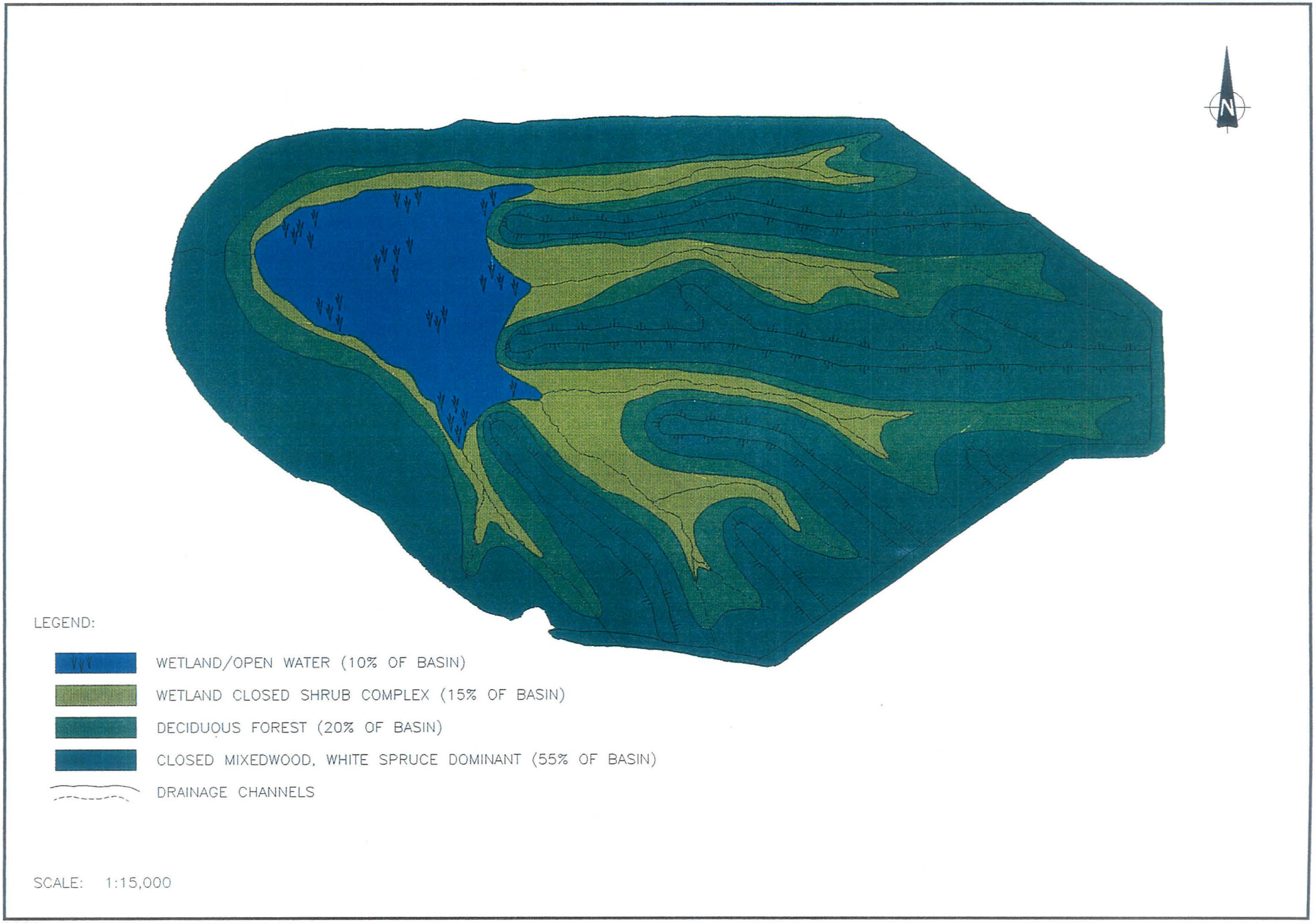
Figure D3.0-32 Reclamation Area 5 – Reclamation Progression Year 2017



2030

DUKGACLR.dwg 11=13970

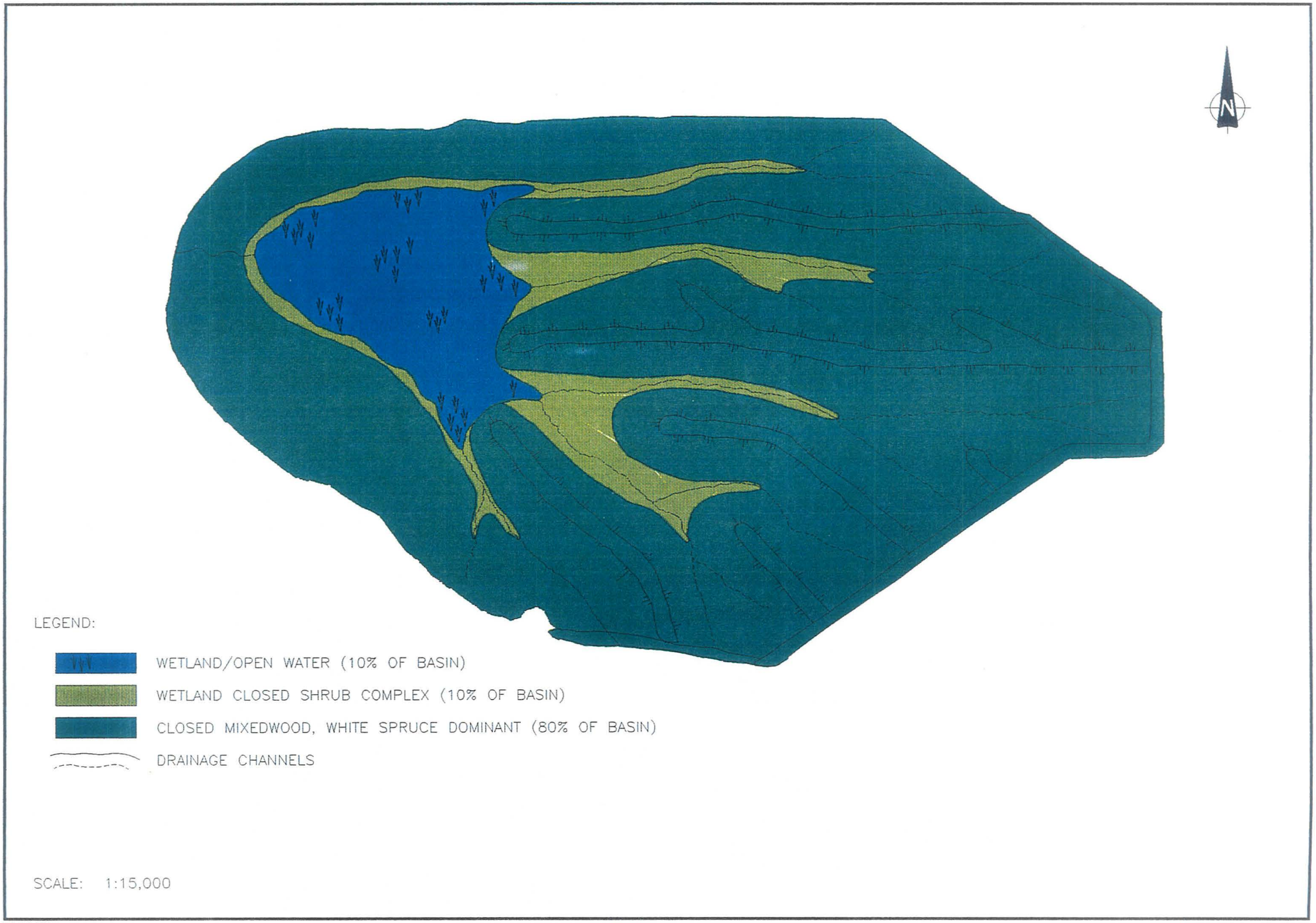
Figure D3.0-33 Reclamation Area 5 – Reclamation Progression Year 2030



2050

DUKGACLR.dwg 11=13970

Figure D3.0-34 Reclamation Area 5 – Reclamation Progression Year 2050



FUTURE

DUKGACLR.dwg 11=13970

Figure D3.0-35 Reclamation Area 5 - Reclamation Progression Far Future

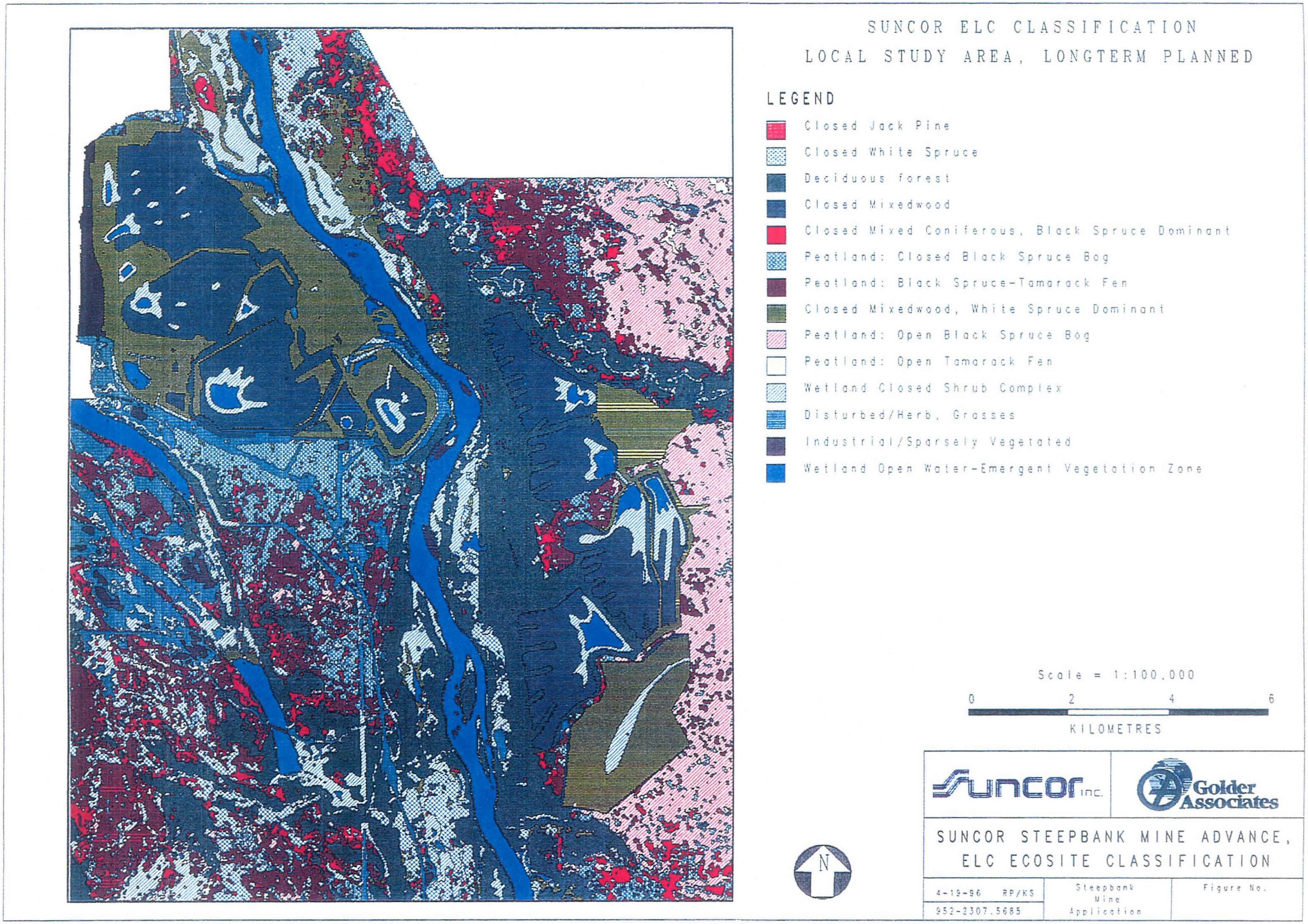


Figure D3.0-36 Reclamation Progression to Far Future

4.0 PESTICIDES

Suncor seldom uses pesticides on its plant site. When it is necessary to use controlled pesticides the job is contracted to a licensed firm that employs certified applicators.

5.0 POTABLE WATER

The potable water supply, approximately 7.6 L/s (650 m^3/day) for operations at Steepbank Mine, will be obtained from water wells constructed in the sand and gravel aquifer between the Athabasca River and the proposed facilities area. If water well supply is shown to be insufficient alternative sources of supply (such as infiltration galleries) will be explored. Design of the water supply will accommodate:

- protection from Athabasca River flooding, ideally by placing facilities above elevation 241 m ASL;
- protection from spills or other contamination from shop facilities; and
- chlorination.

Suncor will request approval for the construction and operation of a potable water system at a later date.

TABLE OF CONTENTS

SECTION E **PAGE**

LIST OF TABLES AND FIGURES

TABLES **PAGE**

LIST OF TABLES AND FIGURES

FIGURES **PAGE**
(located at end of each section - where applicable)

E ENVIRONMENTAL IMPACT ASSESSMENT

1.0 ENVIRONMENTAL IMPACT ASSESSMENT MANAGEMENT FRAMEWORK

1.1 SCOPE OF ASSESSMENT

This Environmental Impact Assessment (EIA) presents a summary of the implications of the environmental and socio-economic effects associated with construction and operation of the Steepbank Mine, the expanded production capacity of the Fixed Plant to 107 kbpcd (thousand barrels per calendar day), and the integrated reclamation of Lease 86/17 and the Steepbank Mine. Associated environmental improvements, such as the Flue Gas Desulphurization Plant are considered within the scope of this EIA.

The purpose of the EIA is to present information and analysis which meets the requirements identified in Terms of Reference provided by Alberta Environmental Protection. The EIA has been integrated with Suncor's Environmental Management Program and also focuses on concerns raised during the company's extensive public consultation process.

1.2 ENVIRONMENTAL IMPACT ASSESSMENT RELATIONSHIP TO SUNCOR'S ENVIRONMENTAL MANAGEMENT PROGRAM

Suncor's Environmental Management Program consists of a number of elements; most importantly, a corporate ethic which is applied to all company operations and emphasizes that good environmental stewardship is a necessity for doing good business.

This EIA, which is one component of Suncor's Environmental Management Program, attempts to identify and mitigate impacts associated with the new project or proposed modifications to existing operations which are requested in this Application. It is predictive in nature and therefore identifies follow-up monitoring required to verify the choice of design options and to identify any additional mitigation needs.

This EIA supports Suncor's application to the Alberta Energy Utilities Board for the proposed Steepbank Mine and meets obligations under the *Alberta Environmental Protection and Enhancement Act* to provide information relating to the potential environmental effects of the development, operation and reclamation of the Steepbank Mine and Lease 86/17. It also discusses measures that will be employed to mitigate impacts, and provides an assessment of the importance of the environmental changes which will result. (Regulatory requirements are addressed in detail in Section A5.0).

1.2.1 Associated Suncor Projects

In addition to the proposal to develop and operate the Steepbank Mine on the east side of the Athabasca River, Suncor is pursuing two other related initiatives.

The Fixed Plant Expansion application (Suncor 1996a) seeks approval to increase the production capacity of the existing Suncor oil sands plant from its current capacity of 79.5 kbpcd to 107 kbpcd. This expansion, in concert with technology improvements, will substantially reduce air emissions and improve the quality of water emissions.

Secondly, the reclamation of the existing mine site on Lease 86/17 has been integrated with the Steepbank Mine. Suncor has chosen to reclaim mined areas by creating "dry landscapes" through the use of "Consolidated Tailings" (CT) technology instead of long term storage of fluid tailings in water-capped fine tails retention ponds. This process will restore mined landscapes to a biologically and diverse environment with, at minimum, a capability equivalent to pre-disturbance conditions. This EIA attempts to address the integrated impacts of all three projects.

1.3 COMMUNITY ISSUES

Suncor's Public Consultation program is explained earlier in Section A3.0. An extensive database of community questions and concerns is maintained by Suncor. The items on the database were reviewed and discussed with groups and individuals to ensure completeness. Table E1.0-1 categorizes the concerns raised by interested parties into EIA topics and identifies the report section where each is discussed. The EIA investigations focused on these concerns.

TABLE E1.0-1

ISSUES RELATING TO THE STEEPBANK MINE DEVELOPMENT APPLICATION

Issue	Section Discussed
Socio-Economic, Human Health and Historical Resources Concerns	
Will recreation impacts be considered in wildlife component or SEIA?	E3.0
Will traditional land uses be considered in determination of end land use?	D3.0
Will archaeological sites be affected?	E10.0
Will there be a loss of recreational, subsistence or commercial fish production due to direct or indirect toxic effects?	E8.0
What are the project's implications to human health?	E4.0
Will there be concerns for human health from consumption of fish?	E4.0, E8.0
What will be the demands upon local services and infrastructure?	E3.0
Will there be a safety concern at Highway 63 intersection?	E3.0
What are the expected population changes due to the project?	E3.0
Will there be a boom/bust situation in Fort McMurray?	E3.0
What will be the cumulative effects on housing, infrastructure, etc., especially during construction?	E3.0
What have been the socio-economic benefits to date (employment, training, business opportunities)?	E3.0
Will Suncor have an annual business opportunity plan?	E3.0
What are the opportunities for local procurement, local employment and training? Are there employment opportunities for the Anzac community members?	E3.0
Will Suncor help local students be trained to meet future technology needs at the new mine?	E3.0
Will Suncor report on success of native involvement, and set targets for native involvement?	A3.0
Will existing land use (hunting and trapping) be displaced?	E3.0
Can people with trapline rights in the area sell them?	E3.0
What will be the construction population pressure on recreational hunting and trapping?	E3.0
Terrestrial	
Will Shipyard Lake be affected by changes to surface and groundwater recharge, and overburden dump? Will there be a loss of vegetation habitat due to direct loss, degradation, contamination, erosion of wetlands?	E5.0
Will there be affects to rivers because of the proximity of the development?	E7.0, E8.0
What will be the impacts resulting from wetland displacement, dewatering of non-mined areas, changes to run-off patterns after reclamation, disturbance to creeks and catchments and impacts to vegetation and wildlife habitats?	E7.0

Issue	Section Discussed
Will reclamation restore pre-disturbance levels of biodiversity?	E5.0
Is erosion a concern for dry landscape units? There is limited availability of reclamation soils. Dykes: what about erosion resistance, recontouring to duplicate natural conditions, side slope habitat requirements?	D3.0
Will there be contaminant uptake by plants in treatment wetlands?	D3.0
Are berry picking plants and medicinal plants part of the survey? Are they a Valued Ecosystem Component?	E5.0
Will rare and endangered plant species be affected?	E5.0
Will elders be consulted to help determine what should be planned for reclamation?	D3.0
Will special plants and ecosystems be saved?	E5.0
How does the EIA relate to the Integrated Resource Plan?	D3.0, E
Aesthetics	
What will be the visual impacts of utility corridor, the mining of the Athabasca River escarpment and shop/maintenance facility?	E5.0
Wildlife	
Will the study boundaries consider migratory routes and facilities?	E6.0
Will unique wildlife habitats in the Athabasca/Steepbank confluence area and north of the proposed center pit be protected?	E6.0
Will the utility corridor location in river valley affect productive wildlife habitats (e.g., moose overwintering, noise, dust, movement corridor)?	E6.0
What will be the effect on wildlife from air emissions and water quality changes?	E6.0
Caribou migrations -- do they cut across the study area?	E6.0
Will the project create a barrier to wildlife movement? Will valley development (bridge, hydrotransport line, pipelines; dykes) be a barrier to wildlife movement?	E6.0
Will tailings ponds be used by waterfowl and shorebirds during migration?	E6.0
How many beaver will be affected?	E6.0
Will wildlife collisions with vehicles and buildings, and wildlife harassment be a problem?	E6.0
Will increased access result in increased hunting, poaching and trapping?	E6.0
Will direct and indirect mortality lead to changes in biodiversity?	E6.0
Will changes in predator-prey relationships occur as a result of the project?	E6.0
Will there be removal of problem wildlife (beaver, bear)?	E6.0

Issue	Section Discussed
Aquatics, Surface and Groundwater	
Human health -- will fish consumption be a concern?	E4.0
Is mercury a concern in fish?	E4.0
Will fish tainting limit use of the resource?	E8.0
Could there be a loss of fish production due to direct or indirect toxic effects?	E8.0
Could there be a potential loss of recreational, subsistence or commercial fish production due to direct or indirect toxic effects?	E8.0
Will there be a loss of habitats that will preclude future fish production (Steepbank and Athabasca Rivers)?	E8.0
Will the aquatic cumulative effects including Syncrude future expansion be considered?	E8.0
Are biomarkers the same as bioindicators? What is known about MFO's?	E8.0
What about naphthenic acids in relation to fish?	E8.0
What will be the effects resulting from discharge of mine drainage water (i.e., water quality, flows); effects of water discharge from facilities (e.g., camp, plant run-off, extraction, upgrading); effects of shop/maintenance facility to water quality in wetland, effects of sewage and garbage disposal, landfill contamination, storage and disposal of fuel, cleaners, run-off from sizers/surge bin/conveyors?	E8.0
What will be the effects on groundwater quality from contaminant migration from landfill, tailings ponds, coke pile, sulphur; spills from tanks, pipeline breaks and leaks, diesel fuel from conveyors, etc?	E7.0
What is the hazard of catastrophic tailings release into the Athabasca River?	D3.0
Will there be impacts to water quality from seepage through tailings dykes?	E8.0
What is the toxicity of surface run-off and seepage water and discharge from tailings?	E8.0
Will there be bioaccumulation of hydrophobic compounds?	E8.0
Will disposal of basal aquifer water affect surface water quality? Can saline basal aquifer water be used in the recycle system?	E7.0
Will there be impacts to Steepbank River from sediment run-off from mining?	E8.0
Will there be river contamination from spills from bridge (paints, salt, etc.)? What is the potential for contamination from pipeline spills/leaks (emergency dumps, freeze up protection, line abrasion and breakage, emergency plans)? What are the potential effects of hydrotransport building failure (e.g., freeze-up), general facility run-off, fire water source and spillage, fate of degreasers and other materials associated with clean-up and rejects disposal?	E8.0
What impacts to the river could be caused by providing water to operate the hydrotransport system?	E7.0
Will groundwater and surface water flow patterns be affected by dewatering?	E7.0

Issue	Section Discussed
What will be the effects on wetlands and other water bodies from mine water discharge?	E5.0
What will be the water impacts from mining (e.g., altered hydrology, sediment or nutrient loading)?	E7.0
Will groundwater discharge and alteration of surface flows to the Steepbank River affect flow conditions (including base flows) and fish?	E7.0, E8.0
What will be the impact to riparian and aquatic habitat impacts to Athabasca River caused by bridge construction (pilings, barrier, siltation, etc.)?	E8.0
What will be the effects on spawning habitat for grayling, and to bull trout in area?	E8.0
Will there be impacts from ice jamming to bridge, river bed and water intake?	E7.0
Will the valley development be susceptible to ice buildup, flooding?	E7.0
Will the bridge provide access to previously remote areas or spills?	C4.0
What will be the impacts of bridge approaches to erosion, stabilization and habitat loss?	E8.0
Will there be impacts to navigation from changed channel depth or bridge height?	C4.0
Will increased bank erosion, instability and other impacts result from waste dump placement near river?	E8.0
How will the project affect the aquatic ecosystem?	E8.0
Air quality	
Is CH_4 included in greenhouse gas review?	E9.0
Global climate change -- what about greenhouse gas emissions?	E9.0
Will there be impacts from fugitive dust from coke piles, overburden dumps and tailings ponds?	E9.0
Will there be gypsum dusting problems?	E9.0
What are the emissions from the hydrotransport building?	C8.0, E9.0
What will be the effects of VOC and THC fugitive emissions?	E9.0
What are the potential effects on off-site water bodies from the atmospheric release of combustion products?	E9.0
Will there be effects on lichen health for caribou habitat in Thickwood Hills, Muskeg Mountain from air emissions?	E5.0
Will there be air emission effects (i.e., acidification) to regional vegetation?	E5.0
What will be the stack emissions including SO_2, NO_x and VOC from operational flaring?	E5.0
Are you considering cumulative effects from the past and future (Syncrude, Solv-Ex,, Alpac, etc.)?	Throughout E
Will air studies be tied into human health?	E4.0
Will particulates and heavy metals be addressed?	E9.0

1.4 REGIONAL LAND USE PLANNING

Understanding the Steepbank Mine proposal as a land resource development requires consideration of the development in a regional context. The Steepbank Mine lies within the Fort McMurray-Athabasca Oil Sands planning area, and is guided by the Draft Fort McMurray -- Athabasca Oil Sands Subregional Integrated Resource Plan (Alberta Environmental Protection 1995).

Suncor recognizes the environmental values of the Athabasca and Steepbank River valleys. The proposed operation incorporates mitigation measures to minimize the impacts related to development, and to restore landscapes and biological processes in the long term. The Integrated Resource Plan identifies specific criteria with respect to valley development. These criteria are addressed in subsequent sections of the EIA:

- wildlife
- erosion
- floodplain
- water quality
- recreation/tourism
- ecological
- traditional use
- historical sites

In addition to being familiar with the Integrated Resource Plan's objectives for public land use, a familiarity with other existing and proposed developments is required to evaluate the Steepbank Mine project from a regional perspective.

2.0 IMPACT ASSESSMENT METHODS

2.1 IMPACT ASSESSMENT APPROACH

This environmental assessment has been structured to provide focused, understandable and relevant information and analysis about the type, extent and significance of environmental effects related to Suncor's proposals and provide input to Suncor's Environmental Management Program. To comply with this intent, the EIA was designed to be:

- issue driven: seeks out concerns of the community, and directs EIA investigations so that answers to those concerns can be provided;
- transparent: clearly explains the assumptions and factors used to assess environmental effects;
- quantitative: provides the measurements used to make judgements; and
- regional/cumulative: considers Suncor's contribution to the overall regional environmental impacts associated with all current and proposed developments.

The environmental impact assessment evolved as the project was defined. The first stages of the environmental impact assessment for the Steepbank Mine began with the project concept and review of existing environmental information (Figure E2.0-1). This was followed by a preliminary scoping of issues in the autumn of 1994, preparation of draft terms of reference early in 1995 and final terms of reference issued by Alberta Environmental Protection in August 1995. Throughout this period, development of the database of environmental baseline conditions, refinement of the project description and public consultation were used to identify additional issues requiring study. This included decisions about the size of the study area, time frames to be considered, and the environmental components that were to be addressed.

The various stages of investigation are presented in a series of reports (Figure E2.0-2). Those reports provide comprehensive information about the existing resources, and present results from research into the effectiveness and risks of proposed technologies. Information from the baseline reports was used to prepare the eight Impact Analysis reports, which assess the implications of the proposed Steepbank Mine project to existing environmental and social conditions.

The Impact Analysis reports were structured to ensure that the issues of importance to the community are clearly addressed. Each report examines a number of "Impact Hypotheses" which are statements that express a concern about the potential for the project to negatively affect an environmental resource or social issue of concern (Table E2.0-1).

For each hypothesis, specialists investigated the ways in which the project could potentially affect the resource. They identified ways to prevent or reduce those impacts, and discussed each impact's severity, how large an area would be affected, and how long the impact would last. Table E2.0-2 lists the parameters used by discipline specialists in classifying degrees of impact.

This EIA section of the Steepbank Mine Project Application summarizes the findings of the reports illustrated in Figure E2.0-2. Readers are invited to refer to the Impact Analyses and baseline reports for further information on the methods and assumptions that lead to the conclusions reported in this section.

2.2 SCOPE OF ASSESSMENT

Determining what to study, how large the study area should be, and whether to include past environmental changes as well as future ones, are three fundamental challenges to undertaking an environmental impact assessment. The task is to choose the best balance between a broad overview versus a narrow, in-depth investigation. These three issues - what to study, where to study it, and within what time frame - were addressed early in the development of this environmental impact assessment.

2.2.1 Valued Ecosystem Component (VEC) Selection

Environmental systems include an infinite number of complex, interconnected elements with each contributing to the functioning of the whole. To focus the environmental assessment in the Terrestrial, Wildlife and Aquatic areas, a variety of environmental components were chosen as priority points of investigation. The identification of these factors does not imply that they have greater importance within the ecosystem than components which were not selected. These elements, typically referred to as Valued Ecosystem Components (VECs), were chosen for a variety of reasons. For example, they may have a special importance as a landscape feature (e.g., Athabasca

TABLE E2.0-1

STEEPBANK MINE EIA IMPACT HYPOTHESES SUMMARY LIST

	SOCIO-ECONOMIC
1	The Steepbank Mine Project will contribute additional local, provincial and national benefits through additional employment, the procurement of goods and services required for the project and the payment of local, provincial and national taxes and royalties.
2	Construction-related activities and employment and the associated temporary increase in population will result in increased demands on services and infrastructure within the Regional Municipality of Wood Buffalo.
3	Operations-related employment and the associated increase in population will result in increased demands on services and infrastructure within communities in the Regional Municipality of Wood Buffalo.
4	The social stability and quality of life of communities within the Regional Municipality of Wood Buffalo will be maintained as a result of the continued operation of the Suncor project, through development of the Steepbank Mine.
5	The Steepbank Mine project will contribute to a loss in the traditional resource base of the Fort MacKay community and displace some traditional activities.
6	The cumulative demands from the Suncor, Solv-Ex and Syncrude projects combined with the expected demands from existing populations within the Regional Municipality of Wood Buffalo will result in increased demands on local communities and affect the quality of life of those communities.
	HUMAN HEALTH
7	The health and well being of people who live, work or engage in recreational activities within the study area may be affected by changes to Athabasca and Steepbank River water quality caused by water releases resulting from extraction, processing and reclamation of oil sands from Suncor's existing and proposed mines.
8	The health and well being of people who live, work or engage in recreational activities within the study area may be affected by air emissions resulting from extraction, processing and reclamation of oils sands from Suncor's existing or proposed mines.
9	The health and well being of people who live, work or engage in recreational activities within the study area may be affected by cumulative exposure to chemicals associated with water and air emissions from Suncor's activities and other developments within the Regional Study Area.
10	The health of people who in the future may occupy and/or use the land reclaimed from Suncor's Lease 86/17 and Steepbank Mine may be affected by release of chemicals from the reclaimed landscapes.
11	The health and safety of on-site workers may be affected by development and operations of the Steepbank Mine and related facilities.
	TERRESTRIAL
12	Valued Ecosystem Components in the Athabasca River valley could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.

13	Existing and future use of the area's landscapes could be limited by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.
14	Visual integrity of the Athabasca River Valley could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.
15	Biodiversity could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.
16	Wetlands could be affected by Lease 86/17 and Steepbank Mine development and operation, including mine dewatering, changes to subsurface drainage, and reclamation release water.
17	Air emissions from the Suncor operation could have an impact on vegetation and soils, as well as aquatic environments.
WILDLIFE	
18	Mine development will result in changes in the availability and quality of wildlife habitat which will bring about a reduction in wildlife populations
19	Disturbance associated with mechanical noise and human activity may result in reduced abundance of wildlife.
20	Direct mortality of wildlife caused by mine development could result in reduced abundance of wildlife.
21	Mine development will disrupt the movement patterns of wildlife in the vicinity of the Steepbank Mine, thereby reducing access to important habitat or interfering with population mechanisms, resulting in decreased abundance of wildlife.
22	Mine development could cause a reduction in wildlife resource use (hunting, trapping, non-consumption recreational use).
23	Development of the Steepbank Mine could contribute to a loss of natural biodiversity.
SURFACE AND GROUNDWATER RESOURCES	
24	Flows in the Athabasca and Steepbank Rivers could be significantly changed by mine development withdrawals for extraction, upgrading and/or reclamation.
25	Ice jams, floods or other hydrological events could cause structure damage and flooding of facilities that will result in subsequent impacts to hydrological/aquatic systems and downstream uses.
26	Navigation along the Athabasca River could be affected by bridge construction.
27	Groundwater quality could be affected by contaminant migration from processing and extraction activities.
AQUATIC RESOURCES	
28	Construction, operational or reclamation activities might adversely affect aquatic habitat in the Steepbank River.
29	Construction, operational or reclamation activities might adversely affect aquatic habitat in the Athabasca River.

30	Water releases associated with construction, operational or reclamation activities might adversely affect aquatic ecosystem health in the Athabasca or Steepbank Rivers.
31	Water releases associated with construction, operational or reclamation activities might adversely affect the quality of fish flesh.
32	Construction, operational or reclamation activities might lead to changes in aquatic habitat and/or aquatic health which might result in a decline in fish abundance in the Athabasca or Steepbank Rivers.
33	Construction, operational or reclamation activities might lead to changes in fish abundance or quality of fish flesh which might result in a decreased use of the fish resource.
34	Construction, operational or reclamation activities might cause changes in Athabasca River water quality which might limit downstream use of the water.
AIR QUALITY	
35	Global climate change could be affected by increased release of greenhouse gases associated with production expansion related to the Steepbank Mine.
HISTORICAL RESOURCES	
36	Significant archaeological, paleontological or historical resources could be affected by the development and operation of the Steepbank Mine.

TABLE E2.0-2
IMPACT ASSESSMENT PARAMETERS

Impact Analyses	Direction[a]	Severity[b]	Duration[c]	Geographic Extent[d]	Degree of Concern[e]
Socio-Economic	increase or decrease in parameter being reviewed	**low**: < 5% change **medium**: 5 - 10% change **high**: > 10% change	**short term**: under 1 year **medium term**: 1 to 5 years **long term**: 5 years or more	**local**: affects Fort MacKay and Fort McMurray **regional**: affects the Regional Municipality of Wood Buffalo **provincial/national**: affects Alberta or Canada	**low**: < 5% change of <1 year, affecting local or regional areas **medium**: change of 5- 10%, affecting local or regional areas **high**: >10% change for >1 year, affecting local or regional areas.
Human Health	+, neutral or - with respect to human health	Where quantified: Nil: ER<1 Low: ER>1 with mitigating factors High: ER > 1 without mitigating factors If not quantified: any impact on human health was assumed to be important.	**operations**: impact is limited to the operating period of the plant **long term**: impact continues after plant closure	**on-site**: impacts are confined to Suncor lease area **off-site**: impacts extend beyond the confines of the Suncor lease area	**nil**: no health impact **low**: impact unlikely but more work needed **high**: impact possible or insufficient information to draw conclusion.

Impact Analyses	Direction[a]	Severity[b]	Duration[c]	Geographic Extent[d]	Degree of Concern[e]
Terrestrial	+favourable effect with respect to parameter being studied - unfavourable effect	**low**: affects <5% of the biophysical resource base **moderate**: affects 5 - 15% of the biophysical resource base **high**: affects > 15% of the resource base	**short term**: impact limited to the period of time of the activity causing the effect **medium term**: impact limited to the mine's operational period **long term**: impact extends past mine closure	**local:** impacts confined within the Suncor Lease 86/17 and Steepbank Mine leases **regional:** impacts extend beyond the local study area and affect a portion of the larger Regional Study Area **beyond regional**: impacts extend beyond the defined Regional Study Area	**low**: any impact that is restricted to the local study area, is low in extent or is of moderate severity of short term duration **moderate**: any impact of moderate severity that does not extend beyond the regional area and is not of long term duration **high**: an impact of moderate or high severity that extends beyond the regional area, or is of long term duration
Wildlife	**positive** = benefits the wildlife resource **negative** = adversely affects the wildlife resource	**low**: affects < 10% of the population or habitat base **medium**: affects 10 - 25 % **high**: affects > 25%	**short term**: impact expected to last less than 10 years **medium-term**: impact lasts between 10 - 25 years **long-term**: effect extends for > 25 years	**local**: effect restricted to the Suncor leases and area immediately adjacent **regional:** effect extends beyond the local study area into the regional area **beyond regional**: effect extends beyond the Regional Study Area	**nil**: effect is neutral or negligible in severity **low**: effect is low severity, local and of short to medium duration **moderate**:effect is intermediate between low and high degrees of concern **high**: effect of moderate or high severity, long-term duration, and/or extends beyond the Regional Study Area

Impact Analyses	Direction[a]	Severity[b]	Duration[c]	Geographic Extent[d]	Degree of Concern[e]
Aquatic	**positive, negative** or **neutral** for the measurement endpoints	**negligible**: no measurable change **low**: measurable change, but < or = 10% change in measurement endpoint **moderate**: >10% but < or = 20% change in measurement endpoint **high**: >20% change in measurement endpoint	**short term**: effect restricted to the period of time of the activity causing the effect **medium-term**: effect extends for <30 years after the activity **long-term**: effect extends for > 30 after the activity	**local**: effect restricted to the local study area **regional**: effect extends beyond the local study area into the regional area **beyond regional**: effect extends beyond the Regional Study Area	**nil**: effect is low severity in the short or medium term, and within the local or regional area **moderate**: effect intermediate between low and high degrees of concern **high**: effect is high severity, or moderate severity in the long term or beyond the regional area
Air Quality	**positive** = reduced contaminants **negative** = increased contaminants	**low**: near existing ambient conditions **moderate**: above existing ambient conditions, but less than ambient guidelines **high**: above ambient guidelines	**short term**: acute (1 hour to 1 day) **medium term**: chronic (annual) **long term**: more than 30 years **plant-life**: during the operational period of the plant and mine	**local**: effect restricted to Steepbank Mine Site **regional**: effect restricted to within 60 km of Mine Site **beyond regional**: effect beyond 60 km of Mine Site	**low**: impact is restricted to local areas, is low in severity, or is a moderate impact of short term duration **moderate**: any moderate impact that does not extend beyond the regional area and is not of long term duration **high**: a moderate or high impact that extends beyond the regional area and is of long term duration

a Direction: favourable or unfavourable
b Severity: degree of change to a resource
c Duration: length of time over which an environmental effect occurs
d Geographic Extent: area affected by the impact
e Degree of Concern: overall rating that expresses the importance of an impact

and Steepbank River valleys), have an important role in traditional land use (e.g., are an important species for hunting), are rare (e.g., endangered species), or play a pivotal role in a food chain (e.g., snowshoe hares). Some VECs were chosen because of their economic or recreational importance and others because they can be early indicators of environmental stress (e.g., longnose suckers that have a high exposure to river sediments). The relevant Impact Analysis report in this series (Figure E2.0-2) details the VEC selection process. Depending on the subject, VEC selection was based on a combination of expert opinion, public concern and feasibility of study.

Table E2.0-3 summarizes the VECs that were selected, and highlights the reasons they were chosen.

2.2.2 Study Area Boundaries

Choosing the right study area boundary is a balance. The larger the area selected, the greater the possibility that an impact will be judged to be of no concern because it is relatively small when considered against the background of a large area. Alternatively, the smaller the study area, the less opportunity there is to consider the context of the project's impacts within the region, and consider its relationship to the effects of other development activities in the area. This environmental assessment attempts to capture the advantages of both large and small study areas by undertaking investigations and presenting an analysis of impacts both within a relatively small Local Study Area, and within a relatively large Regional Study Area.

The boundaries of the Regional Study Area (Figure E2.0-3) used for the terrestrial, wildlife and air quality assessments were developed in consultation with the public and Syncrude Canada Ltd. (Syncrude), to assess combined impacts for all of Suncor's and Syncrude's existing and proposed oil sands operations. The area is intended to be large enough to investigate the cumulative effects of major existing and proposed industries in the area. A number of criteria were considered in defining the boundary:

- airshed - encompasses the maximum areal extent where vegetation could be impacted by sulphur dioxide (SO_2) concentrations;
- watersheds - the entire drainage basin of the Steepbank and Muskeg Rivers, the majority of the MacKay River basin and portions of the Athabasca and Clearwater Rivers. By

TABLE E2.0-3
SELECTED VECS AND RATIONALE FOR SELECTION

Resource Type	Vec Identified	Rationale for Vec Selection
Terrestrial (Landforms, Soils, Vegetation)	riparian floodplain, floodplain terrace	- river valley identified as special feature in Integrated Resource Plan - relatively rare in region, have high biodiversity on landscape and community levels, have high recreational importance and high traditional use values - high wildlife habitat importance
	riparian escarpment	
	mature white spruce forests	- important timber resource, limited distribution, high biodiversity at community and species levels, high recreational importance and high traditional use values, sensitive to pollution and physical disturbance
	mature balsam poplar forests	
	jack pine/lichen communities	- contains species of high traditional use importance (alder, blueberry), sensitive to pollution and disturbance, uncommon and high recreational importance
	riparian wetlands	- contains species of high traditional use importance (alder, cattail, bulrush, pondweed), high rare plant potential, sensitive to disturbance and pollution, high biological diversity and high recreational importance
Wildlife	moose	- high economic, recreational, ecological importance and traditional use
	woodland caribou	- high provincial and COSEWIC[a] status
	black bear	- commercial, recreational and ecological importance
	timber wolf	- high ecological importance, commercial importance and provincial status
	marten	- high commercial and ecological importance
	fisher	- high commercial and ecological importance, provincial status
	wolverine	- high provincial and national status
	lynx	- high provincial status, commercial and ecological importance
	beaver	- high economic and ecological importance
	river otter	- provincial status, commercial and recreational importance
	red-backed vole	- important prey species
	snowshoe hare	- ecological importance
	waterfowl	- habitat indicator

Resource Type	Vec Identified	Rationale for Vec Selection
Wildlife (continued)	whooping crane	- COSEWIC, provincial status
	bald eagle	- provincial status, recreational and ecological importance
	osprey	- provincial status, recreational and ecological importance
	great gray owl	- COSEWIC and provincial status, ecological importance
	terrestrial songbirds	- recreational and ecological importance
	ruffed grouse	- economic, recreational and ecological importance
Aquatic	walleye (Athabasca)	- resident, subsistence, commercial and recreational importance, feasible to study
	longnose sucker (Athabasca)	- resident, feasible to study, and indicates sediment exposure
	goldeye (Athabasca)	- resident, subsistence importance and feasible to study
	longnose sucker (Steepbank)	- resident, feasible to study

[a] COSEWIC: Committee on the Status of Endangered Wildlife in Canada

delineating boundaries on the basis of watersheds, hydrologic patterns and processes can be consistently described; and

- landscapes (ecological land classification criteria) - by considering ecological boundaries, the cumulative effects assessment can assess homogeneous landscape areas with similar climatic, landform, soil, vegetation and wildlife habitat characteristics.

For socio-economic considerations, study areas were based on political jurisdictions for the Regional Municipality of Wood Buffalo, provincial and national boundaries. The Human Health review investigated the project's potential effects on human health, and was not limited by geographic extent.

Industries that were included as part of the cumulative effects analysis of environmental effects within the region are:

- Syncrude Canada Ltd. - existing Mildred Lake Oil Sands facility and proposed expansion for a new oil sands surface mine development called the Aurora Mine (Figure E2.0-3);

- Solv-Ex - a mine and processing facility to extract both mineral and crude oil from oil sands, located adjacent to the Athabasca River, north of the proposed Aurora mine site; and
- Alberta Pacific Forest Industries Inc. (Alpac) and Northland Forest Products Ltd. (Northland) forestry operations - timber harvesting throughout the region.

A general Local Study Area was also defined (Figure E2.0-4), where the potential effects of the Suncor Steepbank project's activities were addressed in detail. This study area was originally defined by the area encompassing all the Suncor leases which were being considered for development. Within this Local Study Area, each discipline's investigations focused on locations that were most relevant to the resource under review. The Impact Analysis reports explain their site-specific study areas and analyses approaches. In some cases, detailed investigations were carried out beyond the EIA's Local Study Area as a component of other elements of Steepbank development program. For example, hydrogeology (i.e., groundwater) was extensively studied on the west side of the Athabasca River as a component of the Conservation and Reclamation component of this Application (see Section D3.0).

2.2.3 Temporal Boundaries

In general, 1995 existing conditions formed the baseline of the environmental assessment, although in some instances past circumstances have been considered to provide a basis for comparison and to help establish trends. The project will continue for some time into the future, so the following study intervals were defined:

- the existing baseline condition (i.e., 1995);
- the time period associated with construction of mine infrastructure for the Steepbank Mine (i.e., 1997 - 2000);
- general operations and mine advance (i.e., from 2000 - 2020); and
- mine closure - the probable conditions when post-mining reclamation is expected to achieve a biological productivity and successional pattern equivalent to the surrounding natural landscapes.

Time periods being reported vary in some of the discipline reports to accommodate discipline-specific issues.

FIGURES SECTION E2.0

FIGURES

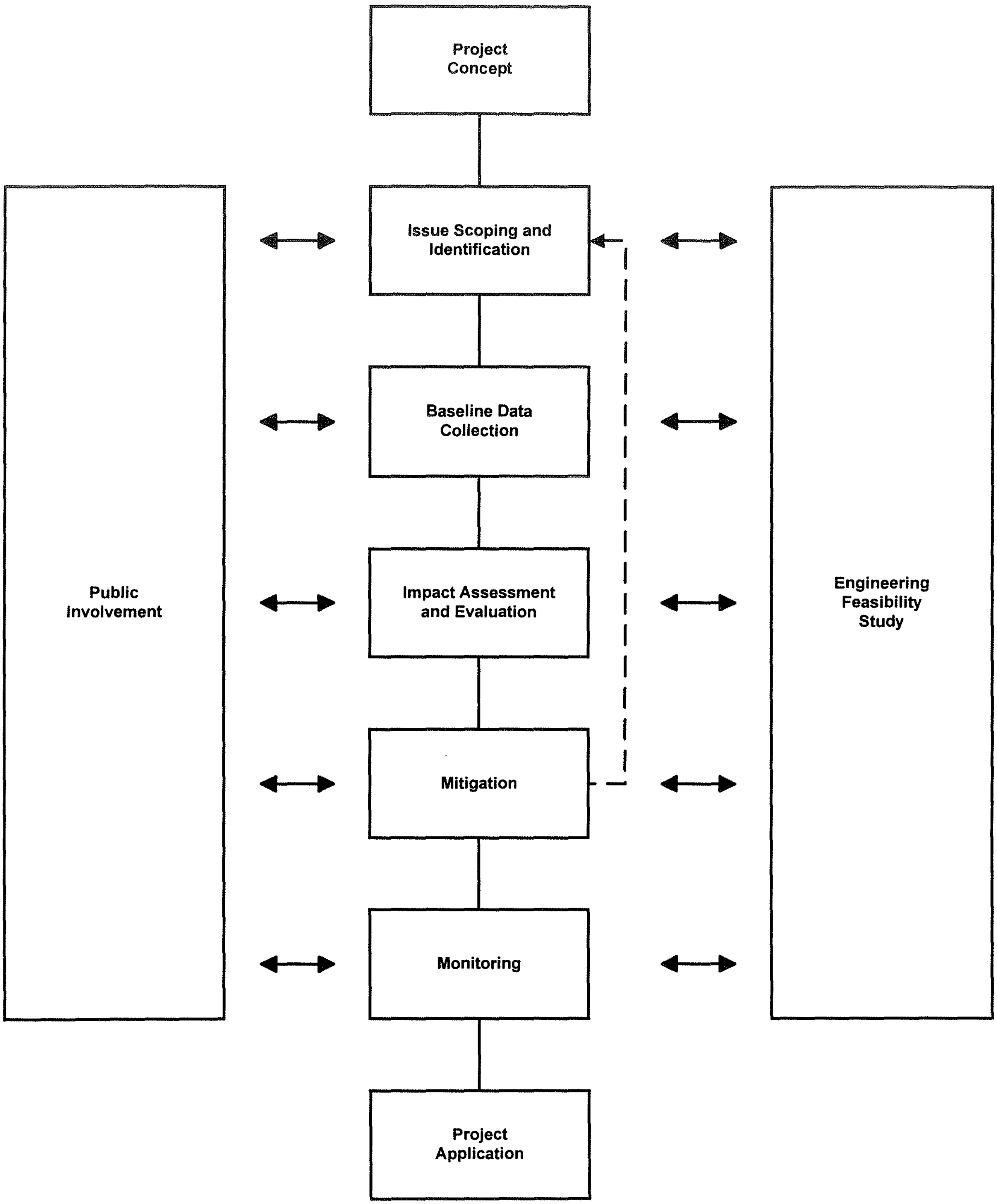


Figure E2.0-1 Steepbank Mine Environmental Impact Assessment Framework

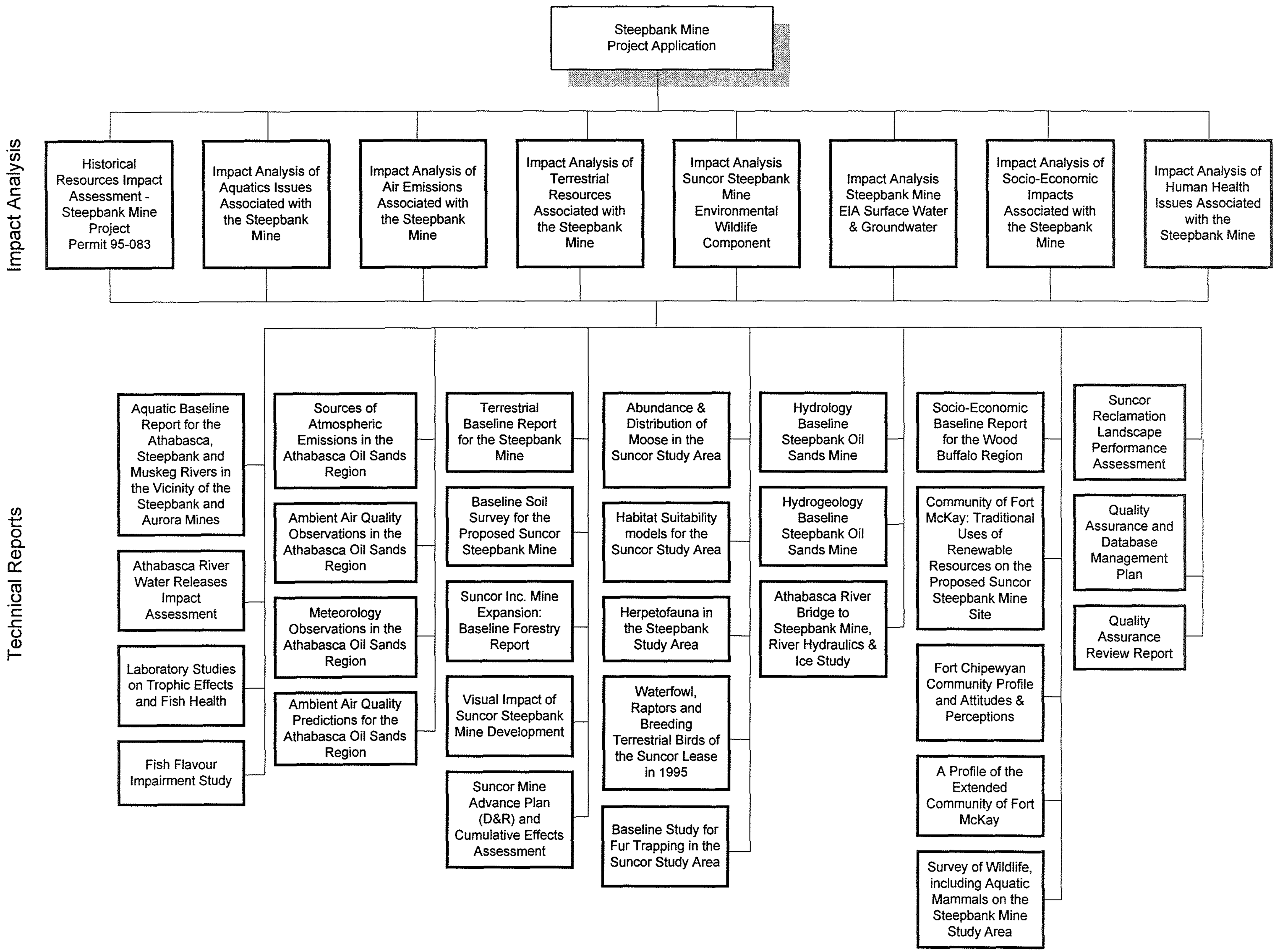
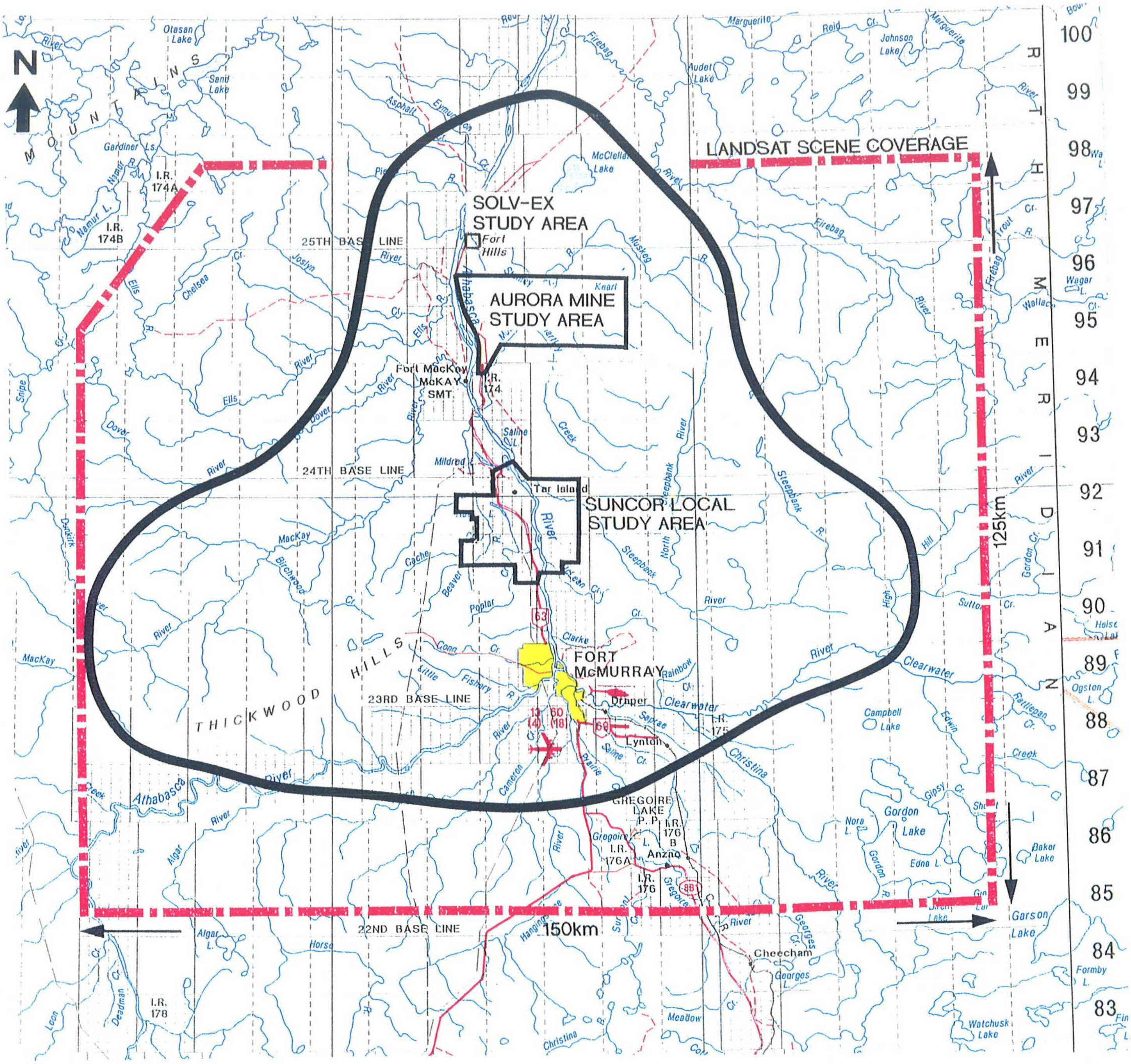


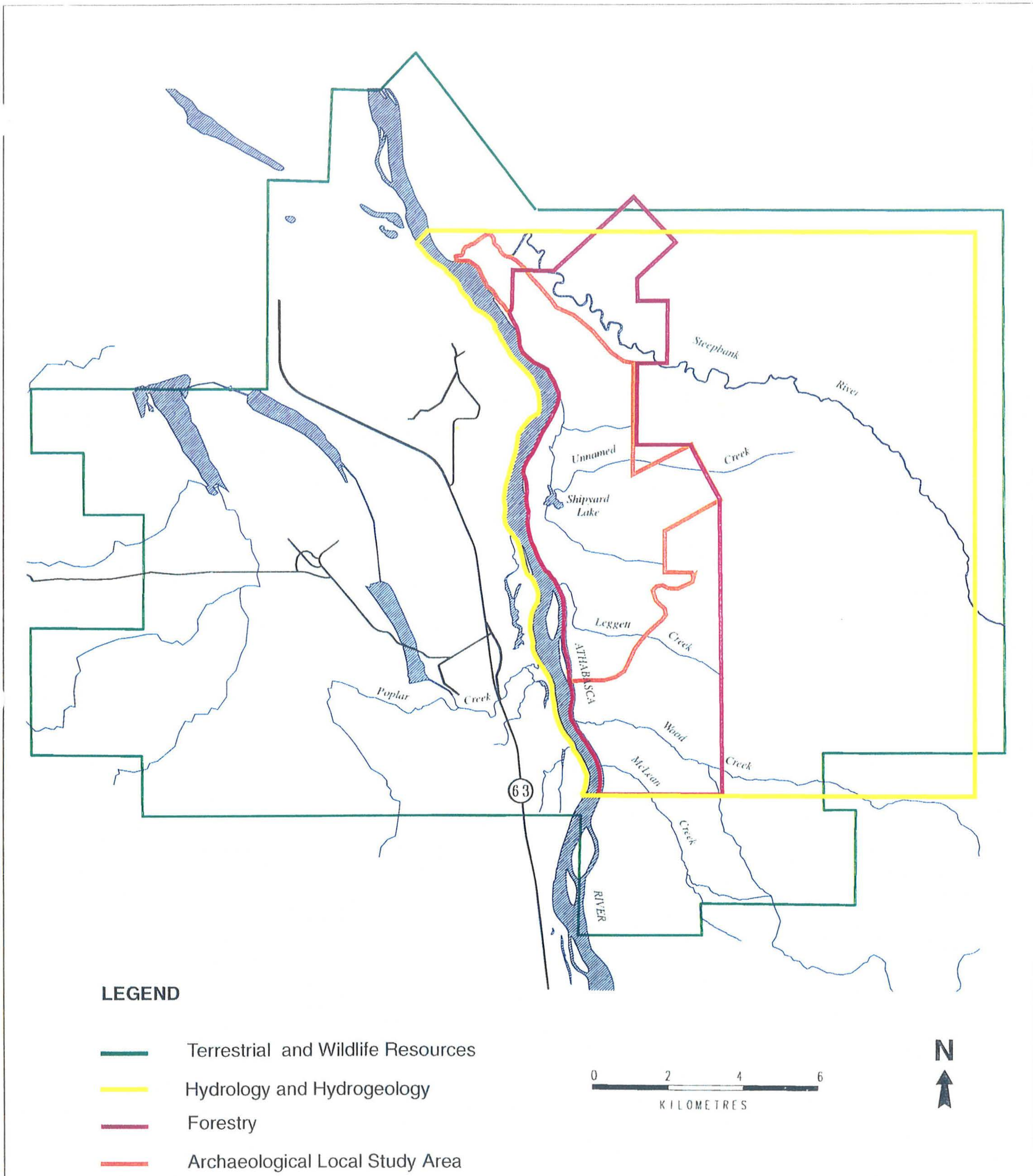
Figure E2.0-2 **Reports Prepared for the Steepbank Mine Environmental Assessment**

r:\1995\2307\repprep5.040\rpt-sch.vsd

Figure E2.0-3

SUNCOR REGIONAL AND APPROXIMATE LOCAL STUDY AREA





Suncor Inc.
Oil Sands Group

LOCAL STUDY AREA BOUNDARIES
FOR THE STEEPBANK MINE
ENVIRONMENTAL ASSESSMENT PROGRAM

SCALE: AS SHOWN	Steepbank Mine Application	REVIEWED BY:
DATE: 18 APR 96		REVISION No.: 1
DRAWN BY: RP		FIGURE No.: E2.0-4

Figure E2.0–4

4.0 HUMAN HEALTH ASSESSMENT

4.1 BACKGROUND

Suncor considers that protection of the health and safety of its workers, its neighbours, and future users of the landscapes is a high priority. As a result, aggressive measures to reduce the sources of potentially harmful emissions have been and are being implemented throughout the Suncor facility. Extensive monitoring related to worker exposure and ambient air quality is part of Suncor's regular monitoring program. Quality of direct water discharges to the Athabasca River and groundwater seepage is also carefully monitored. To measure the potential effects of air emissions on people who live in the area, Suncor is a sponsor and active participant in the Alberta Oil Sands Community Exposure and Health Effects Assessment Program (Regional Community Health study), which is designed to provide a baseline for area residents with respect to air quality.

4.2 SUMMARY OF ASSESSMENT RESULTS

Investigations about the potential impacts of the Steepbank project focused on five concerns that were expressed as Impact Hypotheses (Table E2.0-2). Each of the hypotheses is discussed briefly below. A more complete discussion of the impact analysis and baseline information is available in Impact Analysis of Human Health Issues Associated with the Steepbank Mine (Golder 1996h) as well as a series of background reports (Figure E2.0-2).

Hypothesis 7 ***The health and well being of people who live, work or engage in recreational activities within the study area may be affected by changes to Athabasca and Steepbank River water quality caused by water releases resulting from extraction, processing and reclamation of oil sands from Suncor's existing and proposed mines.***

Assessment: Based on a detailed analysis which quantified the impacts of water releases on people who might use the Athabasca River, it was concluded that water releases associated with Suncor's existing or future operations are safe. Therefore, the degree of concern has been rated as low.

Hypothesis 8 ***The health and well being of people who live, work or engage in recreational activities within the study area may be affected by air emissions resulting from extraction, processing and reclamation of oil sands from Suncor's existing or proposed mines.***

Assessment: There are no studies that indicate the health of people within the study area is affected by current air emissions. The Regional Community Health Study is being initiated to further investigate the issue. Changes in plant operations and the subsequent reduction in both fugitive and operational emissions will further reduce the potential for human exposure to air emissions. The degree of concern has been rated as low.

Hypothesis 9 ***The health and well being of people who live, work or engage in recreational activities within the study area may be affected by cumulative exposure to chemicals associated with water and air emissions from Suncor's activities and other developments within the Regional Study Area.***

Assessment: There is a low potential that the health and well being of people is, or will be, affected by the combined effects of current or future air and water emissions. The degree of concern has been rated as low.

Hypothesis 10 ***The health of people who in the future may occupy and/or use the land reclaimed from Suncor's Lease 86/17 and Steepbank Mine may be affected by release of chemicals from the reclaimed landscapes.***

Assessment: The degree of concern with respect to future use of reclaimed landscapes has been rated as moderate. Future land users could potentially be affected by eating plants with elevated metal concentrations. Nevertheless, concerns associated with that exposure pathway can be mitigated by placing a sufficient capping layer over the CT. Ongoing laboratory and field studies will provide additional information to clarify this issue and to provide direction for reclamation planning.

Hypothesis 11 ***The health and safety of on-site workers may be affected by development and operations of the Steepbank Mine and related facilities.***

Assessment: Suncor's current operations meet all local, provincial and federal rules and regulations for protection of worker safety and health. Proactive occupational health and safety surveillance will continue to assist in maintaining a healthy work environment. Therefore, degree of concern has been rated as nil, with no negative change relative to existing conditions.

4.3 DESCRIPTION OF ASSESSMENT

Most potential health issues related to an industrial project like an oil sands plant pertain directly or indirectly to contamination of air, water or food. The health impact analysis addressed:

- water emissions,
- air emissions,
- exposure to combined air and water emissions (i.e., cumulative impacts),
- safety of reclaimed landscapes, and
- workplace safety.

4.3.1 Water Emissions

Suncor discharges water from the operating mine and fixed plants (operational releases) and from the reclaimed landscapes (reclamation releases). The Steepbank River will not be receiving any operational water releases, and minimal amounts of reclamation waters, so potential impacts on water quality from release of operational and reclamation waters are restricted to the Athabasca River. Operational waters discharged from outfalls as a result of mine operations include mine drainage water, cooling water and discharge from the upgrader and utilities plant. Reclamation water releases are not confined to specific discharge points and will be released for long periods of time after mine operations have been completed. Water draining from consolidated tailings is expected to be a key contributor to reclamation water in the future.

A detailed assessment was conducted to determine which chemicals associated with operational and reclamation water releases might impact people's health, either now or in the future. This included examining all the ways that people using the Athabasca River, immediately downstream of Suncor's operations, might be exposed to these chemicals, including drinking water, eating fish and swimming.

The first step in the health assessment was to screen chemicals associated with either existing or future water releases to identify those that are of potential concern to human health. The screening process compared the maximum concentrations of chemicals measured in release waters against: (1) health-based screening criteria, such as those available from Health Canada; and (2) concentrations that occur naturally within regional surface water bodies. Chemicals for which concentrations exceeded both the screening criteria and background levels included benzo(a)pyrene and benoz(a)anthracene (polycyclic aromatic hydrocarbons), naphthenic acids (a group of organic acids), and the trace elements molybdenum and vanadium. All of these chemicals, which are natural components of oil sands, were assessed in detail to determine potential health impacts that might be caused by their release.

Two scenarios were considered in the health impact assessment: one in which people were assumed to occasionally drink untreated water from the river while boating, fishing, camping or pursuing other activities on or near the river, and the other in which people used the river for swimming. In the latter case, they would be exposed to chemicals in the river via accidental ingestion of water and via absorption through the skin. Potential health impacts on both children and adults were evaluated for existing conditions and for future water release scenarios (Years 2000, 2010, 2020 and long-term). It was assumed that these exposure scenarios would occur at a site immediately downstream of Suncor's operations along the west bank of the river , where chemical concentrations related to Suncor's water releases would be highest. Concentrations decrease substantially further downstream or near the other bank. Hence, the scenarios assessed a worst-case condition with respect to the amount of chemical that a person might receive by drinking untreated river water or swimming in the river.

A quantitative health assessment was performed for the chemicals and scenarios discussed above. The amount of chemical that a person might receive (uptake rate) by drinking river water and swimming in the river was estimated according to Health Canada protocols. The predicted uptake rate for each chemical and scenario was then compared to a reference level that protects the health of the most sensitive individual within a population. If the predicted uptake rate is lower than the reference level, then there is no potential for health impacts associated with the exposure scenario. Cases where the predicted uptake rate is higher than the reference level do not necessarily indicate that adverse health effects will occur; rather they indicate that the scenario poses a potential concern and requires further investigation.

Multiple protective (conservative) assumptions were incorporated into the analysis so that the predicted uptake rate over-estimates that which would actually occur. The results of this analysis showed that even when very conservative assumptions were used, benzo(a)anthracene, benzo(a)pyrene, molybdenum and vanadium do not pose a potential to affect human health. There was, however, insufficient toxicological information to conduct a quantitative assessment for naphthenic acids. Naphthenic acids are a group of complex organic chemicals that occur naturally in all petroleum deposits, including oil sands. It is unlikely that naphthenic acids pose a significant health risk since concentrations within the Athabasca River downstream of Suncor are even lower than occur naturally in other water bodies such as the Steepbank River or Clearwater River. Nonetheless, a study is being designed to collect the additional information necessary to better evaluate potential health impacts from exposure to this group of chemicals.

A similar screening process was performed to identify whether the water releases might result in elevated chemical levels in fish within the Athabasca River and whether eating these fish might affect people's health. No chemicals of concern were identified that were associated with Suncor's release waters. Mercury levels in fish tissue were measured at levels that may be of concern to fish consumers, although the elevated mercury levels appear to be derived from natural sources and are not related to Suncor's water emissions.

Accidental releases (spills) are another avenue through which water emissions might affect river water quality. However, a number of measures have been put into place to minimize the likelihood of an accidental release, reduce the severity of any such releases and, finally, minimize effects through spill containment and clean-up. In the more than 30 years of operations, Suncor has maintained the stability of structures such as tailing dykes, waste dumps and other facilities. These design and safe operating conditions have been supported by an extensive monitoring program and reviewed by independent review boards and regulatory agencies. In the event of an accidental release, Suncor's Environmental Management Plan provides a protocol for dealing with these events. Suncor has a fully trained in-house emergency response team and specialized equipment for handling oil spills and other emergency events. Mutual aid agreements with the Regional Municipality of Wood Buffalo and Syncrude provide immediate additional backup should it be necessary.

In summary, based on the analysis discussed above one can conclude that the health and well being of people who might use the Athabasca River downstream of the Suncor site, are very unlikely to be affected by water releases associated with Suncor's existing or future operations.

4.3.2 Air Emissions

Some types of air emissions associated with the operation and reclamation of the Steepbank Mine project are of interest from a human health perspective: Volatile Organic Compounds (VOCs), particulates and sulphur oxides (So_x). These emissions are released through plant stacks and flares, mining activities and fugitive emissions from settling basins and treatment ponds, and plant leaks. Recent facility improvements have, or will, significantly reduce VOC and SO_x emissions. Particulate emissions will also be further reduced in 1996 when the Flue Gas Desulphurization (FGD) unit becomes operational.

Air emissions from Suncor's existing and future operations have and will result in changes to off-site air quality. However, indirect evidence from on-site VOC and polycyclic aromatic hydrocarbons (PAH) air monitoring data suggest that it is unlikely that off-site concentrations of these chemicals are high enough to affect health of area residents. In addition, the process changes, upgrades and control systems currently being installed or planned for installation as part of the Fixed Plant Expansion are reducing emissions and will continue to improve air quality. These changes will reduce people's potential exposure to air emissions and therefore reduce the likelihood that impacts could occur. Consequently, there is a low degree of concern that emissions from Suncor will affect the health of people living in the surrounding communities. Additional information is being gathered to assist in confirming these conclusions.

4.3.3 Combined Exposure to Air and Water Emissions

Combined exposure to chemicals in air and water emissions (i.e., cumulative impacts) from Suncor's developments and other existing and proposed developments in the region were assessed to determine potential effects to the health of people in the region. As noted above, it is unlikely that concentrations of VOCs in air at off-site locations are present at levels that pose a health hazard. Concentrations of VOCs in water emissions are also low and these chemicals do not bioaccumulate in fish tissue. Thus, it is unlikely that the cumulative exposures to VOCs from breathing air, drinking or swimming in river water and eating fish from the river will affect people's health, even for people who might live, work or engage in recreational activities adjacent to Suncor's leases.

The potential for health impacts from cumulative exposure will likely be restricted to those chemicals associated with air-borne particulate matter which might also be present in Suncor's water emissions. Of primary interest are PAHs and metals. Chemical-specific air quality data are required for off-site monitoring locations before health risks from multiple exposure can be quantified. However, given the extremely low risks calculated for water-based exposure to these chemicals, and probable low risks associated with air-based exposures, the potential for health impacts caused by multiple exposure pathways for these chemicals is low.

Naphthenic acids are considered non-volatile, so inhalation of air vapours is probably an insignificant pathway for this group of chemicals. In addition, they are present as highly soluble sodium salts and so are unlikely to be stored in fish flesh or be present in high concentrations in soils. Therefore, exposure via ingestion of fish flesh or inhalation of dust particles is not expected to be important off-site exposure pathways for this group of chemicals.

Additional information is being gathered to assist in quantifying this conclusion about lack of off-site impacts through initiatives such as the Regional Community Health Study and monitoring done under the review of the Regional Air Quality Coordinating Committee.

4.3.4 Reclaimed Landscapes

After mining is completed, the disturbed areas will be reclaimed with consolidated tailings (CT), overburden and tailings sand. This process consists of backfilling of the mine pits with fluid tailings from the extraction process. Over a period of a few years, water will drain from the deposits, leaving a solid, sandy-textured material. The deposits will then be blanketed with a covering of soil material and revegetated. This is a new technology requiring further investigation of the potential health effects on people who use these areas in the future.

A preliminary assessment has been conducted to determine if the reclaimed sites will be safe for use by people. All the ways in which people using the reclaimed landscape might be exposed to chemicals (drinking water, eating food and accidental consumption of soil) were assessed.

As was done for the investigation of water emissions, a methodological, step-wise screening process was followed to identify which chemicals associated with consolidated tailings deposits require further investigation. Chemicals identified in the screening process included benzo(a)anthracene, benzo(a)pyrene, naphthenic acids, copper, manganese and molybdenum. All of these chemicals are natural components of oil sands.

The health assessment investigated a scenario in which a person lives on or near the reclaimed landscape throughout the year, gets much of his or her food from hunting, trapping and gathering and uses the Athabasca River as the primary source of drinking water.

A quantitative health assessment was performed for the chemicals and scenario discussed above. The amount of chemical that a person might receive (uptake rate) by drinking river water and eating wild game and plants harvested from the reclaimed landscape was estimated according to Health Canada protocols. The predicted uptake rate for each chemical and scenario was then compared to a reference level that protects the health of the most sensitive individual within a population.

The results of this preliminary health assessment suggest that, with the possible exception of consuming large amounts of plants from the site over a long time period, using the site poses little risk to human health. Consuming plants was identified as a potential concern because one of the conservative assumptions included in the assessment was that plants would be grown directly on CT. However, potential uptake from this pathway will be greatly reduced or eliminated once a capping layer is applied over the CT. Nonetheless, this is a potential exposure pathway that requires additional scrutiny. Suncor will address this issue, by constructing a demonstration-scaleconsolidated tailingsreclamation landscape to monitor plant uptake of chemicals.

4.3.5 Worker Safety

Suncor's current operations meet all local, Provincial and Federal rules and regulations for protection of worker safety and health. Suncor's engineering and loss management systems assess health and safety risks of proposed changes or additions to its plant and mine operations. This will continue to be applied as the project advances into the detailed engineering phase.

The objective of the current industrial hygiene program is to understand hazards and risks and protect workers from exposures. This will remain so as the mining shifts from Lease 86/17 to the Steepbank Mine. Emerging issues, such as a reduction in any current permissible exposure level or physical hazard standard, will be dealt with when and if new regulations are issued. Proactive occupational health and safety surveillance will assist in maintaining a healthy and productive workforce.

4.4 ENVIRONMENTAL MONITORING

In addition to Suncor's intensive on-going environmental monitoring program, a number of other studies have been initiated to provide information to help confirm the conclusions of this assessment. These include:

- collection of information to quantify off-site health impacts associated with air emissions through the Regional Air Quality Coordinating Committee;
- expansion of the toxicological information base for naphthenic acids;
- implementation of a demonstration-scale test of CT reclamation, including monitoring of air emissions and chemical uptake by plants; and
- testing of wastewater effluent for toxicity and fish tainting.

Suncor is also a sponsor and active participant in a regional community health study being led by Alberta Health. The information will be used to establish a baseline for health status for the Fort McMurray community for air quality, as well as to determine the relative contribution to exposure of indoor (in-home), outdoor (environmental) and occupational environments.

5.0 TERRESTRIAL RESOURCES ASSESSMENT (GEOLOGY, LANDFORMS, SOILS AND VEGETATION)

5.1 BASELINE CONDITION

Terrestrial resources were classified using an Ecological Land Classification approach. Mapping of terrestrial resources was based on a combination of satellite imagery, air photography mapping, site visits to classify resources into mappable units, and data storage and manipulation in a computer-based Geographic Information System (GIS).

There are a variety of landforms in the Local Study Area (Figure E5.0-1). The Riparian Floodplain and Riparian River Terraces form the Athabasca and Steepbank River bottoms. The Riparian Escarpment consists of the slopes that rise from the valley bottoms of the Athabasca and Steepbank River valley to the upland plains. The Midland and Midland Drainage landforms occur primarily on the west side of the Athabasca River, and form gently undulating plains and depressions which mark old meltwater channels from ancient rivers. The Upland landform, which is the most common within the Local Study Area, is nearly level, and supports extensive areas of peatlands. The Highland landform type in the Local Study Area is located only on the east side of the Athabasca River.

In the Local Study Area, organic soils predominate, primarily Mesisols (65%), reflecting the high water table of the area. Luvisolic soils are widespread on morainal deposits (20%), with a variety of other soil types occurring throughout the remainder of the Local Study Area.

The Regional and Local study areas are located within the Mid Boreal Mixedwood Ecoregion. The vegetation types that occur within the Local Study Area are typical of the region. Table E5.0-1 describes the key characteristics of those vegetation communities. Each type reflects the exposure, moisture conditions, soils topography, and other factors that affect the site specific microclimatic conditions. In addition, vegetation naturally changes over time, with vegetation communities maturing through time from those that colonize immediately following a disturbance (e.g., fire or flood), to mature deciduous or coniferous forests.

TABLE E5.0-1
CHARACTERISTICS OF VEGETATION TYPES FOUND WITHIN THE SUNCOR LOCAL STUDY AREA

Vegetation type	Characteristics
closed jack pine	jack pine/green alder/ blueberry/caribou lichen on well drained escarpment slopes and till deposits
closed white spruce	white spruce/aspen or balsam poplar/balsam fir/green alder/herbs/feathermoss found predominantly on floodplain, escarpment slopes and along drainages
closed deciduous forest	aspen/green alder and aspen balsam poplar on escarpments and upland balsam poplar/willow on floodplain
closed mixed-wood	aspen-white spruce-black spruce-jack pine and tamarack combinations; found in transitional areas between wetland and upland conditions
closed mixed coniferous, black spruce dominant	black spruce-jack pine-white spruce-Labrador tea/feathermoss; found on edges of bogs and till; prevalent above upper edge of escarpments slopes.
peatland: closed black spruce bog	black spruce/Labrador tea/sphagnum moss; most common in upland on poorly drained, organic soils; multi-structural stands
peatland: black spruce-tamarack fen	black spruce-tamarack/bog birch/Labrador tea/sphagnum moss/sedges; common in upland along drainages where conditions are transitional between fen and bog types
closed mixedwood, white spruce dominant	white spruce/aspen-jack pine, black spruce/Canada buffaloberry-Labrador tea/feathermoss; typically a mid to late successional stage from aspen or balsam poplar to white spruce
peatland: open black spruce bog	open black spruce/Labrador tea/sphagnum moss; stands typically open and of low stature; on poorly drained organics
peatland: open tamarack fen	open tamarack/bog birch/sedge/golden moss; found where slow drainage occurs creating saturated organic soils of moderate pH and high nutrient regime
wetlands shrub complex	willow-green alder(bog birch)/bluejoint-sedges/marsh cinquefoil- water hemlock; found on edges or backwater marshes and beaver ponds
disturbed herb-grass	disturbed herb-grass dominated communities on sandbars, recent cutblocks, steep, eroding escarpment slopes and revegetated areas of Tar Island Dyke
wetlands open water - emergent vegetation zone	marshes of backwater ponds of Athabasca River and beaver ponds; dominated by aquatic species such as pond weed, yellow pond lily, cattail, bluejoint and sedges

Figure E5.0-2 illustrates the general distribution of vegetation types throughout the Regional Study Area. Figure E5.0-3 displays the vegetation distribution within the Local Study Area, at a more detailed scale. Almost 2,700 ha of the Local Study Area is currently disturbed by development of Lease 86/17, with some of this area in early to mid stages of reclamation. In the river valley area, closed shrub, deciduous, mixedwood and white spruce forests are common. In the upland landforms where much of the mining will take place, peatlands of open tamarack fens and black spruce bogs predominate.

A survey for rare and uncommon plants within the Local Study Area identified small numbers of rare plants and, with the exception of the regionally uncommon round-leaved sundew, none were found within the proposed mine footprint. To compensate for the difficulty of actually finding rare plants, areas within the Local Study Area with a high *potential* for harbouring rare plants were identified. Those areas are the closed jack pine, closed white spruce, peatland, wetland closed shrub complex and wetland open water-emergent vegetation zone communities. ("Closed" vegetation communities refer to vegetation types which have more than 70% canopy coverage; "open" communities are vegetation types with more scattered coverage of the dominant species.)

5.2 SUMMARY OF ASSESSMENT RESULTS

Key issues relating to the potential for the project to affect terrestrial resources were identified in a series of Impact Hypotheses (Table E2.0-2). Each of the hypotheses is discussed briefly below. A more complete discussion of the impact analysis and baseline information is available in Impact Analysis of Terrestrial Resources Associated with the Steepbank Mine (Golder 1996e), as well as a series of background reports (Figure E2.0-2).

Hypothesis 12 ***Valued Ecosystem Components in the Athabasca River valley could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.***

Assessment: Within the context of the Local Study Area, effects to Valued Ecosystem Components in the Athabasca River valley will be of moderate severity during construction and operations, and in the long-term decrease to low severity. Within the regional context, impacts will be of low severity.

Hypothesis 13 ***Existing and future use of the area's landscapes could be limited by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.***

Assessment: During the period of mine development and operations, effects to land use options within the Local Study Area will be of moderate severity, with a low effect regionally. Over the long-term, land use options will be increased, with an overall positive effect within the Local Study Area.

Hypothesis 14 ***Visual integrity of the Athabasca River valley could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.***

Assessment: Effects to the visual integrity of the Athabasca River Valley will be moderate and local throughout construction and operational phases. Following closure, effects will be low but of long-term duration until revegetation re-establishes the river valley appearance.

Hypothesis 15 ***Biodiversity could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.***

Assessment: Impacts to biodiversity will be low during mine construction, increasing to moderate severity within the Local Study Area during mine operations. In the long term, effects should be low due to reclamation. Within the context of the Regional Study Area, effects to biodiversity will be low.

Hypothesis 16 ***Wetlands could be affected by Lease 86/17 and Steepbank Mine development and operation, including mine dewatering, changes to subsurface drainage and reclamation release water.***

Assessment: During construction, impacts to wetlands will be of low severity. During mine operations, impact severity will increase to moderate within the Local Study Area, although it will remain of low severity within the Regional context. Reclamation will result in an overall long-term increase in wetlands.

Hypothesis 17 ***Air emissions from the Suncor operation could have an impact on vegetation and soils, as well as aquatic environments.***

Assessment: Significant reductions in Suncor's SO_2 emissions will reduce potential effects to soils, vegetation and aquatic habitats in the area.

5.3 DISCUSSION OF ASSESSMENT

Development and operation of the Steepbank Mine will create changes to terrestrial resources within the Local Study Area. Below is a brief discussion of those anticipated changes, and the measures Suncor will implement to minimize the impacts which could occur.

Figure E5.0-4 illustrates the linkages between mine development and operations and the ultimate reclamation of terrestrial resources. Direct effects on terrestrial resources will result from mine preparation and facility construction, associated surface disturbances, mine dewatering and mining operations. Vegetation and soils may also be affected indirectly by air emissions from plant operation.

Table E5.0-2 presents data showing the net vegetation balance for the Lease 86/17 and Steepbank Mine project. The data illustrates that as the mine advances on the east side of the Athabasca River, reclamation is proceeding on Lease 86/17. By 2020, the mine will be advanced to its maximum extent. At that time, almost 2,000 ha of peatlands will be disturbed, almost 700 ha of closed deciduous forest will be affected, and about 200 ha each of closed jack pine and closed white spruce will be lost. The long term reclamation objective is to restore the disturbed landscapes to a level of biodiversity and biological productivity equivalent to natural conditions. Over the long-term, vegetation associations will be re-established on the disturbed areas, with somewhat more closed deciduous and mixedwood forests than existing conditions, somewhat less peatland, and significantly less disturbed area than the Baseline (1995), reflecting the reclamation of Lease 86/17.

Table E5.0-3 presents data which illustrates the vegetation impacts associated with Suncor's Steepbank Mine development in the context of other activities within the Regional Study Area.

To the extent possible, the mine and facilities design has attempted to minimize terrestrial impacts. The Steepbank River will be avoided, with no disturbance to the Steepbank's valley and escarpment slopes. The mine plan minimizes the extent of disturbance at any one time, and maximizes the opportunities for effective reclamation after mining is complete. Facilities will be set back from the Athabasca River wherever possible so that a vegetation buffer can be maintained.

TABLE E5.0-2 LOCAL STUDY AREA VEGETATION BALANCE

ELC Vegetation/Landuse Class	Total Coverage Area (ha)				Longterm	
	1995	2001	2010	2020	Area (ha)	% of 1995
Closed Jack Pine	2760	2701	2581	2536	2532	92
Closed White Spruce	3443	3408	3295	3265	3259	95
Closed Deciduous Forest	5778	5643	5184	5105	6225	108
Closed Mixedwood	2622	2807	2862	3188	5240	200
Closed Mixed Coniferous, Black Spruce Dominant	1440	1420	1355	1329	1328	92
Peatland: Closed Black Spruce Bog	2995	2952	2808	2604	2597	87
Peatland: Black Spruce-Tamarack Fen	3453	3430	3165	2626	2615	76
Closed Mixedwood, White Spruce Dominant	845	825	1012	1200	2804	332
Peatland: Open Black Spruce Bog	6032	6008	5873	5277	5263	87
Peatland: Open Tamarack Fen	2109	2098	2097	2085	2085	99
Wetland Closed Shrub Complex	2673	2640	2539	2586	2881	108
Wetland Open Water - Emergent Vegetation Zone	1345	1345	1333	1313	1767	131
Disturbed/Herb, Grasses	2071	2325	2745	3865	1342	65
Sparsely-Vegetated: Natural	283	283	283	283	283	100
Sparsely-Vegetated: Lease 86/17	1765	1498	1396	386	0	0
Sparsely-Vegetated: Steepbank Mine	0	232	588	1562	0	0
Industrial Open Water	607	606	1105	1011	0	0
Total Area	**40221**	**40221**	**40221**	**40221**	**40221**	**100**

TABLE E5.0-3 CUMULATIVE VEGETATION IMPACT ASSESSMENT, YEAR 2020 RELATIVE TO 1995 BASELINE

ELC Vegetation/Landuse Class	Total Coverage Area (ha)			Syncrude		ALPAC &	Cumulative	Percentage
	1995 Baseline	2020	Suncor	Mildred L/Aurora	Solv-Ex	NORTHLANDS[a]	Loss/Gain (ha)	of 1995 Baseline
Closed Jack Pine	29119	26551	-224	-587	-26	-1731	-2568	-9
Closed White Spruce	43728	23151	-178	349	-3	-20745	-20577	-47
Closed Deciduous Forest	78738	95640	-673	-2266	-32	19873	16902	21
Closed Mixedwood	62530	60383	566	-183	-3	-2527	-2147	-3
Closed Mixed Coniferous, Black Spruce Dominant	86949	82409	-111	-3750	0	-679	-4540	-5
Peatland: Closed Black Spruce Bog	42494	38513	-391	-2771	-190	-629	-3981	-9
Peatland: Black Spruce-Tamarack Fen	50720	48882	-827	-1011	0	0	-1838	-4
Closed Mixedwood, White Spruce Dominant	129594	110858	355	-1895	-3	-17193	-18736	-14
Peatland: Open Black Spruce Bog	80554	79030	-755	-769	0	0	-1524	-2
Peatland: Open Tamarack Fen	57951	57315	-24	-575	-37	0	-636	-1
Peatland: Shrub Dominated Fen/Patterned Fen	58751	53654	0	-5097	0	0	-5097	-9
Wetland Closed Shrub Complex	214209	209657	-87	-4465	0	0	-4552	-2
Disturbed/Herb, Grass and Crop Tree Regeneration	18073	54477	1794	10684	295	23631	36404	201
Industrial/Sparsely-Vegetated [b]	10387	23394	587	12421	-1	0	13007	125
Wetland Open Water - Emergent Vegetation Zone	13502	13384	-32	-85	0	0	-117	-1
Urban Areas	2109	2109	0	0	0	0	0	0
Net Total Area	979408	979407	0	0	0	0	0	n/a

[a] Areas Harvested by ALPAC and Northlands return rapidly to a forest cover type, however, to qualify for a forest cover type, crown closure was set at 70%, which takes decades for seedlings to achieve.

[b] Includes industrial areas and tailings ponds.

During construction and operational phases of the Steepbank Mine, terrestrial impacts will be minimized through implementation of erosion control measures, winter construction of sections of the west overburden dump, and where possible, direct placement of salvaged soils onto reclamation sites.

Despite design and operational mitigations, surface mining of oil sands will create terrain impacts. Suncor will restore disturbed areas to biologically diverse and productive landscapes through the application of dry landscape reclamation technology for both the area to be disturbed by the Steepbank Mine, as well as areas previously disturbed on Lease 86/17. This includes reclamation of existing tailings ponds. A major advance in reclamation technology has been the development of the Consolidated Tailings technology, which will allow the mined areas to be reclaimed to "dry" landscapes capable of supporting a wide variety of end land uses. These "dry" landscapes allow for a mixture of meadow/forest and wetlands areas, in contrast to an alternative reclamation strategy of developing water-capped fine tails ponds. As well, drainage patterns will be re-established, and flows adjusted into the Shipyard Lake wetlands to maintain its habitat values. Section D 3.0, presented earlier in this application, discusses the plans for reclamation of the existing Lease 86/17 and the Steepbank Mine site.

5.3.1 VEC Analysis

The Athabasca River and Steepbank River valleys were selected for a focused investigation of impacts because of the area's special status within the Integrated Resource Plan (Alberta Environmental Protection 1995). The landforms comprising the river valleys - riparian floodplain, floodplain terraces and riparian escarpments - were all identified as Valued Ecosystem Components (VECs) (Figure E5.0-3). In addition to landforms, a number of vegetation types were also selected as VECs because they contained individual species of special interest (e.g., species such as blueberry and alder which are important for traditional use), were highly diverse, rare, or possessed other significant characteristics. Vegetation types selected as VECs are:

- mature white spruce forests,
- mature balsam poplar forests,
- jack pine-lichen communities, and
- riparian wetlands.

Mine development will impact about 1,600 ha of the Athabasca Valley landforms which have been identified as VECs. This is about 20% of the landform type that occurs within the Local Study Area. The impact is considered of long-term duration because landforms are not fully restorable. They will be replaced by overburden dykes which will be revegetated as part of the reclamation program.

VEC vegetation types are also affected. Within the Local Study Area, 180 Ha (5%) of the mature white spruce forests will be impacted. Throughout the Regional Study Area, approximately 50% of closed white spruce forests will be harvested as part of forestry operations. About 160 ha (26% within the Local Study Area) of jack pine-lichen communities will be impacted by mine development. Within the Region, cumulative effects of all industries on closed jack pine will be approximately 2600 ha (9%). The remaining two vegetation VECs, mature balsam poplar forests and riparian wetlands, will be affected to a moderate degree within the Local Study Area (comparable data are not available on a Regional basis). Approximately 10 ha (7%) of balsam poplar forest will be lost, and 47 ha (6%) of riparian wetlands will be affected, mostly associated with the development of the west overburden dump near Shipyard Lake (Figure E5.0-6). Reclamation will restore a diversity of vegetation types (Figure E5.0-7), although mature forests and riparian wetlands will not be restored within 30 years of mine closure, hence the effects are considered long-term.

Landscape reclamation will mitigate river valley and escarpment disturbance by providing a variety of reclaimed landscape types and a variety of vegetation successional types. Future land use options will increase following completion of mining activities and progression of reclamation. Specifically, the long-term replacement and overall increase in the cover of mixedwood, mixedwood white spruce dominant, wetlands closed shrub and wetland open water/emergent vegetation habitats is considered to be a net benefit. These vegetation communities are of high habitat importance to many wildlife species, and the forestry types have a high economic potential.

5.3.2 Visual Impacts

The visual integrity of the Athabasca River, as viewed by travellers along the river, is one of the Integrated Resource Plan's concerns (Alberta Environmental Protection 1995). By retaining treed buffers and setting facilities back from the river shore, the visual impact of the mine infrastructure -- buildings, roads and equipment -- will be minimized. The structures (e.g., buildings) will be relocated out of the river valley by 2030, and will no longer be visible from the river. Dykes and other earthworks will have a somewhat longer term impact, although once revegetated will appear as part of the natural landscape to most observers. The bridge will be the most noticeable visual effect to most observers however, because it is not unique along the river and is adjacent to a pre-existing industrial facility its visual effect is of moderate severity.

5.3.3 Biodiversity

Biodiversity was investigated at three levels: landscape biodiversity, vegetation community types and species biodiversity.

At the landscape level, the Athabasca Valley landforms - floodplain, terraces and escarpment - and the uplands were considered to have high landscape diversity. Impacts to the Athabasca Valley landforms from mine development will be about 20% or less. Over the course of mine development, 1 700 hectares of the upland landform will be lost, which is about 10% of this landform within the Local Study Area.

At the community level, consideration of biodiversity focused on vegetation communities that were uncommon or possessed important ecological characteristics. Mature white spruce and balsam poplar forests, open water and closed shrub wetlands and tamarack fens were identified. Mine development will result in a loss of 5% of the mature white spruce forests, 7% loss of mature balsam poplar forests and impacts to 6% of riparian wetlands. All are considered to be of low concern within the Local Study Area.

At a species level, concerns relate to impacts to communities that have a moderate to high potential for rare or uncommon plants. Habitats with a high rare plant potential are black spruce bogs, tamarack fens, jack pine forests and open water/emergent vegetation wetlands and the riparian marsh edges of wetland closed shrub complex. At a species level within the Local Study Area, the black spruce-tamarack fen will be reduced by about 23% (4% loss regionally), and the closed black spruce bog reduced by about 12%. Within the context of the Regional Study Area, cumulative effects to closed black spruce will be about 2%.

Almost 1,800 hectares of the Steepbank Mine project's footprint will occur in the upland or along the riparian escarpment. As peatlands cover more than half (52%) of these landforms, the corresponding loss to wetlands is relatively high. In particular, the relative loss of closed black spruce bog and black spruce-tamarack fen is 24% of those types within the Local Study Area. This relates to a loss of 2% of these peatland types within the Regional Study Area. These impacts are considered long term because restoration will not occur within 30 years of mine closure.

Within the Local Study Area, the wetland closed shrub and wetland open water/emergent vegetation types are most widespread on the riparian floodplain. Within the Local Study Area, Steepbank Mine development will account for a 3% loss of these wetland types. This is negligible in the context of the Regional Study Area. Mitigations to reduce impacts to wetlands in the Athabasca River valley have included reducing the encroachment of the overburden dump onto the Shipyard Lake wetlands.

5.3.4 Effects of Air Emissions

Observations of vegetation in the Regional Study Area have reported localized impacts to vegetation, primarily in the Athabasca River valley in proximity to the oil sands plants. Although there is no clearly quantified causal relationship between pattern and concentrations of SO_2 emissions and the vegetation condition, SO_2 emissions from the Suncor and Syncrude oil sands plants are implicated. The changing air emission scenario for Suncor (see Section E9.0, Air Quality) will significantly reduce ambient air concentrations of SO_2, and is expected to reduce the potential for further impacts to vegetation.

Impacts to soils from acidification have not been reported in monitoring programs in the region.

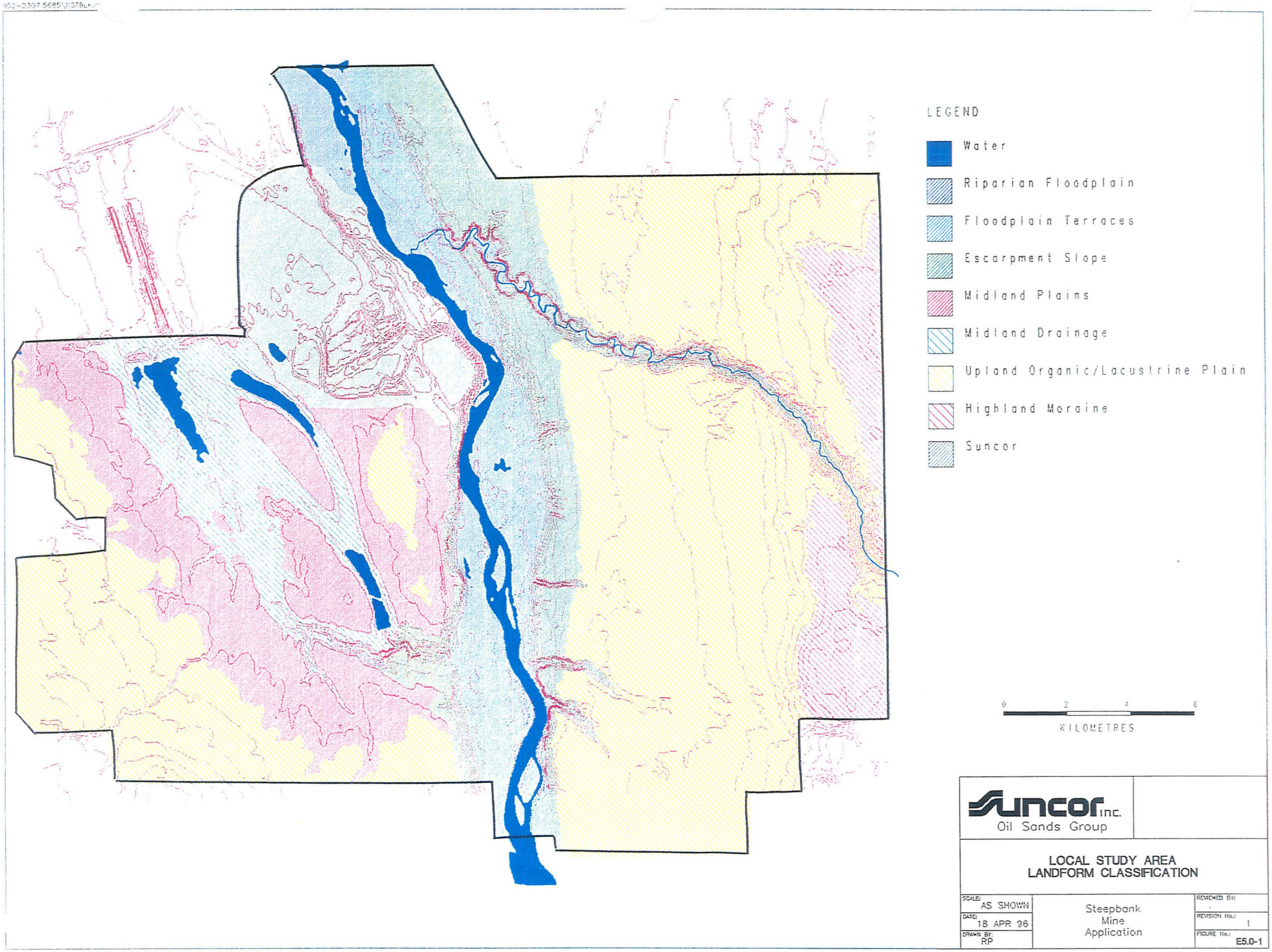
5.4 ENVIRONMENTAL MONITORING

As part of the ongoing environmental management of the Suncor operation, monitoring of progress of reclamation throughout the life of the project will be conducted. The intent of the monitoring program is to continue the development of reclamation techniques to maximize the potential to meet a variety of end land use objectives. Air quality effects to vegetation will be addressed by the Regional Air Quality Coordinating Committee, with Suncor's cooperation.

The terrestrial monitoring program will be designed in conjunction with the wildlife habitat monitoring program as part of a series of follow-on programs that Suncor will conduct throughout the life of the project.

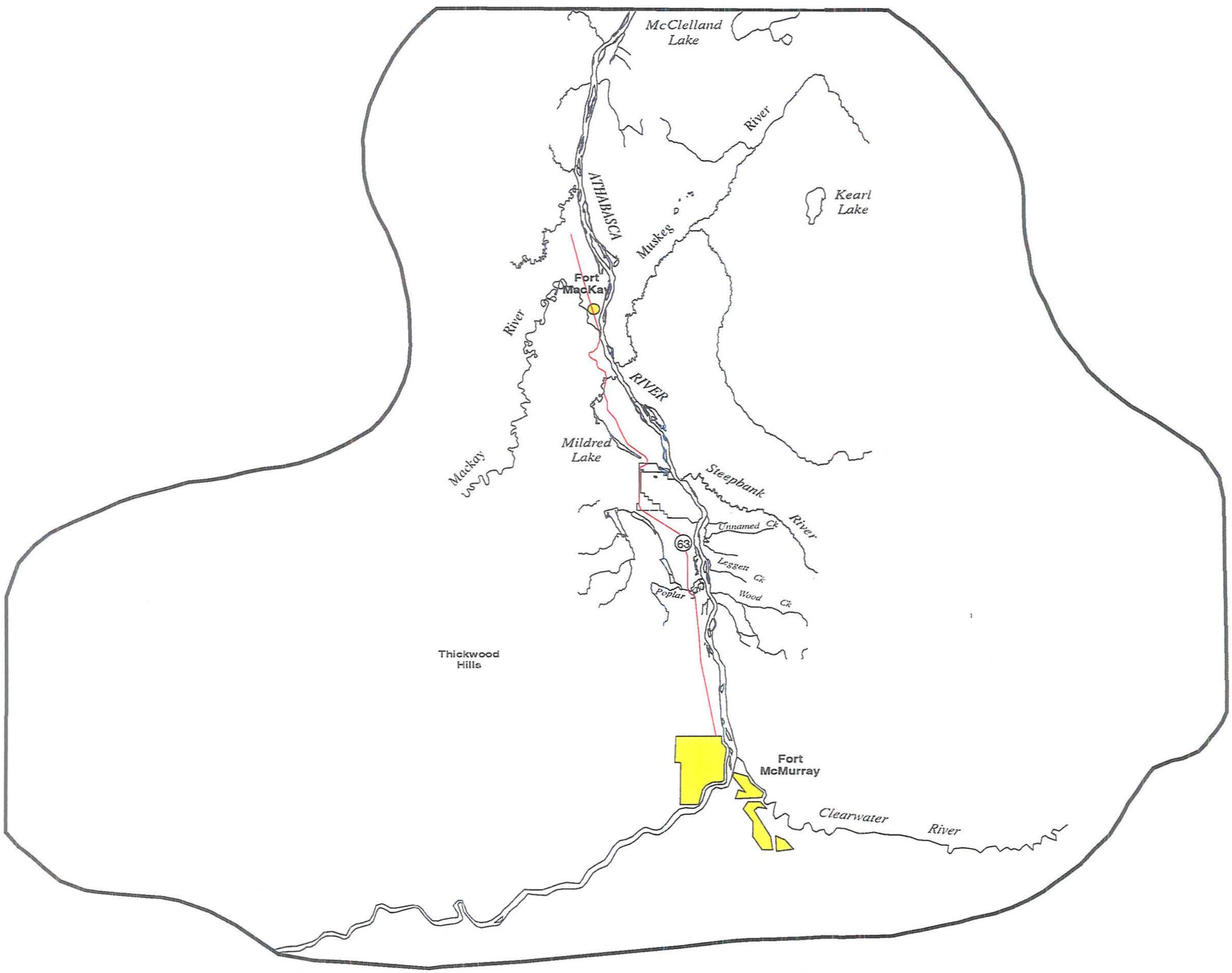
FIGURES SECTION E5.0

FIGURES

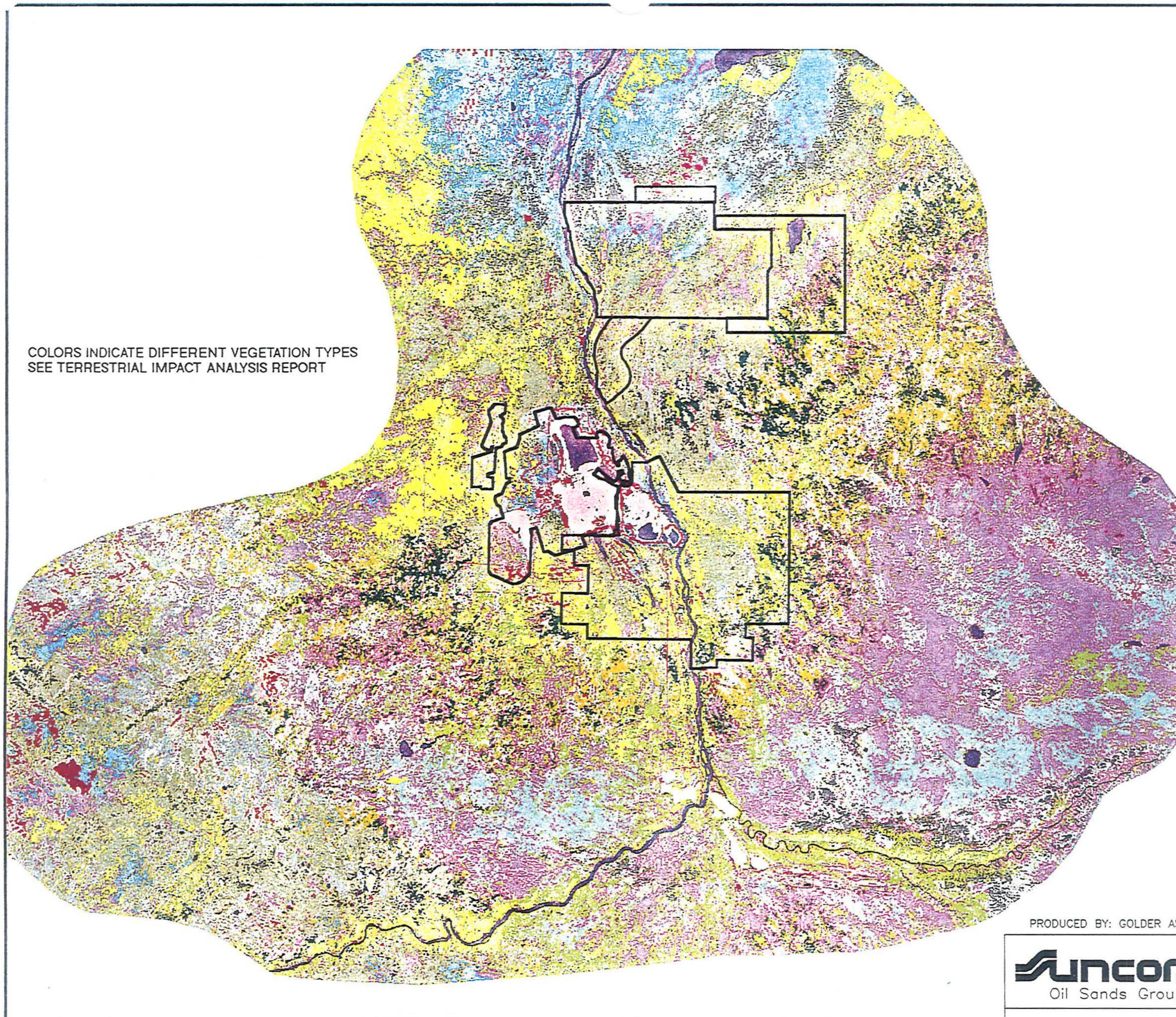


952-2307.5685\LSTBLK
LEGEND
Water
Riparian Floodplain
Floodplain Terraces
Escarpment Slope
Midland Plains
Midland Drainage
Upland Organic/Lacustrine Plain
Highland Moraine
Suncor
0 2 4 6
KILOMETRES
Suncor inc.
Oil Sands Group
LOCAL STUDY AREA
LANDFORM CLASSIFICATION
SCALE: AS SHOWN
DATE: 18 APR 96
DRAWN BY: RP
Steepbank Mine Application
REVIEWED BY:
REVISION No.: 1
FIGURE No.: E5.0-1

Figure E5.0-1



Basemap Guide to Regional Study Area



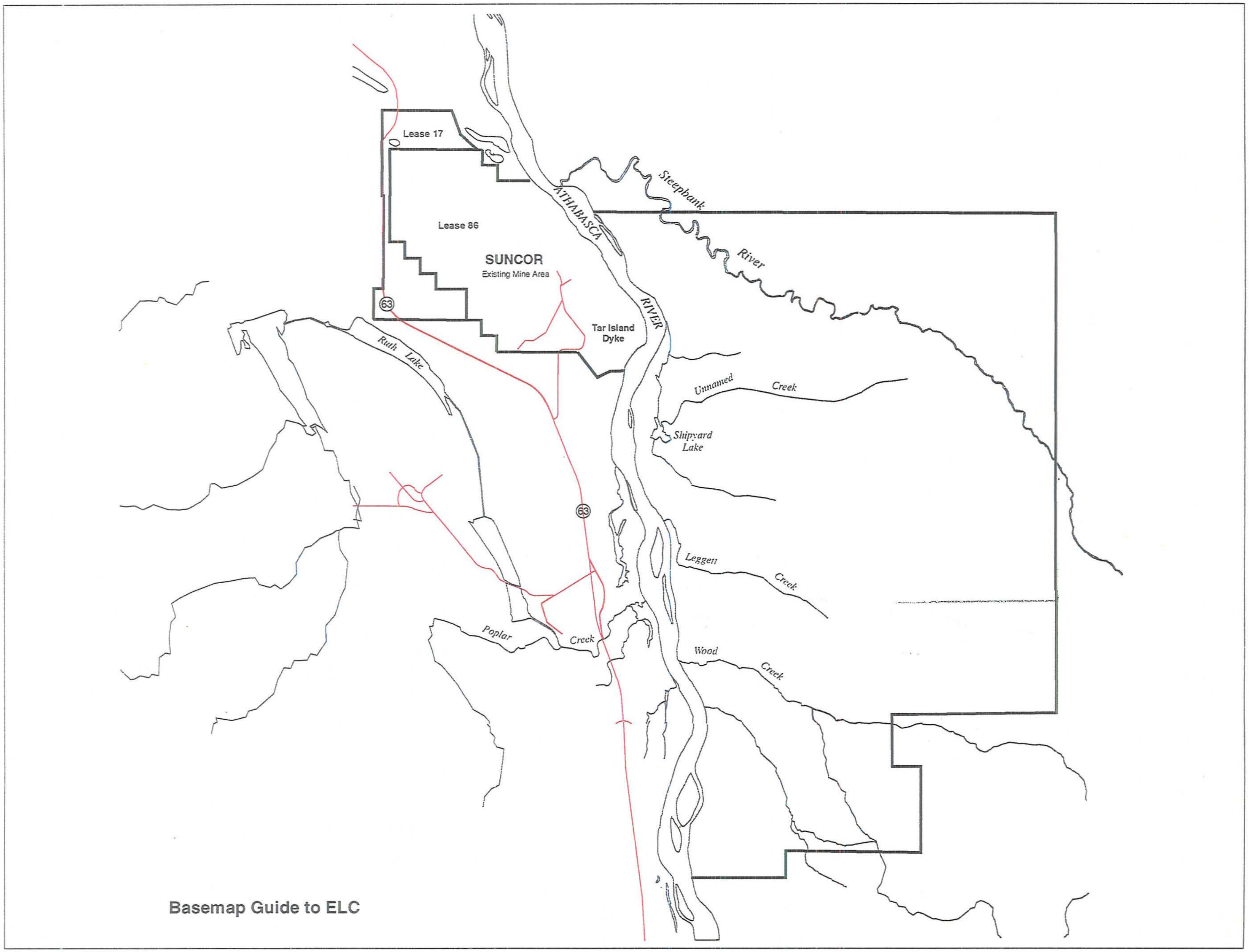
PROJECTION: UTM
PRODUCED BY: GOLDER ASSOCIATES LTD. FOR SUNCOR INC.

Suncor Inc.
Oil Sands Group

VEGETATION DISTRIBUTION,
SUNCOR REGIONAL STUDY AREA, 1995

SCALE: AS SHOWN	Steepbank Mine Application	REVIEWED BY: -
DATE: 18 APR 96		REVISION No.: 1
DRAWN BY: KS/RK		FIGURE No.: E5.0-2

Figure E5.0-2



Basemap Guide to ELC

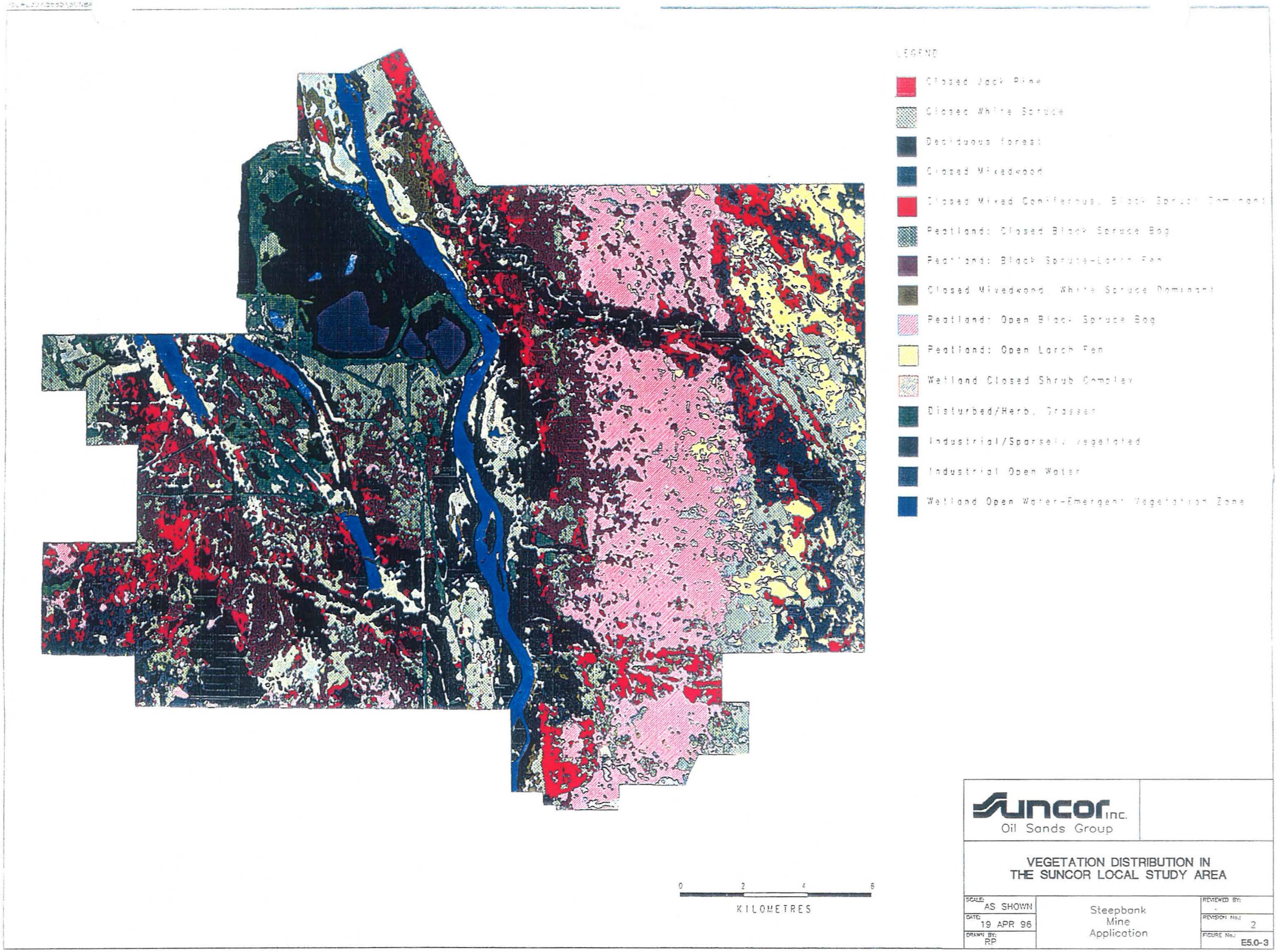

LEGEND
Closed Jack Pine
Closed White Spruce
Deciduous Forest
Closed Mixedwood
Closed Mixed Coniferous, Black Spruce Dominant
Peatland: Closed Black Spruce Bog
Peatland: Black Spruce-Larch Fen
Closed Mixedwood, White Spruce Dominant
Peatland: Open Black Spruce Bog
Peatland: Open Larch Fen
Wetland Closed Shrub Complex
Disturbed/Herb. Grasses
Industrial/Sparsely Vegetated
Industrial Open Water
Wetland Open Water-Emergent Vegetation Zone
0 2 4 6
KILOMETRES
Suncor Inc.
Oil Sands Group
VEGETATION DISTRIBUTION IN THE SUNCOR LOCAL STUDY AREA
SCALE: AS SHOWN
DATE: 19 APR 96
DRAWN BY: RP
Steepbank Mine Application
REVIEWED BY:
REVISION No.: 2
FIGURE No.: E5.0-3

Figure E5.0-3

OVERVIEW OF STEEPBANK MINE INTERACTION WITH TERRESTRIAL RESOURCES

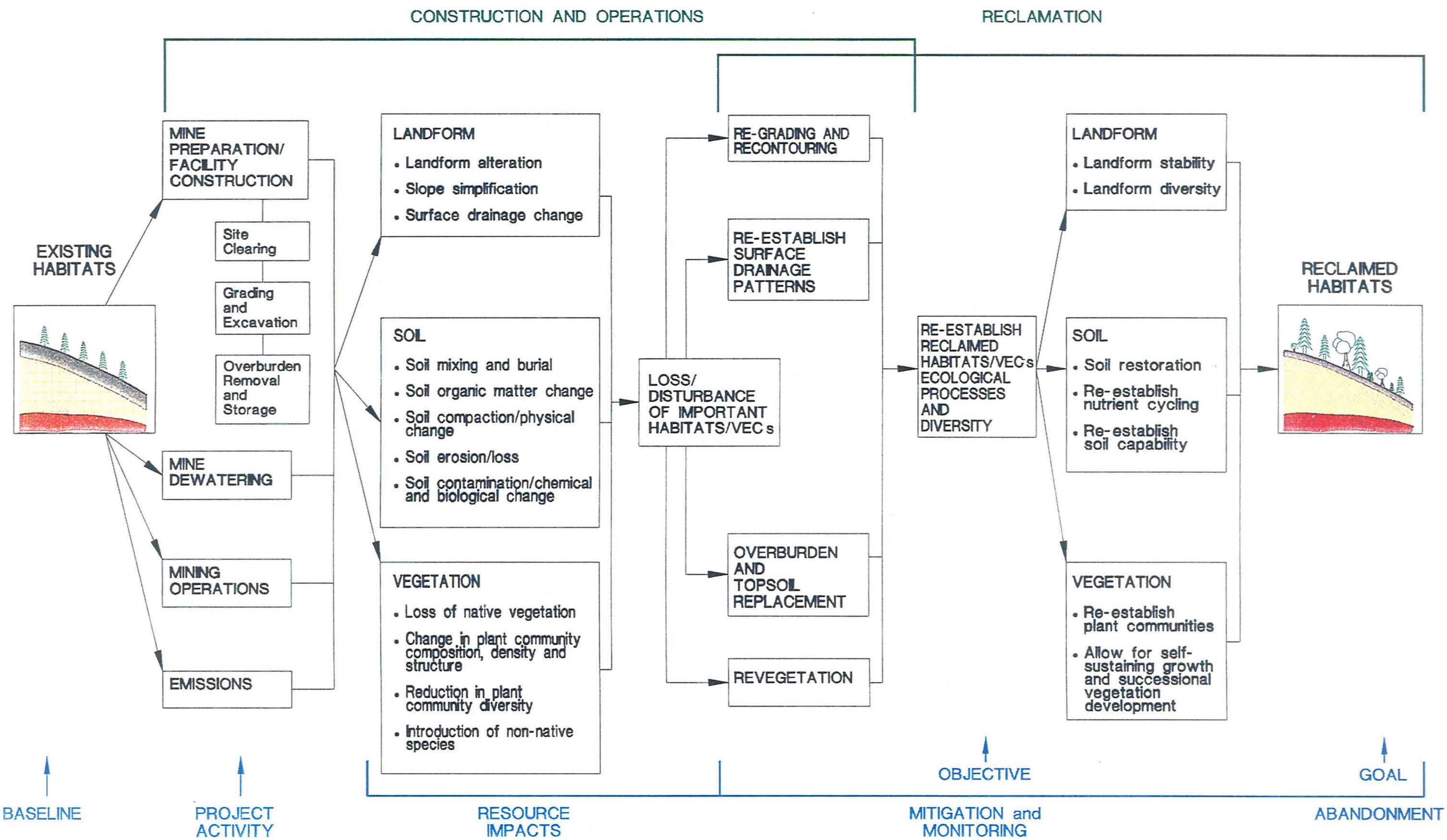


Figure E5.0-4

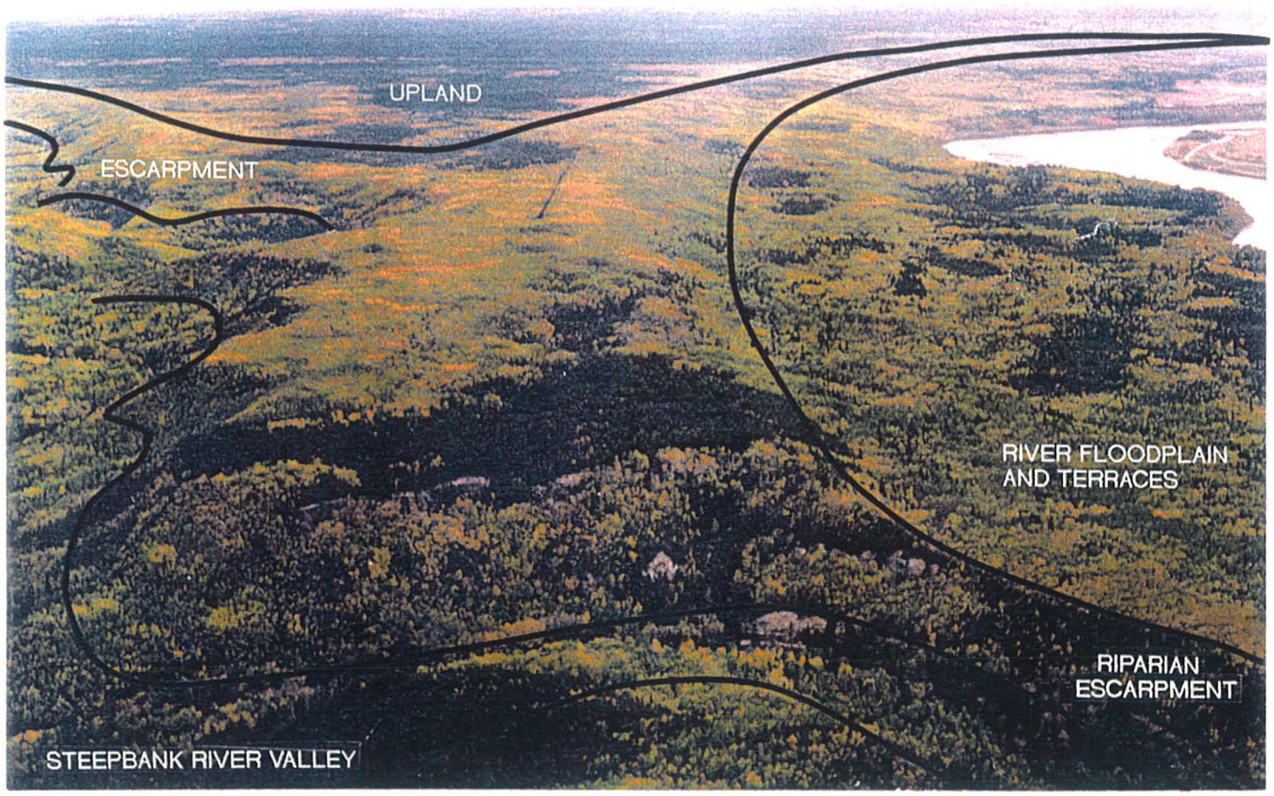
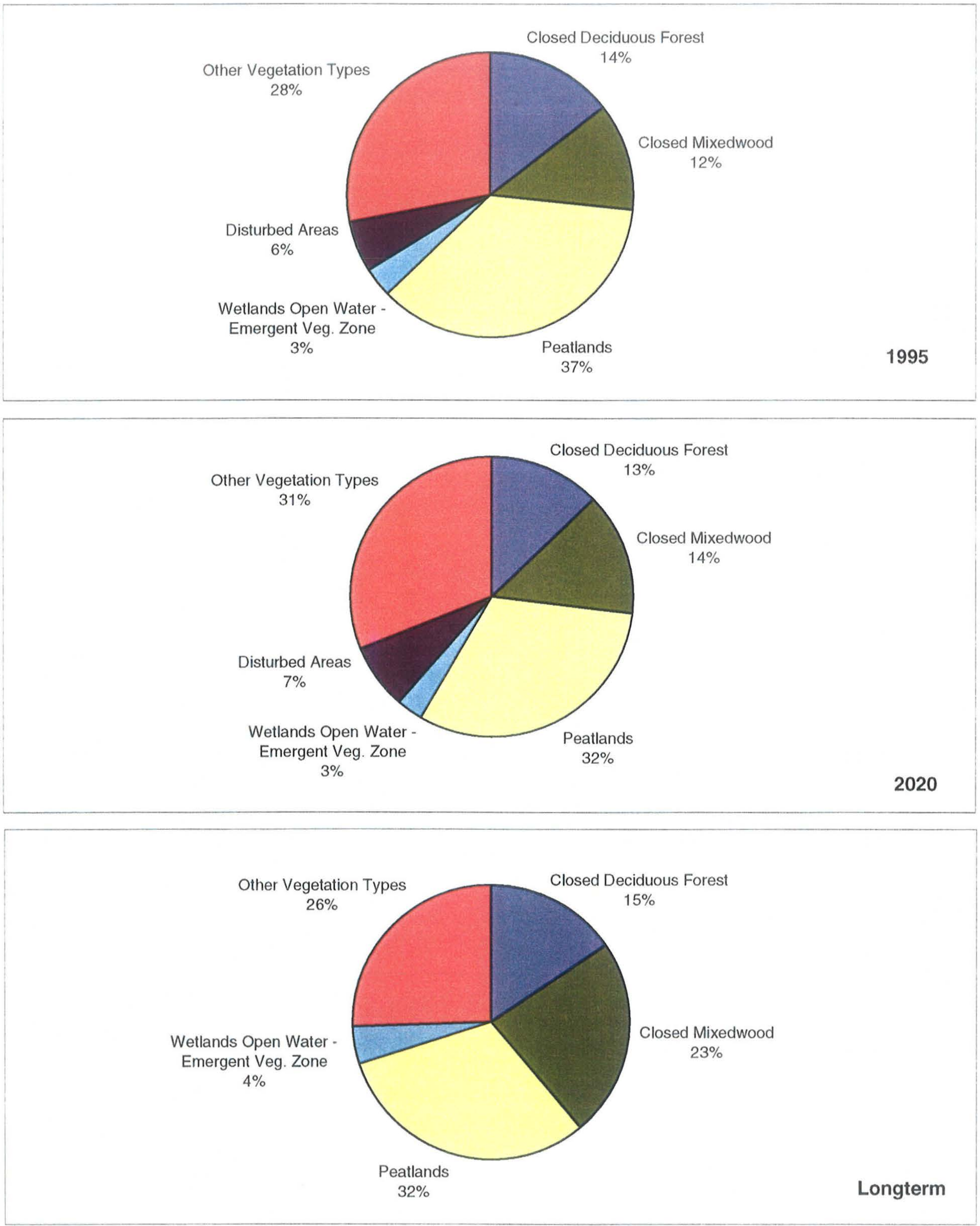


Figure E5.0-5 Aerial view looking south over the Steepbank Mine development project area with landform units defined.

Figure E5.0-6 Shipyard Lake, a riparian wetland in the Athabasca River floodplain. Tar Island Dyke is visible in the upper left hand corner.

Figure E5.0-7 Change In Vegetation Distribution Within The Local Study Area



6.0 WILDLIFE ASSESSMENT

6.1 BASELINE CONDITIONS

The Regional and Local Study Areas provide a wide variety of habitats for wildlife, reflecting a diversity of landforms, vegetation types and successional stages. To undertake an investigation of the project's effects on every wildlife species found in the study area would have been too cumbersome. Therefore, the assessment focused on eight species groups:

- ungulates - moose;
- large carnivores - black bear and wolf;
- terrestrial furbearers - lynx, marten, fisher, wolverine;
- semi-aquatic furbearers - beaver and river otter;
- small herbivores - snowshoe hare and red-backed voles;
- raptors - osprey, bald eagle, great gray owl;
- terrestrial birds - ruffed grouse, songbirds; and
- waterfowl - ducks.

By examining the habitats that occur within the Local Study Area, and doing field studies to determine where the animals are found, a habitat suitability rating was developed to indicate the places that are most important for wildlife.

Moose is the principal ungulate species within the Local Study Area. White-tailed deer are present in small numbers, but woodland caribou do not presently occur in the Steepbank Mine area. Throughout the study area, the best moose habitat is found in closed deciduous forests and closed mixed-wood forests.

Large carnivores are attracted to habitats where their prey occurs, although they also have special habitat requirements for denning. Deciduous forests provide excellent habitat for black bears which are common in the Local Study Area.

Terrestrial fur-bearers have a variety of habitat requirements. Currently, there are few lynx in the Local Study Area, perhaps reflecting a low cycle in the snowshoe hare population. Lynx prefer early successional forests where they prey upon snowshoe hares, and also mature forests where denning habitat is available. Marten prefer mature coniferous forests, with a special preference in the Local Study Area for mature white spruce stands. They are generally found along the Athabasca River escarpment and in the riparian floodplain and terraces. Fisher habitat preferences are not clearly understood, however in the Local Study Area they occur most frequently in the riparian floodplains and terraces. Wolverine habitat preferences are less understood and are sparsely distributed throughout their range, and were not recorded in 1995.

Semi-aquatic furbearers - beaver and river otter-- are associated with riparian environments. In the Local Study Area about 80 active beaver colonies were recorded in 1995, with excellent or good quality beaver habitat occuring primarily on the west side of the Athabasca River. However, Shipyard Lake also provides good habitat. Results of field surveys indicate that the river otter is uncommon in drainages that would be affected by the Steepbank Mine development.

Small herbivores can be found in every habitat in the Local Study Area. For this study, two were considered -- snowshoe hare and red-backed vole. Snowshoe hares are one of the few species being studied which preferred the upland, where they are found most frequently in mixedwood and coniferous forests. They are currently at a low ebb in their population cycle, which fluctuates dramatically over a 10 year period. Red-backed voles are the most common rodent in mature forests, and appear to prefer habitats that do not have a lot of bare ground.

Raptors are hunting birds. In the Local Study Area, three species were selected as VECs: osprey, bald eagle and great gray owl. There is an active bald eagle nest near Shipyard Lake. The osprey and the bald eagle do not overwinter in the area, unlike the third raptor -- great gray owl. Its typical habitat is forested areas interspersed with bogs, muskegs or other openings. Its preferred prey is meadow voles which are found in comparatively open areas. Neither osprey or great gray owl were recorded in the Local Study Area in 1995.

Terrestrial birds have a wide variety of habitat requirements. Both the ruffed grouse, which prefer aspen forests, and terrestrial songbirds, which occur in all habitat types but reach their highest abundance and diversity in closed shrub complexes and riparian deciduous forest, were identified as VECs.

Waterfowl were surveyed throughout the Local Study Area, with the highest breeding pair density recorded in natural wetlands, followed by beaver impoundments, reservoirs, channels and rivers. Mallard were the most common, with scaup, common goldeneye and buffleheads also well represented.

6.2 SUMMARY OF ASSESSMENT

An assessment of the Steepbank Mine's potential effects to wildlife resources was focused on Impact Hypotheses (Table E2.0-2). Each of the hypotheses is discussed briefly below. A more complete discussion of the impact analysis and baseline information is available in Impact Analysis Suncor Steepbank Mine Environmental Wildlife Component (Westworth, Brusnyk and Associates, 1996e) as well as a series of background reports (Figure E2.0-2).

Hypothesis 18 ***Mine development will result in changes in the availability and quality of wildlife habitat that will bring about a reduction in wildlife populations.***

Assessment : The impact of Steepbank Mine development is expected to be low for a number of wildlife VECs, including black bear, snowshoe hare, red-backed vole, beaver and terrestrial songbirds. Impacts will be low for moose and wolves during the construction phase, but moderate during operations. Impacts to lynx, fisher, marten, bald eagle and ruffed grouse will be low to moderate for most of the life of the project. After mine closure, impacts will be negligible for most species, with a net habitat gain for moose, black bear, beaver and, after coniferous forests become re-established, for marten, as well.

Hypothesis 19 ***Disturbance associated with mechanical noise and human activity may result in reduced abundance of wildlife.***

Assessment: For most wildlife VECs, the impacts relating to sensory disturbance are expected to be low. Impacts may be higher for wolf, lynx and wolverine. No information is available which allows an assessment for fisher, marten, great gray owl, and ruffed grouse. After mine closure there will be no sensory disturbance.

Hypothesis 20 ***Direct mortality of wildlife caused by mine development could result in reduced abundance of wildlife.***

Assessment: Direct mortality to all wildlife species during mine development, operations and closure will be low to negligible.

Hypothesis 21 ***Mine development will disrupt the movement patterns of wildlife in the vicinity of the Steepbank Mine, thereby reducing access to important habitat or interfering with population mechanisms, resulting in decreased abundance of wildlife.***

Assessment: Mine development and operation will affect movement of the larger terrestrial wildlife species (i.e., moose, black bear, wolf, lynx, fisher, marten and wolverine) to a low or moderate degree within the Local Study Area. Regionally, the impact to wildlife movement will be low. After reclamation, movement will not be affected.

Hypothesis 22 ***Mine development will cause a reduction in wildlife resource use (hunting, trapping, non-consumptive recreational use).***

Assessment: Existing direct land use (i.e., two trappers) will be displaced. After mine closure and reclamation, wildlife resource use will be restored.

Hypothesis 23 ***Development of the Steepbank Mine could contribute to a loss of natural biodiversity.***

Assessment: Biodiversity within the Local Study Area will be reduced because the change in availability of habitat types could alter the relative abundance and distribution of wildlife populations. Potential impacts to special habitats and species - bald eagle, mature riparian balsam forest and natural wetlands - will also affect the Local Study Area biodiversity over the short term. The post-reclamation strategy of recreating a diversity of landscapes and vegetation types will help to restore the natural biodiversity of the area. The Steepbank Mine will have little effect on regional biodiversity.

6.3 DISCUSSION OF ASSESSMENT

6.3.1 General Background

Mine preparation and facility construction, mine dewatering and drainage alterations, and mining operations all have the potential to affect wildlife populations (Figure E6.0-1). Impact Analysis Suncor Steepbank Mine Environmental Wildlife Component (Westworth, Brusnyk and Associates 1996e) and a series of background reports (Figure E2.0-2) present a comprehensive baseline and analysis of the wildlife issues related to the project.

Effects on wildlife can result from a number of causes. The primary effect is habitat loss. Habitats can be directly impacted as a result of activities such as oil sands mining or building facilities. An animal may also be prevented from using a habitat if movement corridors are blocked by development (called habitat alienation). Sometimes, even though the habitat itself may not be destroyed, animals may not use it because they are disturbed by nearby activity. This "displacement" from the habitat is frequently difficult to predict because different species, and different individuals within a population, may react quite differently to disturbance. Finally, direct mortality can result.

Two issues that frequently result in important wildlife impacts will not be a problem. Increased access to remote wildlife populations for hunters and poachers will not result because the Suncor bridge will not provide public access to the east side of the Athabasca River. Similarly, the concentrated mine development area will not provide a linear access route which enables predator access to susceptible prey populations.

6.3.2 Habitat Losses

Direct habitat loss will result from the siting of facilities and the development of the mine. As the Steepbank Mine advances, reclamation on the existing mine site on Lease 86/17 will lead to habitat replacement. This results in a shifting balance between loss of habitat from the new mine advance, and gain of restored habitats from reclamation (Figure E6.0-2). After mine closure, all disturbed areas will be reclaimed, with the objective being to restore a diversity and quality of habitats equivalent to those existing before mine development.

Mine development and operation will result in a loss of approximately 1240 ha (15%) of good to excellent moose habitat, primarily located in the floodplain and escarpment of the Athabasca River valley.

In the long term, reclamation will result in a net increase (2800 ha) of 34% within the Local Study Area. Over the same time frame (to 2020), good to excellent moose habitat will be increased by about 10% within the Regional Study Area.

Mine development and operations will also affect terrestrial furbearers (i.e., lynx, marten, fisher, wolverine), with a loss of 2700 ha (11% within the Local Study Area) of good to excellent terrestrial furbearer habitat. Reclamation will restore (to within 3%) lost habitat.

Songbirds and grouse will experience a 15% loss (4405 ha) of good to excellent habitat during mine development and operation. Within the Regional context, approximately 5% of good to excellent breeding bird habitat will be lost. Over the long term, habitats will be restored to the 1995 baseline level in the Local Study Area.

Other wildlife species will also be affected by Steepbank Mine development. There will be a loss of about 9 beaver colonies (out of 82 in the Local Study Area), and the breeding habitat for approximately 170 pairs of ducks (out of an estimated 1800 pairs in the Local Study Area).

In the long term, following reclamation, habitats will be essentially restored for most wildlife species. Moose and ruffed grouse habitat will be enhanced during early - mid stages of reclamation. Habitat for species requiring more mature vegetation communities -- marten, for example -- will not recover until vegetation succession is more advanced. Section D of this Application provides details of the reclamation planning for Lease 86/17 and the Steepbank Mine.

6.3.3 Displacement

Displacement results when animals do not use habitats because they are disturbed by adjacent activities, or cannot access the habitat because of barriers to movement.

Development of the valley facilities for the Steepbank Mine will affect movement along the river valley and between the floodplain and the upland. It appears that there is currently limited use of the river valley for movement parallel to the river for species such as moose, with east-west movement between the floodplain and the upland more common. Movement of wide-ranging wildlife -- wolf, lynx and fisher -- likely will be most affected, with a moderate impact associated with valley facilities. However, regionally these movement impacts are expected to be of low consequence. In the long term, these effects will be negligible.

Suncor will mitigate the displacement of wildlife by centralizing activities, maximizing the set-back between the river and facilities, and installing a wildlife bypass around the bridge abutment.

6.3.4 Direct Mortality and Predation

The most significant direct mortality to wildlife populations from new developments frequently results from increased hunter access into previously remote locations. In the case of the Steepbank Mine development, increased hunter access to the east bank of the Athabasca River will not be an issue because the bridge will be closed for public access. Other causes of direct mortality will result from control of nuisance animals -- bears and beavers -- and wildlife/vehicle collisions. The Steepbank Mine project will increase employee numbers marginally, although the number of private vehicles will be minimized because workers are encouraged to use bus transportation. The project will result in a slight increase in highway traffic and negligible increases in wildlife highway mortality. There will be some losses to wildlife during clearing operations. There is also a concern that tailings ponds will result in direct mortality of some waterfowl, although the use of dry landscape reclamation will reduce this problem in comparison to conventional tailings ponds.

The project is unlikely to result in increased predation to vulnerable populations because it is not a linear development which will provide access to new hunting opportunities. In fact, predator populations are frequently more sensitive to human activities, and therefore developments may afford some reduction in predation pressure to prey species.

6.3.5 Species Impact Summary

The development of the Steepbank Mine affects different species of animals differently. Habitat changes that may be negative for one species, may be positive for another. The following discussion presents some of the key Impact Analysis findings.

During the construction and operations phases of the Steepbank Mine, there will be a loss of approximately 15% of the good to excellent moose habitat in the Local Study Area. Approximately 15 - 20 moose will be displaced, from a population of approximately 75 moose in the Local Study Area. In the long term, however, relocation of the Steepbank Mine facilities from the Athabasca River valley, reclamation of Lease 86/17 and reclamation of the Steepbank Mine will result in an overall increase in moose habitat relative to 1995 conditions.

In the Local Study Area, the loss of deciduous habitat for the Steepbank Mine will have a low effect on black bear, which is abundant in the Fort McMurray area. In the long term, however, an increase in deciduous and mixedwood forest after reclamation will enhance habitat suitability for this species. In contrast, wolf will be more affected, partly as a result of a possible decline in the number of moose, their principal prey, and the potential for increased human activity which may displace wolves from important habitat types. In the long term increased moose habitat should benefit wolf populations.

Both the snowshoe hare and red-backed vole will be affected by habitat loss. However, since both species are widespread throughout the Local and Regional Study Areas and due to their ability for quick population recovery with habitat reclamation, the overall impact on these species will be low.

Impacts to terrestrial furbearers vary because of species' different habitat requirements. Lynx could be affected by the loss of potential denning habitat in riparian deciduous forests and the potential for displacement because of increased human activity. Since lynx prefer mature forests for denning, habitats for lynx will take somewhat longer to become re-established than early successional habitats preferred by an number of other species. Marten are associated with mature white spruce forests in riparian and escarpment landscape features, some of which will be lost as a result of mine development. As with lynx, marten prefer late successional stage habitats, and habitat quality will require a number of decades to become fully restored. Fisher will be affected primarily by loss of habitat, although mine dewatering and drainage alterations could also disrupt movement patterns and home ranges, which are often aligned with streams and rivers. After mine closure, drainage courses will be recreated, restoring previous levels of habitat suitability. Although there is concern about the effects of the proposed mine on wolverine populations, information about wolverine abundance and ecology in the Steepbank Mine area is not sufficient to allow an accurate evaluation of impacts.

It has been estimated that development of the Steepbank Mine will result in the loss of approximately nine beaver colonies. In addition, beaver populations within the mine area will likely be controlled in the future to prevent flooding of facilities. In the long-term, after closure, the increased availability of aspen poplar, a preferred forage species, will likely increase habitat suitability for this species. Otters are uncommon in the Steepbank Mine area and there is little evidence that they are normally present in the area that will be affected by the proposed development. However, alteration of drainage patterns due to mine dewatering could affect dispersal and overland movements by this species until drainage patterns are re-established through reclamation.

There is a potential for bald eagle abandonment of the nest near Shipyard Lake, either through habitat alienation or sensory disturbance. This nest has been active for only one year (1995) and it is unknown if the birds will return. The principal source of concern for the great gray owl is that mining operations will reduce the amount of area covered by open tamarack forest, important foraging habitat for this species. Because the reclamation program will establish upland forest types, this would result in the permanent loss of some tamarack forest and reduced habitat availability for the great gray owl.

Ruffed grouse will be affected by the loss of approximately 600 ha of deciduous forest, which is the principal habitat type for this species during all of its life phases. Songbirds will be affected by habitat removal. After reclamation, habitats for both species will be restored.

There is a potential loss of breeding habitat for approximately 170 pairs of ducks, out of a population of approximately 1800 pairs as a result of mining operations. Wetlands developed on the reclaimed landscapes will restore nesting habitats. The adoption of the dry landscape approach to reclamation mitigates future concerns about waterfowl mortality related to the existing tailings ponds.

6.4 MONITORING

Suncor will continue to record observations of wildlife within the lease areas, including use of reclaimed areas to support further development of reclamation plans.

FIGURES SECTION E6.0

FIGURES

OVERVIEW OF STEEPBANK MINE INTERACTION
WITH WILDLIFE RESOURCES

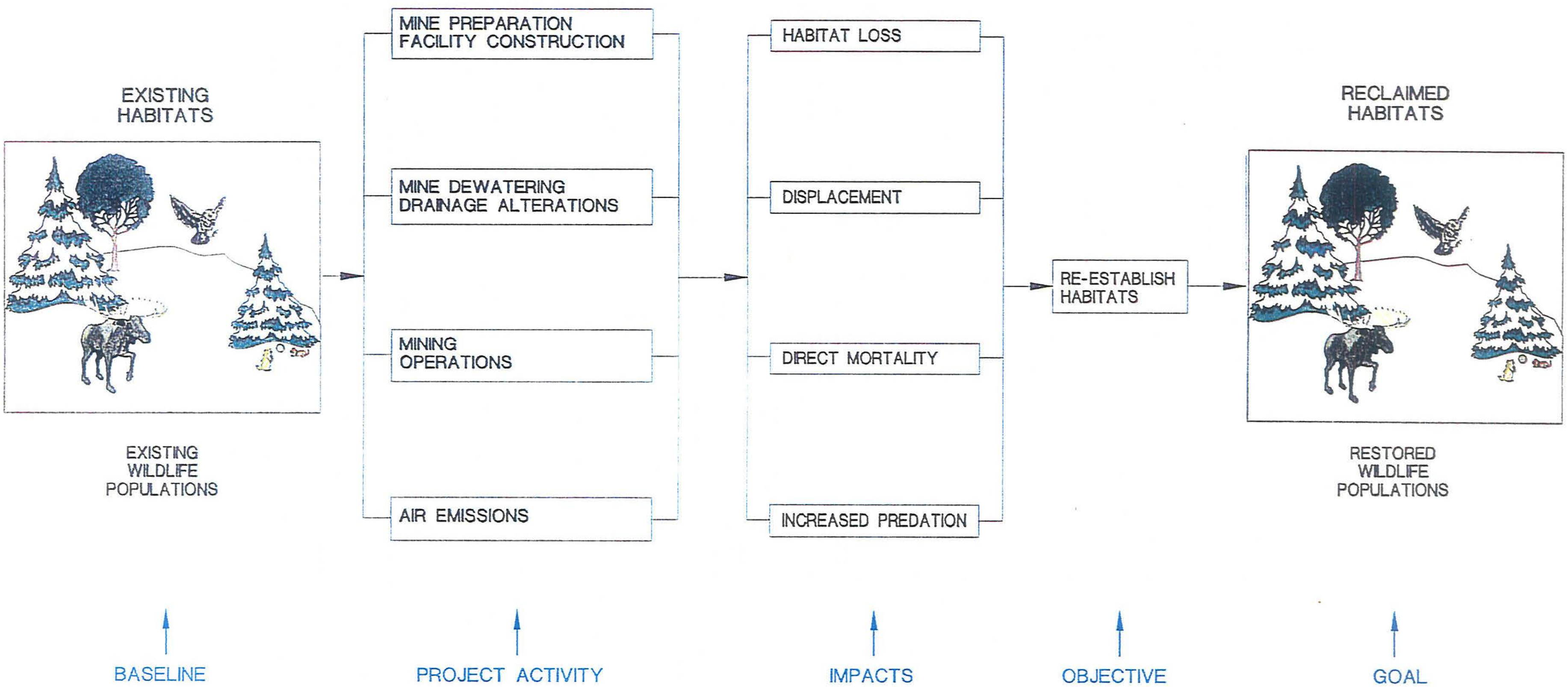
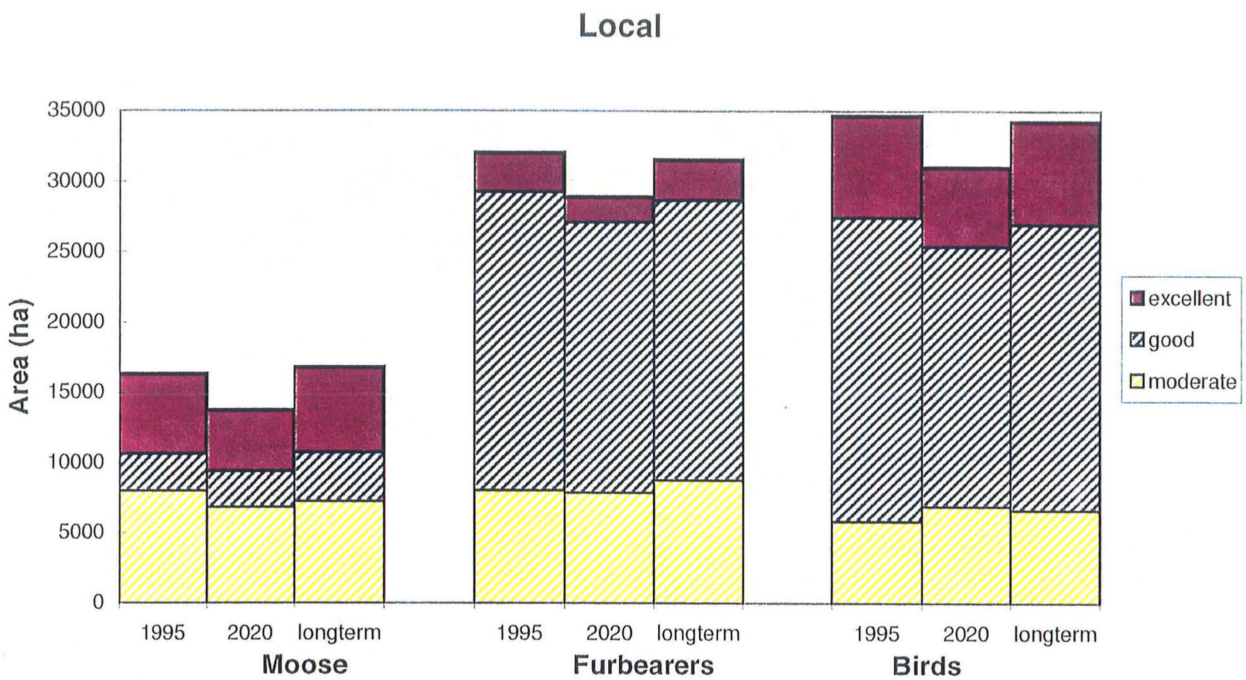


Figure E6.0-1

Wildlife Habitat Changes in Local and Regional Study Areas



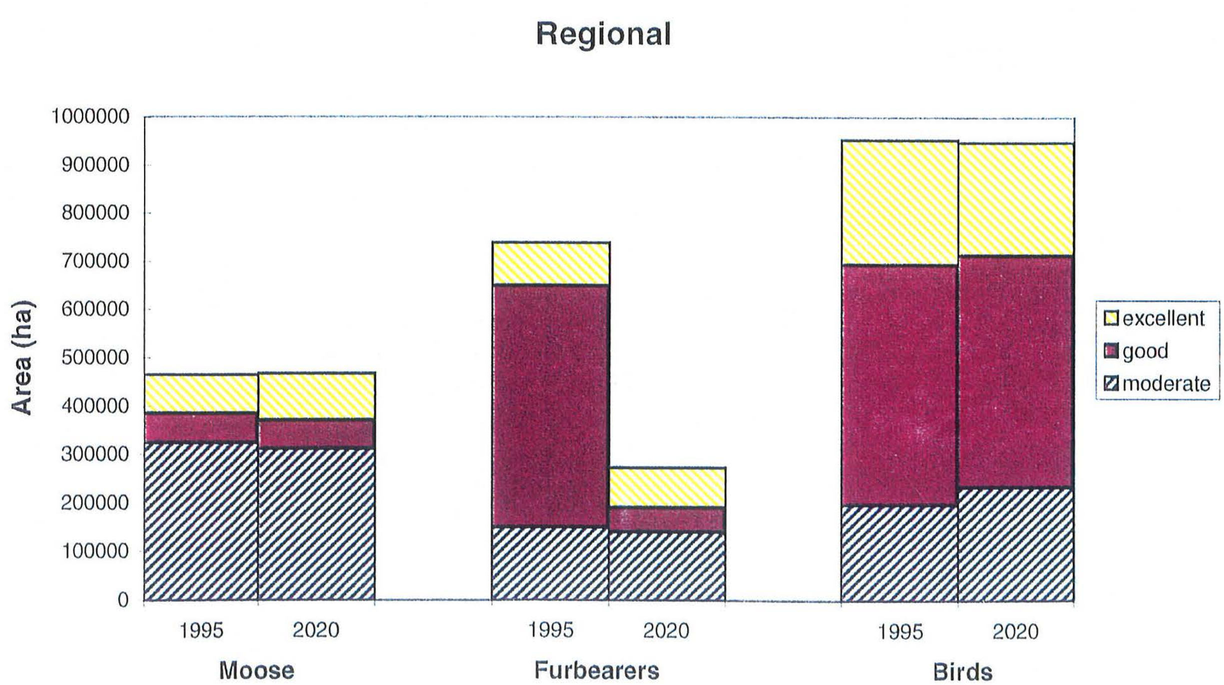


Figure E6.0-2

7.0 SURFACE AND GROUNDWATER ASSESSMENT

7.1 BASELINE CONDITION

The major surface water courses in the vicinity of the proposed Steepbank Mine are the Athabasca and Steepbank Rivers. Smaller watercourses in the area include Wood, Leggett, McLean and Unnamed Creeks. Shipyard Lake is a permanent wetlands located on the Athabasca River floodplain (see Figure E7.0-1).

In the Local Study Area, the major aquifers through which groundwater flows are the surficial sand and gravel deposits, and the Basal Aquifer and Upper Devonian limestone in the bedrock. The primary direction of groundwater flow is toward the Athabasca River. The rate of groundwater flow is very low in comparison to the flows in the nearby surface waters. As shown in Table E7.0-1, the total groundwater discharge from the mine area is less than 1% of the flow in the Athabasca and Steepbank Rivers, and Shipyard Lake.

TABLE E7.0-1

COMPARISON OF GROUNDWATER DISCHARGE TO SURFACE WATER FLOWS

Surface Water System	Mean Annual Flows (m^3/s)	Groundwater Discharge to Surface Water System (m^3/s)	Groundwater Discharge, as a Percentage of Surface Water Flow (%)
Athabasca River	655	0.00137	0.00021
Steepbank River	4.86	0.00042	0.0086
Shipyard Lake	0.111	0.00073	0.66

7.2 SUMMARY OF ASSESSMENT RESULTS

In addition to providing information required to understand the impacts of surface and groundwater changes to other resources (see Sections E5.0: Terrestrial Resources Assessment and E8.0: Aquatics Assessment), the review of hydrological and hydrogeological resources investigated four Impact Hypotheses. Each is discussed briefly below, with a more comprehensive analysis presented in Impact

Analysis Suncor Steepbank Mine EIA Surface Water and Groundwater (Klohn-Crippen 1996c) and a series of baseline reports (Figure E2.0-2).

Hypothesis 24 ***Flows in the Athabasca and Steepbank Rivers could be significantly changed by mine development withdrawals for extraction, upgrading, and/or reclamation.***

Assessment: Changes to flows in the Athabasca and Steepbank Rivers as a result of the Steepbank Mine development, operation and reclamation will be negligible.

Hypothesis 25 ***Ice jams, floods or other hydrological events could cause structure damage and flooding of facilities which will result in subsequent impacts to hydrological/ aquatic systems and downstream users.***

Assessment: Environmental impacts that could result from flooding events are expected to be negligible.

Hypothesis 26 ***Navigation along the Athabasca River could be affected by bridge construction.***

Assessment: Impacts to river navigation will be negligible.

Hypothesis 27 ***Groundwater quality could be affected by contaminant migration from processing and extraction activities.***

Assessment: A low probability of an impact of high severity, short-term duration of potentially regional extent results in a low degree of concern with respect to impacts to surface water.

Effects to groundwater quality will be negligible.

7.3 DESCRIPTION OF ASSESSMENT

7.3.1 Surface Water Impacts and Description

The impacts to surface water resources have been evaluated on the basis of changes to the flow and water quality in the Athabasca and Steepbank Rivers, and Shipyard Lake.

a) Changes to Surface Water Flow

The key changes to the surface water flow system as a result of the development of the Steepbank Mine are illustrated in Figure E7.0-2. The mine will advance across Leggett Creek. The drainage in Leggett Creek basin will be diverted to Wood Creek. Shipyard Lake will be reduced in size, due to the placement of the West Overburden dump. The total wetlands area will be reduced from 150 to 110 ha, with the open water area reduced from 23 to 19 ha. The flows into Shipyard Lake will be adjusted during the operation and reclamation stages of the project to ensure maintenance of the wetlands habitat.

The flow into the Athabasca River will be reduced by less than 0.1% of the annual flow in the river, as a result of the development of the mine. The surface water inflow into the Steepbank River will be reduced by less than 0.5% of the annual flow in the river.

The new Athabasca River Bridge will interact with the flow of the Athabasca River. During construction, cofferdams built for bridge pier construction may increase the potential for ice jam flooding to occur. This will be mitigated by removing the dams prior to river breakup. The bridge is not expected to increase the likelihood of ice jamming or bank erosion in the long-term (Section D3.0).

The placement of facilities in the Athabasca River valley also raises concerns about environmental hazards from flooding, particularly from ice jams. The elevation of the 1 in 100 year ice jam flood is expected to be about 241 m (ASL). This is approximately 2.4 m higher than the open water levels that are expected to occur at the 1-in-100-year flood elevation. All structures adjacent to the Athabasca River, with the exception of the bridge and barge landing, will be constructed above 241 m (ASL). Therefore, there are no environmental concerns with respect to flooding of the mine infrastructure.

Navigation on the Athabasca River will be accommodated. There will be a clearance of 15.2 m between the underside of one span of the bridge, and the level of the 1 in 10 year flood event.

b) <u>Changes to Surface Water Quality</u>

As a result of the development of the Steepbank Mine, there is the potential for the quality of surface water to be affected by:

- contamination by water that has been exposed to oil sands or mining processes;
- increased sedimentation from erosion; and
- contamination from accidental spills.

The Steepbank Mine will be equipped with two separate drainage systems to ensure that surface water is not contaminated by run-off from the mine. Run-off that is exposed to oil sands or mining operations will be contained and, wherever feasible, used as process water. All natural run-off and shallow groundwater will be diverted away from mining areas, and discharged to the Athabasca River.

The potential for sediment to contaminate surface water will arise as a result of disturbances to soil and vegetation, as well as from erosion in constructed drainage channels. Mitigations to control sediment transport include slowing the flow velocities in drainage channels, constructing basins for sediment settling, lining the channels with erosion-resistant materials, and revegetating disturbed areas. These measures will ensure that the concentration of sediment in the outflow meets regulatory standards.

Spills and associated contaminated run-off have the potential to impact the water quality in the Athabasca River. However, site design and management procedures will reduce the risk of spills to a very low probability.

Mitigation measures for these impacts include:

- a separate surface drainage system for the shop facilities which includes retention storage capacity for run-off from this area and sediment settling basins;
- containment of tanks and active leak detection systems;
- no release to the environment of surface run-off from the facilities or mining areas unless waters meet adequate quality standards;
- rupture protection provisions on the hydrotransport, hot water and diesel fuel pipelines;
- containment sumps with impervious linings for liquid storage facilities (for example, fuel tanks);
- rapid-response clean-up procedures for accidental spills;

- drainage channels with settlement basins to collect run-off from disturbed areas, roads and paved areas;
- cross-berms on sloping disturbed areas to retard and reduce run-off; and
- timely revegetation of disturbed areas following construction activities.

Some sediment deposition is expected at the bridge, both upstream and downstream of the west abutment. On the east bank, deposition downstream of the bridge is anticipated. These impacts will not affect the hydrology of the river. Potential aquatic impacts are addressed in Section E8.0, Aquatics Assessment.

7.3.2 Groundwater Impacts and Mitigations

In investigating the potential effects of the Steepbank Mine development on groundwater, three factors were considered:

- changes in direction of groundwater flow;
- changes in the rate of groundwater discharge to surface water bodies; and
- changes in groundwater quality.

Mine operations (dewatering overburden) will result in a change in direction and rate of groundwater flow in the surficial aquifer, although these changes will be short-term and limited to a small area. Widespread groundwater seepage along the Athabasca River, Steepbank River and Shipyard Lake from the surficial aquifer will be replaced by discharge from point sources into Shipyard Lake and the Athabasca River. Groundwater flow in the bedrock aquifers will not be affected in the long-term. Mine operations will not affect groundwater quality in either the surficial or bedrock aquifers.

Spill prevention and containment measures at the Athabasca bridge, east access corridor and facilities area 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 provide notice of any deteriorating water quality.

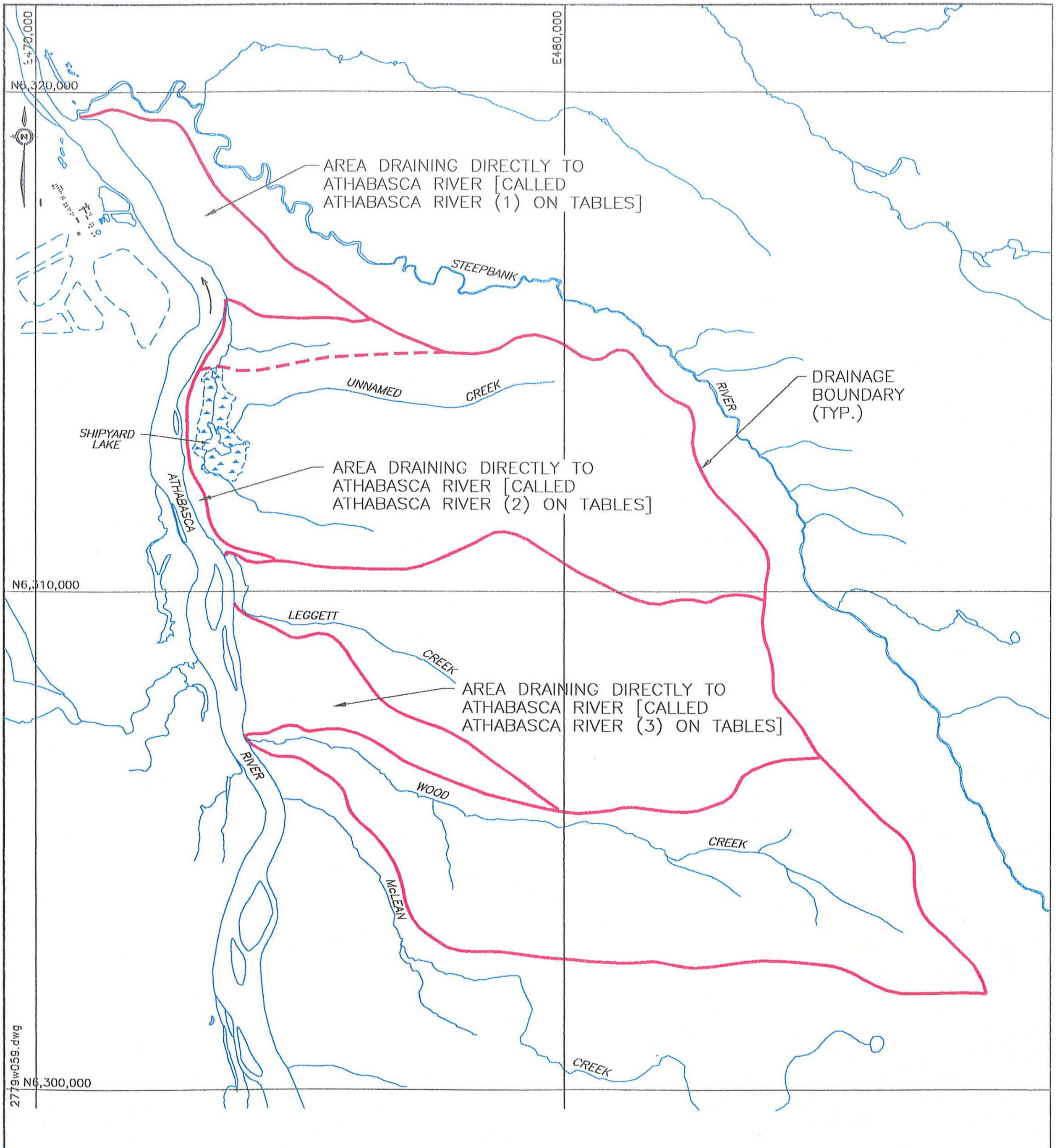
Consolidated tailings (CT) will be placed in the mine pits as part of the mine reclamation. The pore water in the consolidated tailings is similar in quality to the groundwater found in Steepbank Mine bedrock. This includes the existence of naturally-occurring organic compounds and naphthenic acid in both the consolidated tailings and groundwater. Pore water is expected to seep from the consolidated tailings into the groundwater. The effect of this seepage on groundwater quality will be negligible. Further studies are proposed to confirm this.

7.4 ENVIRONMENTAL MONITORING

Although the impacts to hydrological and hydrogeological resources resulting from the development and operation of the Steepbank Mine are expected to be negligible, environmental monitoring will be conducted to confirm predictions. The monitoring will consist of an extension of Suncor's current groundwater and surface water monitoring program to include the Steepbank Mine area. It will include sampling and analysis upgradient and downgradient of the mine area and all other sources of potential groundwater contamination. Monitoring will be conducted to provide information required to adjust surface flow volumes to minimize habitat impacts to Shipyard Lake.

FIGURES SECTION E7.0

FIGURES



Pre-Mine Drainage Patterns, Steepbank Mine Area

Figure E7.0–1

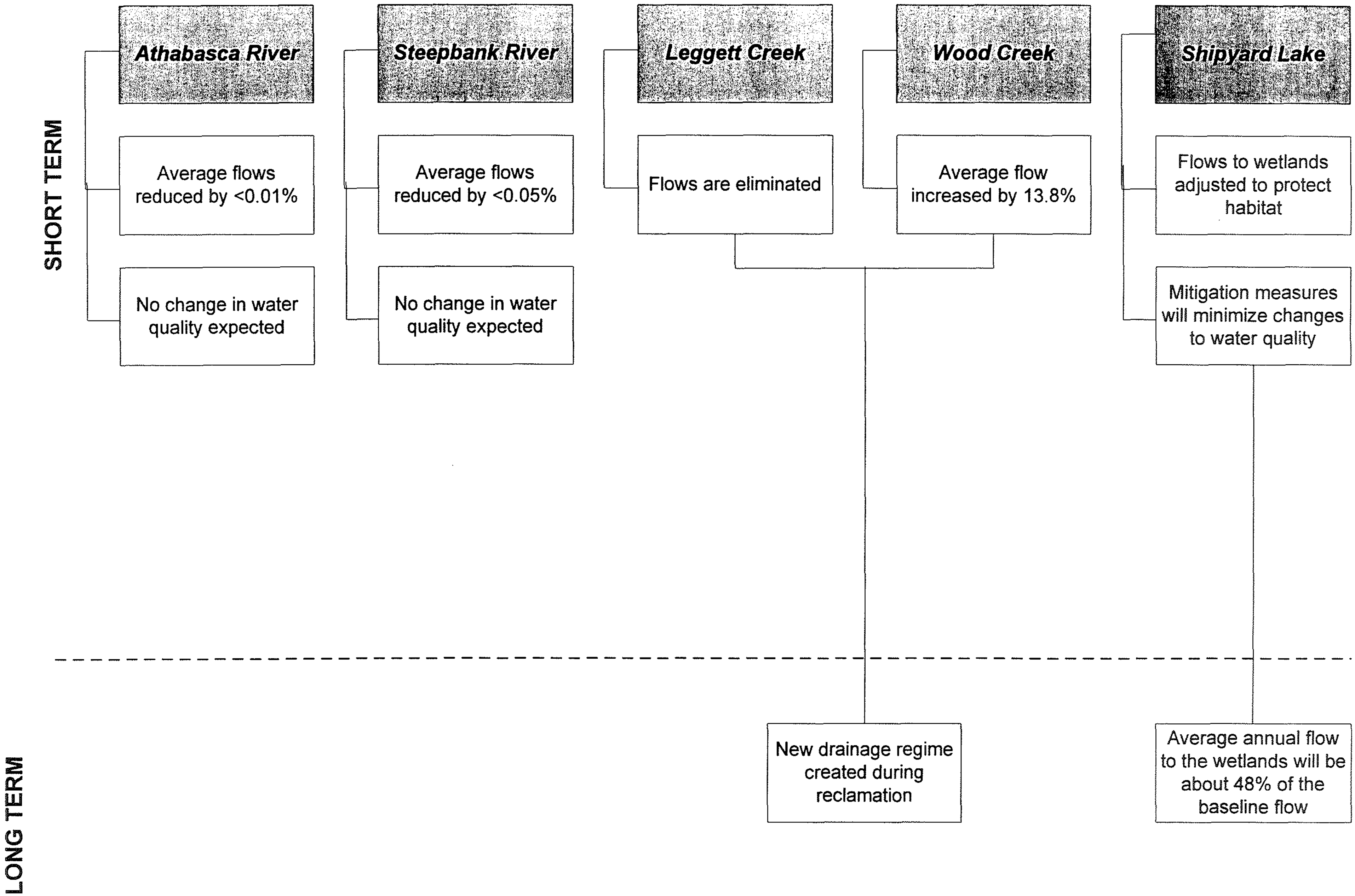


Figure E7.0-2 **Potential Surface Water Impacts from Steepbank Mine Development**

8.0 AQUATICS ASSESSMENT

8.1 BASELINE CONDITIONS

A thorough environmental investigation was undertaken for the Steepbank Mine EIA project. This included studies of surface water, porewater and sediment quality, benthic invertebrates, fish habitat, fish communities, and fish health.

Baseline conditions describe the current situation (1995), including the cumulative effects of developments upstream and within the oil sands region.

8.1.1 Surface Water, Porewater and Sediment Quality

River water within the study area was characterized as moderately alkaline, with low to moderate dissolved salt concentrations and moderate nutrient levels. Dissolved organic carbon concentration was elevated in surface waters, indicating the influence of muskeg drainage. Concentrations of metals were non-detectable to low in all waterbodies sampled, with the exception of occasionally elevated levels of metals associated with suspended sediments. Surface water samples were not toxic to bacteria, invertebrates, fish or plants. In most samples, levels of organic chemicals in surface water were not markedly affected by naturally-occurring deposits of oil sands, although total hydrocarbons, trace organics, and naphthenic acids occasionally were detected at low concentrations.

Naturally-occurring hydrocarbons were found in river sediments and porewater. Sediment chemistry adjacent to Tar Island Dyke (TID) was similar to that of other Athabasca River samples indicating that it is not being affected by TID seepage. Porewater quality varied from site to site, depending on the amount of oil sands in the substratum. Naphthenic acid concentrations were low to moderate at all sites but none of the samples were toxic.

8.1.2 Benthic Invertebrates

Benthic invertebrates are organisms that live along the bottom of streams. In the study area, they are thriving and show no evidence of negative effects associated with exposure to naturally-occurring hydrocarbon deposits or existing oil sands developments.

Results of the bioaccumulation assessment at reference sites in the Athabasca and Steepbank Rivers indicated that concentrations of most metals analyzed were detectable in benthic invertebrate tissues and were similar at all sites. Concentrations of several organic compounds were elevated at some sites relative to others, probably reflecting differences in the amount of oil sands present in the river beds.

8.1.3 Fish

Fish habitat in the Athabasca River within the study area is relatively poor because of the lack of diversity of habitats and the shifting sand bottom of the river. High quality habitat exists in the Steepbank River and in other tributaries to the Athabasca River.

There are diverse fish communities in the Athabasca and Steepbank River Basins. Tables E8.0-1 and E8.0-2 list the fish species which use the Athabasca River and Steepbank Rivers in the vicinity of Suncor's operations.

To assess fish health, a number of factors were studied at several levels: biochemical, physiological, whole-organism, population and community. There is evidence of exposure of fish to naturally-occurring hydrocarbons, although fish general fitness and health indicators suggest that fish populations are healthy. Fish health, as indicated by biochemical and physiological measurements, show that fish are exposed to some environmental condition which is causing elevated liver enzyme activity. However, this elevated is apparently a result of exposure of fish to the natural oil sands deposits in the region, rather than a specific response to Suncor's water releases.

TABLE E8.0-1

FISH SPECIES UTILIZATION OF THE ATHABASCA RIVER NEAR SUNCOR

SPECIES	1995 STUDY	PAST STUDIES[a]	SPAWNING	REARING	FEEDING	OVERWINTERING	MIGRATING
*Arctic Grayling		●			✓	✓	✓
*Burbot	●	●	✓	✓	✓		✓
*Emerald Shiner	●	●	✓	✓	✓	✓?	✓
*Flathead Chub	●	●	✓	✓	✓	✓?	
*Goldeye	●	●	✓?	✓	✓		✓
*Lake Chub	●	●	✓	✓	✓	✓	
*Lake Whitefish	●	●			✓		✓
*Longnose Sucker	●	●		✓	✓		✓
*Northern Pike	●	●			✓	✓	
*Spottail Shiner	●	●	✓	✓	✓	✓	
*Trout-perch	●	●		✓	✓	✓	
*Walleye	●	●		✓	✓		✓
*White Sucker	●	●		✓	✓		✓
Brassy Minnow	●	●			✓		
Brook Stickleback		●			✓		
Bull Trout		●			✓		
Fathead Minnow		●			✓		
Finescale Dace		●			✓		
Iowa Darter		●			✓		
Longnose Dace	●	●			✓		
Mountain Whitefish	●	●			✓		
Ninespine Stickleback		●			✓		
Northern Redbelly Dace		●			✓		
Pearl Dace		●			✓		
Slimy Sculpin	●	●	✓	✓	✓	✓	
Spoonhead Sculpin	●	●			✓		
Yellow Perch	●	●			✓		

[a] Data from Bond (1980), McCart et al. (1977), Tripp and McCart (1979), Tripp and Tsui, (1980), R.L.and L. (1994) and (1995) Suncor Study. See Golder (1996a) for details.

Legend:
- * Common, wide-spread species in the Athabasca River. Note that Arctic grayling are mainly found in the tributaries during the open-water season.
- ● present in study area
- ✓ kind of habitat use
- ? may use habitat but use not confirmed

TABLE E8.0-2

FISH SPECIES UTILIZATION OF THE STEEPBANK RIVER

SPECIES	1995 STUDY	PAST STUDIES[a]	SPAWNING	REARING	FEEDING (LOWER REACHES ONLY)	FEEDING (UPPER AND LOWER REACHES	OVERWINTERING
*Arctic Grayling	●	●	✓	✓		✓	YOY[b]?
*Brook Stickleback		●	✓	✓		✓	✓
*Lake Chub	●	●	✓?			✓	
*Longnose Dace	●	●	✓	✓		✓	✓
*Longnose Sucker	●	●	✓			✓	YOY?
*Northern Pike	●	●			✓	✓	
*Pearl Dace		●				✓	
*Slimy Sculpin		●	✓	✓		✓	✓
*Trout-perch	●	●	✓			✓	
*White Sucker	●	●	✓	✓		✓	YOY?
Brassy Minnow		●				✓	
Bull Trout		●			✓		
Burbot	●	●			✓		
Flathead Chub		●			✓		
Flathead Minnow		●				✓	
Goldeye	●	●			✓		
Lake Cisco		●			✓		
Lake Whitefish	●	●			✓		
Longnose Dace	●	●				✓	
Mountain Whitefish	●	●				✓	
Northern Redbelly Dace		●				✓	
Spoonhead Sculpin	●	●	✓	✓		✓	✓
Spottail Shiner		●				✓	
Yellow Perch		●			✓		
Walleye	●	●			✓		

[a] Data from Sekerack and Walder (1980), Mackinak and Bond (1979), Bond (1980), 1995 Suncor Study. See Golder (1996a) for details.

[b] YOY denotes young-of-year

Legend: * Common, wide-spread species in the Steepbank River. Pearl dace, brook stickleback, and slimy sculpin were not captured in 1995, likely because they are not easily susceptible to capture with a boat electrofisher. All species without an asterisk have been documented in the lower reaches of the Steepbank River but are not common inhabitants of it.

● present in study area

✓ habitat use of study area

? may use habitat but use not confirmed

Studies of fish populations indicated no unusual patterns for fish within the study area. The distribution of fish of different ages, and their size for their age was normal. However, growth rates within the vicinity of Suncor operations were somewhat higher than those of upstream fish. Measurements of the reproductive status of fish indicate that fish reproduction is not being affected by Suncor's current operations.

The types of fish found in surface water bodies near Suncor were similar to those found in other parts of the Athabasca River drainage basin, indicating no discernible effect of present industrial activities on the structure of the fish community. In addition, fish use of habitats does not appear to be affected by Suncor's existing operations.

8.2 SUMMARY OF ASSESSMENT RESULTS

Development of the Steepbank Mine could potentially impact aquatic resources in the Athabasca and Steepbank Rivers and in some smaller tributaries to the Athabasca River. Investigations focused the potential effects of all Suncor discharges - Fixed Plant, Lease 86/17 and the Steepbank Mine - on seven hypotheses (Table E2.0-2), and results are briefly discussed below. A more complete discussion of the impact analysis and baseline information is available in Impact Analysis of Aquatics Issues Associated with the Steepbank Mine (Golder 1996g) as well as a series of background reports (Figure E2.0-2).

Hypothesis 28 ***Construction, operational or reclamation activities might adversely affect aquatic habitat in the Steepbank River.***

Assessment: Impacts on benthic invertebrates and fish habitat will be negligible for all phases of mine development.

Hypothesis 29 ***Construction, operational or reclamation activities might adversely affect aquatic habitat in the Athabasca River.***

Assessment: Impacts to benthic invertebrate communities and fish habitat in the Athabasca River are negligible. Drainage of Unnamed and Leggett Creeks represent a negative short-term local impact during the operational phase. This impact will be reversed in the reclamation phase when Unnamed and Leggett Creek drainages will be restored to equivalent or better aquatic habitat.

Hypothesis 30 ***Water releases associated with construction, operational or reclamation activities might adversely affect aquatic ecosystem health in the Athabasca or Steepbank Rivers.***

Assessment: For all three phases of mine development (i.e., construction, operations and long term) impacts to aquatic ecosystem health will be considered negligible.

Hypothesis 31 ***Water releases associated with construction, operational or reclamation activities might adversely affect the quality of fish flesh.***

Assessment: Refinery wastewater effluent has the potential to taint fish which reside immediately below Suncor's operations in the Athabasca River. Thus, this impact has been identified as a moderate impact of moderate duration, during the construction and operational phases. Additional studies are underway to further investigate this issue. In reclamation conditions no impact will occur because tainting would not occur once the wastewater effluent discharge stops.

Hypothesis 32 ***Construction, operational or reclamation activities might lead to changes in aquatic habitat and/or aquatic health which might result in a decline in fish abundance in the Athabasca or Steepbank Rivers.***

Assessment: Effects to fish abundance will be negligible.

Hypothesis 33 ***Construction, operational or reclamation activities might lead to changes in fish abundance or quality of fish flesh which might result in a decreased use of the fish resource.***

Assessment: A negative, moderate, short-term, local impact to use of the fish resource is anticipated in the construction and operational phases related to fish tainting. Once the wastewater effluent is removed in the reclamation phase, no impact on use of the fish resource is anticipated.

Hypothesis 34 ***Construction, operational or reclamation activities might cause changes in Athabasca River water quality which might limit downstream use of the water.***

Assessment: Potential impacts to human health and other downstream users will be negligible.

8.3 DISCUSSION OF ASSESSMENT

The linkages between mine development activities, modes of impact and impact hypotheses are depicted in Figure E8.0-1. Below is a brief discussion of those anticipated changes, and the measures Suncor will implement to avoid and minimize impacts which may have negative implications to the aquatic resources.

Mine development (construction, operation and reclamation) can affect aquatic resources through three main routes: physical alterations to aquatic habitat, changes in surface and subsurface (groundwater) flow patterns, and water releases to watercourses. Types of water releases include operational and reclamation waters as well as accidental releases.

8.3.1 Physical Alterations to Aquatic Habitat

Aquatic habitat impacts were evaluated in the context of benthic invertebrate communities and habitat requirements of fish VECs (walleye, goldeye and longnose sucker). Physical alterations in aquatic habitat could occur directly as a result of alterations to river beds (e.g., instream construction) or indirectly as a result of on-lease activities (e.g., mine dewatering may lower river flows, road construction may increase suspended solid loads) (Figure E8.0-2).

For the Steepbank River, no alterations to aquatic habitat are anticipated during the construction phase as no construction activities are planned in or near the river. During the mining phase, potential impacts to the Steepbank River will be avoided because a minimum setback of 100 m from the escarpment crest will be maintained. As well, there will negligible alterations to surface water and groundwater flows as a result of the Steepbank Mine (see Section E7.0).

A number of linkages between mine development activities and Athabasca River aquatic habitat were determined. During the construction phase, a barge terminal will be constructed and a barge will be operated to transport materials across the Athabasca River during open-water periods. Barge operation and associated dredging will cause some disturbance to the bottom sediment; however, given the shifting sand bottom of the Athabasca River this disturbance will not be significant. During winter an ice bridge will be used in place of the barge. Ice jams related to this structure will be minimized by making cuts in the ice prior to spring breakup. The barge and ice bridge will be used until the permanent bridge is constructed (about two seasons). The permanent bridge will be used for transport of mining equipment and will support pipelines for the transport of oil sands, tailings, diesel fuel, natural gas and hot water.

Construction of the barge terminal, ice bridge, permanent bridge and road could cause erosion and sedimentation. During construction, several mitigation measures will be used to prevent sedimentation and protect fish habitat. For nearshore construction, river banks will be stabilized and sediment-laden run-off will be routed away from the river. Since the facilities road is a permanent structure and it is close to the river, a permanent sediment and run-off collection system will be implemented. Instream construction of bridge piers and abutments will not occur during sensitive periods for fish (e.g., during spring when walleye and Arctic grayling are moving upstream to spawn). Also, work areas around piers and abutments will be isolated from the river with cofferdams and excavated bottom sediment will be removed from the river.

The presence of the bridge will cause a small alteration in physical habitat. Aquatic habitat at the bridge pier footings and the abutments will be lost and a backwater habitat behind the bridge piers will be created. The west bridge abutment juts out into the river and will likely cause an accumulation of sediment along the west bank. These effects will affect <1% of the aquatic habitat within the Local Study Area.

During mine operations, potential alterations to aquatic habitat as a result of mining include removal of Unnamed and Leggett Creeks during mining of Pit 1 and 2 and resulting increases in flows in Wood Creek as additional drainage is routed to this creek (Section E7.0). In the reclamation phase, equivalent or better aquatic habitat will be created to replace that lost by mine advances across Unnamed and Leggett Creeks.

The loss of fish habitat is minimal and not expected to reduce fish abundance. Similarly, no changes in fish health are expected so the linkage between fish health and fish abundance is incomplete. Another possible linkage between mine development and fish abundance is increased fishing pressure from use of the bridge to access the Steepbank River. The bridge will not be open to the public during the operational phase of the mine.

8.3.2 Changes in Surface and Sub-surface Flow Patterns

Flow changes that might occur in the Athabasca and Steepbank Rivers as a result of mine operations and reclamation were discussed in Section E7.3. These expected changes are very small (i.e., less than 1% of Steepbank River flows; less than 0.01% of the Athabasca River flows) and will not affect fish habitat.

8.3.3 Water Releases

There are three categories of water releases from Steepbank Mine development: operational waters, reclamation waters and accidental releases. Operational waters are waters discharged from outfalls and occur during the mine operations (e.g., mine drainage, cooling water and discharge from plant operations). Reclamation waters are not confined to specific discharge points, and will be released for long periods of time after mine operations have been completed. Water draining from consolidated tailings is expected to be a key contributor to reclamation water. Both operational and reclamation waters have higher levels of trace organic compounds, naphthenic acids and some metals than occurs naturally in either the Athabasca or Steepbank Rivers. The Steepbank River will not receive any operational water discharges, and minimal amounts of reclamation waters, so potential water quality effects from release of operational and reclamation waters are restricted to the Athabasca River.

There are potentially three main types of accidental water releases: catastrophic releases related to failure of an engineered structure (e.g., breaching of tailings dykes); spills associated with hydrotransport, pipeline transport or accidents on the bridge or barge; and releases related to upset conditions (e.g., flooding of storage ponds, failures in wastewater treatment systems). All engineered structures used by Suncor are designed to prevent catastrophic failure. As well, the use of consolidated tailings will minimize the movement of tailings should a break in a tailings dyke occur. Features will be incorporated into the design of the bridge to prevent and contain spills. The bridge has a solid bridge deck below the pipelines and a curb to contain spills. Each pipe is equipped with an emergency shut-off valve and has steel plates around the joints to prevent spray should a joint leak. The diesel fuel pipeline will be double walled.

An evaluation of linkages between water releases and water quality indicates that accidental spills are unlikely given the mitigation measures built into the project. However, slight changes in water quality will occur as a result of discharge of both operational and reclamation waters. Changes in ecosystem health were evaluated in the context of potential water quality effects on fish health, benthic community structure, and acute and chronic toxicity in the food chain.

A number of laboratory toxicity studies were completed to determine whether water releases from Suncor's operation might adversely affect aquatic plants and animals in the Athabasca or Steepbank Rivers. A number of different organisms, including algae, bacteria, zooplankton and fish were tested. The results of these studies indicated that none of the current or proposed water releases are expect to adversely affect the health of aquatic organisms in either the Athabasca or Steepbank Rivers.

Field investigations of benthic invertebrate communities along the Athabasca River support the results of the laboratory toxicity studies. The field studies showed that discharges from Suncor's operations did not cause measurable benthic community alteration at any of the sites sampled in 1995. Similarly, when all future discharges are considered, it will still be unlikely that future water releases will result in changes to benthic invertebrate community structure.

Laboratory experiments in conjunction with field data and computer modelling studies were used to examine the effects of operational and reclamation waters on fish health. The results of these detailed studies indicated that it is very unlikely that exposure of fish to operational and reclamation water releases would affect the health of fish using the Athabasca River near Suncor's operations. This conclusion is supported by observation of current fish populations which have been exposed to water releases from Suncor operations for the last three decades. These populations continue to occupy habitat in the Suncor study area, and exhibit normal growth and reproduction. Since future chemical concentrations in water releases to the Athabasca River are predicted to be lower than current conditions, future populations of fish should continue to be healthy.

Two aspects of fish flesh quality were examined: the potential for tainting and the potential for changes in chemical concentrations in fish tissue. A combined field and laboratory study was used to examine the potential for changes in chemical concentrations in fish tissue. There were no increases in fish tissue concentrations for fish exposed to release waters relative to control water. Thus, bioaccumulation of chemicals in fish tissue does not appear to be of concern.

Tainting is not a human health concern and does not impact fish health but it is significant nonetheless because tainting might limit the use of the fish resource. The potential for fish tainting was examined by exposing rainbow trout in the laboratory to various release waters and submitting them to a taste panel. Tainting was evident in fish exposed to fixed plant wastewater but not to Tar Island Dyke seepage water or Athabasca River water.

Although no change in fish abundance is anticipated, and no measurable increase in fish tissue concentrations of organic chemicals or metals is expected, there is potential for moderate-level tainting of fish flesh in fish exposed for long-time periods at a site immediately below Suncor's wastewater effluent. This impact may contribute to decreased use of the fish resource. Additional studies are currently underway to further investigate this issue.

8.4 MONITORING

Water quality monitoring is a component of Suncor's regular monitoring programs. In addition, the potential for refinery wastewater to contribute to fish flesh tainting is under continuing investigation. In particular, Suncor has initiated a series of studies to evaluate ways to reduce levels of chemicals which might contribute to tainting.

FIGURES SECTION E8.0

FIGURES

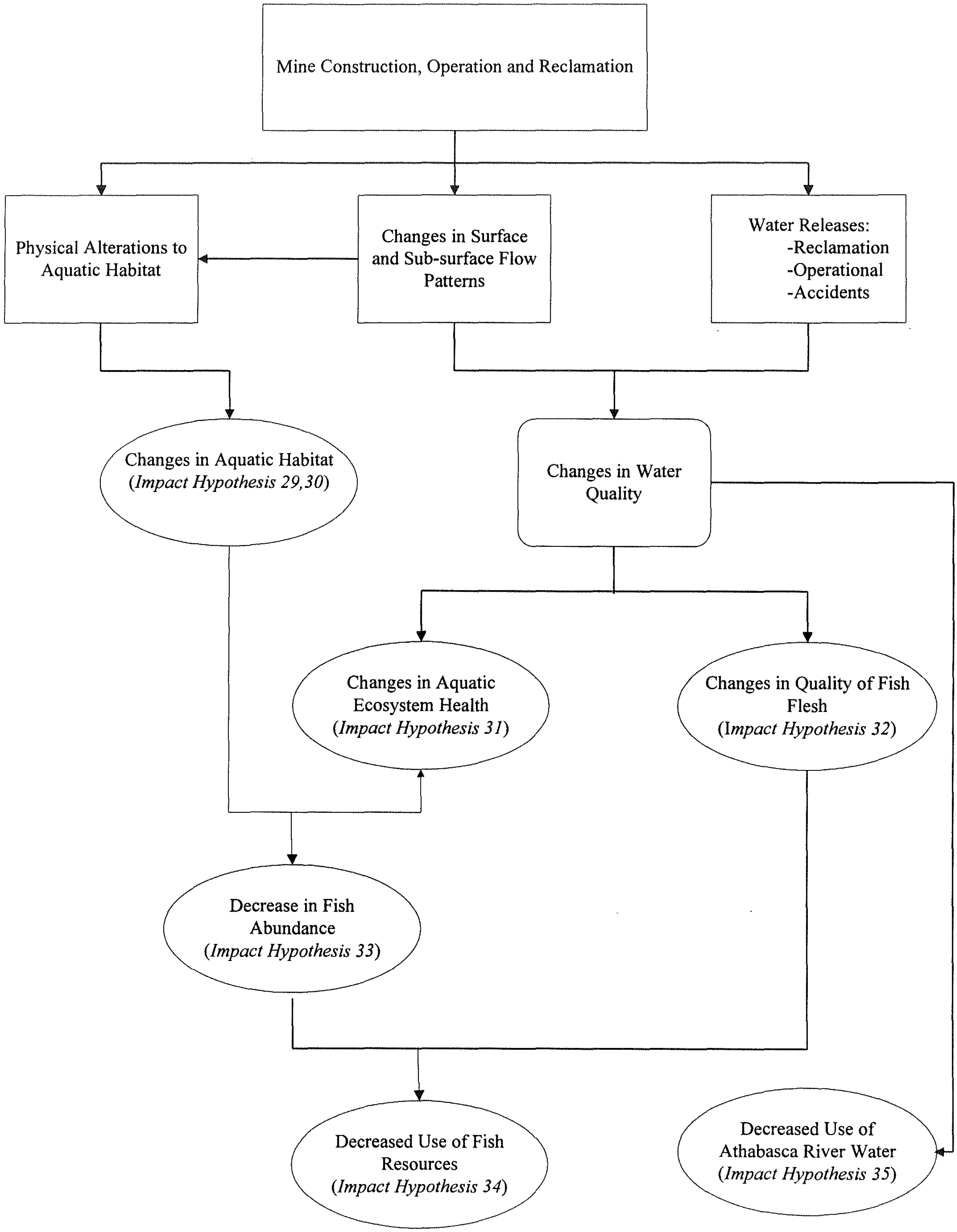


Figure E8.0-1 **Linkages Between Mine Development and Aquatic Resources**

STEEPBANK RIVER

ATHABASCA RIVER

Figure E8.0-2 Aquatic habitats in the Steepbank River and Athabasca River in the Suncor local study area are quite different as a result of different landform and substrate condition.

9.0 AIR QUALITY ASSESSMENT

9.1 BASELINE CONDITIONS

Oil sands activities in the Fort McMurray area have had a measureable effect on the air quality of the region. Emissions of interest are:

- sulphur dioxide (SO_2)
- oxides of nitrogen (NO_x)
- carbon dioxide (CO_2)
- reduced sulphur compounds (TRS) including hydrogen sulphide (H_2S)
- particulates
- Volatile organic compounds (VOC), a component of total hydrocarbons (THC)

A number of factors are considered when assessing the impacts of air emissions.

First, the source is considered, specifically the location, quantity, timing and type of emissions. Sources of air emissions are plant stacks, flares and vents, and fugitive sources such as tailings ponds, leaks and the coke pile. Suncor's facilities employ design features and management practices to control and reduce potential emissions to the atmosphere. New emission control programs are in progress to further reduce current emissions.

A second factor to consider is ambient air quality. An air quality monitoring program is routinely carried out to determine the concentrations of air emissions in the atmosphere. Ambient air quality monitoring in the region reveals that the operation of the Suncor and Syncrude oil sands facilities has affected air quality downwind from the facilities. SO_2 emissions have resulted in concentrations that exceed ambient guidelines. These exceedences occur most frequently in the vicinity of the Suncor site. In addition, deposition of sulphate compounds is higher than in other regions in northern Alberta or Saskatchewan.

A third factor is the effect of air quality on a "receptor" (e.g., humans, plants, the soil). Suncor will participate in an enhanced receptor monitoring program which will better allow correlations between exposures and receptor effects. This participation is through the Regional Air Quality Coordinating Committee (RAQCC). In addition, Suncor is a sponsor and active participant in the Alberta Oil Sands Community Exposure and Health Effects Assessment Program (Regional Community Health Study) which is attempting to identify potential effects of air emissions on the health of residents in the Fort McMurray region. The effects of air quality changes on human health and terrestrial resources were considered previously in Sections E4.0 and E5.0.

9.2 SUMMARY OF ASSESSMENT RESULTS

Public concern was expressed with respect to the potential for Suncor's emissions to contribute to global climate change. This concern was stated as an Impact Hypothesis, which focused a discussion relating to air emission effects on global climate change (Table E2.0-2). The results of the assessment are briefly discussed below.

Hypothesis 35 ***Global climate change could be affected by increased release of greenhouse gases associated with production expansion related to the Steepbank Mine.***

Assessment: Suncor is responding to the global climate change concern by commiting to reduce greenhouse gas emissions to the 1990 level by the year 2001. Suncor has submitted an action plan under the Canadian Climate Voluntary Challenge and Registry Program.

The increased efficiency of Suncor's operations is reflected in significant decreases in CO_2 emissions on a per-barrel basis. By 2001 the per-barrel emissions will be 38% lower than 1990 levels, although overall emissions will increase marginally (from 9312 to 9819 tonnes per day). Suncor proposes to increase production (in this period) by 80% with an increase of CO_2 emissions of only 5%.

Specific initiatives that improve energy efficiency include: hydrotransport technology which reduces extraction energy needs and improved heat recovery in the fixed plants.

9.3 DISCUSSION OF ASSESSMENT

In addition to providing information required to respond to the Impact Hypothesis specific to greenhouse gases, additional investigations were conducted to understand the impact on other resources as a result of changes in air emissions (see Sections E4.0, Human Health; E5.1, Terrestrial). Impact Analysis of Air Emissions Associated with the Steepbank Mine (Bovar Environmental 1996e) provides a more complete discussion of air quality with respect to the Steepbank Mine. Further information is also provided in a series of background reports (Figure E2.0-2) which were prepared as part of the Steepbank Mine Environmental Assessment program. Below is a summary of the Impact Analysis discussion.

9.3.1 Suncor Source Characterization

Part of Suncor's continuing environmental improvement and Fixed Plant Expansion project has been to implement technologies and management systems to reduce air emissions. Table E9.0-1 summarizes the trend in air emissions, from the current operation (1995) projected through 1998 and 2001. The primary changes include production expansion and commissioning of the Flue Gas Desulphurization Unit (FGD). The projections indicate a significant decrease in SO_2 , THC and particulate emissions, and relatively constant NO_x and CO_2 emissions.

The effects of the Steepbank Mine and associated projects to ambient air quality will be mitigated through Suncor's emissions reduction program. Despite a 35% production increase, all emissions associated with plant operations will be reduced from current levels, with the exception of CO_2, which will increase by less than 2%. SO_2 releases will be about one fifth of their current levels, mostly as a result of FGD commissioning. The vapour recovery unit, more efficient capture of diluent in the processing stream and the use of hydrotransport will reduce VOC emissions by half. Particulate matter from the Powerhouse stack will be reduced to about one fifth of the current emission level, again as a result of FGD commissioning.

The application of consolidated tailings technology is new, and as such, is under scrutiny with respect to its long-term emissions of VOC. Field-scale consolidated tailings landscape study areas are currently under development, to address the rate and type of emissions which may be associated with consolidated tailings deposits.

TABLE E9.0-1

SUMMARY OF SOURCE EMISSION CHANGES ASSOCIATED WITH SUNCOR'S EXISTING AND PROPOSED OPERATIONS

Parameter	1990		1995		1998		2001[a]	
	tpcd	t/ production	tpcd	t/ production	tpcd	t/ production	tpcd	t/ production
Production rate of upgraded crude oil (thousand barrels per calendar day)	57.8		77.5		87.0		107	
SO_2 (sulphur dioxide)	212.3	3.67	233.5	3.01	51.0	0.59	51.0	0.48
NO_x (nitrogen oxides)	36.3	0.63	37.1	0.48	36.9	0.42	35.9	0.34
CO_2 (carbon dioxide)	9312	158.0	9643	124.4	10395	119.5	9819	91.2
VOC (volatile organic compounds)	30.9	0.53	42.3	0.55	25.2	0.29	13.9[a]	0.13
Particulate matter (combustion sources only)			6.75	0.087	1.46	0.017	1.47	0.013

[a] Includes hydrotransport cyclofeeder.

9.3.2 Regional Source Characterization

In addition to emissions from Suncor's activities, other sources include Syncrude, other industrial and traffic/residential sources. Table E9.0-2 summarizes current regional emissions.

Main contributors to air emissions within the region will continue to be Suncor and Syncrude, although the proposed Solv-Ex Bitumount and Ruth Lake facilities will also contribute.

TABLE E9.0-2

1995 REGIONAL EMISSIONS (t/d)

Emission	Suncor	Syncrude	Other Industry	Traffic/ Residential	Total
SO2	233.5	207.4	0.1	0.2	441.2
NOx	37.1	31.7	0.5	1.3	70.6
CO2	9643	23 733	1101	587	35 064
VOC	42.3	17.2	3.0	2.3	64.8
particulates	6.8	13.9	0.3	2.9	23.9

Table E9.0-3 compares future SO_2 emissions from 1995 to 2001 for the regional sources.

Overall SO_2 emissions will decline in the region due to Suncor reductions. Data for the other emissions (No_x, CO_2, VOC) in 2001 is currently unavailable.

TABLE E9.0-3

CURRENT AND PROPOSED REGIONAL SO_2 EMISSIONS (t/d)

Year	Suncor	Syncrude	Other Industry[a]	Traffic Residential	Total
1995	233.5	207.4	0.1	0.2	441.2
2001	51	208-218[b]	7.4	0.2	266.6-276.6

a Includes Solv-Ex Bitumount and Ruth Lake.

b Syncrude preliminary prediction.

9.3.3 Fugitive Dust

Fugitive dust emissions have been assessed qualitatively. The current coke stockpile and handling activities are sources of dust. Suncor is investigating long-term handling and storage options for the excess coke produced during bitumen processing. Hydroseeding (i.e., surface revegetation) will be used to control erosion and dust from the storage pile.

Mine haul roads can be a source of dust under dry conditions. Suncor waters roads in high traffic areas to reduce these dust emissions. Exterior slopes of tailings pond dykes are revegetated to reduce blowing sand. The beach areas of tailing ponds are a source of dust but will be reclaimed as soon as these areas reach design elevation. The pond required for gypsum disposal will be wet. Dried stockpile areas will have a relatively hard surface, which will have a negligible potential to create dust problems.

9.3.4 Combustion Particulates

Particulates released from combustion sources can contain heavy metals component. Dispersion modelling indicates that metal concentrations from air emissions were several orders of magnitude lower than ambient guidelines. Reductions from the 1995 scenario will be realized with the commissioning of the FGD system which will result in a further decrease in particulate emissions from Suncor's operations (i.e., from current levels of 6.75 tpcd to 1.47 tpcd in 2001).

9.4 CHANGES IN AMBIENT AIR QUALITY AND DEPOSITION

Ambient SO_2 concentrations are expected to decrease as a result of the SO_2 reduction program. Figure E9.0-1 illustrates the differences in maximum predicted hourly average SO_2 concentrations that will result from the changed emission scenarios, and Table E9.0-4 presents data for maximum predicted acidic deposition associated with current and proposed SO_2 emissions.

TABLE E9.0-4

MAXIMUM PREDICTED DEPOSITION ASSOCIATED WITH CURRENT AND PROPOSED SO_2 EMISSIONS

YEAR	SUNCOR ONLY			ALL REGIONAL SOURCES	
	Total deposition (SO_4^{-2} equivalent/ha/y)			Total deposition (SO_4^{-2} equivalent/ha/y)	Effective Acidity[a] (kmol H^+/ha/y)
	dry	wet	total		
1995	13.6	8.2	19.2	25.5	0.66
1998	3.5	2.1	5.2	13.8	0.42
2001	3.8	2.4	5.8	14.8	0.44

[a] Effective acidity includes a background value of 0.13 kmol H^+/ha/y

As NO_x, CO and particulate emissons are within guidelines, and will either be reduced or remain constant with the production increase, further evaluation of their ambient concentrations was not undertaken.

Previously recorded high total hydrocarbon concentrations (THC) are likely due primarily to Suncor fugitive sources. These emissions will decrease due to the Vapour Recovery Unit and implementation of hydrotransport, and should reduce THC values recorded in Fort McMurray and Fort MacKay by at least 50%. Similarly, operational improvements will significantly reduce total reduced sulphur (TRS) concentrations. Although ozone (O_3) concentrations in the area exceed guidelines, it is believed ambient concentrations are primarily due to natural sources.

Notwithstanding the positive benefits of the emissions reduction program, two issues of concern remain with respect to SO_2 emissions:

- Planned and unplanned intermittent flaring can result in relatively high SO_2 concentrations for short time periods. Suncor has minimized flaring events through continuous improvement and will continue these efforts.
- Flue gas desulphurization (FGD) downtime. During planned or unplanned downtime of the FGD , the emissions and associated maximum ambient SO_2 concentrations will be similar to the 1994/95 levels. Procedures will be implemented to minimize downtime.

Table E9.0-5 presents a summary of the air quality impacts associated with the Suncor Fixed Plant Expansion and the Steepbank Mine.

9.5 MONITORING

Suncor will continue to monitor source emissions as a component of the environmentalmManagement program and will continue to participate with the Regional Air Quality Coordinating Committee to address air quality issues of regional concern. In addition, Suncor will cooperate with the Community Regional Health Study to investigate the potential effects of air emissions to human health.

TABLE E9.0-5

AMBIENT AIR QUALITY IMPACTS ASSOCIATED WITH THE SUNCOR FIXED PLANT EXPANSION AND THE STEEPBANK MINE

	SO_2	Deposition	NO_x	CO	Particulates	VOC	TRS	O_3
direction	positive	postitive	neutral	neutral	positive	positive	positive	neutral
severity	moderate	unknown	low	low	low	unknown	unknown	low
duration	short-term	long-term	short-term	short-term	short-term long-term	short-term	short-term	short-term
geographical extent	regional	regional	regional	regional	regional	regional	regional	regional
degree of concern	moderate	moderate	low	low	low	moderate	low	low

FIGURES SECTION E9.0

FIGURES

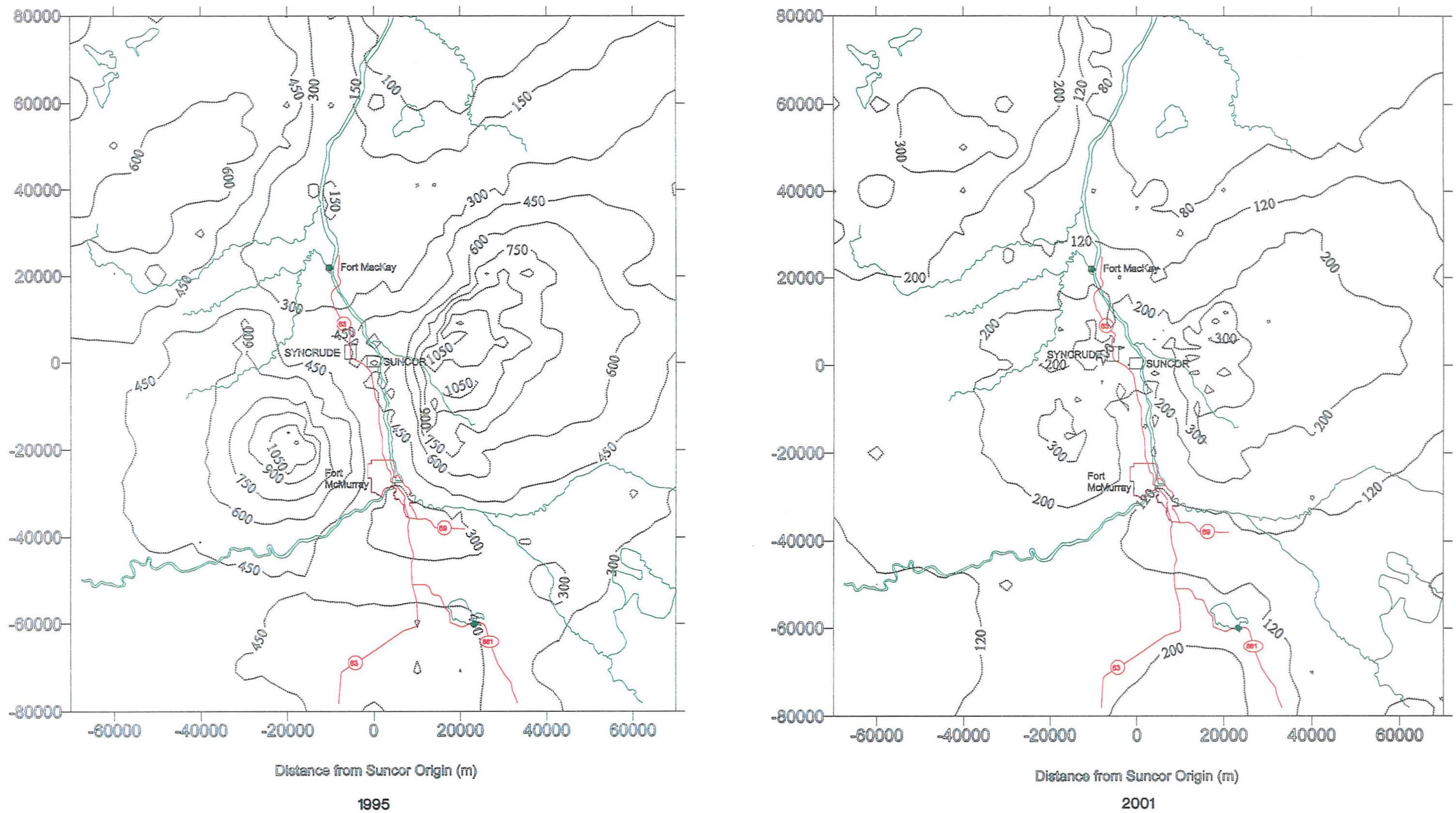


Figure E9.0-1

MAXIMUM PREDICTED HOURLY AVERAGE SO_2 CONCENTRATIONS ($\mu g/m^3$)
1995 AND 2001 EMISSION SCENARIOS

10.0 HISTORICAL RESOURCES IMPACT ASSESSMENT

10.1 BASELINE CONDITIONS

The primary objective of the historical resources impact assessment for the Steepbank Mine Project was to determine if any historical resources (paleontological, prehistoric and historic period resources) would be disturbed by the development and operation of the Steepbank Mine. To do this, background research encompassing the Regional Study Area was completed, and the findings were used to predict the most sensitive locations for archaeological resources within the area to be disturbed by the Steepbank Mine.

Based on the predictions, archaeologists concentrated most of their efforts on landforms judged to exhibit moderate to high potential for archaeological resources. Areas of particular concern included terraces and ridges which were reasonably level, well drained and had fairly open vegetation. Aerial reconnaissance and boat traverses along the shoreline preceded extensive foot traverses accompanied by surface observation and in excess of 1 100 shovel tests to locate buried sites.

Two sites were found as a result of the investigations. Both are prehistoric isolated find sites. One consists of a Beaver River Sandstone secondary flake which was recovered from a shovel test on a level bench overlooking a remnant drainage to the south and the Steepbank River to the east. Although 24 additional shovel tests were excavated near this find, all were negative. The second find was a chert biface (a stone cutting tool) which was recovered from the surface of an existing bulldozer cut approximately 25 m north of Leggett Creek and 3 m east of a ravine edge on the east side of the Athabasca River. Thirteen shovel tests were conducted in the area with no additional finds. Complete documentation of both sites was undertaken.

Both sites are considered to be of minor significance as they consist of a single artifact with no associated artifacts or features. Neither temporal nor cultural affiliation can be assigned to either site, which limits the information they can provide to understanding past human use of the area.

No historic period or paleontological sites were identified during the site inventory.

10.2 SUMMARY OF ASSESSMENT RESULTS

One Impact Hypothesis was developed to provide a focus for investigations of archaeological and historical resources (Table E2.0-2).

Hypothesis 36 ***Significant archaeological, paleontological or historical resources could be affected by the development and operation of the Steepbank Mine.***

Assessment: Since both sites that were found are considered to be of minor significance, the overall Degree of Concern related to the Steepbank Mine's effects on archaeological resources is considered to be Low.

10.3 DISCUSSION OF ASSESSMENT

A comprehensive description and analysis of the archaeological and historical resource assessment of the Steepbank Mine project is provided in Historical Resources Impact Assessment Steepbank Mine Project Permit 95-083 (Golder 1996j).

As a result of mine development, two small prehistoric sites will be destroyed. The sites are located within the Local Study Area and will be affected by overburden removal related to the mining process. Mitigation is considered to have been accomplished by the documentation of the sites and the collection of the artifacts.

10.4 MONITORING

No further investigations are required. The study area as defined to date has been adequately examined by archaeologists. Additional historical resource investigations to inventory and assess paleontological, prehistoric and historic resources are not required in advance of construction.

11.0 ENVIRONMENTAL IMPACT ASSESSMENT SUMMARY

This EIA has extensively evaluated the impacts of Suncor's Steepbank Mine, expansion of production to 107 kbpcd and Lease 86/17 reclamation. Mitigations arising from the assessment have been incorporated into the mine design and will influence Suncor's operations of these facilities. The net impact of Suncor's developments on the community and the surrounding environment is detailed in Table 11.0-1 and are summarized below.

11.1 SOCIO-ECONOMIC IMPACTS

Development of the Steepbank Mine will ensure operations of Suncor's Oil Sands Group beyond the year 2000 and provide continued employment for its 1 700 existing employees and contractors. It will require an additional 100 employees by the year 2010.

The net benefit of the projects to residents of the Regional Municipality of Wood Buffalo is considerable. Over the life of the project, tax revenues to the municipality will exceed $300 million dollars. Local business will benefit in a major way from both capital and operating expenditures. Suncor spends about $90 million a year for local goods and services. Benefits to the Alberta and Canadian economies are also very significant.

Suncor is committed to ensuring the aboriginal communities in the Fort McMurray area share in the economic benefits of the project through development of jobs and business opportunities. There will be some displacement of traditional land use associated with development of the new leases. Progressive reclamation of Lease 86/17 and the Steepbank Mine with dry landscape technologies will open opportunities for re-development of traditional and other new land uses that will be of benefit to all community residents. To ensure effective land use planning, final decisions on Suncor's detailed reclamation strategy should be integrated on a regional scale with the programs being undertaken by the other oil sands operators and the forestry companies operating in the region.

The construction workforce required to build the Steepbank Mine project, facilities associated with the Suncor production expansion, the Solv-Ex project and Syncrude's Aurora Mine will increase to over

700 in 1999. However, community services and infrastructure should be able to handle the projected increase in both construction and and permanent residents.

11.2 HEALTH PROTECTION

Facility improvements associated with the Fixed Plant expansion will result in improved local and regional air quality. Even with the increase in oil production, odours will be reduced due to a lowering of total sulphur and hydrocarbon compound emissions from the plant. Similarly, concentrations of nitrogen oxides, ozone, sulphur dioxide and particulates in the air will be improved. The projected air quality improvements should further limit the potential for any health effects on local or regional residents.

Suncor does release water to the Athabasca River from its operations (mining, extraction, upgrading), and with time, releases of water from the reclaimed mining areas will have to occur in order to achieve sustainable reclamation. Studies done for this project indicate that the existing wastewater releases do not impact downstream water users. Indications are that future reclamation water releases similarly should not detrimentally impact Athabasca River water quality. This finding will be confirmed through time as additional information on reclamation release waters is collected and evaluated.

Reclamation of Lease 86/17 and the Steepbank Mine with consolidated tailings (CT) should not impact the health of future land users. However, there are some information gaps on metal uptake into vegetation and air emission releases from the consolidated tailings deposits and studies will be undertaken to confirm this finding.

Suncor believes that Steepbank Mine and the fixed plant expansion will not be detrimental to the health of the residents of the Regional Municipality of Wood Buffalo. To monitor this issue, Suncor is taking part in the Regional Community Health Study being undertaken by the Alberta Department of Health.

11.3 IMPACTS ON THE TERRESTRIAL ENVIRONMENT

Steepbank Mine will have to disturb the surface environment of the new leases until such time as reclamation can proceed. Fortunately, consolidated tailings technology provides a reclamation solution for fine tails that allows them to be incorporated back into a dry landscape. By the year 2020, an additional 1800 ha will be reclaimed on the combined leases (Lease 86/17 and the Steepbank Mine).

In the long term, mining and reclamation of the Suncor leases will result in a small net shift from wet to dry habitats. Existing bogs and fens in the upland areas will be lost to mine development, as well a small area of the Shipyard Lake wetlands. In turn, there will be an increase in wetland shrub habitats as the consolidated tailings deposits and the surface drainage courses are reclaimed. Relative to 1995, there will be some loss of closed jack pine and white spruce areas, and a substantial increase in deciduous and mixed-wood forests on the combined leases.

The implications of this terrain and vegetation shift for wildlife will be to create an actual long term increase in habitat for species like moose, black bear and grouse. The loss of mature spruce and mixed-wood forests has some negative implications for species like marten which prefer this habitat type. Concerns with regard to wildlife movement along the Athabasca River valley are tempered by the observation that strong north-south animal migrations were not observed in the 1995 field studies. Nevertheless, maintenance of a vegetation buffer along the river bank and the inclusion of a wildlife by-pass at the bridge should reduce any remaining concerns.

Development of the bridge, hydrotransport system and overburden disposal area in the river valley can be undertaken while still complying with the Draft Fort McMurray - Athabasca Oil Sands Subregional Integrated Resource Plan (Alberta Environmental Protection 1995). This plan emphasizes that the Athabasca River valley ecosystem is sensitive and must be protected. Mining will disturb the escarpment and its associated vegetation. However, the escarpment will be replaced with overburden and Suncor is committed to reclaiming the vegetation back to its present state. There will be a net loss of mature forest in the river valley, but it will be small in a regional context. Shipyard Lake wetlands will be reduced in size, but maintained in both the short and long term as a viable wetlands habitat. River valley wildlife will be protected by returning habitat through reclamation, and maintenance of a river vegetation buffer and bridge bypass that will maintain movement corridors.

The visual integrity of the Athabasca River valley will not be seriously impacted because of the Steepbank Mine overall setback from the river, and the maintenance of river vegetation buffer which will visually screen most of the valley facilities. Suncor will also take considerable care in ensuring mine and facility erosion will not impact river water quality. Studies to date have not found any unique historical resources or traditional use areas in the river valley disturbance area. Lastly, in order to ensure long-term maintenance of Athabasca River valley habitats, Suncor will remove all mining facilities, except the bridge, from the river valley by 2030.

At a regional scale, by the year 2020, the combined activities of Suncor, Syncrude, Solv-Ex, Alpac and Northland will affect certain habitats, especially white spruce dominant and mixedwood white spruce forests. Timber harvesting rather than oil sands development is the greatest factor contributing to this change. Correspondingly, there will be a substantial regional increase in closed deciduous forest. These changes have implications for wildlife management, many of which are positive. The 75% reduction in SO_2 emissions from Suncor will also improve the situation with regard to SO_2 impacts to vegetation and the potential for soil acidification.

11.4 IMPACTS ON THE AQUATIC ENVIRONMENT

Physical habitat alterations to the Steepbank River will be negligible since the mine will not daylight to the Steepbank River valley, and mine development will not alter river flows. The placement and construction of the bridge piers and abutments will not substantially affect fisheries habitat in the Athabasca River. Some low potential habitat will be lost at the mouths of small streams draining the Steepbank Mine Leases. These will be returned at mine closure through reclamation.

The aquatic ecosystem in the vicinity of the Suncor leases shows evidence that river biota are properly coping with background levels of hydrocarbons that naturally occur in the region. This exposure is not impacting overall ecosystem health. The existing fixed plant wastewater releases from the Suncor facility do not impact downstream water users, but could cause some low level fish tainting. Suncor will take action to deal with this issue.

A cumulative assessment of future operational and reclamation water releases to the Athabasca River from all sources indicated the impact on water quality and fisheries should not be significant. This will be confirmed through additional investigation and monitoring.

11.5 CONCLUSION

Suncor concludes that it can develop the Steepbank Mine and reclaim Lease 86/17 without significant negative effects to local or regional residents, nor the terrestrial or aquatic environments.

Substantial reduction in air and water emissions from plant facilities, plus the advent of consolidated tailings technology for reclamation, will allow Suncor to continue operations into the twenty-first century in a manner that is environmentally responsible. Suncor's commitment to its ongoing environmental management program will ensure that the impacts identified here are properly managed and mitigated.

TABLE E11.0-1
SUMMARY OF IMPACTS AND MITIGATING FACTORS AND IMPACT ASSESSMENT

Impact Hypothesis	Comments	Mitigation/Monitoring	Assessment
Socio-Economic			
effects on local economy from employment, procurement of goods and services and taxes (Hypothesis #1)	- construction expenditures: $336 million; 60% to remain in Alberta - Suncor will obtain $90 million in goods and services from local businesses - Suncor participates in ongoing training programs (e.g., Keyano college, career fairs) - Canadian GDP generation from Steepbank project is $7.3 billion; Alberta's share is $6.1 billion. Project tax generation is $3.5 billion; municipality's share is $305 million - operation will continue to generate royalties	- will work with local groups (e.g., Aboriginal Business Development Committee, Fort McMurray Chamber of Commerce) - preference to local suppliers of goods and services - preference to hiring local residents	**Construction:** positive, high. provincial/national extent **Operations:** positive, high provincial/national extent **Long Term:** not applicable
effects on services and infrastructure of Regional Municipality of Wood Buffalo from construction related activities and temporary workforces. (Hypothesis#2)	- demand for temporary services (e.g., hotel accommodation, restaurant meals, transportation) will increase	- Suncor works with the Regional Municipality of Wood Buffalo Standing Committee on Oil Sands Development - busing to worksite to reduce traffic - Suncor's work camp will house temporary workers - maximize employment of residents - will work with the Municipality and Alberta Transportation to address traffic safety on Highway 63	**Construction:** increased activity, low severity, local and regional effects **Operations:** not applicable **Long Term:** not applicable
operations-related employment during operations will impact local services and infrastructure (Hypothesis #3)	- will require about 350 additional workers (create community growth of <1%) - Suncor's contribution to municipal tax base ($305 million) will assist in infrastructure development	- busing to worksite will reduce traffic effects - Suncor works with the Regional Municipality of Wood Buffalo Standing Committee on Oil Sands Development	**Construction:** not applicable **Operations:** increase, low severity, for duration of operations, local and regional effects **Long Term:** not applicable

Impact Hypothesis	Comments	Mitigation/Monitoring	Assessment
quality of life and community stability (Hypothesis#4)	- mature community: expected changes can be easily assimilated	- Suncor will work with Municipality, Standing Committee on Oil Sands Development, political representatives, First Nations and others - will continue to bus employees to worksite and work with the Municipality and Alberta Transportation to address traffic safety - will continue to be involved in community programs	**Construction:** increase, low severity, local and regional Operations: increase, low severity, local and regional **Long** Term: not applicable
effects to traditional resource base and displacement of traditional activities (Hypothesis#5)	- traditional use in Local Study Area displaced - long term reclamation will restore uses	- traditional land users will help determine reclamation objectives - trappers from mine area have been compensated - training positions for aboriginals, Summer Employment program for students, provide work experience and employee training	**Construction:** decrease, high severity in Local Study Area context, low severity in regional context, local extent **Operations:** decrease, high severity in Local Study Area context, low severity in regional context, local extent **Long Term:** increase, high severity (i.e., improvement) in Local Study Area, low in regional context, local extent
cumulative effects on communities and quality of life from combined projects. (Hypothesis #6)	- mature community: expected changes can be easily assimilated - economic benefits to the community will be significant	- Suncor will work with Municipality, Standing Committee on Oil Sands development, political representatives, First Nations and others - will continue to bus employees to worksite and work with Alberta Transportation to address traffic safety issues on Highway 63 - will continue to participate in community programs	**Construction:** increase, low severity, local extent **Operations:** increase, low severity, local extent **Long Term:** not applicable

Impact Hypothesis	Comments	Mitigation/Monitoring	Assessment
Human Health			
effects on human health from water releases (Hypothesis #7)	- Suncor water releases does not and will not affect the health of people swimming and incidentally drinking river water	- further research related to naphthenic acids and refinery wastewater effluent.	**Construction:** low **Operations:** low **Long Term:** low
effects on human health from air releases. (Hypothesis #8)	- reduced emissions from plant will reduce potential for exposure to air emissions	- source emissions significantly reduced - cooperation with Regional Air Quality Coordinating Committee - Regional Community Health study being developed to investigate human health concerns	**Construction:** low **Operations:** low **Long Term:** nil
effects on human health from cumulative exposure to water and air emissions from Suncor and other developments in the region. (Hypothesis #9)	as above for water and air emissions	as above for water and air emissions	**Construction:** low **Operations:** low **Long Term:** low
effects on the health of people who use reclaimed landscapes. (Hypothesis #10)	- CT deposits are unlikely to affect health of future users, possible exception of accumulation of chemicals in plants	- testing and monitoring are underway to investigate consolidated tailings deposits and determine if mitigations would be advisable	**Construction:** not applicable **Operations:** not applicable **Long Term:** moderate
effects on health and safety of on-site workers. (Hypothesis #11)	- no change in worker exposure to risk results from Steepbank projects	- continuing commitment to industrial hygiene program - application of current loss management practices to detailed project engineering	**Construction:** nil **Operations:** nil **Long Term:** not applicable

Impact Hypothesis	Comments	Mitigation/Monitoring	Assessment
Terrestrial Resources			
effects on Valued Ecosystem Components in the Athabasca River and Steepbank River valleys (Hypothesis #12)	- escarpment landforms lost. Created dykes will restore some of properties of original landforms (e.g., landscape diversity, visual appearance) - mature vegetation associations will not be restored within a few decades of mine closure - within the Local Study Area, 21% of the river valley landforms will be impacted - in a Regional Context, approximately 7% of the Athabasca River valley will be affected.	In the Athabasca River valley, impacts will be mitigated by: - overburden (not sand) dykes will restore slope and landscape diversity - footprint of west waste dump on floodplain will be minimized - mine facilities (e.g., mine buildings, cyclofeeder) will be relocated out of the river valley by 2030. Steepbank River landforms will not be affected.	**Construction**: moderate severity locally; low severity regionally **Operations:** moderate severity locally; low severity regionally **Long Term**: low severity locally and regionally
effects on existing and future land use options (Hypothesis #13)	- dry landscape reclamation will create opportunities for variety of land uses - in the near and moderate term, land uses will be limited to oil sands development	- future land users will participate in the development of reclamation	**Construction**: low severity locally and regionally **Operations:** moderate severity locally, low severity regionally **Long Term**: positive, local and regional
effects on visual integrity of the Athabasca River valley. (Hypothesis # 14)	- most facilities screened from view - the appearance of new facilities is not out of context with the existing Suncor plant and mine - bridge will be permanent structure and visible to river travellers - overburden dykes will be reclaimed, but will present a different landscape profile than existing horizon	- setbacks and maintenance of natural vegetation buffer between river and most mine facilities - landform appearance essentially restored and revegetated.	**Construction**: moderate, local **Operations:** moderate, local **Long Term**: low, local
effects on biodiversity (Hypothesis #15)	- greatest loss of landforms within the Local Study Area is to Upland landform, which is well represented throughout the region - greatest loss of communities with a high potential for rare plants will be peatlands that are common in the region	- landform biodiversity restored with dry landscape reclamation - reclaimed vegetation associations will be diverse	**Construction**: low severity **Operations:** moderate severity locally, low severity regionally **Long Term**: low severity locally and regionally

Impact Hypothesis	Comments	Mitigation/Monitoring	Assessment
effects on wetlands (Hypothesis #16)	- impacts relate largely to reduction in size of Shipyard Lake - Steepbank development will affect about 0.1% of wetlands within the Regional Study Area	- reclamation of tailings ponds will provide more upland wetlands	**Construction:** low severity **Operations:** moderate local severity, low regional severity **Long Term:** increase
effects of air emissions to soils, vegetation and aquatic habitats (Hypothesis #17)	- major reduction in air emissions at Suncor source; improved air quality and reduced particulate and acidic deposition	- will continue to control emissions at source	**Construction:** low **Operations:** positive, low **Long Term:** low
WILDLIFE			
effects on wildlife populations as a result of habitat changes (Hypothesis # 18)	- none of the habitats types affected are of key importance within a regional context - expected reduction of 15 - 20 moose from population of about 75. - species requiring early successional vegetation types (e.g., deciduous forest) will have more rapid habitat recovery than species requiring mature vegetation types (e.g., mature white spruce forest) - reclamation will enhance habitats for some species (e.g., moose)	- vegetation clearing for facilities will be minimized - long term reclamation will enhance moose habitat, and restore habitats for other animals	**Construction and Operations:** Local Study Area: moderate severity for moose, wolf and terrestrial songbirds; low to moderate severity for lynx, fisher, marten, bald eagle and ruffed grouse; negligible or low for remaining VECs Regional Study Area: negligible or low for all species **Long Term:** Local Study Area: positive impacts on moose, black bear, marten, beaver and ruffed grouse; negligible to low severity for great gray owl, negligible impacts to other VECs Regional Study Area: impacts generally negligible
effects on abundance of wildlife as a result of mechanical noise and human activity (Hypothesis #19)	- moose, black bears, small herbivores and beavers unlikely to be disturbed by activity - wolves, terrestrial furbearers, river otters, raptors and waterfowl likely to be affected by activity	- berms constructed where possible to reduce sound transmission - treed buffers maintained around industrial and mechanical sites - during breeding and nesting, activities will be curtailed within 250 m of the bald eagle nest - no firearms or public access on the Steepbank Mine	**Construction and Operations:** Local Study Area: possible moderate impacts to wolf, lynx, and wolverine; unknown effects on fisher, marten, otter, great gray owl and ruffed grouse. Negligible or low impacts on remaining VECs Regional Study Area: low impacts to wolf and wolverine; negligible for other species **Long Term:** Local Study Area: no impact

Impact Hypothesis	Comments	Mitigation/Monitoring	Assessment
effects on abundance of wildlife as a result of direct mortality (Hypothesis #20)	- some direct mortality may result to young animals and birds and to small mammals during clearing and overburden removal - problem wildlife (i.e., bears and beavers) may be removed - wildlife/vehicle collisions	- workers encouraged to travel by bus to the worksite - avoid use of sodium chloride as de-icer on Suncor roads - dry landscape reclamation will minimize hazards associated with the tailings ponds - no public (including hunters) access across the bridge	**Construction and Operations**:low or no severity to all VECs in Local and Regional Study Area **Long Term:** no impact
effects on abundance of wildlife as a result of wildlife movement barriers or interference with population mechanisms (Hypothesis #21)	- the river valley is not a key movement corridor - aquatic mammals will be minimally affected because the river shore environment will remain largely unaffected; fisher and river otter movement affected by loss drainages - facilities and mine development could affect movements by moose, wolves, and lynx - habitat alienation minimized by a mine layout that is not scattered	- facilities removed from valley floor before 2030 - wildlife bypass constructed at the bridge - upland drainages restored after mine closure - development setback maintained along the Athabasca River, except for the barge landing, bridge and short section of access road - no disturbance to the Steepbank River valley	**Construction and Operations**: Local Study Area: moderate impacts to moose, wolf, lynx and fisher; low severity to black bear, marten and wolverine; negligible to other VECs Regional Study Area: low impacts to moose, black bear, wolf, lynx, fisher , marten and wolverine; negligible for other VECs **Long Term:** no effects
effects on wildlife resource use (Hypothesis #22)	- existing on-site use (e.g., trapping) will be displaced - reduced abundance of some wildlife (e.g., moose) within Local Study Area during mining; increased habitats after reclamation	- habitats will be restored - displaced trappers compensated	**Construction and Operations:** Local Study Area: high impact Regional Study Area: low impact **Long Term**: no effect
effects on biodiversity (Hypothesis #23)	- developments in the Athabasca River valley will affect landscapes and vegetation communities with high biodiversity	- diverse landscapes, including wetlands will be restored - native species used for reclamation	**Construction andOperations**: Local Study Area: moderate impacts Regional Study Area: low **Long Term:** Local Stiudy Area: negligible to low Regional Study Area: negligible
SURFACE AND GROUNDWATER RESOURCES			
effects on flows in the Athabasca and Steepbank Rivers (Hypothesis # 24)	- low changes <1%	- none required	negligible effects

Impact Hypothesis	Comments	Mitigation/Monitoring	Assessment
effects on hydrological/aquatic systems and downstream users from ice jams, floods or other hydrogeological events (Hypothesis #25)	- all structures (except bridge) above 1 in 100 ice jam flood level - bridge structure designed to accommodate ice and flooding events	- coffer dams removed and ice bridge decommissioned before breakup	negligible effects
effects on navigation along the Athabasca River (Hypothesis #26)	- navigation not affected	- bridge designed to accommodate navigation	negligible effects
effects on groundwater quality from contaminant migration (Hypothesis #27)	- CT drainage water similar to existing groundwater quality	- spill prevention mitigations - continuous monitoring to detect problems	negligible effects
AQUATIC RESOURCES			
effects on aquatic habitat in the Steepbank River (Hypothesis #28)	- negligible changes to groundwater flows to river; no physical effects because of setback	- setback from Steepbank escarpment	**Construction:** negligible **Operation:** negligible **Long Term:** negligible
effects on aquatic habitat in the Athabasca River (Hypothesis #29)	- minor changes to aquatic environment during bridge construction - Unnamed, Leggett and Wood Creeks and Shipyard Lake affected during mine operations	- construction scheduling for in-stream facilities to avoid spawning periods - sedimentation prevented during construction and operations by run-off management and retention basins - ice bridge decommisioned removed before spring break-up - setback for all facilities, except bridge, barge landing and small sections of access road - drainage basins restored to provide equivalent on better aquatic habitat than currently available - flows to Shipyard Lake adjusted to provide for habitat requirements	**Construction**: low severity, short term, local extent **Operation:** low severity, short term, local extent **Long Term**: nil

Impact Hypothesis	Comments	Mitigation/Monitoring	Assessment
effects on aquatic ecosystem health from water releases (Hypothesis #30)	- minimal changes to water quality - effluent from plant operations will meet effluent standards	- continual improvements to wastewater treatment system - mine drainage water will be recycled - spill prevention and containment measures - flows to Shipyard Lake adjusted to provide for aquatic ecosytem health	**Construction**: negligible **Operation:** negligible **Long Term**: negligible
effects on fish tainting from water releases (Hypothesis #31)	- some evidence that refinery wastewater can taint fish	- studies to better define potential for tainting and cause of tainting are underway	**Construction**: moderate severity, local extent **Operation:** moderate severity, local extent **Long Term**: negligible
effects on fish abundance (Hypothesis #32)	- no changes to fish populations expected	- as above for 29, 30, 31	**Construction**: negligible **Operation:** negligible **Long Term**: negligible
effects on availability and quality of fish for resource use (Hypothesis #33)	- impacts relate to potential fish tainting. See above.	- as above for 32 and 33	**Construction**: moderate severity, local extent **Operation:** moderate severity, regional extent **Long Term**: negligible
effects on water quality that might limit downstream water use (Hypothesis #34)	- water quality changes resulting from both operations and reclamation will be negligible	- as above for 30	**Construction**: negligible **Operation:** negligible **Long Term**: negligible
AIR			
effects to global climate change (Hypothesis # 35)	- marginal increase in total CO_2 production, although emissions per unit of production will decrease - more efficient capture of waste heat - hydrotransport, and location of mine facilities to maximize energy efficiency of ore transport contribute to CO_2 reduction	- Suncor is committed to voluntary climate challenge - continuing improvements to energy efficiency through environmental management program and continuing technological improvements	**Total emissions:** 5% increase in CO_2 emissions during plant operations, with global interaction **Efficiency:** 21% reduction in CO_2 emissions during plant operations, with global interaction

Impact Hypothesis	Comments	Mitigation/Monitoring	Assessment
HISTORICAL			
effects to archaeological, paleontological or historical resources (Hypothesis #36)	- extensive archaeological surveys identified two isolated finds of limited significance	- no mitigations necessary	low degree of concern

APPENDIX I

BITUMEN RECOVERY TECHNOLOGIES

BITUMEN RECOVERY TECHNOLOGIES

1.0 INTRODUCTION

At the end of 2001 mining of oil sand is expected to be completed on Suncor Lease 86/17. A new mine, utilizing efficient mining and processing methods (Steepbank Mine) will then commence operations on the east side of the Athabasca River.

In order to select the most cost-effective mining system several different technologies have been studied by Suncor. This Appendix reports highlights from those studies.

2.0 BITUMEN RECOVERY TECHNOLOGY REVIEW

This section reviews the main alternative technologies vying for a position in the process of recovery of bitumen from a new mine. There have been significant efforts made in the development of each of these concepts and they are all championed by reputable entities (AOSTRA, Syncrude, Suncor, industry task forces). Suncor's goal in the review of these technologies was to determine if any technology has reached a stage in development where it could either replace or augment Suncor's production from a future mine.

2.1 SAGD PROCESS

The Steam-Assisted Gravity Drainage (SAGD) bitumen recovery system utilizes technology developed at the Alberta Oil Sands Technology and Research Authority (AOSTRA) Underground Test Facility (UTF). This process or mining system can be used to recover bitumen either by underground or by surface methods. Suncor is a member of the UTF Industry Partners.

The SAGD system requires placement of one horizontal well in the oil sand immediately above the Devonian limestone. A second horizontal well is placed approximately three to five metres above the first. Initially both wells are steam injectors until a connection is made between them. As steam is injected in the upper well a mixture of oil and condensed steam is recovered from the lower well and then pumped to the surface for water removal. Chemical demulsifiers and diluents are used to separate bitumen from water; in Suncor's case either a wet or dry product would be created. The wet process generates a product containing 65% bitumen, 30% diluent and a maximum of 5% water;

wet product can be sent to the Extraction plant for water removal. The dry product contains less than 0.5% bottom sand and water plus 50% bitumen and 50% diluent, and it can be sent directly to the Upgrader.

During the past several years Suncor has been investigating alternative technologies that may provide additional or replacement bitumen production at a cost lower than the Clark hot water extraction process. As a result Suncor entered into an agreement with AOSTRA in 1991 to carry out a study on the economics of producing bitumen from two of Suncor's oil sand leases using the SAGD process.

Two areas considered for development are Leases 17 and 98. Lease 17 contains a small remnant of the existing mining area in its southwest corner. Advantages in development of Lease 17 include use of Suncor's Utilities plant for injection steam (excess steam from the plant can be supplied at low cost) and ability to utilize existing infrastructure. Two production rates were examined (5 000 bpcd and 10 000 bpcd). Lease 98 is located 45 km north of Suncor's plant on the east side of the Athabasca River. This site (called the Green Field Site) was chosen for a stand-alone development. The economics of three production rates (40 000 bpcd, 60 000 bpcd and 90 000 bpcd) were studied. Costs of a hot water extraction plant linked to a surface mine were also estimated for comparative purposes.

The bitumen recovery system used for the Lease 17 and Lease 98 cases is based on underground access; ramps are driven from the surface to the Devonian limestone. A series of horizontal drifts (tunnels) is placed 15 m below the surface of the limestone. These drifts (approximately 5 m x 5 m in size) will provide access to the drill sites for workers, materials and productive pipelines. The wells are drilled upward into the oil sand formation and once the oil sand is reached the holes are flattened to a horizontal position. The well pairs average 500 m to 700 m in length and are approximately 70 m apart. A typical well pairs layout is shown in Figure I-1.

The SAGD process study estimated the capital and operating costs of delivering either wet or dry bitumen product to the Suncor plant. Operating costs for both cases were considerably higher than for Suncor's existing methods of mining and extraction. The capital cost of each case was high compared to the cost of developing new production from Steepbank Mine using truck and shovel surface mining linked to hydrotransport. Therefore the SAGD process cannot at the present time compete with Suncor's existing infrastructure.

Since this study was completed in 1992 several new developments have occurred including improvements in drilling technology that have made it possible to drill horizontal parallel holes from the surface with reasonable success.

Suncor has also acquired Lot 2 which is located at the southern boundary of Lease 86. This lot contains a relatively-small ore body which is not suitable for exploitation by surface mining but which may be suitable for SAGD. In addition, Suncor is planning to expand its Upgrader capacity. A new and inexpensive source of bitumen would be attractive during the period of phasing-out of the existing mine and development of Steepbank Mine. As a result of these changes Suncor examined the feasibility of developing Lot 2 by use of the SAGD process in combination with surface drilling.

The study was based on production of 5000 bpcd in 1998 followed by production of 10 000 bpcd in 1999. Pairs of wells would be drilled at a 32° angle and would become horizontal at a distance of 60 m. Twenty-six pairs of wells are required to produce 10 000 bpcd. Minimum depth of cover over the oil sand is approximately 30 m to 70 m; in several locations the ore body is covered by only 30 m of overburden. Lower-than-normal operating pressures would be required so mining of this ore body can take advantage of low-cost steam from the Utilities plant.

Capital costs for developing Lot 2 are high compared to the cost of supplying bitumen from Steepbank Mine. However, operating costs are attractive and this provides an incentive for pursuing this technology further. In addition to the high capital cost this ore body presents several disadvantages that may increase operating costs. Operating at low pressures may generate unforeseen technical difficulties. Strength and thinness of the overburden may result in loss of steam. The ore body contains several shale barriers (that may restrict the flow of bitumen) or it may have mobile water zones (that will remove steam). A unique drill has to be built to drill 32° holes. Low bitumen recovery, and surface subsidence and heating are also possible. For these reasons the Lot 2 ore body is considered a high risk and not suitable for development at the present time. Suncor plans to continue exploration for ore bodies that are located close to the Utilities plant and have more suitable geology.

Suncor's Resources Group owns the Burnt Lake property north of Cold Lake (which has geology more suitable for a SAGD process) and it has recently announced plans to develop a test SAGD facility on this site. Drilling and construction will begin in 1996. Steam injection should begin in late 1996, with production expected to reach 2.5 kbpcd. If Phase 1 is successful construction of Phase 2 (designed for a production rate of 12.5 kbpcd) could begin in 1999.

2.2 TACIUK PROCESS

The Taciuk Process was developed in the late seventies by Mr. Bill Taciuk. A commercial arrangement was subsequently made with the Alberta Oil Sands Technology and Research Authority (AOSTRA) and the process has since been called the AOSTRA Taciuk Process (ATP).

ATP technology is based on the retorting of oil sands in a rotating vessel. Products from the vessel are treated by conventional upgrading methods to produce a synthetic crude oil. A simplified schematic of the ATP process is shown in Figure I-2.

This figure identifies the main features of the process. Oil sand is conveyed into the vessel and enters a pre-heat zone where oversize material is rejected. The remaining oil sand passes into the reaction area of the vessel where it is mixed with recycled hot sand. Then mixed material enters the combustion area where most of the heat is generated by burning coke residue left on the sand (auxiliary heat is provided by natural gas). A hot, dry tailings is produced from the cooling zone and the hydrocarbon vapours are sent to a distillate recovery unit. The main advantage of this system is the utilization of coke to produce the heat necessary to separate the hydrocarbons from the sand.

An ATP oil sands pilot plant was built in Calgary in 1992 to test this process. The capacity of the plant is five tonnes per day and results of the test work have been favourable, indicating that ATP may have commercial application. This development led to a joint venture task force being formed to examine the economics of ATP. The group (called the AOSTRA Taciuk Process (ATP) Demonstration Commercial Oil Sands Mining Joint Industry AEOSRD Task Force and including Suncor Inc. as a member) was formed in 1994 with its main purpose to determine the economics of this process when it is used on a commercial scale.

Task force investigation estimated capital and operating costs for a plant capable of processing 105 000 tpcd of oil sand (at an average grade of 10.54% bitumen) which would require five ATP processors (each with a rated capacity of 1029 t/h). Truck and shovel mining methods would be used to produce oil sand feed for the plant. Dry tailings from the ATP process would be mixed with recycle water to produce a slurry suitable to be pumped to the mine for disposal. The ATP distillate product would be hydrotreated to produce 11 800 m^3/d of synthetic crude oil.

Capital costs of developing a new plant as described previously cannot compete with costs of an existing facility. Additional or replacement capacity at the Suncor mine site can be developed at a much lower cost using the existing Extraction plant, Upgrader plant and upgrader. Therefore ATP is not a competitive process for implementation at Steepbank Mine. In the future this process may prove to be a competitive method of developing a completely-new oil sand deposit on a stand-alone basis. Further testing is planned at a five-tonne-per-day pilot plant located on the Suncor mine site which will operate on run-of-mine ore for one year.

2.3 TRUCK AND SHOVEL MINING

Suncor has used bucketwheel mining methods for over twenty years to exploit its oil sand deposits. This method requires stripping of overburden with conventional truck and shovel technology and then excavating oil sand with bucketwheels from three active mining faces. Oil sand from the bucketwheels was transported (by a beltwagon onto a sloping grizzly positioned over a face conveyor) through a system of movable 1.5 m wide conveyors and more permanent 2.1 m wide trunk conveyors to the Extraction plant. By the late 1990s the limitations of this system were becoming evident: it was inflexible and was having difficulty handling more-complex geological conditions. Also, the system was expensive to operate and was not generating the cash flow necessary for a new mine development. These factors as well as others provided incentive to examine the viability of alternative mining methods for reduction of operating costs.

By the early 1990s large, 44 m^3 shovels and 218-t-capacity trucks were commonplace in the mining industry. This equipment had a reputation for achieving low operating costs and high productivities. In addition large, double-roll crushers had been developed to handle sticky or frozen oil sand at production rates of 5000 to 7000 t/h, providing a key link between truck and shovel mining and the conveyor feed system.

In 1992 Suncor decided to evaluate the benefits of changing from a bucketwheel mining system to a truck and shovel mining method. This latter method would utilize 44 m^3 shovels and 218-t trucks to remove overburden and oil sand. The mining equipment itself is interchangeable between the activities. Overburden is either hauled to waste dumps or is used to construct tailings dykes. Oil sand is hauled by trucks to the in-pit double-roll crusher where the ore is reduced to 40 mm and then placed on 2.1 m wide conveyors, to be sent six kilometres to the Extraction plant. In order for a truck and shovel system to work successfully in oil sand good-quality roads have to be built and maintained. Wet weather can stop a truck and shovel operation in oil sand unless well-built haul roads are available.

Truck and shovel mining has several advantages over bucketwheel mining. These advantages are summarized below:

- high productivity and availability can be achieved;
- equipment can be interchanged between overburden and oil sand operations;
- truck and shovel methods can deal more effectively with complex geology and restrictive operating conditions;
- overburden haul distances are reduced (conveyors no longer interfere with haul routes);
- a steady and better-conditioned oil feed is provided to the Extraction plant;
- a reduced operating and maintenance workforce is required;
- a change in technology provides opportunity to improve work practices; and
- overall it's a simpler mining method for management and planning.

The evaluation disclosed a savings of 50% in operating costs due to the advantages described above so the decision was made to implement the new mining scheme. By the end of 1993 a complete conversion to truck and shovel mining had taken place. A better-than-expected reduction in operating costs occurred in 1994. As a result of these improvements truck and shovel mining was selected as the best method for developing new mine sites and was incorporated into the subsequent pre-feasibility and Steepbank Mine-feasibility studies.

2.4 HYDROTRANSPORT

Hydrotransport is an oil sand processing and transportation system that has been under investigation by Syncrude Canada Ltd. for the past ten years through both pilot plant testing and operation of a full-scale system for two years. In this testing the oil sand is hauled to a Krupp double-roll crusher (capable of handling up to 5000 t/h) where it is reduced to 40 mm and then conveyed to the cyclofeeder where hot water and recycled slurry are added. The slurry is then screened to 10 mm, dropped into a pump box, and then pumped approximately 2 km through a 61-mm-diameter pipe to the Extraction plant where the slurry by-passes the tumblers and is distributed to the separation cells.

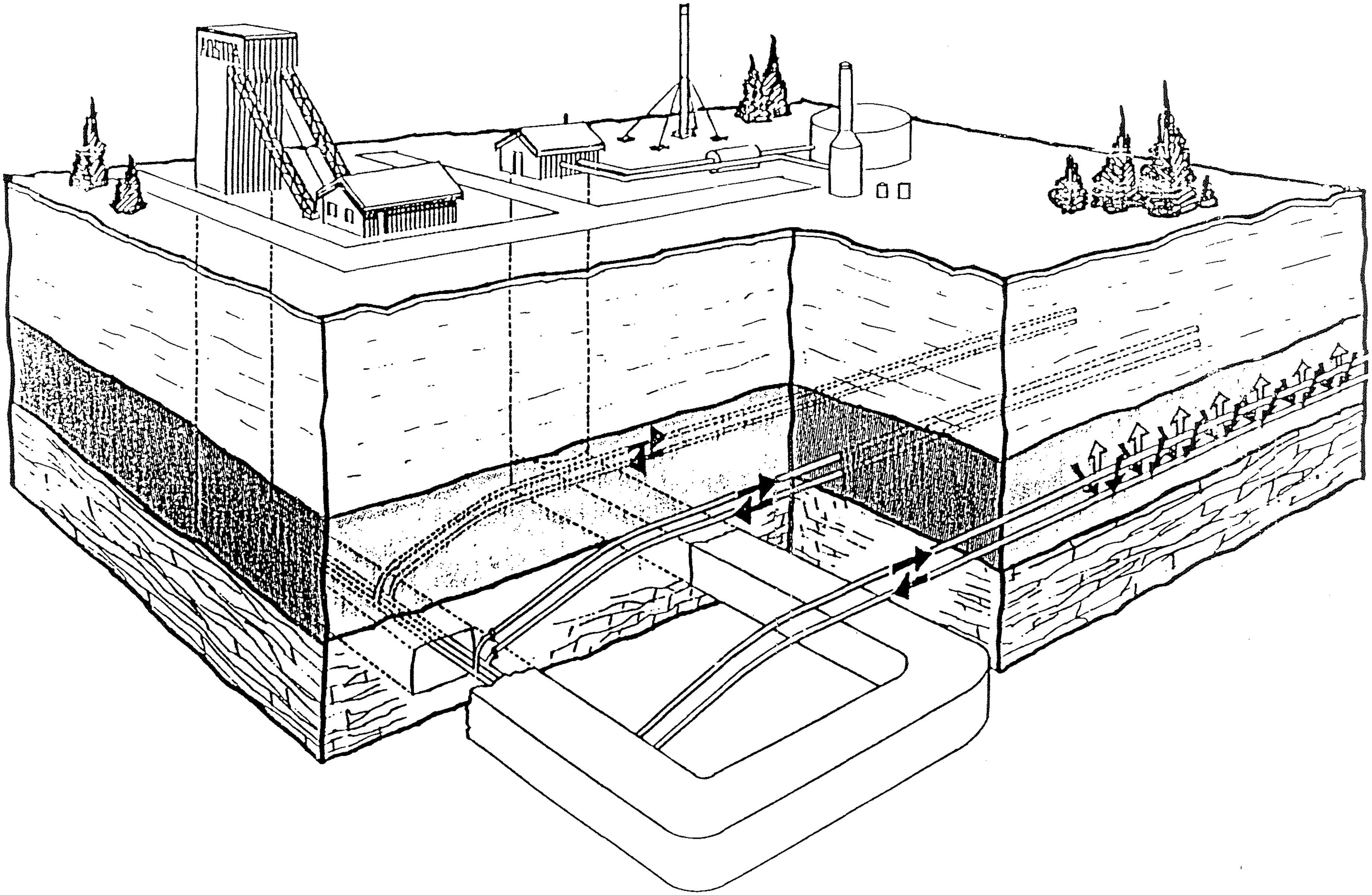
Operation of this test facility has been successful and it has become an important auxiliary source of Syncrude's plant feed.

Hydrotransport of oil sand from the mine site to an Extraction plant has several advantages. Transportation costs are less than for a conveyor system. Hydrotransport eliminates the use of tumblers through the conditioning of the ore in the pipelines. The process uses less energy by allowing bitumen separation at 55°C instead of 85°C. Capacity of the system is not reduced by increased distances as it is in conveyor systems. Hydrotransport permits greater flexibility in planning so it can be used to exploit small and remote ore bodies.

As a result of these advantages and the success of Syncrude's full-scale test Suncor has purchased this technology and is now a partner in its future development. The main objective of buying this technology is to reduce the costs of developing and operating off-site leases.

2.5 DESANDING PLANT

A desanding plant may be required where an ore body is located more than eight km from an Extraction plant as at these distances the cost of transporting oil sand and coarse sand tailings becomes very high. A desanding plant would be designed to remove the coarse portion of sands from conditioned slurry delivered by a hydrotransport system. Technical work completed to date indicates that a desanding plant would provide a less-costly means of transporting and processing oil sand at distances greater than eight km from an Extraction plant. Therefore while a desanding plant (working in tandem with a hydrotransport system) may provide an economical method of exploiting remote ore bodies (such as on the east side of the Athabasca River), this process has not been proven and a considerable amount of research work still has to be completed. Testing has to be done to determine if a hot water/bitumen mixture can even be pumped over long distances. Since this technology may have application in Suncor's long-term plans the company will continue to be involved in the development of this process.



UNDERGROUND TEST FACILITY

FIGURE I–1

Taciuk Process

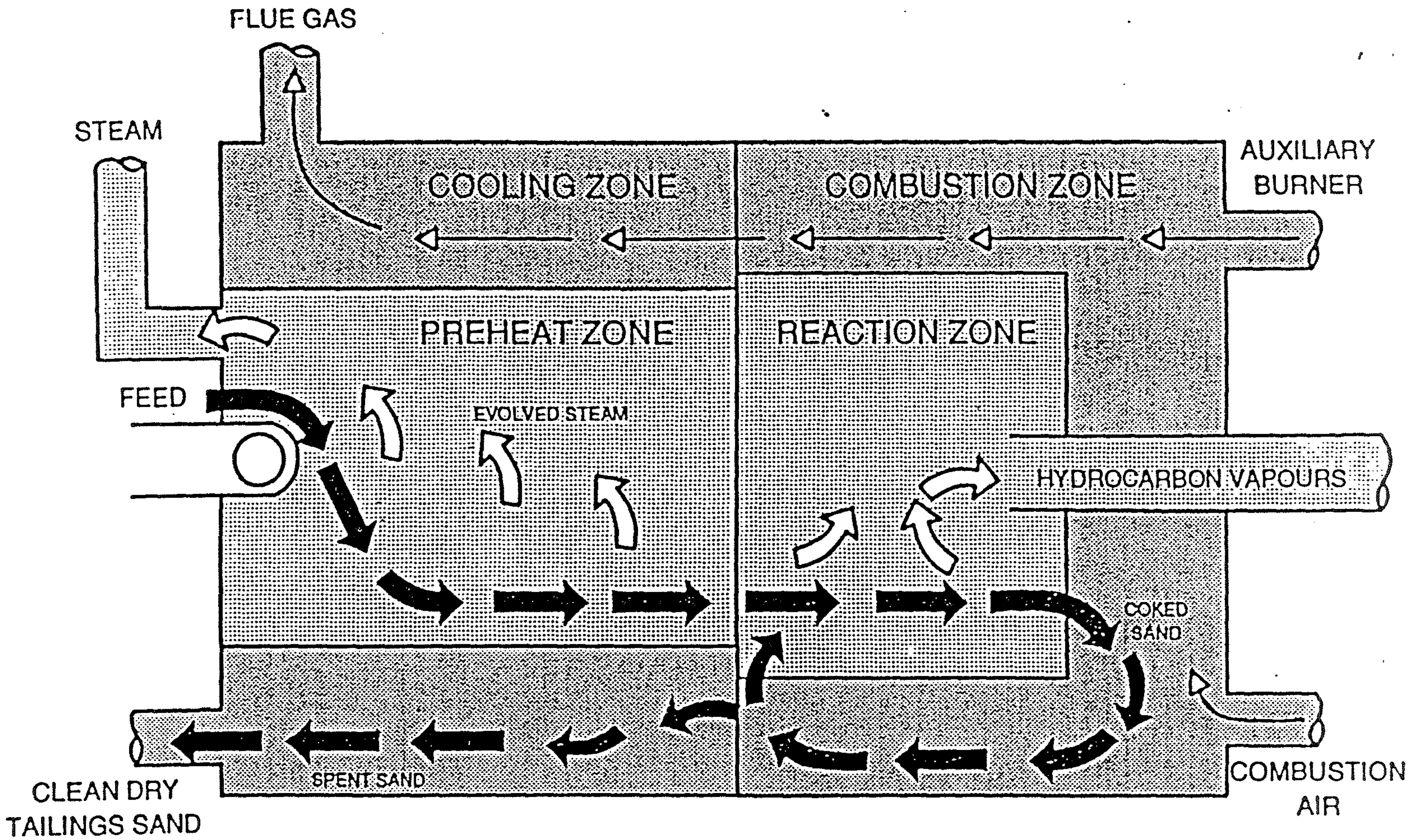


FIGURE I–2

APPENDIX II

LIST OF SUNCOR'S ENVIRONMENTAL ACTIVITIES AND INITIATIVES SINCE 1990

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990		
	Project Summary	**Value ($k)**
AIR EMISSIONS	Odour Abatement 1	3200
	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	2500
	Flue Gas Desulphurization Plant	120 000
	Plant 35 Coker Gas Utilization	60
	Electrostatic Precipitator Reliability Upgrade	80
	Air Conditioner Coolant Changeover	160
	Total Expenditure on Air Activities and Initiatives:	**158 910**
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	3000
	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	2045
	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:	**9690**
WATER TREATMENT AND POTABLE WATER	Upgrade of Potable Water Plant	2716
	Clarified Water to Water Treatment Facility	53
	Reverse Osmosis	11 000
	Emergency Water Supply	400
	Firewater System	8000
	Total Expenditure on Water Treatment and Potable Water Activities and Initiatives:	**22 169**

Appendix II: List of Suncor's Environmental Activities and Initiatives since 1990 (Continued)

Project Summary		Value ($k)
ENVIRONMENTAL DILIGENCE	Environmental Auditing	329
	Community Consultation	100
	Environmental Impact Assessment Projects	654
	Total Expenditure on Environmental Diligence Activities and Initiatives:	**1083**
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	3343
	Sulphur Pit Reclamation	1332
	Coke Pile Modifications	200
	Fine Tailings Transfer	7391
	Pond 1 Reclamation	780
	Wildlife Monitoring Programs and Raptor Enhancement Program	50
	Research - Wetlands Research	3088
	- Sustainable Lake Research	
	- Environmental Implications of Dry Landscape Technologies	
	- Reclamation Landscape Model	260
	Oil Sands Reclamation Performance Assessment Protocol	5970
	Freeze-Thaw Treatment of Fine Tailings Project and Non-Segregating Tailings Field Assessment Projects	15
	Reclamation Rooting Study	175
	Erosional Resistance of Tailings Sand Dykes	75
	Ecological Sustainability of Revegetated Areas of Tailings Sand Dykes	47
	TID Toe Berm Erosion Assessment	5000
	Consolidated Tailings Commercial Trial	
		27 726
	Total Expenditure on Reclamation Activities and Initiatives:	
Total Expenditure on Environmental Activities and Initiatives		**220 008**

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	3200	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	1500	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
		1000	Added piping to send stripped sour water and slop tank pump-outs to Extraction Naphtha Recovery Unit	Stripped 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
		3000	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 (Continued)				
Superclaus	1994	15 000	Addition of a common 4th 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	Program 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 improvement of 5% (from 68% to 73%)
Reduction of SO_2 Emissions	1994 to 1995	2500	Burning of natural gas rather than coke; purchase of power	Reduction of SO_2 emissions from Power house to ensure compliance with 90-day rolling average

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)				
Project	**Date**	**Value ($k)**	**Description**	**Impact**
AIR EMISSIONS (Continued)				
Flue Gas Desulphurization (FGD) Plant	1994	120 000	FGD plant site 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 subtances in mine equipment air-conditioning units	Part of Suncor's program to eliminate regulated ozone-depleting subtances
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 groundwaters from oil sands development activities
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

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
WATER EMISSIONS (Continued)				
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 make-up 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 fresh water 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 impact environment
Ring Dam Water Project	1993 to 1994	150	Elimination of fresh water addition to disc centrifuge process	Improved recovery and water conservation
Sewage Treatment System Upgrade	1995	2045	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

Appendix II: List of Suncor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
WATER EMISSIONS (Continued)				
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:		9690		

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	2716	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 4900 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 7 mos of 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 consitency 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
Firewater System	1995	8000	Upgrading of Suncor's firewater system - improved provision of water supply for emergencies	Improvement in Suncor's capability to address emergencies
Total Expenditures on Water Treatment and Potable Water Activities and Initiatives:		22 169		

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 initatives 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 Projects	1995	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 consitions 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	
Total Expenditures on Environmental Diligence Activities and Initiatives:		1083		

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	30m 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	3343	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	1332	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	7391	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	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 Sucnor's Environmental Activities and Initiatives Since 1990 (Continued)

Project	Date	Value ($k)	Description	Impact
RECLAMATION (Continued)				
Wetlands Research	1991 to 1995	3088	Evaluation of potential for employment of constructed wetlands for treatment of wastewaters from oil sands 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 (Continued)				
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	5970	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 (Continued)				
Ecological Sustainment of Revegetated Areas of 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	5000	Initiation of project to assess full implementation of consolidated tailings technology	Elimination of fine tailings
Total Expenditures on Reclamation Activities and Initiatives:		27 726		

APPENDIX III

PLANT PROCESS BALANCES

PLANT PROCESS BALANCES

1.0 INTRODUCTION

1.1 PROPOSED EXPANSION

Suncor is proposing the expansion of its plant capacity from its current gross production capacity of 79.5 kbpcd (12 639m^3/cd) to 107 kbpcd (17 012 m3/cd) by late 1998, with an intermediate step of 87 kbpcd (13 832 m^3/cd) by mid-1987. Average net production (products marketed) is less than gross production by up to 2 kbpcd due to internal consumption.

1.2 CALCULATION BASIS

All balances are reported in gross measurements per calendar day. Stream day data is also provided for hydrocarbon, sulphur and Extraction balances. All balances were derived through use of best professional judgment and are based on process engineering models of plant performance 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. The component and energy balances for the 87 kbpcd and 107 kbpcd cases are compared to the 79.5 kbpcd (12 639 m^3/cd) base case.

1.3 PURPOSE OF CALCULATIONS

Suncor maintains production control and measurement practices in its operations. Primary emphasis is given to operating criteria in the areas of:

- products and production;
- bitumen extraction and hydrocarbon recovery;
- sulphur recovery;
- water intake, disposal and recycle;
- waste processing and disposal;
- energy consumption; and
- air emissions.

Systems have been developed to measure, monitor, and report data that will ensure that:

- operations are effective; and
- Suncor meets its licence requirements.

Three of the existing operating criteria are:

- 91% overall bitumen extraction recovery;
- 98% sulphur recovery; and
- 99.1% diluent recovery.

1.4 KEY ASSUMPTIONS

The following key assumptions were used in determining the material and energy balances:

- bitumen in oil sand is 12% for the 79.5 kbpcd and 87 kbpcd cases, and 11.7% for the 107 kbpcd case;
- all surplus generated power can be exported; and
- the diluent to bitumen ratio is 0.86 by volume.

Although not part of the expansion project, the following projects are implemented by the time 107 kbpcd capacity is reached:

- a third turbo-generator unit;
- a system to capture and re-use continuously flared emissions;
- ammonia destruct modifications to the sulphur plant;
- hydrogen purification vent condensers;
- hot diluent coupling projects; and
- 18 days of flue gas desulphurization outage effect is based on seven planned summer days during a main boiler outage and 11 unplanned days.

1.5 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); and
- recognized and frequently used industrial recommended practices (e.g., API) standards.

Specifications and standards of conformity apply to:

- installation,
- calibration,
- data collection, and
- data calculation and conversion.

1.6 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. The AEUB and Suncor are currently developing a methodology which will demonstrate the validity of the bitumen and diluent measurement.

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 metre proving, conform to recognized and certifiable standards. Monitoring programs are in place to identify deviations from expected recoveries or potential metering issues.

1.7 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. The report is organized by specific products and feedstocks.

2.0 PLANT BALANCES

2.1 HYDROCARBON BALANCE

The hydrocarbon balances are shown in:

- Figure III-1 and Table III-1 for the 79.5 kbpcd (12 639 m^3/cd) production rate,
- Figure III-2 and Table III-2 for the 87 kbpcd (13 832 m^3/cd) production rate, and
- Figure III-3 and Table III-3 for the 107 kbpcd (17 012 m^3/cd) production rate.

The hydrocarbon balance changes proportionally when production is increased to 87 kbpcd. The hydrocarbon balance changes most significantly in the 107 kbpcd case with the implementation of hydrotransport of oil sand and vacuum stripping of bitumen.

The extraction process fraction of feed bitumen lost to rejects is not expected to change in the 87 kbpcd) case as the 6-foot by 16-foot (1.8 m by 4.9 m) reject screens will be replaced with 8-foot by 20-foot (2.4 m by 6.1 m) screens. The loss of bitumen to rejects will decrease at the 107 kbpcd stage with the recrushing and rescreening process that will be implemented as a part of the Steepbank Mine operation.

The recovery of diluent fed to the extraction process will be enhanced in the 87 kbpcd case to 99.3%. This will be sustained at 99.3% for the 107 kbpcd production level.

A potential reduction in average bitumen recovery is expected as a result of the lower average grade ore (higher fines) in the Steepbank Mine. A number of options for increasing bitumen recovery are being pursued to ensure suitable resource recovery is achieved

Virgin oil production increases in the 87 kbpcd case with the introduction of the heavy atmospheric gas-oil draw. The vacuum unit will significantly increase virgin oil production in the 107 kbpcd stage of the expansion. This will reduce the load on the cokers and will change the yield structure of the coker products.

Gross liquid yield on bitumen across upgrading will remain unchanged from current in the 87 kbpcd.

At the 107 kbpcd stage, the gross liquid yield on bitumen will improve to 85.4% (from 83.9%) contributing to overall site energy efficiency. This is attributed to the vacuum unit removing the virgin oil from the coker charge. If it were not removed, the virgin oil would crack into fuel gas and coke.

The amount of coke produced will increase proportionally with production during the 87 kbpcd stage of expansion, while the quantity of coke used as fuel in utilities will increase by 3.3% from the base case. The net effect is that the quantity of coke stockpiled will increase by 20% from the base case during the 87 kbpcd stage of expansion.

With the addition of the vacuum unit and increased use of atmospheric draws in the 107 kbpcd stage of expansion, the coke yield on a bitumen feed basis (to upgrading) will decrease by 5.5%. The quantity of coke used as fuel in utilities will increase by 14% from the base case for the 107 kbpcd stage of expansion. The net effect is the quantity of coke stockpiled will increase by 40% from the base case during the 107 kbpcd stage of expansion.

There will be no changes in the Unifiner yields from the base case.

Coker blends and virgin oil sales will increase to 34% of total sales by the 107 kbpcd stage of expansion.

2.2 WATER BALANCE

The water balance for 79 kbpcd , 87 kbpcd and 107 kbpcd is shown in Figure III-4 and Table III-4. At the 87 kbpcd stage of expansion, the total water intake from the Athabasca River will decrease by 28 272 m^3/cd (25%) from the base case as a result of modifications in extraction, upgrading, and utilities. Similarly, the total water intake will decrease a further 1214 m^3/cd (29 486 m^3/cd, 26%, overall from base case) at the 107 kbpcd.

Changes to the fresh water pond in the 87 kbpcd) case will reduce the quantity of once-through cooling water by about 36 750 m^3/d (70%) through increased on-site recycle. This will be maintained at the 107 kbpcd production level.

Wastewater outfall will decrease by 7000 m^3/d (24%) by the time 107 kbpcd production level is reached as a result of reuse and recycling initiatives. Total water discharge to the Athabasca River will decrease by about 33 750 m^3/cd (37%) from the base case at the 87 kbpcd production level. The total water discharge will decrease by 42 630 m^3/cd (46%) from the base case at the 107 kbpcd case.

The net accumulation of water in the tailings pond system will increase by about 13 000 m^3/d from the base case to the 107 kbpcd case, commensurate with the increase in production rate. Consolidated tailings technology will, within 8 to 10 years, decrease external water consumption as make-up water will be replaced by water released from the tailings solids as they consolidate.

In primary extraction, sparge steam will be eliminated with the introduction of hydrotransport technology, thereby reducing vent water losses. Vent water losses from froth heating will increase as a result of a higher temperature differential (separation cells will be run at cooler temperatures) and increased throughput at the 107 kbpcd production level. The net effect will be a 696 m^3/cd reduction in extraction vent water losses.

Total vent water losses from the upgrader will decrease by 1443 m^3/cd (70%), largely as a result of modifications to condense the process vent stream from the hydrogen purification unit (part of Suncor's submission to the Canadian Climate Change Voluntary Challenge and Registry Program, a program to reduce greenhouse gas emissions).

The quality of water discharged to the Athabasca River will be unaffected by the fixed plant expansion modifications.

A breakdown of streams 13 (steam and water supply to Upgrading), 17 (steam and process water from upgrading to Extraction) and 24 (steam and water from Utilities to Extraction) of the water balance is shown in Table III-5.

2.3 SULPHUR BALANCE

The sulphur balances are shown in:

- Figure III-5 and Table III-6 for the 79.5 kbpcd production rate,
- Figure III-6 and Table III-7 for the 87 kbpcd production rate, and
- Figure III-7 and Table III-8 for the 107 kbpcd production rate.

The sulphur being sent to the utilities plant will be removed in the gypsum once the flue gas desulphurization plant is on line. This will reduce the SO_2 emissions from the utilities stack by 91% to 95% (75% plant wide).

The tail gas and elemental sulphur will increase proportionally to production rate at the 87 kbpcd stage of expansion. There is essentially no change in these from 87 kbpcd to 107 kbpcd as a result of increased sales of sour products.

The continuously flared emissions from vessels within the upgrader (sour water separator, gas-oil Unifier fractionator receiver, and the oil and water separator) will be significantly reduced when the system to capture and re-use these gases is installed. This proposal is currently under engineering evaluation and will be the subject of a separate application.

2.4 ENERGY BALANCE

The overall energy efficiency for Suncor's operations is shown in Table III-9. The energy balance for the 79.5 kbpcd, 87 kbpcd, and 107 kbpcd production rates are shown in Figure III-8 and Table III-10.

Energy-saving initiatives in the second stage of expansion, such as recovering waste heat from upgrading plant 25 for use in extraction, will increase the overall site energy efficiency.

Natural gas consumption will increase by 1.4% at the 87 kbpcd production level and by another 6% at the 107 kbpcd level. This incremental increase in natural gas use is required as a result of the increased use of fuel gas in upgrading plant 25 and to maintain the utility plant's gas-fired boilers at a minimum rate for reliability.

The overall energy efficiency will increase from 72.4% to 74% as a result of the waste heat recovery project, hydrotransportation of oil sand, vacuum stripping of bitumen, and efficiency improvements in utilities, upgrading and extraction.

Internal Suncor measurement, testing, and reconciliation provide the necessary supporting data and records to meet reporting requirements.

2.5 EXTRACTION MATERIAL BALANCE

The Extraction process flow sheet is shown in Figure III-9.

Extraction material balances on a calendar basis are shown in:

- Table III-11 for 79.5 kbpcd
- Table III-13 for 87 kbpcd
- Table III-15 for 107 kbpcd

Extraction material balances on a stream day basis are shown in:

- Table III-12 for 79.5 kbpcd
- Table III-14 for 87 kbpcd
- Table III-16 for 107 kbpcd

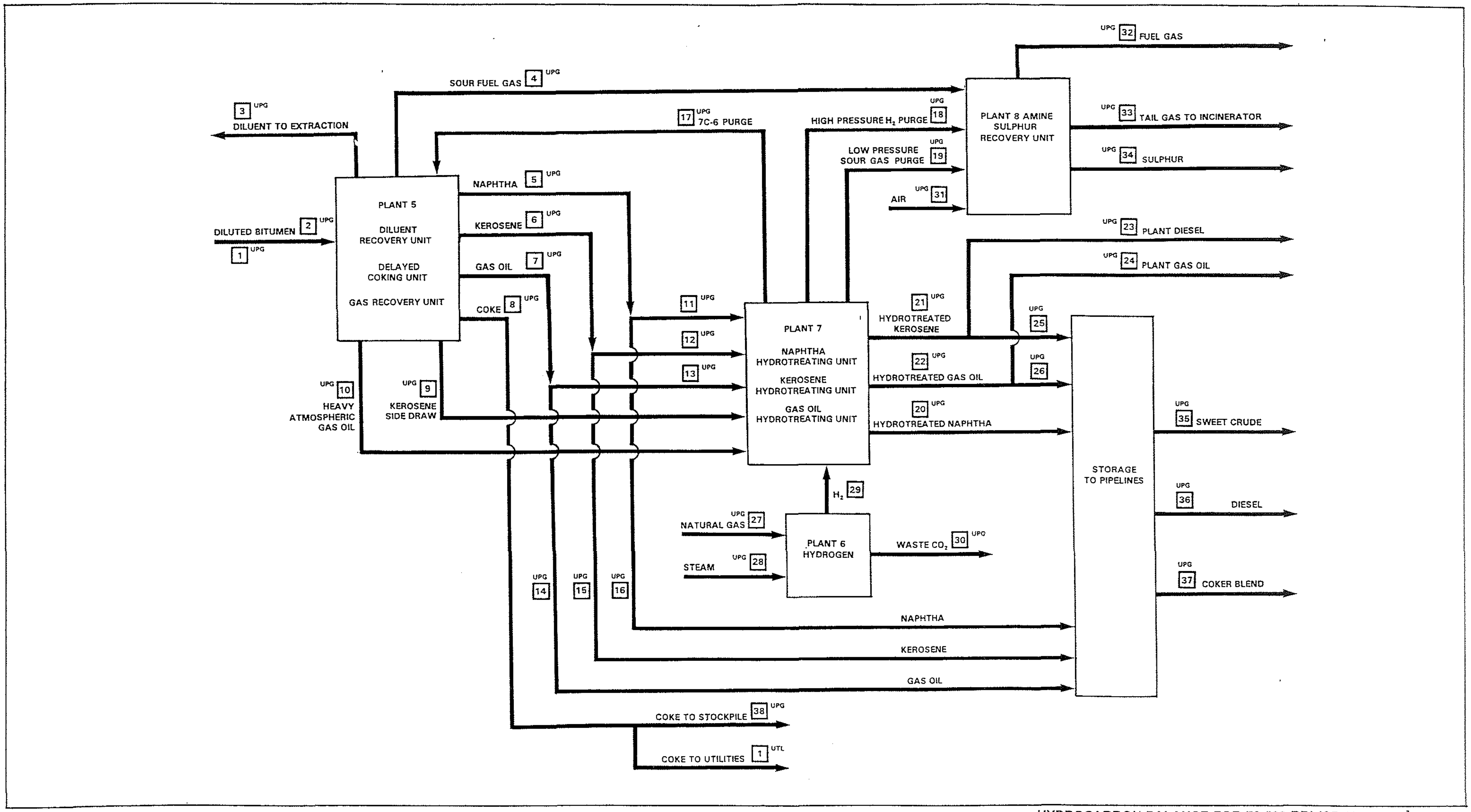
Extraction operations at 107 kbpcd will incorporate three major changes relative to current operations:

- Overland transport of oil sand, currently accomplished with conveyors, and oil sand conditioning, currently accomplished with conditioning drums, will be simultaneously achieved in two oil sand slurry pipelines. The slurry pipelines move oil sand from the Steepbank mine to an expanded operation on the current plant site.
- Oil sand conditioning and bitumen separation will be accomplished at 50 to 55 ^{0}C, rather than 70 to 74^{0}C.
- The average Steepbank mine ore is expected to contain higher fines relative to current operations. Higher fines ore typically requires a higher water to ore ratio in the feed to the separation circuit.

LIST OF TABLES AND FIGURES

TABLES

LIST OF FIGURES



HYDROCARBON BALANCE FOR 79,500 BBL/CD (12,639 m^3/CD)

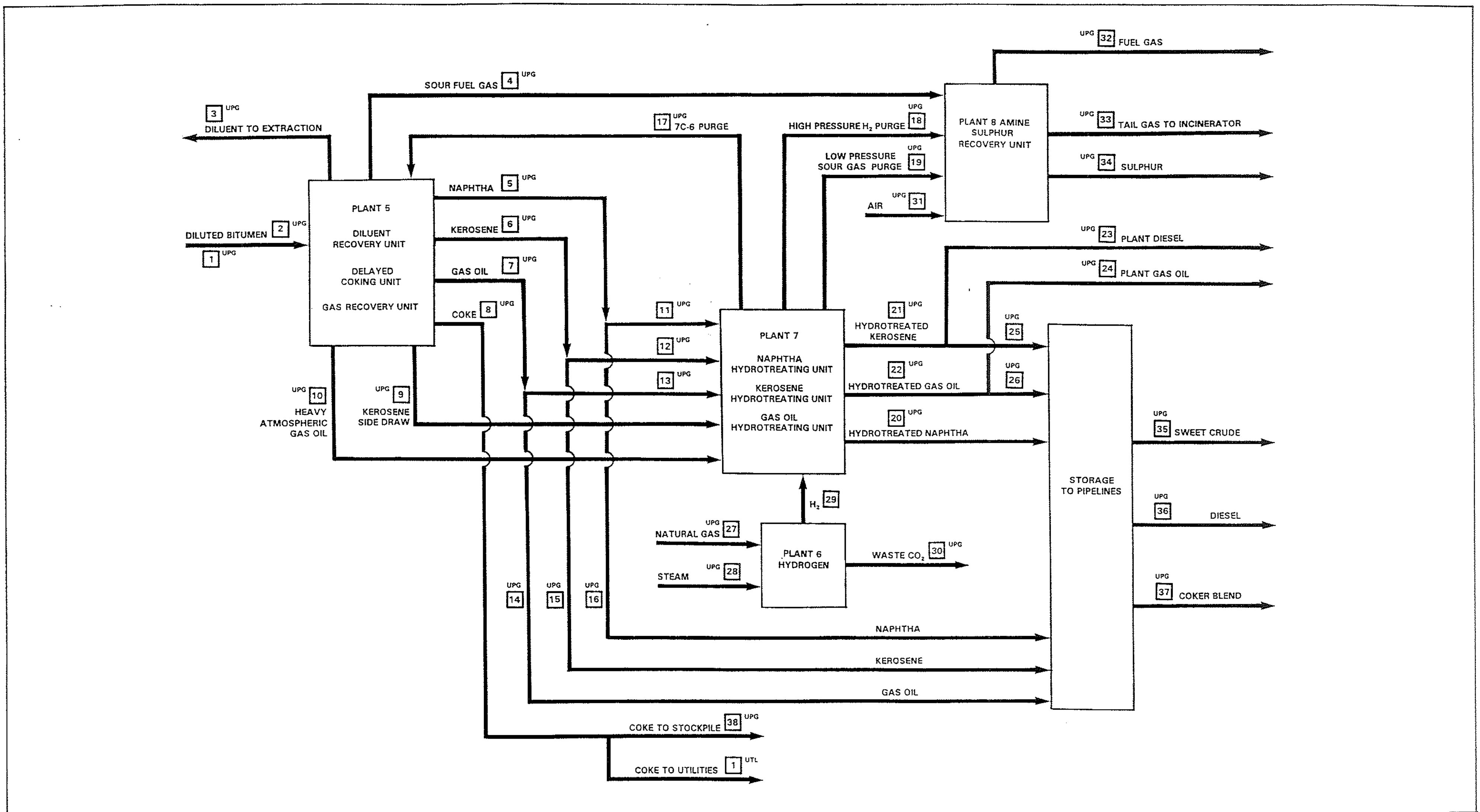
FIGURE III-1

STREAM NUMBER	1 UPG	2 UPG	3 UPG	4 UPG	5 UPG	6 UPG	7 UPG	8 UPG	9 UPG	10 UPG	11 UPG	12 UPG	13 UPG	14 UPG	15 UPG	16 UPG	17 UPG	18 UPG	19 UPG	20 UPG
UNITS (GROSS FLOWS PER DAY)	10^3 m^3	10^3 m^3	10^3 m^3	10^6 m^3	10^3 m^3	10^3 m^3	10^3 m^3	TONNE	10^3 m^3	10^3 m^3	10^3 m^3	10^3 m^3	10^3 m^3	10^3 m^3	10^3 m^3	10^3 m^3	10^6 m^3	10^6 m^3	10^6 m^3	10^3 m^3
DESCRIPTION	DILUTED BITUMEN TO DRU 1	FRESH BITUMEN IN D/B	REC. DILUENT FROM DRU 1	SOUR FG	COKER NAPHTHA	COKER KEROSENE	COKER GAS OIL	COKE	KEROSENE SD FROM DRU 1	HAGO FROM DRU 1	NAPHTHA TO NHU	KEROSENE TO KHU	GAS OIL TO GHU	COKER GAS OIL TO PIPELINE	COKER KEROSENE TO PIPELINE	COKER NAPHTHA TO PIPELINE	7C-6 PURGE	HP HYDROGEN PURGE	LP SG PURGE	HT NAPHTHA
COMPONENT																				
HYDROCARBON (Calendor)	27.6	14.9	12.8	1.04	2.5	2.8	6.3	2,886	0.8	N/A	2.3	2.7	5.5	0.8	0.2	0.1	0.05	0.01	0.31	2.4
HYDROCARBON (Stream)	29.3	15.8	13.6	1.11	2.6	3.0	6.7	3,066	0.9	N/A	2.5	2.9	5.8	0.9	0.2	0.1	0.05	0.01	0.33	2.6

STREAM NUMBER	21 UPG	22 UPG	23 UPG	24 UPG	25 UPG	26 UPG	27 UPG	28 UPG	29 UPG	30 UPG	31 UPG	32 UPG	33 UPG	34 UPG	35 UPG	36 UPG	37 UPG	38 UPG		1 UTL
UNITS (GROSS FLOWS PER DAY)	10^3 m^3	10^3 m^3	10^3 m^3	10^3 m^3	10^3 m^3	10^3 m^3	10^6 m^3	10^6 m^3	10^6 m^3	10^6 m^3	10^6 m^3	10^6 m^3	10^6 m^3	TONNE	10^3 m^3	10^3 m^3	10^3 m^3	TONNE		TONNE
DESCRIPTION	HT KEROSENE FROM KHU	HT GAS OIL FROM GHU	PLANT DIESEL	PLANT GAS OIL	HT KEROSENE TO PIPELINE	HT GAS OIL TO PIPELINE	NATURAL GAS	REACTION STEAM	TOTAL HYDROGEN	WASTE GAS	COMBUSTION AIR	FUEL GAS	TAIL GAS TO INCINERATOR	SULPHUR	SWEET CRUDE	DIESEL	COKER BLEND	COKE TO STOCKPILE		COKE TO UTILITIES
COMPONENT																				
HYDROCARBON (Calendor)	2.7	6.3	0.15	0.03	2.6	6.3	0.46	2.28	1.58	0.38	0.84	1.01	1.09	485	9.7	1.6	1.1	1,185		1,703
HYDROCARBON (Stream)	2.9	6.7	0.16	0.03	2.7	6.7	0.48	2.42	1.68	0.40	0.90	1.07	1.16	515	10.3	1.7	1.2	1,343		1,723

HYDROCARBON BALANCE FOR 79,500 BBL/CD (12,639 m^3/CD)

TABLE III–1



HYDROCARBON BALANCE FOR 87,000 BBL/CD (13,832 m^3/CD)

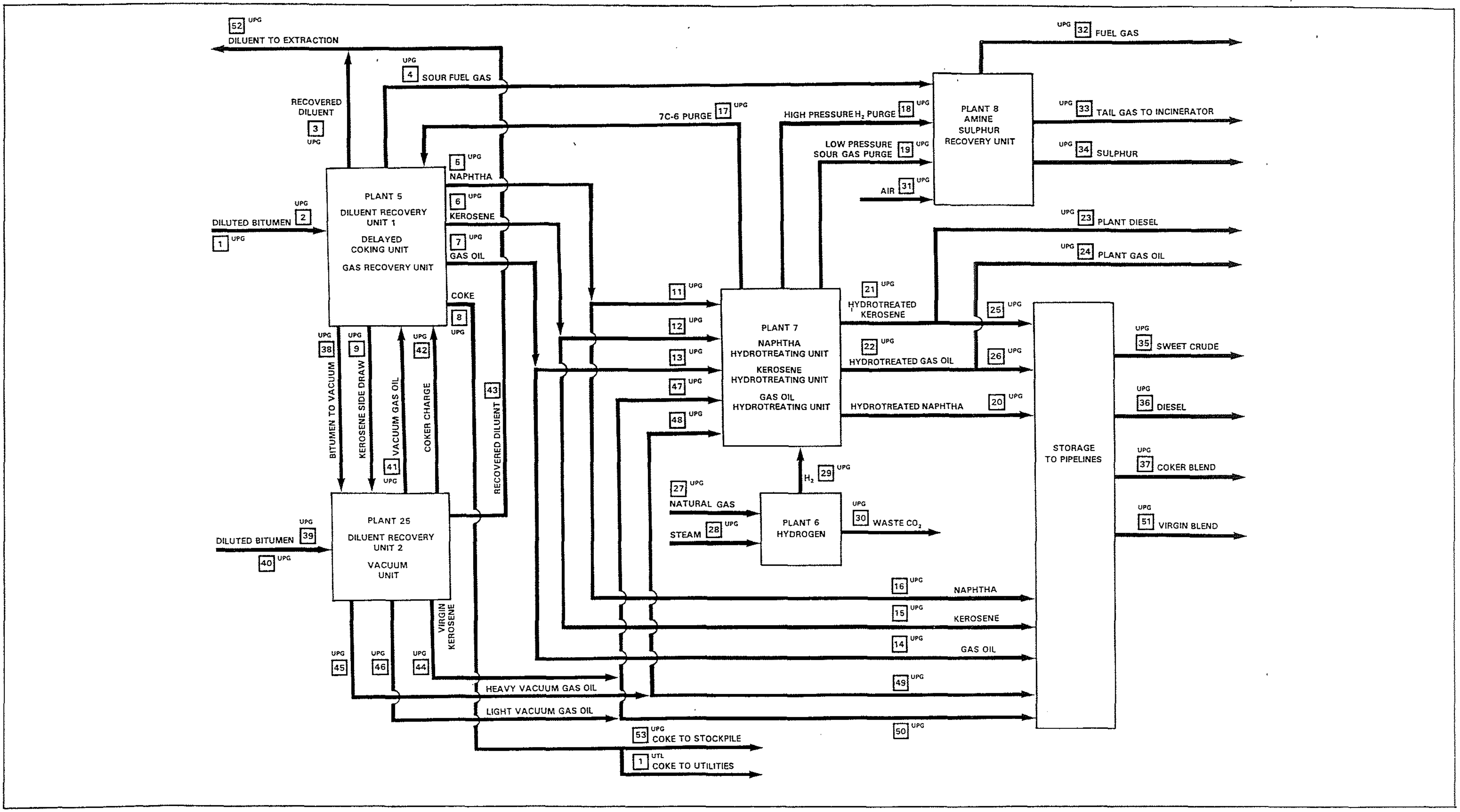
FIGURE III–2

STREAM NUMBER	UPG 1	UPG 2	UPG 3	UPG 4	UPG 5	UPG 6	UPG 7	UPG 8	UPG 9	UPG 10	UPG 11	UPG 12	UPG 13	UPG 14	UPG 15	UPG 16	UPG 17	UPG 18	UPG 19	UPG 20
UNITS (GROSS FLOWS PER DAY)	10^3 m³	10^3 m³	10^3 m³	10^6 m³	10^3 m³	10^3 m³	10^3 m³	TONNE	10^3 m³	10^3 m³	10^3 m³	10^3 m³	10^3 m³	10^3 m³	10^3 m³	10^3 m³	10^6 m³	10^6 m³	10^6 m³	10^3 m³
DESCRIPTION	DILUTED BITUMEN TO DRU 1	FRESH BITUMEN IN D/B	REC. DILUENT FROM DRU 1	SOUR FG	COKER NAPHTHA	COKER KEROSENE	COKER GAS OIL	COKE	KEROSENE SD FROM DRU 1	HAGO FROM DRU 1	NAPHTHA TO NHU	KEROSENE TO KHU	GAS OIL TO GHU	COKER GAS OIL TO PIPELINE	COKER KEROSENE TO PIPELINE	COKER NAPHTHA TO PIPELINE	7C-6 PURGE	HP HYDROGEN PURGE	LP SG PURGE	HT NAPHTHA
COMPONENT																				
HYDROCARBON (Calendar)	30.3	16.3	14.1	1.13	3.0	3.6	5.5	3,185	1.1	0.3	2.9	2.9	4.8	0.8	0.7	0.1	0.05	0.01	0.33	3.1
HYDROCARBON (Stream)	30.3	16.3	14.1	1.13	3.0	3.6	5.5	3,185	1.1	0.3	2.9	2.9	4.8	0.8	0.7	0.1	0.05	0.01	0.33	3.1

STREAM NUMBER	UPG 21	UPG 22	UPG 23	UPG 24	UPG 25	UPG 26	UPG 27	UPG 28	UPG 29	UPG 30	UPG 31	UPG 32	UPG 33	UPG 34	UPG 35	UPG 36	UPG 37	UPG 38		UTL 1
UNITS (GROSS FLOWS PER DAY)	10^3 m³	10^3 m³	10^3 m³	10^3 m³	10^3 m³	10^3 m³	10^6 m³	10^6 m³	10^6 m³	10^6 m³	10^6 m³	10^6 m³	10^6 m³	TONNE	10^3 m³	10^3 m³	10^3 m³	TONNE		TONNE
DESCRIPTION	HT KEROSENE FROM KHU	HT GAS OIL FROM GHU	PLANT DIESEL	PLANT GAS OIL	HT KEROSENE TO PIPELINE	HT GAS OIL TO PIPELINE	NATURAL GAS	REACTION STEAM	TOTAL HYDROGEN	WASTE GAS	COMBUSTION AIR	FUEL GAS	TAIL GAS TO INCINERATOR	SULPHUR	SWEET CRUDE	DIESEL	COKER BLEND	COKE TO STOCKPILE		COKE TO UTILITIES
COMPONENT																				
HYDROCARBON (Calendar)	2.9	6.3	0.16	0.03	2.7	6.2	0.48	2.41	1.68	0.40	0.89	1.09	1.15	542	10.3	1.7	1.6	1,426		1,759
HYDROCARBON (Stream)	2.9	6.3	0.16	0.03	2.7	6.2	0.48	2.41	1.68	0.40	0.89	1.09	1.15	542	10.3	1.7	1.6	1,259		1,926

HYDROCARBON BALANCE FOR 87,000 BBL/CD (13,832 m^3/CD)

TABLE III–2



HYDROCARBON BALANCE FOR 107,000 BBL/CD (17,012 m^3/CD)

FIGURE III-3

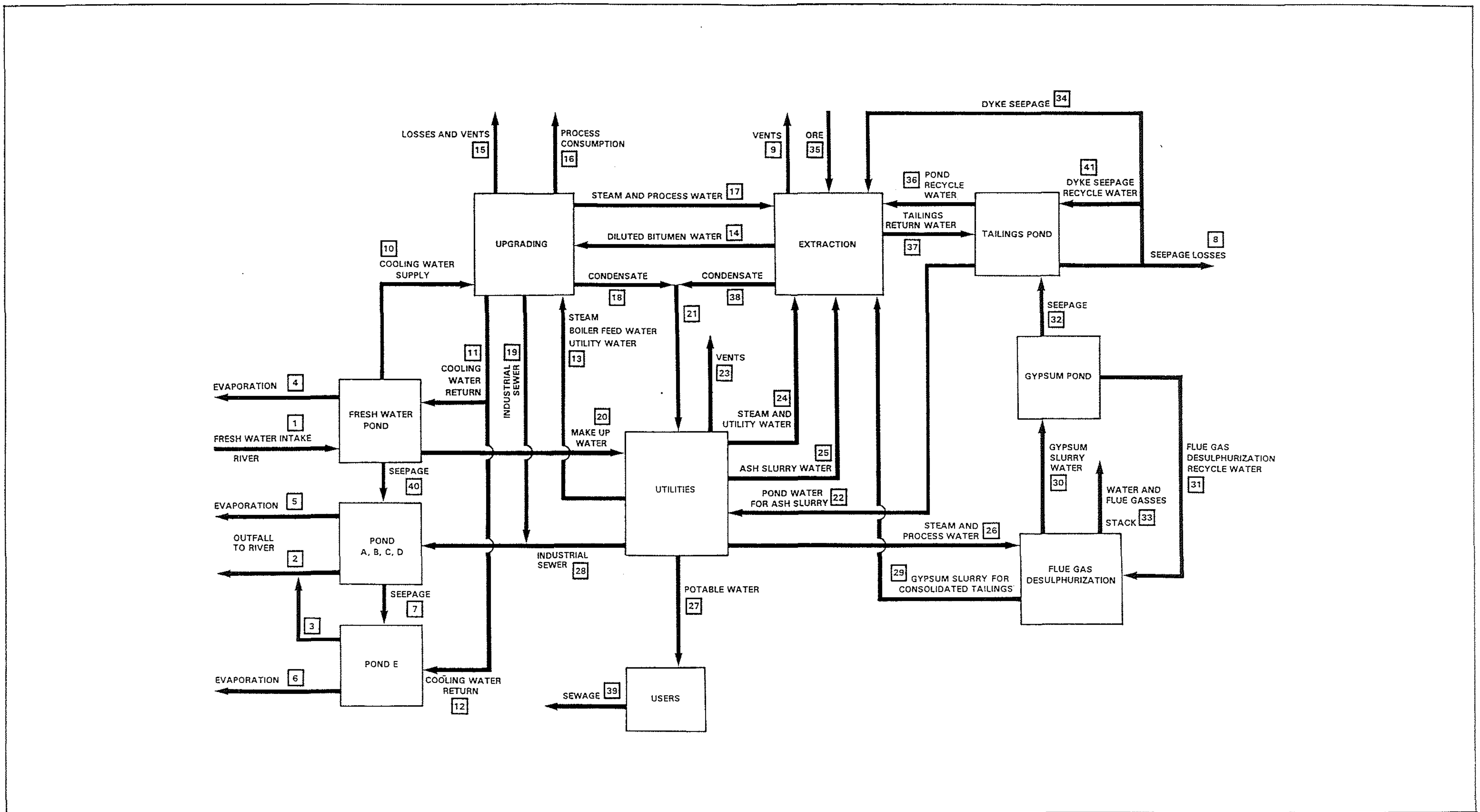
STREAM NUMBER	UPG 1	UPG 2	UPG 3	UPG 4	UPG 5	UPG 6	UPG 7	UPG 8	UPG 9	UPG 10	UPG 11	UPG 12	UPG 13	UPG 14	UPG 15	UPG 16	UPG 17	UPG 18	UPG 19	UPG 20
UNITS (GROSS FLOWS PER DAY)	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^6\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	TONNE	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^6\ m^3$	$10^6\ m^3$	$10^6\ m^3$	$10^3\ m^3$
DESCRIPTION	DILUTED BITUMEN TO DRU 1	FRESH BITUMEN IN D/B TO DRU 1	REC. DILUENT FROM DRU 1	SOUR FG	COKER NAPHTHA	COKER KEROSENE	COKER GAS OIL	COKE	KEROSENE SD FROM DRU 1	HAGO FROM DRU 1	NAPHTHA TO NHU	KEROSENE TO KHU	GAS OIL TO GHU	COKER GAS OIL TO PIPELINE	COKER KEROSENE TO PIPELINE	COKER NAPHTHA TO PIPELINE	7C-6 PURGE	HP HYDROGEN PURGE	LP SG PURGE	HT NAPHTHA
COMPONENT																				
HYDROCARBON (Calendar)	24.9	13.4	11.7	1.06	2.8	2.6	3.1	3,607	0.5	N/A	2.3	1.8	2.4	0.8	0.8	0.4	0.05	0.01	0.31	2.5
HYDROCARBON (Stream)	25.3	13.5	11.8	1.07	2.8	2.6	3.2	3,633	0.5	N/A	2.4	1.8	2.4	0.8	0.8	0.4	0.05	0.01	0.31	2.5

STREAM NUMBER	UPG 21	UPG 22	UPG 23	UPG 24	UPG 25	UPG 26	UPG 27	UPG 28	UPG 29	UPG 30	UPG 31	UPG 32	UPG 33	UPG 34	UPG 35	UPG 36	UPG 37	UPG 38	UPG 39	UPG 40
UNITS (GROSS FLOWS PER DAY)	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^6\ m^3$	$10^6\ m^3$	$10^6\ m^3$	$10^6\ m^3$	$10^6\ m^3$	$10^6\ m^3$	$10^6\ m^3$	TONNE	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$
DESCRIPTION	HT KEROSENE FROM KHU	HT GAS OIL FROM GHU	PLANT DIESEL	PLANT GAS OIL	HT KEROSENE TO PIPELINE	HT GAS OIL TO PIPELINE	NATURAL GAS	REACTION STEAM	TOTAL HYDROGEN	WASTE GAS	COMBUSTION AIR	FUEL GAS	TAIL GAS TO INCINERATOR	SULPHUR	SWEET CRUDE	DIESEL	COKER BLEND	DRU 1 REDUCED BITUMEN TO VAC. UNIT	FRESH BITUMEN IN D/B TO DRU 2	DILUTED BITUMEN TO DRU 2
COMPONENT																				
HYDROCARBON (Calendar)	2.9	5.9	0.16	0.03	2.7	5.8	0.48	2.41	1.68	0.40	0.86	1.01	1.11	545	8.7	2.3	1.7	12.8	6.3	11.7
HYDROCARBON (Stream)	2.9	5.9	0.16	0.03	2.7	5.9	0.48	2.43	1.69	0.40	0.87	1.02	1.12	545	8.8	2.3	1.7	12.9	6.4	11.8

STREAM NUMBER	UPG 41	UPG 42	UPG 43	UPG 44	UPG 45	UPG 46	UPG 47	UPG 48	UPG 49	UPG 50	UPG 51	UPG 52	UPG 53			UTL 1				
UNITS (GROSS FLOWS PER DAY)	$10^6\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	$10^3\ m^3$	TONNE			TONNE				
DESCRIPTION	VACUUM OFF GAS	COKER CHARGE	REC. DILUENT FROM DRU #2	VIRGIN KEROSENE	HVGO DIST.	LVGO DIST.	VIRGIN KERO TO KHU	HVGO TO GHU	HVGO TO PIPELINE	LVGO TO PIPELINE	VIRGIN BLEND	M/U DILUENT TO EXTRACTION	COKE TO STOCKPILE			COKE TO UTILITIES				
COMPONENT																				
HYDROCARBON (Calendar)	0.01	11.3	5.4	1.5	6.0	0.8	1.1	3.5	2.5	1.2	4.0	17.1	1,659			1,948				
HYDROCARBON (Stream)	0.01	11.4	5.4	1.5	6.0	0.8	1.1	3.5	2.5	1.2	4.0	17.2	1,334			2,299				

HYDROCARBON BALANCE FOR 107,000 BBL/CD (17,012 m^3/CD)

TABLE III-3



WATER BALANCE FOR CURRENT AND FUTURE PRODUCTION

FIGURE III–4

STREAM NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
UNITS (GROSS FLOWS PER CALENDAR DAY)	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3
DESCRIPTION	FRESH WATER INTAKE FROM RIVER	RIVER OUTFALL	POND E EFFLUENT TO RIVER	EVAPORATION LOSSES FROM FW POND	EVAPORATION LOSSES FROM POND A/B/C/D	EVAPORATION LOSSES FROM POND E	SEEPAGE POND A/B/C TO POND E	SEEPAGE LOSSES FROM TAILINGS PONDS	VENT LOSSES FROM EXTRACTION	COOLING WATER SUPPLY TO UPG.	CW RETURN TO FW POND	CW RETURN TO POND E	STEAM & WATER SUPPLY TO UPG. FROM UTIL.	DB WATER TO UPG. FROM EXTR.	UPG. UNIT LOSSES TO ATM.	UPG. UNIT LOSSES TO PROCESS	STEAM/PROCESS WATER FROM UPG. TO EXTR.	STEAM/CONDENS. FROM UPG. TO UTIL.	UPG. WATER TO SEWER	FRESH WATER MAKE-UP TO UTIL.
COMPONENT																				
79.5 KBPCD CASE	110,493	81,551	52,676	1,088	408	386	5,442	2,203	1,332	178,231	130,612	47,619	20,615	1301	2,063	610	9,981	54	9,208	60,620
87.0 KBPCD CASE	81,491	44,038	15,918	1,088	408	408	5,442	2,436	1,463	178,231	167,347	10,884	20,915	1,426	2,074	610	10,101	348	9,208	68,158
107 KBPCD CASE	78,503	37,807	15,918	1,088	408	408	5,442	2,332	636	178,231	167,347	10,884	20,800	1,731	620	610	10,792	457	10,052	65,170

STREAM NUMBER	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
UNITS (GROSS FLOWS PER CALENDAR DAY)	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3
DESCRIPTION	TOTAL STEAM CONDENS. RETURN TO UTIL.	POND WATER TO UTIL. FOR ASH SLURRY	VENT LOSSES FROM UTIL.	STEAM, UW & CBD TO EXTR.	ASH SLURRY WATER TO TAILINGS PONDS	PROCESS WATER TO FGD	POTABLE WATER TO PLANTSITE	WATER TO SEWER FROM UTIL.	GYPSUM WATER TO CT FROM FGD	WATER IN GYPSUM SLURRY FROM FGD	FGD RECYCLE WATER	GYPSUM SEEPAGE LOSSES	STACK LOSSES FROM FGD	DYKE SEEPAGE MINE AREA	WATER WITH ORE LESS OVERSIZE	POND WATER TO EXTRACTION	TAILINGS RETURN WATER	CONDENSATE FROM EXTR. TO UTIL.	SEWAGE TO RIVER	SEEPAGE FROM FRESH WATER POND
COMPONENT																				
79.5 KBPCD CASE	10,732	0	816	22,073	0	2,134	1,361	24,354	272	1361	680	408	1,181	2,344	3,988	203,679	230,104	9,600	289	1,165
87.0 KBPCD CASE	11,983	0	816	24,838	0	8,539	1,633	23,401	1,088	5,442	2,721	1,633	4,730	2,344	4,718	239,810	269,583	10,427	400	1,361
107 KBPCD CASE	18,454	8,163	816	35,237	8,163	8,539	1,905	16,327	1,088	5,442	2,721	1,633	4,730	2,344	6,492	291,549	336,683	16,615	450	1,361

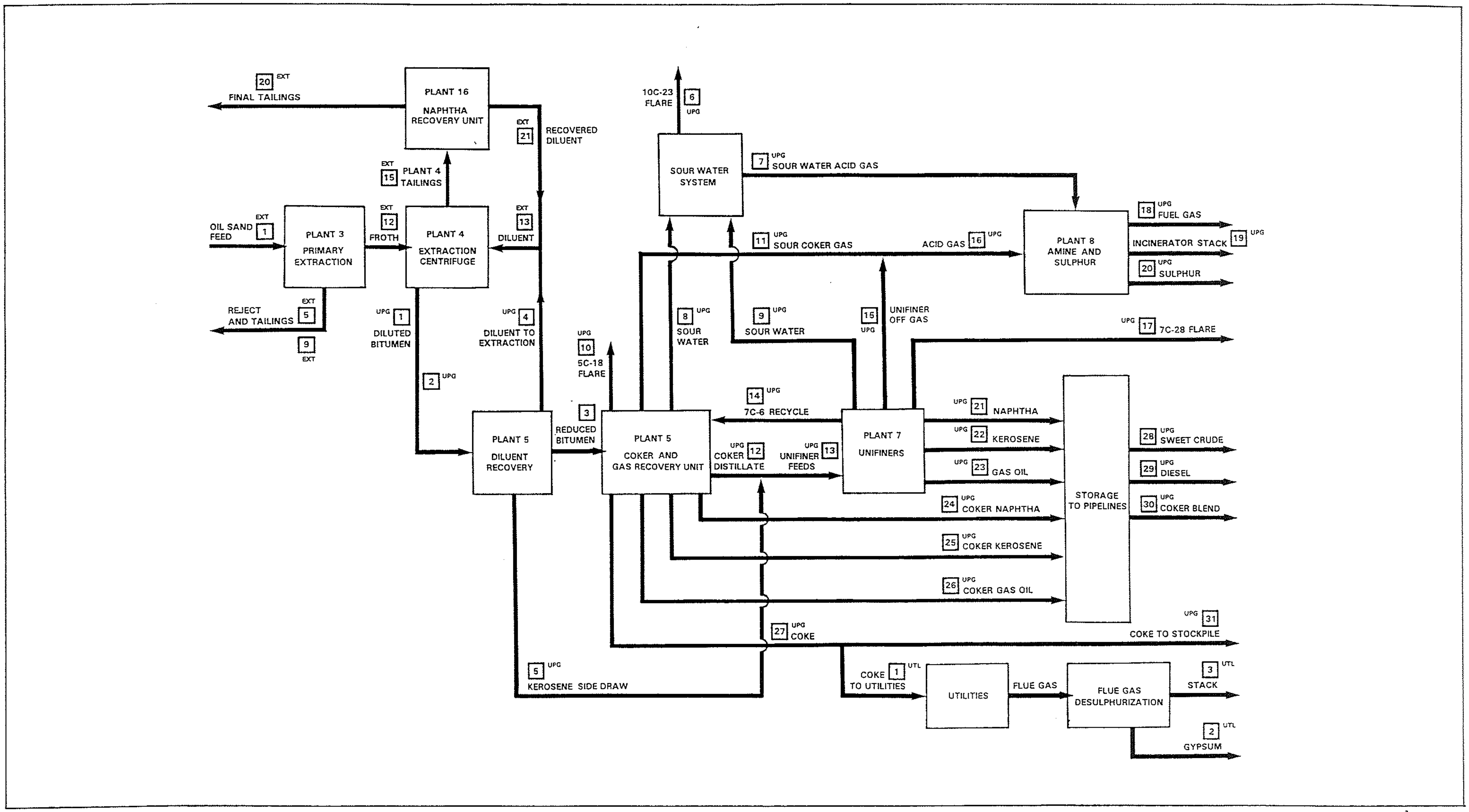
STREAM NUMBER	41
UNITS (GROSS FLOWS PER CALENDAR DAY)	m^3
DESCRIPTION	DYKE SEEPAGE RECYCLE WATER
COMPONENT	
79.5 KBPCD CASE	13,277
87.0 KBPCD CASE	13,805
107 KBPCD CASE	14,349

WATER BALANCE FOR CURRENT AND FUTURE PRODUCTION

TABLE III-4

WATER BALANCE STREAM DETAILS									
	Stream 13 (t/cd)			Stream 17 (t/cd)			Stream 24 (t/cd)		
	79,500 bbl/cd (12,639 m^3/cd)	87,000 bbl/cd (13,832 m^3/cd)	107,000 bbl/cd (17,012 m^3/cd)	79,500 bbl/cd (12,639 m^3/cd)	87,000 bbl/cd (13,832 m^3/cd)	107,000 bbl/cd (17,012 m^3/cd)	79,500 bbl/cd (12,639 m^3/cd)	87,000 bbl/cd (13,832 m^3/cd)	107,000 bbl/cd (17,012 m^3/cd)
Components (t/cd)									
Steam	8,158	9,301	8,504	5,499	5,499	5,352	7,967	9,426	12,114
Boiler Feedwater	2,895	2,046	2,427	-	-	-	-	-	-
Utility Water	9,562	9,568	9,869	-	-	-	13,257	14,503	22,084
Continuous Blowdown	-	-	-	1,621	1,621	1,621	849	909	1,039
Process Water	-	-	-	2,861	2,981	3,819	-	-	-

TABLE III-5



SULPHUR FLOW DIAGRAM FOR 79,500 BBL/CD (12,639 m^3/CD)

FIGURE III–5

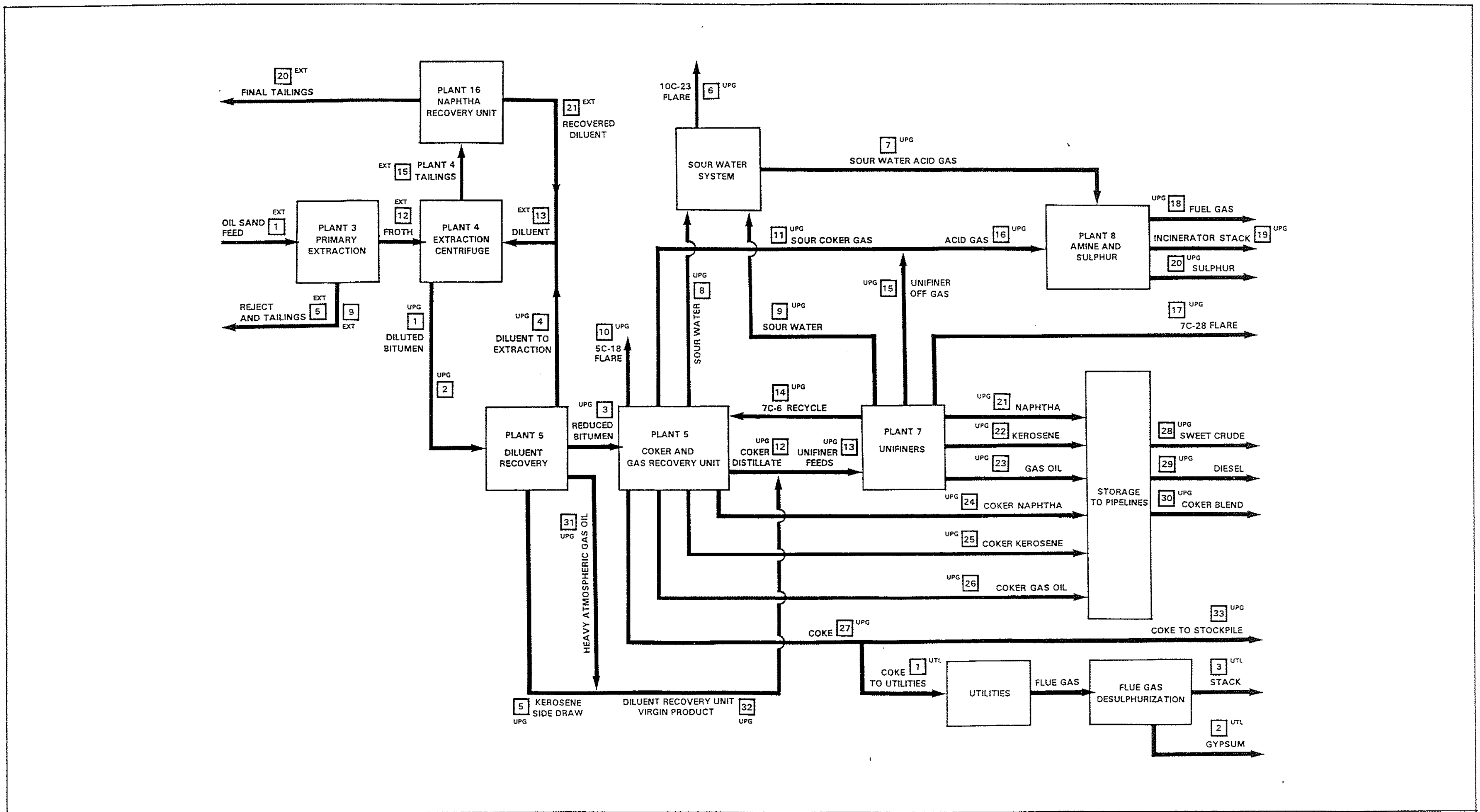
STREAM NUMBER	1 UPG	2 UPG	3 UPG	4 UPG	5 UPG	6 UPG	7 UPG	8 UPG	9 UPG	10 UPG	11 UPG	12 UPG	13 UPG	14 UPG	15 UPG	16 UPG	17 UPG	18 UPG	19 UPG	20 UPG
UNITS (GROSS FLOWS PER DAY)	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE
DESCRIPTION	DILUTED BITUMEN	FRESH BITUMEN IN D/B	BITUMEN TO COKERS	DILUENT TO EXTRACTION	KEROSENE SIDE DRAW	10C-23 SOUR GAS TO FLARE	SWS ACID GAS	PLANT 5 SOUR WATER	PLANT 7/8 SOUR WATER	5C-18 SOUR GAS TO FLARE	GRU SOUR FUEL GAS	COKER PROD. TO PLANT 7	TOTAL UNIFINER CHARGE	7C-6 RECYCLE	PLANT 7 LP SOUR FUEL GAS	SOUR GAS FROM PLANT 5/7	7C-28 SOUR GAS TO FLARE	SWEET FUEL GAS	TAIL GAS TO INCINERATOR	ELEMENTAL SULPHUR
COMPONENT																				
SULPHUR (Calendar)	903.2	726.3	716.3	178.0	9.0	0.3	11.2	4.8	6.7	0.6	246.9	276.2	285.1	20.3	235.6	482.5	0.7	0.3	8.9	484.5
SULPHUR (Stream)	959.6	771.6	761.0	189.1	9.5	0.3	11.9	5.1	7.1	0.7	262.3	293.4	302.9	21.5	250.9	512.6	0.8	0.3	9.5	514.7

STREAM NUMBER	21 UPG	22 UPG	23 UPG	24 UPG	25 UPG	26 UPG	27 UPG	28 UPG	29 UPG	30 UPG	31 UPG									
UNITS (GROSS FLOWS PER DAY)	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE									
DESCRIPTION	UNIFIED NAPHTHA	UNIFIED KEROSENE	UNIFIED GAS OIL	COKER NAPHTHA	COKER KEROSENE	COKER GAS OIL	COKE	SWEET CRUDE	DIESEL	COKER BLEND	COKE TO STOCKPILE									
SULPHUR (Calendar)	0.3	1.1	20.3	1.5	3.6	27.8	175.1	21.1	0.7	32.9	68.1									
SULPHUR (Stream)	0.4	1.2	21.6	1.6	3.8	29.6	186.0	22.4	0.8	35.0	67.3									

STREAM NUMBER	1 UTL	2 UTL	3 UTL				1 EXT	5 EXT	9 EXT	12 EXT	13 EXT	15 EXT	20 EXT	21 EXT						
UNITS (GROSS FLOWS PER DAY)	TONNE	TONNE	TONNE				TONNE	TONNE		TONNE	TONNE	TONNE	TONNE	TONNE						
DESCRIPTION	COKE TO UTILITIES	GYPSUM	UTILITIES STACK				TARSAND FEED	REJECT & TAILINGS		FROTH	DILUENT	PLANT 4 TAILINGS	FINAL TAILINGS	RECOVERED DILUENT						
COMPONENT																				
SULPHUR (Calendar)	107.0	6.0	101.0				795.4	50.4		745.0	181.0	22.8	19.7	2.9						
SULPHUR (Stream)	118.7	0.0	118.7				982.3	62.9		919.7	223.4	28.1	24.5	3.6						

SULPHUR BALANCE FOR 79,500 BBL/CD (12,639 m^3/CD)

TABLE III-6



SULPHUR FLOW DIAGRAM FOR 87,000 BBL/CD (13,832 m^3/CD)

FIGURE III–6

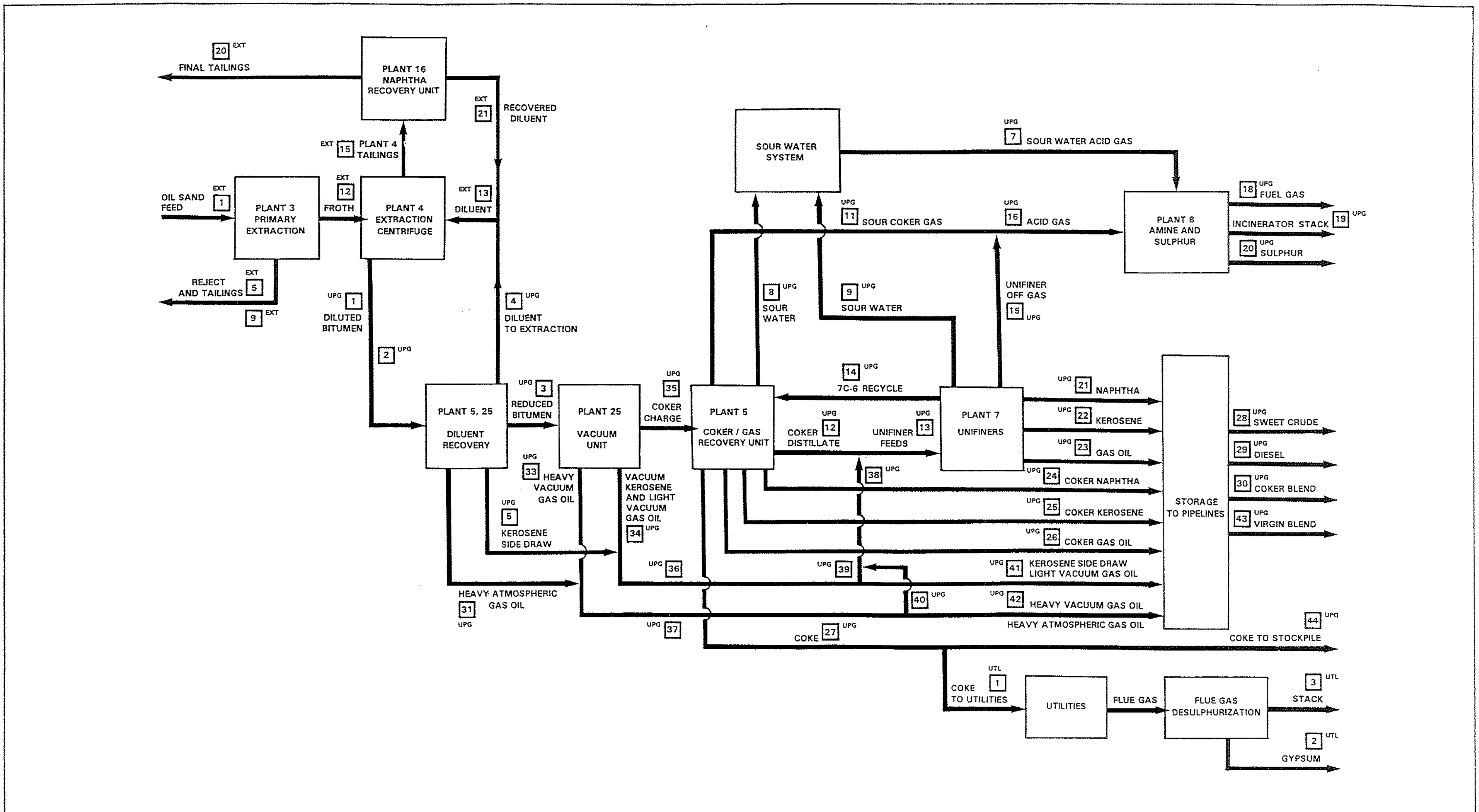
STREAM NUMBER	1 UPG	2 UPG	3 UPG	4 UPG	5 UPG	6 UPG	7 UPG	8 UPG	9 UPG	10 UPG	11 UPG	12 UPG	13 UPG	14 UPG	15 UPG	16 UPG	17 UPG	18 UPG	19 UPG	20 UPG
UNITS (GROSS FLOWS PER DAY)	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE
DESCRIPTION	DILUTED BITUMEN	FRESH BITUMEN IN D/B	BITUMEN TO COKERS	DILUENT TO EXTRACTION	KEROSENE SIDE DRAW	10C-23 SOUR GAS TO FLARE	SWS ACID GAS	PLANT 5 SOUR WATER	PLANT 7/8 SOUR WATER	5C-18 SOUR GAS TO FLARE	GRU SOUR FUEL GAS	COKER PROD. TO PLANT 7	TOTAL UNIFINER CHARGE	7C-6 RECYCLE	PLANT 7 LP SOUR FUEL GAS	SOUR GAS FROM PLANT 5/7	7C-28 SOUR GAS TO FLARE	SWEET FUEL GAS	TAIL GAS TO INCINERATOR	ELEMENTAL SULPHUR
COMPONENT																				
SULPHUR (Calendar)	1008.0	813.6	792.1	195.6	12.6	0.3	11.9	5.1	7.1	0.7	266.5	304.8	325.1	21.5	273.9	540.4	0.7	0.3	9.9	542.1
SULPHUR (Stream)	1008.0	813.6	792.1	195.6	12.6	0.3	11.9	5.1	7.1	0.7	266.5	304.8	325.1	21.5	273.9	540.4	0.7	0.3	9.9	542.1

STREAM NUMBER	21 UPG	22 UPG	23 UPG	24 UPG	25 UPG	26 UPG	27 UPG	28 UPG	29 UPG	30 UPG	31 UPG	32 UPG	33 UPG							
UNITS (GROSS FLOWS PER DAY)	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE							
DESCRIPTION	UNIFINED NAPHTHA	UNIFINED KEROSENE	UNIFINED GAS OIL	COKER NAPHTHA	COKER KEROSENE	COKER GAS OIL	COKE	SWEET CRUDE	DIESEL	COKER BLEND	DRU HAGO	DRU VIRGIN PROD.	COKE TO STOCKPILE							
COMPONENT																				
SULPHUR (Calendar)	0.4	1.2	20.2	1.1	16.5	26.1	192.8	21.1	0.8	43.7	7.8	20.4	69.4							
SULPHUR (Stream)	0.4	1.2	20.2	1.1	16.5	26.1	192.8	21.1	0.8	43.7	7.8	20.4	42.8							

STREAM NUMBER	1 UTL	2 UTL	3 UTL				1 EXT	5 EXT	9 EXT	12 EXT	13 EXT	15 EXT	20 EXT	21 EXT						
UNITS (GROSS FLOWS PER DAY)	TONNE	TONNE	TONNE				TONNE	TONNE		TONNE	TONNE	TONNE	TONNE	TONNE						
DESCRIPTION	COKE TO UTILITIES	GYPSUM	UTILITIES STACK				TARSAND FEED	REJECT & TAILINGS		FROTH	DILUENT	PLANT 4 TAILINGS	FINAL TAILINGS	RECOVERED DILUENT						
COMPONENT																				
SULPHUR (Calendar)	112.0	99.0	13.0				890.9	56.4		834.5	198.7	25.2	22.1	3.1						
SULPHUR (Stream)	150.0	142.5	7.5				1100.4	70.3		1030.1	245.5	31.2	27.1	3.8						

SULPHUR BALANCE FOR 87,000 BBL/CD (13,832 m^3/CD)

TABLE III-7



SULPHUR FLOW DIAGRAM FOR 107,000 BBL/CD (17,012 m^3/CD)

FIGURE III–7

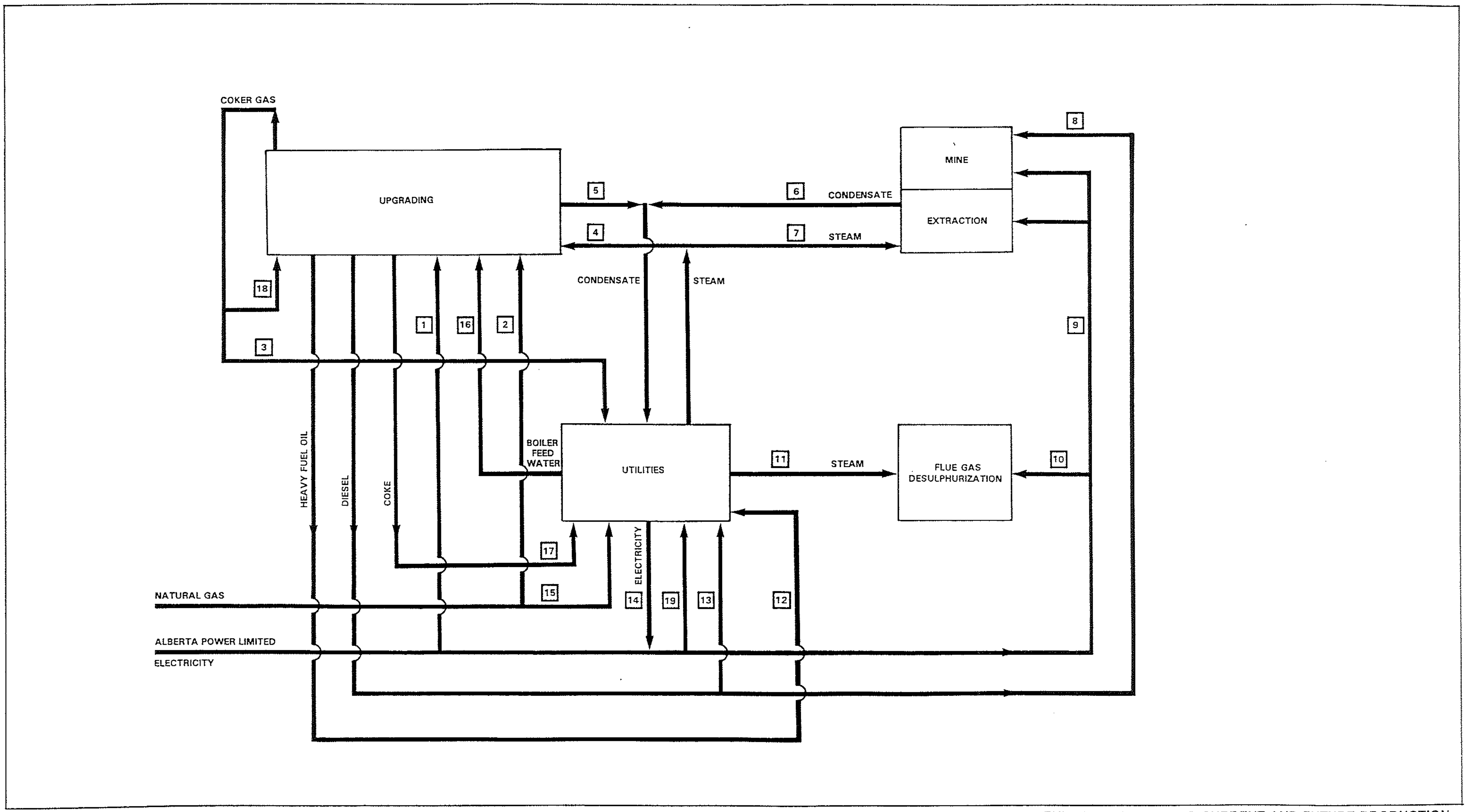
STREAM NUMBER	1 UPG	2 UPG	3 UPG	4 UPG	5 UPG	6 UPG	7 UPG	8 UPG	9 UPG	10 UPG	11 UPG	12 UPG	13 UPG	14 UPG	15 UPG	16 UPG	17 UPG	18 UPG	19 UPG	20 UPG
UNITS (GROSS FLOWS PER DAY)	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE
DESCRIPTION	DILUTED BITUMEN	FRESH BITUMEN IN D/B	BITUMEN TO COKERS	DILUENT TO EXTRACTION	KEROSENE SIDE DRAW		SWS ACID GAS	PLANT 5 SOUR WATER	PLANT 7/8 SOUR WATER		GRU SOUR FUEL GAS	COKER PROD. TO PLANT 7	TOTAL UNIFINER CHARGE	7C-6 RECYCLE	PLANT 7 LP SOUR FUEL GAS	SOUR GAS FROM PLANT 5/7		SWEET FUEL GAS	TAIL GAS TO INCINERATOR	ELEMENTAL SULPHUR
COMPONENT																				
SULPHUR (Calendar)	1202.0	966.9	949.5	236.6	14.4		12.2	5.1	7.0		262.5	212.4	329.7	21.4	280.4	542.9		0.3	10.0	544.8
SULPHUR (Stream)	1211.0	974.1	956.9	238.3	14.5		12.2	5.1	7.1		264.4	214.0	332.2	21.5	282.5	546.9		0.3	10.1	548.8

STREAM NUMBER	21 UPG	22 UPG	23 UPG	24 UPG	25 UPG	26 UPG	27 UPG	28 UPG	29 UPG	30 UPG	31 UPG	32 UPG	33 UPG	34 UPG	35 UPG	36 UPG	37 UPG	38 UPG	39 UPG	40 UPG
UNITS (GROSS FLOWS PER DAY)	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE
DESCRIPTION	UNIFINED NAPHTHA	UNIFINED KEROSENE	UNIFINED GAS OIL	COKER NAPHTHA	COKER KEROSENE	COKER GAS OIL	COKE	SWEET CRUDE	DIESEL	COKER BLEND	DRU HAGO		HVGO	VAC. KEROSENE & LVGO	BITUMEN TO COKERS	PLANT 25 KEROSENE	HVGO & HAGO	TOTAL VIRGIN PRODUCT TO UNIFINERS	VAC. KEROSENE TO UNIFINERS	HEAVY GAS OILS TO UNIFINERS
COMPONENT																				
SULPHUR (Calendar)	0.3	1.2	19.3	6.9	28.3	37.1	223.6	19.8	1.0	67.5	1.6		180.2	14.7	754.6	29.1	181.8	117.3	12.1	105.2
SULPHUR (Stream)	0.3	1.2	19.3	6.9	28.5	37.4	225.3	20.0	1.0	68.0	1.6,		181.6	14.8	760.1	29.3	183.1	118.2	12.2	106.0

STREAM NUMBER	41 UPG	42 UPG	43 UPG	44 UPG		1 UTL	2 UTL	3 UTL			1 EXT	5 EXT 9 EXT	12 EXT	13 EXT	15 EXT	20 EXT	21 EXT		
UNITS (GROSS FLOWS PER DAY)	TONNE	TONNE	TONNE	TONNE		TONNE	TONNE	TONNE			TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE		
DESCRIPTION	MIXED LVGO PRODUCT	MIXED HGO PRODUCT	VIRGIN BLEND	COKE TO STOCKPILE		COKE TO UTILITIES	GYPSUM	UTILITIES STACK			TARSAND FEED	REJECT & TAILINGS	FROTH	DILUENT	PLANT 4 TAILINGS	FINAL TAILINGS	RECOVERED DILUENT		
COMPONENT																			
SULPHUR (Calendar)	17.0	76.6	98.4	99.6		124.0	109.0	15.0			1061.3	69.6	991.7	241.0	30.5	26.2	4.3		
SULPHUR (Stream)	17.1	77.2	99.1	41.3		184.0	174.2	9.2			1310.4	85.9	1224.5	297.6	37.7	32.4	5.3		

SULPHUR BALANCE FOR 107,000 BBL/CD (17,012 m^3/CD)

TABLE III-8



ENERGY BALANCE FOR CURRENT AND FUTURE PRODUCTION

FIGURE III-8

Table III-9: OVERALL ENERGY EFFICIENCY			
CASE	**79,500 BBL (12,639 m^3/cd)**	**87,000 BBL (13,832 m^3/cd)**	**107,000 BBL (17,012 m^3/cd)**
	10^4 MW	**10^4 MW**	**10^4 MW**
Input:			
Bitumen	762.0	836.5	1,014.5
Natural Gas	28.0	28.5	30.3
Power import (export)	1.7	3.3	(0.7)
Output:			
Hydrocarbon products	534.2	584.3	718.6
Sulphur	5.3	5.9	5.9
Coke to stockpile	39.2	47.1	54.8
Losses:			
Bitumen to tails	52.1	58.1	78.3
Diluent to tails	4.4	4.4	4.4
Onsite fuels	65.8	67.9	74.9
To air and cooling water	96.2	106.2	113.6
Overall energy efficiency %	**73.1**	**73.4**	**74.6**

TABLE III-9

STREAM NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
UNITS	MMBTU/Hr	MMBTU/Hr	MMBTU/Hr	MMBTU/Hr	MMBTU/Hr	MMBTU/Hr	MMBTU/Hr	MMBTU/Hr	MMBTU/Hr	MMBTU/Hr	MMBTU/Hr	MMBTU/Hr	MMBTU/Hr	MMBTU/Hr	MMBTU/Hr	MMBTU/Hr	MMBTU/Hr	MMBTU/Hr	MMBTU/Hr
DESCRIPTION	POWER TO UPGRADING	NG TO UPGRADING	CG TO UTILITIES	STEAM TO UPGRADING LESS EXPORT	CONDENSATE FROM UPGRADING TO UTILITIES	CONDENSATE FROM EXTRACTION TO UTILITIES	STEAM TO EXTRACTION	DIESEL TO MINE	POWER TO MINE AND EXTRACTION	POWER TO F.G.D.	STEAM TO F.G.D. LESS EXPORT	HVY FUEL OIL TO UTILITIES	DIESEL TO UTILITIES	UTILITIES POWER GENERATION	NG TO UTILITIES	B.F.W. TO UPGRADING	COKE TO UTILITIES	CG TO UPGRADING	POWER TO UTILITIES
COMPONENT																			
79.5 KBPCD CASE	56	822	266	354	1	106	1,457	136	125	34	27	33	2	170	134	71	2,055	1,775	53
87.0 KBPCD CASE	56	822	266	487	4	125	1,615	149	139	34	27	33	2	167	147	50	2,346	1,775	50
107.0 KBPCD CASE	69	827	233	409	6	183	1,891	183	159	34	27	33	2	344	205	62	2,596	1,730	57

LIST OF ASSUMPTIONS:

1. 1GJ = 0.95 MMBTU ; 1 MWHR = 3.412 MMBTU

2. CALOROFIC VALUES: NG 987 BTU/scF
   CG 1302 BTU/scF
   COKE 13,200 BTU/lb
   DIESEL 5.667 MMBTU/BBL
   HVY. FUEL OIL 5.831 MMBTU/BBL

3. ENTHALPIES VALUES: 790#, 750°F STEAM 1368 BTU/lb
   425#, 550°F STEAM 1272 BTU/lb
   150#, SAT. STEAM 1195 BTU/lb
   50#, SAT. STEAM 1179 BTU/lb
   B.F.W. 268 BTU/lb
   CONDENSATE 138 BTU/lb

ENERGY BALANCE FOR CURRENT AND FUTURE PRODUCTION

TABLE III-10

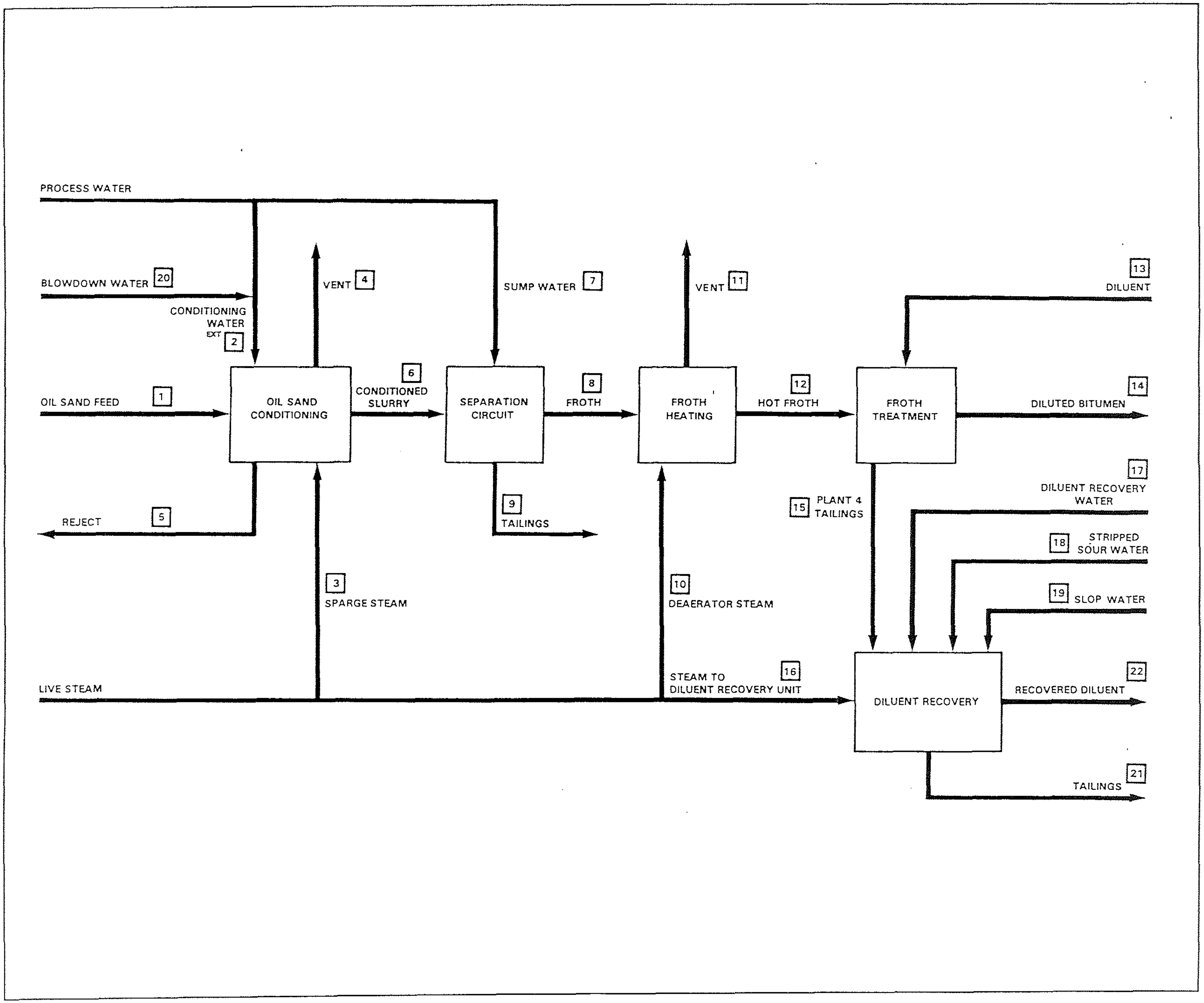


FIGURE III-9 EXTRACTION PROCESS FLOWSHEET

EXTRACTION CALENDAR DAY MATERIAL BALANCE FOR 79,500 BBL/CD (12,639 m^3/CD)

STREAM NUMBER	EXT 1	EXT 2	EXT 3	EXT 4	EXT 5	EXT 6	EXT 7	EXT 8	EXT 9	EXT 10
UNITS (GROSS FLOWS PER CALENDAR DAY)	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE
DESCRIPTION	TARSAND FEED	CONDITIONING WATER	SPARGE STEAM	VENT	REJECT	CONDITIONED SLURRY	SUMP WATER	TOTAL FROTH	SEP'N CIRCUIT TAILINGS	DEAERATOR STEAM
COMPONENT										
BITUMEN t/d	16,439	0	0	0	329	16,110	0	15,389	722	0
MINERAL t/d	115,073	424	0	0	6,987	108,511	157	2,591	106,077	0
WATER t/d	5,480	42,008	4,389	1,057	904	49,915	31,149	7,787	73,277	897
DILUENT t/d	0	0	0	0	0	0	0	0	0	0
TOTAL t/d	136,992	42,432	4,389	1,057	8,220	174,536	31,306	25,767	180,075	897
m3/d	65,196	42,168	0	0	3,866	106,829	31,208	24,016	112,954	0
IGPM	9,959	6,441	0	0	591	16,319	4,767	3,669	17,255	0
USGPM	11,960	7,736	0	0	709	19,598	5,725	4,406	20,722	0
SULPHUR t/h	795.70	0.00	0.00	0.00	15.91	779.79	0.00	744.86	34.93	0.00
DENSITY (t/m3)	2.10	1.01	0.00	0.00	2.13	1.63	1.00	1.07	1.59	0.00
TEMP °C	1.00	93.00	0.00	0.00	50.00	76.00	62.00	72.00	72.00	0.00

STREAM NUMBER	EXT 11	EXT 12	EXT 13	EXT 14	EXT 15	EXT 16	EXT 17	EXT 18	EXT 19	EXT 20
UNITS (GROSS FLOWS PER CALENDAR DAY)	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE
DESCRIPTION	VENT	HOT FROTH	DILUENT	DILUTED BITUMEN	PLANT 4 TAILINGS	STEAM TO PLANT 16	DRU WATER	STRIPPED SOUR WATER	SLOP WATER	BLOWDOWN WATER
COMPONENT										
BITUMEN t/d	0	15,389	0	15,004	385	0	0	0	0	0
MINERAL t/d	0	2,591	0	130	2,461	0	0	0	0	0
WATER t/d	276	8,408	79	1,174	7,313	208	593	2,879	1,299	1,963.2
DILUENT t/d	0	0	10,034	9,783	251	0	0	0	0	0
TOTAL t/d	276	26,388	10,113	26,092	10,409	208	593	2,879	1,299	1,963.2
m3/d	0	24,637	13,195	28,882	8,951	0	593	2,879	1,299	1,963.2
IGPM	0	3,764	2,016	4,412	1,367	0	91	440	198	299.8788
USGPM	0	4,520	2,421	5,298	1,642	0	109	528	238	360.1654
SULPHUR t/h	0.00	744.86	180.98	903.14	22.69	0.00	0.00	0.00	0.00	0.00
DENSITY (t/m3)	0.00	1.07	0.77	0.90	1.16	0.00	1.00	1.00	1.00	1.0
TEMP °C	0.00	95.00	54.00	84.00	84.00	0.00	99.00	99.00	24.00	99.00

STREAM NUMBER	EXT 21	EXT 22
UNITS (GROSS FLOWS PER CALENDAR DAY)	TONNE	TONNE
DESCRIPTION	TAILINGS	RECOVERED DILUENT
COMPONENT		
BITUMEN t/d	385	0
MINERAL t/d	2,461	0
WATER t/d	12,293	0
DILUENT t/d	90	161
TOTAL t/d	15,228	161
m3/d	13,720	210
IGPM	2,096	32
USGPM	2,517	38
SULPHUR t/h	19.80	2.90
DENSITY (t/m3)	1.11	0.77
TEMP °C	91.00	91.00

TABLE III-11

EXTRACTION STREAM DAY MATERIAL BALANCE FOR 79,500 BBL/CD (12,639 m^3/CD)

STREAM NUMBER		EXT 1	EXT 2	EXT 3	EXT 4	EXT 5	EXT 6	EXT 7	EXT 8	EXT 9	EXT 10	EXT 11	EXT 12	EXT 13	EXT 14	EXT 15	EXT 16	EXT 17	EXT 18	EXT 19	EXT 20
UNITS (GROSS FLOWS PER DAY)		TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE
DESCRIPTION		TARSAND FEED	CONDITIONING WATER	SPARGE STEAM	VENT	REJECT	CONDITIONED SLURRY	SUMP WATER	TOTAL FROTH	SEP'N CIRCUIT TAILINGS	DEAERATOR STEAM	VENT	HOT FROTH	DILUENT	DILUTED BITUMEN	PLANT 4 TAILINGS	STEAM TO PLANT 16	DRU WATER	STRIPPED SOUR WATER	SLOP WATER	BLOWDOWN WATER
COMPONENT																					
BITUMEN	t/d	18,066	0	0	0	361	17,705	0	16,912	793	0	0	16,912	0	16,489	423	0	0	0	0	0
MINERAL	t/d	126,464	466	0	0	7,678	119,252	172	2,847	116,576	0	0	2,847	0	143	2,704	0	0	0	0	0
WATER	t/d	6,022	46,166	4,823	1,162	994	54,856	34,232	8,558	80,530	864	266	9,156	87	1,290	7,953	227	593	2,879	1,299	1,963
DILUENT	t/d	0	0	0	0	0	0	0	0	0	0	0	0	11,027	10,751	276	0.00	0	0	0	0
TOTAL	t/d	150,552	46,632	4,823	1,162	9,033	191,812	34,404	28,317	197,899	864	266	28,916	11,114	28,674	11,356	227	593	2,879	1,299	1,963
	m3/d	71,649	46,342			4,249	117,403	34,297	26,393	124,135			26,992	14,502	31,741	9,753		593	2,879	1,299	1,963
	IGPM	10,945	7,079			649	17,934	5,239	4,032	18,963			4,123	2,215	4,849	1,490		91	440	198	300
	USGPM	13,144	8,502			780	21,538	6,292	4,842	22,773			4,952	2,660	5,823	1,789		109	528	238	360
SULPHUR	t/d (note1)	982.35	0.00	0.00	0.00	19.65	962.70	0	919.58	43.12	0.00	0.00	919.58	223.43	1114.99	28.02	0.00	0.00	0.00	0.00	0.00
DENSITY	(t/m^3)	2.10	1.01			2.13	1.63	1.00	1.07	1.59			1.07	0.77	0.90	1.16		1.00	1.00	1.00	1.0
TEMP.	(°C)	1.00	93.00			50.00	76.00	72.00	75.00	75.00			95.00	54.00	84.00	84.00		99.00	99.00	24.00	99.00

STREAM NUMBER		EXT 21	EXT 22
UNITS (GROSS FLOWS PER DAY)		TONNE	TONNE
DESCRIPTION		Plant 16 Tailings	Recovered Diluent
COMPONENT			
BITUMEN	t/d	423	0
MINERAL	t/d	2,704	0
WATER	t/d	12,951	0
DILUENT	t/d	99	176
TOTAL	t/d	16,178	176
	m3/d	14,521	231
	IGPM	2,218	35
	USGPM	2,664	42
SULPHUR	t/d (note1)	24.44	3.57
DENSITY	(t/m^3)	1.11	0.77
TEMP.	(°C)	91.00	91.00

TABLE III-12

EXTRACTION CALENDAR DAY MATERIAL BALANCE FOR 87,000 BBL/CD (13,832 m³/CD)

STREAM NUMBER	EXT 1	EXT 2	EXT 3	EXT 4	EXT 5	EXT 6	EXT 7	EXT 8	EXT 9	EXT 10	EXT 11	EXT 12	EXT 13	EXT 14	EXT 15	EXT 16	EXT 17	EXT 18	EXT 19	EXT 20
UNITS (GROSS FLOWS PER CALENDAR DAY)	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE
DESCRIPTION	TARSAND FEED	CONDITIONING WATER	SPARGE STEAM	VENT	REJECT	CONDITIONED SLURRY	SUMP WATER	TOTAL FROTH	SEP'N CIRCUIT TAILINGS	DEAERATOR STEAM	VENT	HOT FROTH	DILUENT	DILUTED BITUMEN	PLANT 4 TAILINGS	STEAM TO PLANT 16	DRU WATER	STRIPPED SOUR WATER	SLOP WATER	BLOWDOWN WATER
COMPONENT																				
BITUMEN t/d	18,046	0	0	0	361	17,685	0	16,893	792	0	0	16,893	0	16,471	422	0	0	0	0	0
MINERAL t/d	126,323	466	0	0	7,670	119,119	172	2,844	116,446	0	0	2,844	0	143	2,701	0	0	0	0	0
WATER t/d	6,015	46,114	4,818	1,161	993	54,794	34,194	8,548	80,440	984	303	9,230	87	1,289	8,028	229	593	2,879	1,299	1,963
DILUENT t/d	0	0	0	0	0	0	0	0	0	0	0	0	11,015	10,739	275	0	0	0	0	0
TOTAL t/d	150,384	46,580	4,818	1,161	9,023	191,598	34,366	28,286	197,679	984	303	28,967	11,102	28,642	11,427	229	593	2,879	1,299	1,963
m3/d	71,569	46,290	0	0	4,244	117,272	34,259	26,364	123,997	0	0	27,046	14,485	31,705	9,826	0	593	2,879	1,299	1,963
IGPM	10,933	7,071	0	0	648	17,914	5,233	4,027	18,942	0	0	4,131	2,213	4,843	1,501	0	91	440	198	300
USGPM	13,130	8,492	0	0	779	21,514	6,285	4,837	22,748	0	0	4,962	2,657	5,816	1,803	0	109	528	238	360
SULPHUR t/h	891.42	0.00	0.00	0.00	17.83	873.59	0.00	834.46	39.13	0.00	0.00	834.46	199.19	1008.0	25.65	0.00	0.00	0.00	0.00	0.00
DENSITY (t/m3)	2.10	1.01	0.00	0.00	2.13	1.63	1.00	1.07	1.59	0.00	0.00	1.07	0.77	0.90	1.16	0.00	1.00	1.00	1.00	1.0
TEMP °C	1.00	93.00	0.00	0.00	50.00	76.00	62.00	72.00	72.00	0.00	0.00	95.00	54.00	84.00	84.00	0.00	99.00	99.00	24.00	99.00

STREAM NUMBER	EXT 21	EXT 22
UNITS (GROSS FLOWS PER CALENDAR DAY)	TONNE	TONNE
DESCRIPTION	TAILINGS	RECOVERED DILUENT
COMPONENT		
BITUMEN t/d	422	0
MINERAL t/d	2,701	0
WATER t/d	13,028	0
DILUENT t/d	77	198
TOTAL t/d	16,288	198
m3/d	14,566	259
IGPM	2,225	40
USGPM	2,672	48
SULPHUR t/h	22.06	3.59
DENSITY (t/m3)	1.11	0.77
TEMP °C	91.00	91.00

TABLE III-13

EXTRACTION STREAM DAY MATERIAL BALANCE FOR 87,000 BBL/CD (13,832 m^3/CD)

STREAM NUMBER	EXT 1	EXT 2	EXT 3	EXT 4	EXT 5	EXT 6	EXT 7	EXT 8	EXT 9	EXT 10	EXT 11	EXT 12	EXT 13	EXT 14	EXT 15	EXT 16	EXT 17	EXT 18	EXT 19	EXT 20
UNITS (GROSS FLOWS PER DAY)	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE
DESCRIPTION	TARSAND FEED	CONDITIONING WATER	SPARGE STEAM	VENT	REJECT	CONDITIONED SLURRY	SUMP WATER	TOTAL FROTH	SEP'N CIRCUIT TAILINGS	DEAERATOR STEAM	VENT	HOT FROTH	DILUENT	DILUTED BITUMEN	PLANT 4 TAILINGS	STEAM TO PLANT 16	DRU WATER	STRIPPED SOUR WATER	SLOP WATER	BLOWDOWN WATER
COMPONENT																				
BITUMEN t/d	21,226	0	0	0	425	20,801	0	19,869	932	0	0	19,869	0	19,373	497	0	0	0	0	0
MINERAL t/d	148,579	548	0	0	9,021	140,106	202	3,345	136,963	0	0	3,345	0	168	3,177	0	0	0	0	0
WATER t/d	7,075	54,239	5,667	1,365	1,167	64,449	40,219	10,055	94,613	1,015	312	10,758	102	1,516	9,344	267	593	2,879	1,299	1,963
DILUENT t/d	0	0	0	0	0	0	0	0	0	0	0	0	12,955	12,632	324	0.00	0	0	0	0
TOTAL t/d	176,880	54,787	5,667	1,365	10,613	225,356	40,421	33,269	232,507	1,015	312	33,972	13,058	33,689	13,341	267	593	2,879	1,299	1,963
m3/d	84,179	54,446			4,992	137,934	40,295	31,009	145,843			31,712	17,038	37,291	11,458		593	2,879	1,299	1,963
IGPM	12,859	8,317			763	21,071	6,155	4,737	22,279			4,844	2,603	5,697	1,750		91	440	198	300
USGPM	15,443	9,988			916	25,305	7,392	5,689	26,756			5,818	3,126	6,841	2,102		109	528	238	360
SULPHUR t/d (note1)	1100.52	0.00			22.01	1078.51	0	1030.20	48.31			1030.20	245.91	1244.44	31.66		0.00	0.00	0.00	0.00
DENSITY (t/m3)	2.10	1.01			2.13	1.63	1.00	1.07	1.59			1.07	0.77	0.90	1.16		1.00	1.00	1.00	1.0
TEMP. (°C)	1.00	93.00			50.00	76.00	72.00	75.00	75.00			95.00	54.00	84.00	84.00		99.00	99.00	24.00	99.00

STREAM NUMBER	EXT 21	EXT 22
UNITS (GROSS FLOWS PER DAY)	TONNE	TONNE
DESCRIPTION	Plant 16 Tailings	Recovered Diluent
COMPONENT		
BITUMEN t/d	497	0
MINERAL t/d	3,177	0
WATER t/d	14,382	0
DILUENT t/d	91	233
TOTAL t/d	18,146	233
m3/d	16,192	305
IGPM	2,473	47
USGPM	2,970	56
SULPHUR t/d (note1)	27.24	4.43
DENSITY (t/m3)	1.12	0.77
TEMP. (°C)	92.00	92.00

TABLE III-14

EXTRACTION CALENDAR DAY MATERIAL BALANCE FOR 107,000 BBL/CD (17,012 m^3/CD)

STREAM NUMBER		1 EXT	2 EXT	3 EXT	4 EXT	5 EXT	6 EXT	7 EXT
UNITS (GROSS FLOWS PER CALENDAR DAY)		TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE
DESCRIPTION		TARSAND FEED	CONDITIONING WATER	SPARGE STEAM	VENT	REJECT	CONDITIONED SLURRY	SUMP WATER
COMPONENT								
BITUMEN	t/d	21,832	0	0	0	280	21,552	0
MINERAL	t/d	156,744	798	0	0	2,986	154,556	219
WATER	t/d	8,024	79,010	0	0	467	86,568	43,584
DILUENT	t/d	0	0	0	0	0	0	0
TOTAL	t/d	186,600	79,808	0	0	3,732	262,676	43,803
	m3/d	88,810	79,312	0	0	1,871	166,251	43,666
	IGPM	13,566	12,115	0	0	286	25,395	6,670
	USGPM	16,293	14,550	0	0	343	30,500	8,011
SULPHUR	t/h	1061.35	0.00	0.00	0.00	13.61	1047.74	0.00
DENSITY (t/m3)		2.10	1.01	0.00	0.00	2.00	1.58	1.00
TEMP °C		1.00	93.00	0.00	0.00	50.00	58.00	48.00

STREAM NUMBER		8 EXT	9 EXT	10 EXT	11 EXT	12 EXT	13 EXT	14 EXT
UNITS (GROSS FLOWS PER CALENDAR DAY)		TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE
DESCRIPTION		TOTAL FROTH	SEP'N CIRCUIT TAILINGS	DEAERATOR STEAM	VENT	HOT FROTH	DILUENT	DILUTED BITUMEN
COMPONENT								
BITUMEN	t/d	20,401	1,152	0	0	20,401	0	19,891
MINERAL	t/d	3,479	151,296	0	0	3,479	0	173
WATER	t/d	10,319	119,832	2,066	635	11,750	105	1,560
DILUENT	t/d	0	0	0	0	0	13,371	13,037
TOTAL	t/d	34,199	272,280	2,066	635	35,629	13,476	34,661
	m3/d	31,851	178,067	0	0	33,281	17,493	38,292
	IGPM	4,865	27,200	0	0	5,084	2,672	5,849
	USGPM	5,843	32,668	0	0	6,106	3,209	7,025
SULPHUR	t/h	991.75	55.99	0.00	0.00	991.75	240.98	1202.16
DENSITY (t/m3)		1.07	1.53	0.00	0.00	1.07	0.77	0.91
TEMP °C		55.00	55.00	0.00	0.00	95.00	54.00	84.00

STREAM NUMBER		15 EXT	16 EXT	17 EXT	18 EXT	19 EXT	20 EXT
UNITS (GROSS FLOWS PER CALENDAR DAY)		TONNE	TONNE	TONNE	TONNE	TONNE	TONNE
DESCRIPTION		PLANT 4 TAILINGS	STEAM TO PLANT 16	DRU WATER	STRIPPED SOUR WATER	SLOP WATER	BLOWDOWN WATER
COMPONENT							
BITUMEN	t/d	510	0	0	0	0	0
MINERAL	t/d	3,306	0	0	0	0	0
WATER	t/d	10,295	289	1,356	1,500	1,630	1,963
DILUENT	t/d	334	0	0	0	0	0
TOTAL	t/d	14,445	289	1,356	1,500	1,630	1,963
	m3/d	12,483	0	1,356	1,500	1,630	1,963
	IGPM	1,907	0	207	229	249	300
	USGPM	2,290	0	249	275	299	360
SULPHUR	t/h	30.57	0.00	0.00	0.00	0.00	0.00
DENSITY (t/m3)		1.16	0.00	1.00	1.00	1.00	1.0
TEMP °C		84.00	0.00	99.00	99.00	24.00	99.00

STREAM NUMBER		21 EXT	22 EXT
UNITS (GROSS FLOWS PER CALENDAR DAY)		TONNE	TONNE
DESCRIPTION		TAILINGS	RECOVERED DILUENT
COMPONENT			
BITUMEN	t/d	510	0
MINERAL	t/d	3,306	0
WATER	t/d	15,069	0
DILUENT	t/d	94	241
TOTAL	t/d	18,979	241
	m3/d	16,944	313
	IGPM	2,588	48
	USGPM	3,109	57
SULPHUR	t/h	26.23	4.34
DENSITY (t/m3)		1.12	0.77
TEMP °C		90.00	90.00

TABLE III-15

EXTRACTION STREAM DAY MATERIAL BALANCE FOR 107,000 BBL/CD (17,012 m^3/CD)

STREAM NUMBER	EXT 1	EXT 2	EXT 3	EXT 4	EXT 5	EXT 6	EXT 7	EXT 8	EXT 9	EXT 10	EXT 11	EXT 12	EXT 13	EXT 14	EXT 15	EXT 16	EXT 17	EXT 18	EXT 19	EXT 20
UNITS (GROSS FLOWS PER CALENDAR DAY)	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE	TONNE
DESCRIPTION	TARSAND FEED	CONDITIONING WATER	SPARGE STEAM	VENT	REJECT	CONDITIONED SLURRY	SUMP WATER	TOTAL FROTH	SEP'N CIRCUIT TAILINGS	DEAERATOR STEAM	VENT	HOT FROTH	DILUENT	DILUTED BITUMEN	PLANT 4 TAILINGS	STEAM TO PLANT 16	DRU WATER	STRIPPED SOUR WATER	SLOP WATER	BLOWDOWN WATER
COMPONENT																				
BITUMEN t/d	28,080	0	0	0	360	27,720	0	26,238	1,482	0	0	26,238	0	25,582	656	0	0	0	0	0
MINERAL t/d	201,600	1,026	0	0	3,840	198,786	282	4,475	194,594	0	0	4,475	0	223	4,252	0	0	0	0	0
WATER t/d	10,320	101,621	0	0	600	111,341	56,056	13,271	154,126	2,657	817	15,111	135	2,006	13,240	372	1,366	1,500	1,641	1,963
DILUENT t/d	0	0	0	0	0	0	0	0	0	0	0	0	17,197	16,767	430	0	0	0	0	0
TOTAL t/d	240,000	102,647	0	0	4,800	337,847	56,338	43,984	350,202	2,657	817	45,823	17,332	44,578	18,578	372	1,366	1,500	1,641	1,963
m3/d	114,225	102,008	0	0	2,406	213,828	56,162	40,963	229,027	0	0	42,803	22,498	49,247	16,054	0	1,366	1,500	1,641	1,963
IGPM	17,448	15,582	0	0	367	32,662	8,579	6,257	34,984	0	0	6,538	3,437	7,523	2,452	0	209	229	251	300
USGPM	20,956	18,714	0	0	441	39,228	10,303	7,515	42,017	0	0	7,853	4,127	9,035	2,945	0	251	275	301	360
SULPHUR t/h	1310.37	0.00	0.00	0.00	16.80	1293.57	0.00	1224.39	69.18	0.00	0.00	1224.39	297.50	1484.15	37.74	0.00	0.00	0.00	0.00	0.00
DENSITY (t/m3)	2.10	1.01	0.00	0.00	2.00	1.58	1.00	1.07	1.53	0.00	0.00	1.07	0.77	0.91	1.16	0.00	1.00	1.00	1.00	1.0
TEMP °C	1.00	93.00	0.00	0.00	50.00	58.00	48.00	55.00	55.00	0.00	0.00	95.00	54.00	84.00	84.00	0.00	99.00	99.00	24.00	99.00

STREAM NUMBER	EXT 21	EXT 22
UNITS (GROSS FLOWS PER CALENDAR DAY)	TONNE	TONNE
DESCRIPTION	TAILINGS	RECOVERED DILUENT
COMPONENT		
BITUMEN t/d	656	0
MINERAL t/d	4,252	0
WATER t/d	18,118	0
DILUENT t/d	120	310
TOTAL t/d	23,146	310
m3/d	20,529	403
IGPM	3,136	61
USGPM	3,766	74
SULPHUR t/h	32.39	5.36
DENSITY (t/m3)	1.13	0.77
TEMP °C	92.00	92.00

TABLE III-16

APPENDIX IV

LEASE 86/17 AND STEEPBANK MINE

RECLAMATION PLAN DETAIL

LEASE 86/17 AND STEEPBANK MINE RECLAMATION PLAN DETAIL

Suncor's reclamation strategy and conceptual plan was outlined in the February 1995 Application for Renewal of Environmental Operating Approval (Suncor 1995a). Major components of this discussion as well as specific applications to Steepbank Mine are presented below.

1.0 RECLAMATION AREA PREPARATION

Reclamation area preparation includes three components: structure construction, capping (where required) and soil amendment application. Reclamation areas are initially prepared through placement of three primary types of landform materials: tailings sand (found within tailings sand dykes, plateaus and sand storage areas); consolidated tailings (which will be placed within Ponds 1, 5 and 6 on Lease 86/17 and in Ponds 7 and 8 in Steepbank Mine); and overburden materials (which are used to construct waste dumps and dykes structures).

a) Landscape Structure Construction

Land surfaces created on the mined-out areas of Lease 86/17 have been constructed to provide long-term geotechnical stability while functioning as integral components of Suncor's tailings and recycle water management process. Waste dumps and dykes are constructed on dry, firm foundations for which suitable geotechnical stability evaluations have been conducted. Preparation for waste dump construction includes surface clearing and grubbing (i.e., removal of roots and surface organic layers) on dry waste dump sites, and draining and removal of all unstable and muskeg-type materials on wet sites. Structures are bounded by large dykes constructed of overburden, tailings sand or a combination of materials. All dykes are configured with 2.5H:1V slopes interrupted by berms to form overall slopes of 3H:1V. Most dyke slopes on Lease 86/17 are configured with regular (even) slope faces.

Activities associated with movement of earthen materials and construction of waste dumps and dykes will begin on Steepbank Mine in 2000. Recovery and stockpiling of muskeg soil reserves will also begin in 2000 and will continue through 2020. Table IV-I details materials to be placed in dykes, waste piles and muskeg storage areas on a yearly basis between 2000 and 2010 then for the periods 2011-2015 and 2016-2020.

A proposed overburden dyke (which will recreate the Athabasca River valley escarpment wall for Steepbank Mine) will also be constructed with 2.5H:1V slopes interrupted by berms to form overall slopes of 3H:1V.

TABLE IV-1

MATERIAL MOVEMENT AND DESTINATIONS

Year	Dyke Construction	Waste Dump Disposal	Muskeg Stockpile	Total Materials
2000	0	10 200	300	10 500
2001	950	9150	400	10 500
2002	7722	21 278	400	29 400
2003	14 587	14 413	400	29 400
2004	15 767	13 233	400	29 400
2005	20 575	37 825	400	58 800
2006	34 105	34 795	400	69 300
2007	31 887	26 513	400	58 800
2008	17 970	40 430	400	58 800
2009	21 700	36 700	400	58 800
2010	38 000	20 400	400	58 800
2011-2015	112 950	246 350	2000	361 300
2016-2020	166 690	196 310	2000	365 000
Total kt:	**482 903**	**707 597**	**8300**	**1 198 800**

The majority of landscape structures on Lease 86/17 have been completed. Table IV-2 details structures remaining to be constructed or completed on Lease 86/17 (as of 1996) and structures for Steepbank Mine.

Overburden dyke and dump structures (which will form parts of the new Athabasca River valley escarpment in Steepbank Mine) will be designed and constructed to minimize erosion. Whenever possible design variations will be incorporated to allow development of an escarpment face which more closely resembles the current escarpment. However, the primary focus of the dyke and dump construction remains the achievement of a stable structure with a surface that is as erosion-resistant as possible.

disturbance was minimal. Undisturbed material was excavated, hauled and dumped directly on the reclamation site. A refinement to the process of depositing topsoil was to excavate and haul soil-building materials during the winter months, noteworthy because dormant, in situ native seed and root fragments were transferred with the partially-frozen in-situ pockets of soil. Spreading of muskeg soil on the reclamation site is completed in early spring with the usual result the emergence of a variety of native, woody-stemmed plants, forbs, wildflowers and grasses. This prolific vegetative growth provides an erosion-controlling cover which is diverse and consistent with that of regional ecosystems.

Current soil reconstruction technique has been used on an operational scale since 1984. Suncor's reclamation focus is to amend reclamation sites with quality soil-building material. The technique involves stripping muskeg to include 25% to 50% (by volume) of mineral overburden. This peat/till mixture is designated as Type 1 muskeg soil when muskeg is mixed with fine-textured till, clay or silt (fines) and is designated as Type 2 muskeg soil when muskeg is mixed with coarse- textured material (sand and gravel). Key chemical and physical properties of materials to be covered and of Type 1 and Type 2 muskeg soils are shown in Table IV-3. Type 1 muskeg soil is the principal soil amendment for tailings sand, consolidated tailings and overburden. Type 2 muskeg soil is primarily used to amend overburden spoil when Type 1 supply is exhausted or mine logistics dictate Type 2 utilization. Muskeg soils have enhanced fines content and cation exchange capacity (CEC) compared to unamended tailings sand and consolidated tailings.

2.0 REVEGETATION PROGRAM

Once the reclamation landform and structure surface is prepared, revegetation activities are initiated; the methodology is described in Subsection D3.5 of the Application.

Reclamation activities planned for Lease 86/17 during the period 1996 to 2000 will focus on reclaiming the oversize dump, completed tailings plateaus and some small overburden dump sites. Reclamation maintenance activities (including fertilizer application and infill tree planting) will continue for all previously-reclaimed sites. Muskeg salvaged as part of the stripping operation will be applied as a soil amendment to available sites with surplus being stockpiled for later use. Revegetation of overburden storage areas and tailings sand slopes will also continue throughout 1996 to 2000. Generally, revegetation of various sites immediately follows their reclamation.

TABLE IV-3

KEY CHEMICAL AND PHYSICAL PROPERTIES OF SOIL BUILDING MATERIALS

Parameters		Soil Materials				
		Tailings Sand [a]	Overburden Spoil [b]	Consolidated Tailings [c]	Type 1 Muskeg Soil [d]	Type 2 Muskeg Soil [d]
Texture (%)	Clay	3	26	7	19	15
	Silt	2	22	8	25	15
	Sand	95	52	85	56	70
pH		7.5	7.5	8.2	7.4	5.6
Electrical Conductivity (mS/cm)		0.1	2.0	2.8	0.7	1.2
Organic Carbon (%)		0.2	4.2	ND	7.6	13.5
Total Nitrogen (%)		0.01	0.6	ND	0.3	0.6
Carbon / Nitrogen Ratio		20	69	ND	28	23
Cation Exchange Capacity (meq/100 g)		0.3	11.5	2.4	26.0	40.7
Sodium Adsorption Ratio		ND	6.3	ND	4.4	2.2

[a] *Adapted from Rowell 1979 (from Suncor 1995).*
[b] *From 1987 operational areas (from Suncor 1995).*
[c] *From Xu 1996.*
[d] *From 1984 operational areas (from Suncor 1995).*
ND *No Data.*

Planned reclamation activities for Lease 86/17 during the period 1996 through 2020 are detailed in Table IV-4 while reclamation progression to 2001 is shown in Figure IV-2. The reclamation progression for the Tar Island Reclaimed Area (TIRA) between 1996 and 2010 is shown in Figure IV-3.

Progression of reclamation activities for both Lease 86/17 and Steepbank Mine is shown for the period to 2010 in Figure IV-3; and for the period to 2020 in Figure IV-4.

Table IV-4: Lease 86/17 Planned Reclamation Activities

Year, Reclamation Type and Location	Area (ha)	Muskeg Source	Seed Type and Rate (kg/ha)	Fertilizer Rate (kg/ha)	Tree Planting - % of Type			
					Pine	Spruce	Poplar	Shrub
1996 - New Reclamation								
Tar Island Dyke	16	in situ	barley - 62	300	50	--	25	25
Dyke 4	21	in situ	barley - 62	300	50	10	20	20
Dyke 5	7	in situ	barley - 62	300	10	50	20	20
1996 - Maintenance Activities								
Dyke 5	7.2	--	--	200	--	--	--	--
WA[a] 16	5.3	--	--	200	--	--	--	--
Dyke 5	6.6	--	--	200	--	--	--	--
WA[a] 8 Extension	7.3	--	--	200	--	--	--	--
WA[a] 18	5.8	--	--	200	--	--	--	--
1997 - New Reclamation								
Dyke 6	63	in situ	barley - 62	300	20	50	10	20
Dyke 5	49	in situ	barley - 62	300	20	50	10	20
East/West Dyke	18	in situ	barley - 62	300	20	50	10	20
Dyke 5 Oversize	8.2	in situ	barley - 62	300	20	50	10	20
Dyke 2 - Top	40	in situ	barley - 62	300	20	50	10	20
1997 - Maintenance Activities								
Dyke 5	20.8	--	--	200	--	--	--	--
WA[a] 16	5.3	--	--	200	--	--	--	--
Horseshoe - Site 16	7.3	--	--	200	--	--	--	--
WA[a] 18	5.8	--	--	200	--	--	--	--
Tar Island Dyke	16	--	--	200	--	--	--	--
Dyke 4	21	--	--	200	--	--	--	--
1998 - New Reclamation								
Dyke 7	38	in situ	barley - 62	300	50	10	20	20
Tar Island Dyke	19.5	stockpile	barley - 62	300	20	50	10	20

a Waste Area

Table IV-4: Lease 86/17 Planned Reclamation Activities								
Year, Reclamation Type and Location	Area (ha)	Muskeg Source	Seed Type and Rate (kg/ha)	Fertilizer Rate (kg/ha)	Tree Planting - % of Type			
					Pine	Spruce	Poplar	Shrub
1998 - Maintenance Activities								
WA[a] 18	5.8	--	--	200	--	--	--	--
Tar Island Dyke	16	--	--	200	--	--	--	--
Dyke 4	21	--	--	200	--	--	--	--
Dyke 5	56	--	--	200	--	--	--	--
Dyke 6	63	--	--	200	--	--	--	--
East/West Dyke	18	--	--	200	--	--	--	--
Dyke 5 Oversize	8.2	--	--	200	--	--	--	--
Dyke 2 - Top	40	--	--	200	--	--	--	--
Dyke 7	38	--	--	200	--	--	--	--
1999 - New Reclamation								
Pond 5 West	33	in situ	barley - 62	300	--	50	25	25
Tar Island Dyke	18.8	stockpile	barley - 62	300	20	50	10	20
1999 - Maintenance Activities								
Tar Island Dyke	35.5	--	--	200	--	--	--	--
Dyke 4	21	--	--	200	--	--	--	--
Dyke 5	68	--	--	200	--	--	--	--
Dyke 6	63	--	--	200	--	--	--	--
East/West Dyke	18	--	--	200	--	--	--	--
Dyke 5 Oversize	8.2	--	--	200	--	--	--	--
Dyke 2 - Top	40	--	--	200	--	--	--	--
Dyke 7	38	--	--	200	--	--	--	--

[a] Waste Area

Table IV-4: Lease 86/17 Planned Reclamation Activities								
Year, Reclamation Type and Location	Area (ha)	Muskeg Source	Seed Type and Rate (kg/ha)	Fertilizer Rate (kg/ha)	Tree Planting - % of Type			
					Pine	Spruce	Poplar	Shrub
2000 - New Reclamation								
Tar Island Dyke	29.8	stockpile	barley - 62	300	20	50	10	20
2000 - Maintenance Activities								
Tar Island Dyke	54.3	--	--	200	--	--	--	--
Dyke 4	21	--	--	200	--	--	--	--
Dyke 5	68	--	--	200	--	--	--	--
Dyke 6	63	--	--	200	--	--	--	--
East/West Dyke	18	--	--	200	--	--	--	--
Dyke 5 Oversize	8.2	--	--	200	--	--	--	--
Dyke 2 - Top	40	--	--	200	--	--	--	--
Dyke 7	38	--	--	200	--	--	--	--
Pond 5 West	33	--	--	200	--	--	--	--
2001 - New Reclamation								
Tar Island Dyke	26	stockpile	barley - 62	300	20	50	10	20
2001 - Maintenance Activities								
Tar Island Dyke	68.1	--	--	200	--	--	--	--
Dyke 6	63	--	--	200	--	--	--	--
Dyke 5	61	--	--	200	--	--	--	--
East/West Dyke	18	--	--	200	--	--	--	--
Dyke 5 Oversize	8.2	--	--	200	--	--	--	--
Dyke 2 - Top	40	--	--	200	--	--	--	--
Dyke 7	38	--	--	200	--	--	--	--
Pond 5 West	33	--	--	200	--	--	--	--
2002 - New Reclamation								
Tar Island Dyke	22.1	stockpile	barley - 62	300	20	50	10	

Table IV-4: Lease 86/17 Planned Reclamation Activities								
Year, Reclamation Type and Location	**Area (ha)**	**Muskeg Source**	**Seed Type and Rate (kg/ha)**	**Fertilizer Rate (kg/ha)**	**Tree Planting - % of Type**			
					Pine	**Spruce**	**Poplar**	**Shrub**
2002 - Maintenance Activities								
Tar Island Dyke	94.1	--	--	200	--	--	--	--
Dyke 7	38	--	--	200	--	--	--	--
Dyke 5	12	--	--	200	--	--	--	--
Pond 5 West	33	--	--	200	--	--	--	--
2003 - New Reclamation								
Tar Island Dyke	19.7	stockpile	barley - 62	300	20	50	10	20
2003 - Maintenance Activities								
Tar Island Dyke	96.7	--	--	200	--	--	--	--
2004 - New Reclamation								
Tar Island Dyke	17	stockpile	barley - 62	300	20	50	10	20
2004 - Maintenance Activities								
Tar Island Dyke	97.6	--	--	200	--	--	--	--
2005 - New Reclamation								
Tar Island Dyke	18.7	stockpile	barley - 62	300	20	50	10	20
2005 - Maintenance Activities								
Tar Island Dyke	84.8	--	--	200	--	--	--	--
2006 - New Reclamation								
Tar Island Dyke	15	stockpile	barley - 62	300	20	50	10	20
2006 - Maintenance Activities								
Tar Island Dyke	77.5	--	--	200	--	--	--	--
2007 - New Reclamation								
Tar Island Dyke	15.8	stockpile	barley - 62	300	20	50	10	20
2007 - Maintenance Activities								
Tar Island Dyke	70.4	--	--	200	--	--	--	--

Table IV-4: Lease 86/17 Planned Reclamation Activities								
Year, Reclamation Type and Location	Area (ha)	Muskeg Source	Seed Type and Rate (kg/ha)	Fertilizer Rate (kg/ha)	Tree Planting - % of Type			
					Pine	Spruce	Poplar	Shrub
2008 - New Reclamation								
Tar Island Dyke	15.8	stockpile	barley - 62	300	20	50	10	20
Pond 6 West	76	stockpile	barley - 62	300	--	50	25	25
Pond 6 East	191	stockpile	barley - 62	300	--	50	25	25
2008 - Maintenance Activities								
Tar Island Dyke	66.5	--	--	200	--	--	--	--
2009 - No New Reclamation								
2009 - Maintenance Activities								
Tar Island Dyke	67.2	--	--	200	--	--	--	--
Pond 6 West	76	--	--	200	--	--	--	--
Pond 6 East	191	--	--	200	--	--	--	--
2010 - New Reclamation								
WA[a] 8 - West	93	stockpile	barley - 62	300	--	50	25	25
2010 - Maintenance Activities								
Tar Island Dyke	48.5	--	--	200	--	--	--	--
Pond 6 West	76	--	--	200	--	--	--	--
Pond 6 East	191	--	--	200	--	--	--	--
Activities During the Period 2011 - 2019 Are Not Detailed in This Table.								
2020 - New Reclamation								
Pond 4	121	stockpile	barley - 62	300	20	50	15	15
Pond 5	409	stockpile	barley - 62	300	20	50	15	15
Pond 6	481	stockpile	barley - 62	300	20	50	15	15

a Waste Area

Distribution of vegetation types in the Steepbank Mine area is detailed in Section E5 (EIA Biophysical Impact Assessment) of this Application. The revegetation program for the Steepbank Mine area will follow the principles for revegetation of Lease 86/17, namely areas will be restored using techniques and planting schemes which allow rapid return of the area to an ecosystem similar to that before development.

Ecosystem development on reclaimed areas of Steepbank Mine will be dependent on topography, parent material, drainage, climate and time. However, with the use of current site and soil preparation methodologies it is expected that areas of primary focus (e.g., the new valley escarpment areas) will quickly return to a condition similar to that which existed prior to development. It is anticipated that an early successional Mixed-Wood Forest (Deciduous Dominant) will cover overburden dyke and waste dump faces in the Athabasca River valley within ten to twenty years.

Commencement of mining activities on Steepbank Mine in 2001 means that reclamation activities will be taking place concurrently for areas of Lease 86/17 and Steepbank Mine during 2001 to 2020. Table IV-5 details the timing, locations and areas of reclamation activities for Steepbank Mine during the years 2001 - 2020. Additional activities are planned to complete reclamation efforts for remaining areas in Steepbank Mine following 2020. These areas (a further 1185 ha of Steepbank Mine) are scheduled for completion of reclamation by 2030.

Progression of reclamation for the Steepbank Mine area is detailed in Figures IV-3 and IV-4.

a) <u>Methodology</u>

Revegetation methodology includes consideration of factors such as fertilizer application, herbaceous ground cover establishment, woody plant establishment and revegetation area maintenance.

i) Fertilization

Fertilizer is applied during the initial years of area reclamation as an aid to rapid development of an erosion-controlling vegetative cover. Once cover is established annual fertilization is discontinued so the developing herbaceous cover will not compete too vigorously with planted woody seedlings. Starter fertilizers incorporated into the seedbed are essentially the same for tailings sand and

TABLE IV-5 Steepbank Mine - New Reclamation Activities			
Year	Areas Reclaimed (Numbers in brackets indicate size of reclaimed area)	Annual Area (ha)	Total Area (ha)
2001	• North Overburden Dump (10)	10	10
2002	• North Overburden Dump (30) • East Overburden Dump (10)	40	50
2003	• No new reclamation activities	--	50
2004	• East Overburden Dump (10) • Dyke 10 (25)	35	85
2005	• East Overburden Dump (10) • Dyke 10 (40)	50	135
2006	• West Overburden Dump (30) • East Overburden Dump (10) • Dyke 10 (50)	90	225
2007	• West Overburden Dump (30) • East Overburden Dump (20) • Dyke 10 (60)	110	335
2008	• West Overburden Dump (60) • East Overburden Dump (20) • Dyke 10 (60)	140	475
2009	• West Overburden Dump (80) • South Overburden Dump (90)	170	645
2010	• South Overburden Dump (90) • Dyke 11 (30)	120	765
2011	• South Overburden Dump (90) • Dyke 11 (30) • North Overburden Dump (12)	132	897
2012	• South Overburden Dump (90) • Dyke 11 (30) • North Overburden Dump (12)	132	1029
2013	• South Overburden Dump (90) • Dyke 11 (30) • North Overburden Dump (12)	132	1161
2014	• South Overburden Dump (90) • Dyke 11 (30) • North Overburden Dump (12)	132	1293
2015	• South Overburden Dump (90) • Dyke 11 (30) • North Overburden Dump (12)	132	1425
2016	• South Overburden Dump (120) • Dyke 11 (30) • North Overburden Dump (12)	162	1587
2017	• North Overburden Dump (12) • Dyke 12 (40)	52	1639
2018	• North Overburden Dump (12) • Dyke 12 (30) • East Overburden Dump (15)	57	1696
2019	• North Overburden Dump (12) • Dyke 12 (30) • East Overburden Dump (20) • Dyke 11 (15)	77	1773
2020	• North Overburden Dump (12) • Dyke 12 (50) • East Overburden Dump (30) • Pond 7 (150)	242	2015

overburden. Typical rates and composition (determined from field trials and results of annual monitoring) are provided in Table IV-6.

TABLE IV-6

TYPICAL RECLAMATION FERTILIZATION PROGRAM

Starter Fertilizer (First Growing Season)	Fertilizer (kg/ha) [a]		
	Nitrogen	Phosphorus	Potassium
Tailings Sand and Consolidated Tailings	55	80	80
	60 [b]	--	--
Overburden Spoil	55	70	20
	50 [b]	--	--

[a] *Fertilizer blend will depend on commercial availability.*

[b] *To be applied after emergence of seedlings if deficiency symptoms appear critical.*

ii) Herbaceous Ground Cover Establishment

Suncor's strategy for ground cover establishment has been to develop a vegetative cover that does not become overly-competitive with out-planted woody stock yet still provides erosion control. The original Suncor reclamation program specified high seeding rates of agronomic species which easily became established (providing nearly-immediate erosion control) but which also impeded both establishment of trees and shrubs and invasion of native plant species.

The current approach for ground cover establishment is to seed a barley crop either by helicopter (primary method) or by hydroseeding. Barley (an annual cereal species) provides nearly-immediate erosion control in its first growing season. Additionally, it produces a litter and root biomass that further controls erosion in succeeding growing seasons. Native plants may easily spring up either from invasion of reclaimed areas or from muskeg soil applied during seedbed preparation. Out-planted woody stock performance is also greatly enhanced. Results from a study conducted by Hardy BBT Limited (1990) for the Alberta Reclamation Research Technical Advisory Committee (RRTAC) as well as results from Suncor's Annual Reclamation Monitoring Program continue to attest to the success of this approach.

iii) Woody-Plant Establishment

Suncor began activities in 1972 to establish woody plants on reclamation areas (i.e., afforestation). Since that time over 1.6 million trees and shrubs of various species have been planted on Suncor reclamation sites. Various company research projects on woody-plant establishment have included evaluation of plant container types, planting time, effect of ground cover density on woody-plant survival, fertilizer amendments, species selection, direct seeding and planting of hardwood cuttings.

Assessment plots established in reclamation operational areas yield results for the annual Suncor reclamation monitoring program which are used to refine the operational afforestation program.

Selection of species and proportions of each species in the planting mix are based on existing field conditions and the vegetative type expected to develop on the site. The species selected are representative of different stages of vegetative succession in the region so that, as woody cover develops and the micro-environment evolves (providing favourable conditions for later successional and mature species), these species are already present, established and capable of taking advantage of condition changes. This methodology accelerates the process of natural succession towards optimal vegetation covers.

Seedlings are propagated from either seed or cuttings collected in the Fort McMurray area. Out-planting periods occur in both early spring and late summer depending on logistics and availability of reclaimed areas. Planting of tree and shrub seedlings (which are out-planted at an average total density of 2500 stems/ha) is undertaken as soon as possible after soil reconstruction. This planting density is used to ensure sufficient seedlings are planted to permit establishment of volunteer plants and to provide adequate stocking of each species after reductions from initial mortality. The proposed composition of afforestation stock planned for the balance of reclamation activities on Lease 86/17 is detailed in Table IV-4.

3.0 RECLAMATION MAINTENANCE PROGRAM

Reclamation area maintenance activities involve fertilization of revegetated areas, erosion repair and control, and reseeding of areas with poor performance.

Fertilizer maintenance rates are determined by criteria such as results of soil tests and cover performance. Maintenance periods (which depend on the rate of ground cover establishment) are two to three years for overburden and three to four years for tailings sand. Typical fertilizer components and application rates are provided in Table IV-7.

TABLE IV-7

TYPICAL MAINTENANCE FERTILIZATION PROGRAM

Fertilizer (Second Growing Season and Older)	Fertilizer (kg/ha) [a]		
	Nitrogen	Phosphorus	Potassium
Tailings Sand and Consolidated Tails	80	30	10
Overburden Spoil	80	30	10

[a] *Fertilizer blend will depend on commercial availability.*

4.0 RESTORATION OF CAPABILITY

Suncor's reclamation goal changed during the early 1980s from rapid generation of an erosion-controlling vegetative cover (through use of agronomic grass mixtures) to development of a self-sustaining ecosystem consistent with others in the region. One of the primary changes associated with the new goal is a shift in the soil amendment type. Rather than utilizing peat alone, a portion of the underlying soil is also taken as a reclamation amendment which results in more fine components to the amendment and produces a better-quality soil for the reclamation site. Depth of soil application layer was increased to 15 cm in an attempt to reduce the number of areas where insufficient soil amendment had been placed.

As part of its reclamation strategy Suncor has adopted a planting program designed to provide a diverse mixture of woody-stemmed species in reclaimed areas. The species mixture includes wild rose, raspberry, gooseberry, saskatoon and chokecherry, all of which are used by wildlife species. Tree species are also selected to provide ecosystem diversity and health. Vegetation from the planting program (together with the profusion of native plants developing from soil amendment) provide a diverse vegetative community for reclamation sites. Sufficient numbers of trees are planted to meet the Alberta Environmental Protection - Lands and Forest Service's establishment criteria for marketable forests.

a) Pre-Mining Land Use and Capability

Information on pre-mining land use and capabilities for Lease 86/17 is found in Suncor's Application for Renewal of Environmental Operating Approval (Suncor 1995a) while Section E5 of this Application provides corresponding information for Steepbank Mine area.

b) Post-Reclamation Land Use and Capability

Representatives from the oil sands industry, regulatory agencies and private consultants participated in a working group in 1995/96 to develop a land capability classification system for forest ecosystems in the oil sands region (CAN-AG 1996a). The intent of this classification system is to provide a methodology for evaluation of the contributions of two primary components (i.e., soil and landscape, individually or in combination) to the capability of reclaimed areas.

Developers of this system recognized that:

> "Successful reclamation is dependent upon reconstructing favourable growing conditions in the soil profile, with emphasis on the root-zone, which is primarily the upper 50 cm. Key factors relating to root zone quality that are used in this system include: available water holding capacity, organic carbon content, nutrient retention capacity, surface peat thickness, structure and consistence, salinity, sodicity, soil reaction, and moisture and nutrient regimes." (CAN-AG 1996a).

The capability classification system involves giving each component (soil and landscape) a numerical rating derived from values assigned to defined categories for all the key factors mentioned above. Soils are assigned a rating based on characteristics of the three principal layers in the upper 1 m of soil (which includes topsoil, upper subsoil and lower subsoil). Landscape factors affecting forest growth, sustainability and land management include slope, exposure, stoniness and erosion.

Assigning a soil capability rating requires collection of a variety of information. These data (which are defined in detail in CAN-AG 1996a) include:

- soil survey - determination of available soils in area of interest;
- soil sampling - collection of representative samples of topsoils and subsoils;
- soil analyses - required for baseline characterizations;

- soil factor recording (for both surface and subsurface) - including moisture, structure, organic carbon, organics (peat), soil reaction, salinity, sodicity and saturation percentages, and nutrient retention capacity; and
- soil edaphic grid - linkage of moisture and nutrient profiles.

Tables IV-8 and IV-9 provide examples of soil capability work-sheets for reclamation soils on Lease 86/17 and Steepbank Mine.

Use of the capability classification system also requires consideration of landscape factors (which can enhance or limit commercial forestry) including topographic features which are modified by criteria such as exposure, stoniness and visible erosion. Calculation of landscape capability requires:

- determination of average slope steepness;
- assignment of an exposure rating;
- assignment of a stoniness/rock outcrop factor; and
- determination of an erosion category.

Table IV-8 : Soil Capability - for a 20-cm peat-mineral mix (Type 1, Table 3.4-2) over 80 cm of sandy clay loam overburden spoil (Table 3.4-2). Location: Lease 86/17 (from CAN-AG 1996b).

Factors	Value	Point Deduction	TOTAL
1. Profile AWHC (M) 50 - (TS 24 + US 45 + LS 75) / 3 =	48	2	2
2. Topsoil Factors			
Physical: Choose most-limiting			
- structure/consistency (D)	peat mix	0	
- organic equivalent (F)	>80 t/ha	0	
- peaty surface (O)	---	0	0
Chemical: Choose most-limiting		% deduction	
- acidity (V)	7.4 (H_20)	10	
- salinity (N)	0.7	0	
- sodicity / saturation % (Y)	SAR 4.4	10	
- nutrient retention (K)	High	0	10
Basic Soil Rating = [80 M+D, F or O][100% - % deduction for V, N, Y or K] = (a)			**70**
3. Upper Subsoil Factors - Choose most-limiting		% deduction	
- structure (D)	2-10, firm	20	
- acidity (V)	7.5 (H_20)	10	
- salinity (N)	2	10	
- sodicity / saturation % (Y)	SAR 6.3	15	
Upper Subsoil Deduction = 20 % of (a) x 0.67		**= (b)**	**9**
4. Lower Subsoil Factors - Choose most-limiting		% deduction	
- structure (D)	2-10, firm	20	
- acidity (V)	7.5 (H_20)	10	
- salinity (N)	2	10	
- sodicity / saturation % (Y)	SAR 6.3	15	
Lower Subsoil Deduction = 20 % of (a) x 0.33		**= (c)**	**5**
Interim Soil Rating = (a) 70 - (b) 9 - (c) 5		**= (d)**	**56**
5. Edaphic Grid (R)		multiplier	
- moisture	dry		
- nutrients	medium	1.0	
Edaphic Grid = (R)		**= (e)**	**1.0**
FINAL SOIL RATING (S) = (d) 56 x (e) 1.0 = 56 CLASS 3 SUBCLASS D			

Table IV-9 : Soil Capability - for a 20-cm peat-mineral mix over 80 cm of "clean" sandy clay loam overburden spoil. Location: Steepbank Mine (from CAN-AG 1996b).

Factors	Value	Point Deduction	TOTAL
1. Profile AWHC (M) $50 - \frac{TS^{24} + US^{45} + LS^{75}}{3} =$	48	2	2
2. Topsoil Factors			
Physical: Choose most-limiting			
- structure/consistency (D)	peat mix	0	
- organic equivalent (F)	>80 t/ha	0	
- peaty surface (O)	---	0	0
Chemical: Choose most-limiting		% deduction	
- acidity (V)	5.0-7.0 (H_20)	0	
- salinity (N)	0.7	0	
- sodicity / saturation % (Y)	SAR <4	0	
- nutrient retention (K)	High	0	0
Basic Soil Rating = [80 M+D, F or O][100% - % deduction for V, N, Y or K] = (a)			**78**
3. Upper Subsoil Factors - Choose most-limiting		% deduction	
- structure (D)	2-10, firm	20	
- acidity (V)	7.5 (H_20)	10	
- salinity (N)	EC <2	0	
- sodicity / saturation % (Y)	SAR < 4	0	
Upper Subsoil Deduction = 20 % of (a) x 0.67		**= (b)**	**10**
4. Lower Subsoil Factors - Choose most-limiting		% deduction	
- structure (D)	2-10, firm	20	
- acidity (V)	7.5 (H_20)	10	
- salinity (N)	EC <2	0	
- sodicity / saturation % (Y)	SAR < 4	0	
Lower Subsoil Deduction = 20 % of (a) x 0.33		**= (c)**	**5**
Interim Soil Rating = (a) 78 - (b) 10 - (c) 5		**= (d)**	**63**
5. Edaphic Grid (R)		Multiplier	
- moisture	dry		
- nutrients	medium	1.0	
Edaphic Grid = (R)		**= (e)**	**1.0**
FINAL SOIL RATING (S) = (d) 63 x (e) 1.0 = 63 CLASS 2 SUBCLASS D			

APPENDIX IV

LEASE 86/17 AND STEEPBANK MINE

RECLAMATION PLAN DETAIL

LEASE 86/17 AND STEEPBANK MINE RECLAMATION PLAN DETAIL

Suncor's reclamation strategy and conceptual plan was outlined in the February 1995 Application for Renewal of Environmental Operating Approval (Suncor 1995a). Major components of this discussion as well as specific applications to Steepbank Mine are presented below.

1.0 RECLAMATION AREA PREPARATION

Reclamation area preparation includes three components: structure construction, capping (where required) and soil amendment application. Reclamation areas are initially prepared through placement of three primary types of landform materials: tailings sand (found within tailings sand dykes, plateaus and sand storage areas); consolidated tailings (which will be placed within Ponds 1, 5 and 6 on Lease 86/17 and in Ponds 7 and 8 in Steepbank Mine); and overburden materials (which are used to construct waste dumps and dykes structures).

a) Landscape Structure Construction

Land surfaces created on the mined-out areas of Lease 86/17 have been constructed to provide long-term geotechnical stability while functioning as integral components of Suncor's tailings and recycle water management process. Waste dumps and dykes are constructed on dry, firm foundations for which suitable geotechnical stability evaluations have been conducted. Preparation for waste dump construction includes surface clearing and grubbing (i.e., removal of roots and surface organic layers) on dry waste dump sites, and draining and removal of all unstable and muskeg-type materials on wet sites. Structures are bounded by large dykes constructed of overburden, tailings sand or a combination of materials. All dykes are configured with 2.5H:1V slopes interrupted by berms to form overall slopes of 3H:1V. Most dyke slopes on Lease 86/17 are configured with regular (even) slope faces.

Activities associated with movement of earthen materials and construction of waste dumps and dykes will begin on Steepbank Mine in 2000. Recovery and stockpiling of muskeg soil reserves will also begin in 2000 and will continue through 2020. Table IV-I details materials to be placed in dykes, waste piles and muskeg storage areas on a yearly basis between 2000 and 2010 then for the periods 2011-2015 and 2016-2020.

A proposed overburden dyke (which will recreate the Athabasca River valley escarpment wall for Steepbank Mine) will also be constructed with 2.5H:1V slopes interrupted by berms to form overall slopes of 3H:1V.

TABLE IV-1

MATERIAL MOVEMENT AND DESTINATIONS

Year	Dyke Construction	Waste Dump Disposal	Muskeg Stockpile	Total Materials
2000	0	10 200	300	10 500
2001	950	9150	400	10 500
2002	7722	21 278	400	29 400
2003	14 587	14 413	400	29 400
2004	15 767	13 233	400	29 400
2005	20 575	37 825	400	58 800
2006	34 105	34 795	400	69 300
2007	31 887	26 513	400	58 800
2008	17 970	40 430	400	58 800
2009	21 700	36 700	400	58 800
2010	38 000	20 400	400	58 800
2011-2015	112 950	246 350	2000	361 300
2016-2020	166 690	196 310	2000	365 000
Total kt:	**482 903**	**707 597**	**8300**	**1 198 800**

The majority of landscape structures on Lease 86/17 have been completed. Table IV-2 details structures remaining to be constructed or completed on Lease 86/17 (as of 1996) and structures for Steepbank Mine.

Overburden dyke and dump structures (which will form parts of the new Athabasca River valley escarpment in Steepbank Mine) will be designed and constructed to minimize erosion. Whenever possible design variations will be incorporated to allow development of an escarpment face which more closely resembles the current escarpment. However, the primary focus of the dyke and dump construction remains the achievement of a stable structure with a surface that is as erosion-resistant as possible.

Lease 86/17 reclamation progression to 1996 is shown in Figure IV-1.

b) Capping of Materials Used to Construct Landforms

Some materials available for use in construction of reclamation landforms include concentrations of chemicals which make them less suitable for the purpose. Where these materials are located near a structure's surface, a capping layer of materials such as overburden, tailings sand or lean consolidated tailings (8:1 sand:fines ratio) will be deposited prior to placement of any soil amendment.

TABLE IV-2

LANDSCAPE STRUCTURES

Lease/Mine Area	Structures to be Completed	Structures to be Constructed
Lease 86/17	Dyke 8	Dyke 9
	Infilling of Ponds 1, 1A, 2/3, 4, 5 and 6	Northeast Sand Storage Area
Steepbank Mine		North Waste Dump *
		Dykes 10 and 11 *
* designates an area which will form part of the Athabasca River valley escarpment		West Waste Dump *
		Dyke 10A
		East Waste Dump
		Dykes 11A and 11B
		Dyke 12
		South Waste Dump
		Infilled Ponds 7 and 8

c) Soil Amendment

For restoration of soil capabilities to a state equal to or superior than pre-disturbed conditions, definitions of reconstructed soil conditions are required. Design specifications ensure that reconstructed soil provides adequate moisture and nutrient supplies as well as acceptable erosion control.

Suncor originally excavated and stockpiled muskeg soils from which annual reclamation requirements for spreading were drawn. The source of muskeg soil changed during the 1983 and 1984 reclamation programs from stockpiles to muskeg deposits located in unmined areas where disturbance was minimal. Undisturbed material was excavated, hauled and dumped directly on the reclamation site. A refinement to the process of depositing topsoil was to excavate and haul soil-building materials during the winter months, noteworthy because dormant, in situ native seed and root fragments were transferred with the partially-frozen in-situ pockets of soil. Spreading of muskeg soil on the reclamation site is completed in early spring with the usual result the emergence of a variety of native, woody-stemmed plants, forbs, wildflowers and grasses. This prolific vegetative growth provides an erosion-controlling cover which is diverse and consistent with that of regional ecosystems.

Current soil reconstruction technique has been used on an operational scale since 1984. Suncor's reclamation focus is to amend reclamation sites with quality soil-building material. The technique involves stripping muskeg to include 25% to 50% (by volume) of mineral overburden. This peat/till mixture is designated as Type 1 muskeg soil when muskeg is mixed with fine-textured till, clay or silt (fines) and is designated as Type 2 muskeg soil when muskeg is mixed with coarse- textured material (sand and gravel). Key chemical and physical properties of materials to be covered and of Type 1 and Type 2 muskeg soils are shown in Table IV-3. Type 1 muskeg soil is the principal soil amendment for tailings sand, consolidated tailings and overburden. Type 2 muskeg soil is primarily used to amend overburden spoil when Type 1 supply is exhausted or mine logistics dictate Type 2 utilization. Muskeg soils have enhanced fines content and cation exchange capacity (CEC) compared to unamended tailings sand and consolidated tailings.

2.0 REVEGETATION PROGRAM

Once the reclamation landform and structure surface is prepared, revegetation activities are initiated; the methodology is described in Subsection D3.5 of the Application.

Reclamation activities planned for Lease 86/17 during the period 1996 to 2000 will focus on reclaiming the oversize dump, completed tailings plateaus and some small overburden dump sites. Reclamation maintenance activities (including fertilizer application and infill tree planting) will continue for all previously-reclaimed sites. Muskeg salvaged as part of the stripping operation will be applied as a soil amendment to available sites with surplus being stockpiled for later use. Revegetation of overburden storage areas and tailings sand slopes will also continue throughout 1996 to 2000. Generally, revegetation of various sites immediately follows their reclamation.

TABLE IV-3

KEY CHEMICAL AND PHYSICAL PROPERTIES OF SOIL BUILDING MATERIALS

Parameters		Soil Materials				
		Tailings Sand [a]	Overburden Spoil [b]	Consolidated Tailings [c]	Type 1 Muskeg Soil [d]	Type 2 Muskeg Soil [d]
Texture (%)	Clay	3	26	7	19	15
	Silt	2	22	8	25	15
	Sand	95	52	85	56	70
pH		7.5	7.5	8.2	7.4	5.6
Electrical Conductivity (mS/cm)		0.1	2.0	2.8	0.7	1.2
Organic Carbon (%)		0.2	4.2	ND	7.6	13.5
Total Nitrogen (%)		0.01	0.6	ND	0.3	0.6
Carbon / Nitrogen Ratio		20	69	ND	28	23
Cation Exchange Capacity (meq/100 g)		0.3	11.5	2.4	26.0	40.7
Sodium Adsorption Ratio		ND	6.3	ND	4.4	2.2

[a] *Adapted from Rowell 1979 (from Suncor 1995).*

[b] *From 1987 operational areas (from Suncor 1995).*

[c] *From Xu 1996.*

[d] *From 1984 operational areas (from Suncor 1995).*

ND *No Data.*

Planned reclamation activities for Lease 86/17 during the period 1996 through 2020 are detailed in Table IV-4 while reclamation progression to 2001 is shown in Figure IV-2. The reclamation progression for the Tar Island Reclaimed Area (TIRA) between 1996 and 2010 is shown in Figure IV-3.

Progression of reclamation activities for both Lease 86/17 and Steepbank Mine is shown for the period to 2010 in Figure IV-3; and for the period to 2020 in Figure IV-4.

Year, Reclamation Type and Location	Area (ha)	Muskeg Source	Seed Type and Rate (kg/ha)	Fertilizer Rate (kg/ha)	Tree Planting - % of Type			
					Pine	Spruce	Poplar	Shrub
1996 - New Reclamation								
Tar Island Dyke	16	in situ	barley - 62	300	50	--	25	25
Dyke 4	21	in situ	barley - 62	300	50	10	20	20
Dyke 5	7	in situ	barley - 62	300	10	50	20	20
1996 - Maintenance Activities								
Dyke 5	7.2	--	--	200	--	--	--	--
WA[a] 16	5.3	--	--	200	--	--	--	--
Dyke 5	6.6	--	--	200	--	--	--	--
WA[a] 8 Extension	7.3	--	--	200	--	--	--	--
WA[a] 18	5.8	--	--	200	--	--	--	--
1997 - New Reclamation								
Dyke 6	63	in situ	barley - 62	300	20	50	10	20
Dyke 5	49	in situ	barley - 62	300	20	50	10	20
East/West Dyke	18	in situ	barley - 62	300	20	50	10	20
Dyke 5 Oversize	8.2	in situ	barley - 62	300	20	50	10	20
Dyke 2 - Top	40	in situ	barley - 62	300	20	50	10	20
1997 - Maintenance Activities								
Dyke 5	20.8	--	--	200	--	--	--	--
WA[a] 16	5.3	--	--	200	--	--	--	--
Horseshoe - Site 16	7.3	--	--	200	--	--	--	--
WA[a] 18	5.8	--	--	200	--	--	--	--
Tar Island Dyke	16	--	--	200	--	--	--	--
Dyke 4	21	--	--	200	--	--	--	--
1998 - New Reclamation								
Dyke 7	38	in situ	barley - 62	300	50	10	20	20
Tar Island Dyke	19.5	stockpile	barley - 62	300	20	50	10	20

Table IV-4: Lease 86/17 Planned Reclamation Activities

a Waste Area

Table IV-4: Lease 86/17 Planned Reclamation Activities								
Year, Reclamation Type and Location	**Area (ha)**	**Muskeg Source**	**Seed Type and Rate (kg/ha)**	**Fertilizer Rate (kg/ha)**	**Tree Planting - % of Type**			
					Pine	**Spruce**	**Poplar**	**Shrub**
1998 - Maintenance Activities								
WA[a] 18	5.8	--	--	200	--	--	--	--
Tar Island Dyke	16	--	--	200	--	--	--	--
Dyke 4	21	--	--	200	--	--	--	--
Dyke 5	56	--	--	200	--	--	--	--
Dyke 6	63	--	--	200	--	--	--	--
East/West Dyke	18	--	--	200	--	--	--	--
Dyke 5 Oversize	8.2	--	--	200	--	--	--	--
Dyke 2 - Top	40	--	--	200	--	--	--	--
Dyke 7	38	--	--	200	--	--	--	--
1999 - New Reclamation								
Pond 5 West	33	in situ	barley - 62	300	--	50	25	25
Tar Island Dyke	18.8	stockpile	barley - 62	300	20	50	10	20
1999 - Maintenance Activities								
Tar Island Dyke	35.5	--	--	200	--	--	--	--
Dyke 4	21	--	--	200	--	--	--	--
Dyke 5	68	--	--	200	--	--	--	--
Dyke 6	63	--	--	200	--	--	--	--
East/West Dyke	18	--	--	200	--	--	--	--
Dyke 5 Oversize	8.2	--	--	200	--	--	--	--
Dyke 2 - Top	40	--	--	200	--	--	--	--
Dyke 7	38	--	--	200	--	--	--	--

[a] Waste Area

Table IV-4: Lease 86/17 Planned Reclamation Activities

Year, Reclamation Type and Location	Area (ha)	Muskeg Source	Seed Type and Rate (kg/ha)	Fertilizer Rate (kg/ha)	Tree Planting - % of Type			
					Pine	Spruce	Poplar	Shrub
2000 - New Reclamation								
Tar Island Dyke	29.8	stockpile	barley - 62	300	20	50	10	20
2000 - Maintenance Activities								
Tar Island Dyke	54.3	--	--	200	--	--	--	--
Dyke 4	21	--	--	200	--	--	--	--
Dyke 5	68	--	--	200	--	--	--	--
Dyke 6	63	--	--	200	--	--	--	--
East/West Dyke	18	--	--	200	--	--	--	--
Dyke 5 Oversize	8.2	--	--	200	--	--	--	--
Dyke 2 - Top	40	--	--	200	--	--	--	--
Dyke 7	38	--	--	200	--	--	--	--
Pond 5 West	33	--	--	200	--	--	--	--
2001 - New Reclamation								
Tar Island Dyke	26	stockpile	barley - 62	300	20	50	10	20
2001 - Maintenance Activities								
Tar Island Dyke	68.1	--	--	200	--	--	--	--
Dyke 6	63	--	--	200	--	--	--	--
Dyke 5	61	--	--	200	--	--	--	--
East/West Dyke	18	--	--	200	--	--	--	--
Dyke 5 Oversize	8.2	--	--	200	--	--	--	--
Dyke 2 - Top	40	--	--	200	--	--	--	--
Dyke 7	38	--	--	200	--	--	--	--
Pond 5 West	33	--	--	200	--	--	--	--
2002 - New Reclamation								
Tar Island Dyke	22.1	stockpile	barley - 62	300	20	50	10	

Table IV-4: Lease 86/17 Planned Reclamation Activities

Year, Reclamation Type and Location	Area (ha)	Muskeg Source	Seed Type and Rate (kg/ha)	Fertilizer Rate (kg/ha)	Tree Planting - % of Type			
					Pine	Spruce	Poplar	Shrub
2002 - Maintenance Activities								
Tar Island Dyke	94.1	--	--	200	--	--	--	--
Dyke 7	38	--	--	200	--	--	--	--
Dyke 5	12	--	--	200	--	--	--	--
Pond 5 West	33	--	--	200	--	--	--	--
2003 - New Reclamation								
Tar Island Dyke	19.7	stockpile	barley - 62	300	20	50	10	20
2003 - Maintenance Activities								
Tar Island Dyke	96.7	--	--	200	--	--	--	--
2004 - New Reclamation								
Tar Island Dyke	17	stockpile	barley - 62	300	20	50	10	20
2004 - Maintenance Activities								
Tar Island Dyke	97.6	--	--	200	--	--	--	--
2005 - New Reclamation								
Tar Island Dyke	18.7	stockpile	barley - 62	300	20	50	10	20
2005 - Maintenance Activities								
Tar Island Dyke	84.8	--	--	200	--	--	--	--
2006 - New Reclamation								
Tar Island Dyke	15	stockpile	barley - 62	300	20	50	10	20
2006 - Maintenance Activities								
Tar Island Dyke	77.5	--	--	200	--	--	--	--
2007 - New Reclamation								
Tar Island Dyke	15.8	stockpile	barley - 62	300	20	50	10	20
2007 - Maintenance Activities								
Tar Island Dyke	70.4	--	--	200	--	--	--	--

Table IV-4: Lease 86/17 Planned Reclamation Activities								
Year, Reclamation Type and Location	Area (ha)	Muskeg Source	Seed Type and Rate (kg/ha)	Fertilizer Rate (kg/ha)	Tree Planting - % of Type			
					Pine	Spruce	Poplar	Shrub
2008 - New Reclamation								
Tar Island Dyke	15.8	stockpile	barley - 62	300	20	50	10	20
Pond 6 West	76	stockpile	barley - 62	300	--	50	25	25
Pond 6 East	191	stockpile	barley - 62	300	--	50	25	25
2008 - Maintenance Activities								
Tar Island Dyke	66.5	--	--	200	--	--	--	--
2009 - No New Reclamation								
2009 - Maintenance Activities								
Tar Island Dyke	67.2	--	--	200	--	--	--	--
Pond 6 West	76	--	--	200	--	--	--	--
Pond 6 East	191	--	--	200	--	--	--	--
2010 - New Reclamation								
WA[a] 8 - West	93	stockpile	barley - 62	300	--	50	25	25
2010 - Maintenance Activities								
Tar Island Dyke	48.5	--	--	200	--	--	--	--
Pond 6 West	76	--	--	200	--	--	--	--
Pond 6 East	191	--	--	200	--	--	--	--
Activities During the Period 2011 - 2019 Are Not Detailed in This Table.								
2020 - New Reclamation								
Pond 4	121	stockpile	barley - 62	300	20	50	15	15
Pond 5	409	stockpile	barley - 62	300	20	50	15	15
Pond 6	481	stockpile	barley - 62	300	20	50	15	15

a Waste Area

Distribution of vegetation types in the Steepbank Mine area is detailed in Section E5 (EIA Biophysical Impact Assessment) of this Application. The revegetation program for the Steepbank Mine area will follow the principles for revegetation of Lease 86/17, namely areas will be restored using techniques and planting schemes which allow rapid return of the area to an ecosystem similar to that before development.

Ecosystem development on reclaimed areas of Steepbank Mine will be dependent on topography, parent material, drainage, climate and time. However, with the use of current site and soil preparation methodologies it is expected that areas of primary focus (e.g., the new valley escarpment areas) will quickly return to a condition similar to that which existed prior to development. It is anticipated that an early successional Mixed-Wood Forest (Deciduous Dominant) will cover overburden dyke and waste dump faces in the Athabasca River valley within ten to twenty years.

Commencement of mining activities on Steepbank Mine in 2001 means that reclamation activities will be taking place concurrently for areas of Lease 86/17 and Steepbank Mine during 2001 to 2020. Table IV-5 details the timing, locations and areas of reclamation activities for Steepbank Mine during the years 2001 - 2020. Additional activities are planned to complete reclamation efforts for remaining areas in Steepbank Mine following 2020. These areas (a further 1185 ha of Steepbank Mine) are scheduled for completion of reclamation by 2030.

Progression of reclamation for the Steepbank Mine area is detailed in Figures IV-3 and IV-4.

a) <u>Methodology</u>

Revegetation methodology includes consideration of factors such as fertilizer application, herbaceous ground cover establishment, woody plant establishment and revegetation area maintenance.

i) Fertilization

Fertilizer is applied during the initial years of area reclamation as an aid to rapid development of an erosion-controlling vegetative cover. Once cover is established annual fertilization is discontinued so the developing herbaceous cover will not compete too vigorously with planted woody seedlings. Starter fertilizers incorporated into the seedbed are essentially the same for tailings sand and

TABLE IV-5 Steepbank Mine - New Reclamation Activities			
Year	Areas Reclaimed (Numbers in brackets indicate size of reclaimed area)	Annual Area (ha)	Total Area (ha)
2001	• North Overburden Dump (10)	10	10
2002	• North Overburden Dump (30) • East Overburden Dump (10)	40	50
2003	• No new reclamation activities	--	50
2004	• East Overburden Dump (10) • Dyke 10 (25)	35	85
2005	• East Overburden Dump (10) • Dyke 10 (40)	50	135
2006	• West Overburden Dump (30) • East Overburden Dump (10) • Dyke 10 (50)	90	225
2007	• West Overburden Dump (30) • East Overburden Dump (20) • Dyke 10 (60)	110	335
2008	• West Overburden Dump (60) • East Overburden Dump (20) • Dyke 10 (60)	140	475
2009	• West Overburden Dump (80) • South Overburden Dump (90)	170	645
2010	• South Overburden Dump (90) • Dyke 11 (30)	120	765
2011	• South Overburden Dump (90) • Dyke 11 (30) • North Overburden Dump (12)	132	897
2012	• South Overburden Dump (90) • Dyke 11 (30) • North Overburden Dump (12)	132	1029
2013	• South Overburden Dump (90) • Dyke 11 (30) • North Overburden Dump (12)	132	1161
2014	• South Overburden Dump (90) • Dyke 11 (30) • North Overburden Dump (12)	132	1293
2015	• South Overburden Dump (90) • Dyke 11 (30) • North Overburden Dump (12)	132	1425
2016	• South Overburden Dump (120) • Dyke 11 (30) • North Overburden Dump (12)	162	1587
2017	• North Overburden Dump (12) • Dyke 12 (40)	52	1639
2018	• North Overburden Dump (12) • Dyke 12 (30) • East Overburden Dump (15)	57	1696
2019	• North Overburden Dump (12) • Dyke 12 (30) • East Overburden Dump (20) • Dyke 11 (15)	77	1773
2020	• North Overburden Dump (12) • Dyke 12 (50) • East Overburden Dump (30) • Pond 7 (150)	242	2015

overburden. Typical rates and composition (determined from field trials and results of annual monitoring) are provided in Table IV-6.

TABLE IV-6

TYPICAL RECLAMATION FERTILIZATION PROGRAM

Starter Fertilizer (First Growing Season)	**Fertilizer (kg/ha)** [a]		
	Nitrogen	**Phosphorus**	**Potassium**
Tailings Sand and Consolidated Tailings	55	80	80
	60 [b]	--	--
Overburden Spoil	55	70	20
	50 [b]	--	--

[a] *Fertilizer blend will depend on commercial availability.*

[b] *To be applied after emergence of seedlings if deficiency symptoms appear critical.*

ii) Herbaceous Ground Cover Establishment

Suncor's strategy for ground cover establishment has been to develop a vegetative cover that does not become overly-competitive with out-planted woody stock yet still provides erosion control. The original Suncor reclamation program specified high seeding rates of agronomic species which easily became established (providing nearly-immediate erosion control) but which also impeded both establishment of trees and shrubs and invasion of native plant species.

The current approach for ground cover establishment is to seed a barley crop either by helicopter (primary method) or by hydroseeding. Barley (an annual cereal species) provides nearly-immediate erosion control in its first growing season. Additionally, it produces a litter and root biomass that further controls erosion in succeeding growing seasons. Native plants may easily spring up either from invasion of reclaimed areas or from muskeg soil applied during seedbed preparation. Out-planted woody stock performance is also greatly enhanced. Results from a study conducted by Hardy BBT Limited (1990) for the Alberta Reclamation Research Technical Advisory Committee (RRTAC) as well as results from Suncor's Annual Reclamation Monitoring Program continue to attest to the success of this approach.

iii) Woody-Plant Establishment

Suncor began activities in 1972 to establish woody plants on reclamation areas (i.e., afforestation). Since that time over 1.6 million trees and shrubs of various species have been planted.on Suncor reclamation sites. Various company research projects on woody-plant establishment have included evaluation of plant container types, planting time, effect of ground cover density on woody-plant survival, fertilizer amendments, species selection, direct seeding and planting of hardwood cuttings.

Assessment plots established in reclamation operational areas yield results for the annual Suncor reclamation monitoring program which are used to refine the operational afforestation program.

Selection of species and proportions of each species in the planting mix are based on existing field conditions and the vegetative type expected to develop on the site. The species selected are representative of different stages of vegetative succession in the region so that, as woody cover develops and the micro-environment evolves (providing favourable conditions for later successional and mature species), these species are already present, established and capable of taking advantage of condition changes. This methodology accelerates the process of natural succession towards optimal vegetation covers.

Seedlings are propagated from either seed or cuttings collected in the Fort McMurray area. Out-planting periods occur in both early spring and late summer depending on logistics and availability of reclaimed areas. Planting of tree and shrub seedlings (which are out-planted at an average total density of 2500 stems/ha) is undertaken as soon as possible after soil reconstruction. This planting density is used to ensure sufficient seedlings are planted to permit establishment of volunteer plants and to provide adequate stocking of each species after reductions from initial mortality. The proposed composition of afforestation stock planned for the balance of reclamation activities on Lease 86/17 is detailed in Table IV-4.

3.0 RECLAMATION MAINTENANCE PROGRAM

Reclamation area maintenance activities involve fertilization of revegetated areas, erosion repair and control, and reseeding of areas with poor performance.

Fertilizer maintenance rates are determined by criteria such as results of soil tests and cover performance. Maintenance periods (which depend on the rate of ground cover establishment) are two to three years for overburden and three to four years for tailings sand. Typical fertilizer components and application rates are provided in Table IV-7.

TABLE IV-7

TYPICAL MAINTENANCE FERTILIZATION PROGRAM

Fertilizer (Second Growing Season and Older)	Fertilizer (kg/ha) [a]		
	Nitrogen	**Phosphorus**	**Potassium**
Tailings Sand and Consolidated Tails	80	30	10
Overburden Spoil	80	30	10

[a] *Fertilizer blend will depend on commercial availability.*

4.0 RESTORATION OF CAPABILITY

Suncor's reclamation goal changed during the early 1980s from rapid generation of an erosion-controlling vegetative cover (through use of agronomic grass mixtures) to development of a self-sustaining ecosystem consistent with others in the region. One of the primary changes associated with the new goal is a shift in the soil amendment type. Rather than utilizing peat alone, a portion of the underlying soil is also taken as a reclamation amendment which results in more fine components to the amendment and produces a better-quality soil for the reclamation site. Depth of soil application layer was increased to 15 cm in an attempt to reduce the number of areas where insufficient soil amendment had been placed.

As part of its reclamation strategy Suncor has adopted a planting program designed to provide a diverse mixture of woody-stemmed species in reclaimed areas. The species mixture includes wild rose, raspberry, gooseberry, saskatoon and chokecherry, all of which are used by wildlife species. Tree species are also selected to provide ecosystem diversity and health. Vegetation from the planting program (together with the profusion of native plants developing from soil amendment) provide a diverse vegetative community for reclamation sites. Sufficient numbers of trees are planted to meet the Alberta Environmental Protection - Lands and Forest Service's establishment criteria for marketable forests.

a) Pre-Mining Land Use and Capability

Information on pre-mining land use and capabilities for Lease 86/17 is found in Suncor's Application for Renewal of Environmental Operating Approval (Suncor 1995a) while Section E5 of this Application provides corresponding information for Steepbank Mine area.

b) Post-Reclamation Land Use and Capability

Representatives from the oil sands industry, regulatory agencies and private consultants participated in a working group in 1995/96 to develop a land capability classification system for forest ecosystems in the oil sands region (CAN-AG 1996a). The intent of this classification system is to provide a methodology for evaluation of the contributions of two primary components (i.e., soil and landscape, individually or in combination) to the capability of reclaimed areas.

Developers of this system recognized that:

> "Successful reclamation is dependent upon reconstructing favourable growing conditions in the soil profile, with emphasis on the root-zone, which is primarily the upper 50 cm. Key factors relating to root zone quality that are used in this system include: available water holding capacity, organic carbon content, nutrient retention capacity, surface peat thickness, structure and consistence, salinity, sodicity, soil reaction, and moisture and nutrient regimes." (CAN-AG 1996a).

The capability classification system involves giving each component (soil and landscape) a numerical rating derived from values assigned to defined categories for all the key factors mentioned above. Soils are assigned a rating based on characteristics of the three principal layers in the upper 1 m of soil (which includes topsoil, upper subsoil and lower subsoil). Landscape factors affecting forest growth, sustainability and land management include slope, exposure, stoniness and erosion.

Assigning a soil capability rating requires collection of a variety of information. These data (which are defined in detail in CAN-AG 1996a) include:

- soil survey - determination of available soils in area of interest;
- soil sampling - collection of representative samples of topsoils and subsoils;
- soil analyses - required for baseline characterizations;

- soil factor recording (for both surface and subsurface) - including moisture, structure, organic carbon, organics (peat), soil reaction, salinity, sodicity and saturation percentages, and nutrient retention capacity; and
- soil edaphic grid - linkage of moisture and nutrient profiles.

Tables IV-8 and IV-9 provide examples of soil capability work-sheets for reclamation soils on Lease 86/17 and Steepbank Mine.

Use of the capability classification system also requires consideration of landscape factors (which can enhance or limit commercial forestry) including topographic features which are modified by criteria such as exposure, stoniness and visible erosion. Calculation of landscape capability requires:

- determination of average slope steepness;
- assignment of an exposure rating;
- assignment of a stoniness/rock outcrop factor; and
- determination of an erosion category.

Table IV-8 : Soil Capability - for a 20-cm peat-mineral mix (Type 1, Table 3.4-2) over 80 cm of sandy clay loam overburden spoil (Table 3.4-2). Location: Lease 86/17 (from CAN-AG 1996b).

Factors	Value	Point Deduction	TOTAL
1. Profile AWHC (M) $50 - \frac{(TS^{24} + US^{45} + LS^{75})}{3} =$	48	2	2
2. Topsoil Factors Physical: Choose most-limiting - structure/consistency (D) - organic equivalent (F) - peaty surface (O)	 peat mix >80 t/ha ---	 0 0 0	 0
Chemical: Choose most-limiting - acidity (V) - salinity (N) - sodicity / saturation % (Y) - nutrient retention (K)	 7.4 (H_20) 0.7 SAR 4.4 High	% deduction 10 0 10 0	 10
Basic Soil Rating = [80 M+D, F or O][100% - % deduction for V, N, Y or K] = (a)			70
3. Upper Subsoil Factors - Choose most-limiting - structure (D) - acidity (V) - salinity (N) - sodicity / saturation % (Y)	 2-10, firm 7.5 (H_20) 2 SAR 6.3	% deduction 20 10 10 15	
Upper Subsoil Deduction = 20 % of (a) x 0.67		= (b)	9
4. Lower Subsoil Factors - Choose most-limiting - structure (D) - acidity (V) - salinity (N) - sodicity / saturation % (Y)	 2-10, firm 7.5 (H_20) 2 SAR 6.3	% deduction 20 10 10 15	
Lower Subsoil Deduction = 20 % of (a) x 0.33		= (c)	5
Interim Soil Rating = (a) 70 - (b) 9 - (c) 5		= (d)	56
5. Edaphic Grid (R) - moisture - nutrients	 dry medium	multiplier 1.0	
Edaphic Grid = (R)		= (e)	1.0
FINAL SOIL RATING (S) = (d) 56 x (e) 1.0 = 56 CLASS 3 SUBCLASS D			

Table IV-9 : Soil Capability - for a 20-cm peat-mineral mix over 80 cm of "clean" sandy clay loam overburden spoil. Location: Steepbank Mine (from CAN-AG 1996b).

Factors	Value	Point Deduction	TOTAL
1. Profile AWHC (M) $50 - \frac{(TS^{24} + US^{45} + LS^{75})}{3} =$	48	2	2
2. Topsoil Factors Physical: Choose most-limiting - structure/consistency (D) - organic equivalent (F) - peaty surface (O)	 peat mix >80 t/ha ---	 0 0 0	 0
Chemical: Choose most-limiting - acidity (V) - salinity (N) - sodicity / saturation % (Y) - nutrient retention (K)	 5.0-7.0 (H_20) 0.7 SAR <4 High	% deduction 0 0 0 0	 0
Basic Soil Rating = [80 M+D, F or O][100% - % deduction for V, N, Y or K] = (a)			**78**
3. Upper Subsoil Factors - Choose most-limiting - structure (D) - acidity (V) - salinity (N) - sodicity / saturation % (Y)	 2-10, firm 7.5 (H_20) EC <2 SAR < 4	% deduction 20 10 0 0	
Upper Subsoil Deduction = 20 % of (a) x 0.67		= (b)	**10**
4. Lower Subsoil Factors - Choose most-limiting - structure (D) - acidity (V) - salinity (N) - sodicity / saturation % (Y)	 2-10, firm 7.5 (H_20) EC <2 SAR < 4	% deduction 20 10 0 0	
Lower Subsoil Deduction = 20 % of (a) x 0.33		= (c)	**5**
Interim Soil Rating = (a) 78 - (b) 10 - (c) 5		**= (d)**	**63**
5. Edaphic Grid (R) - moisture - nutrients	 dry medium	Multiplier 1.0	
Edaphic Grid = (R)		= (e)	**1.0**
FINAL SOIL RATING (S) = (d) 63 x (e) 1.0 = 63 CLASS 2 SUBCLASS D			

LIST OF TABLES AND FIGURES

TABLES

FIGURES

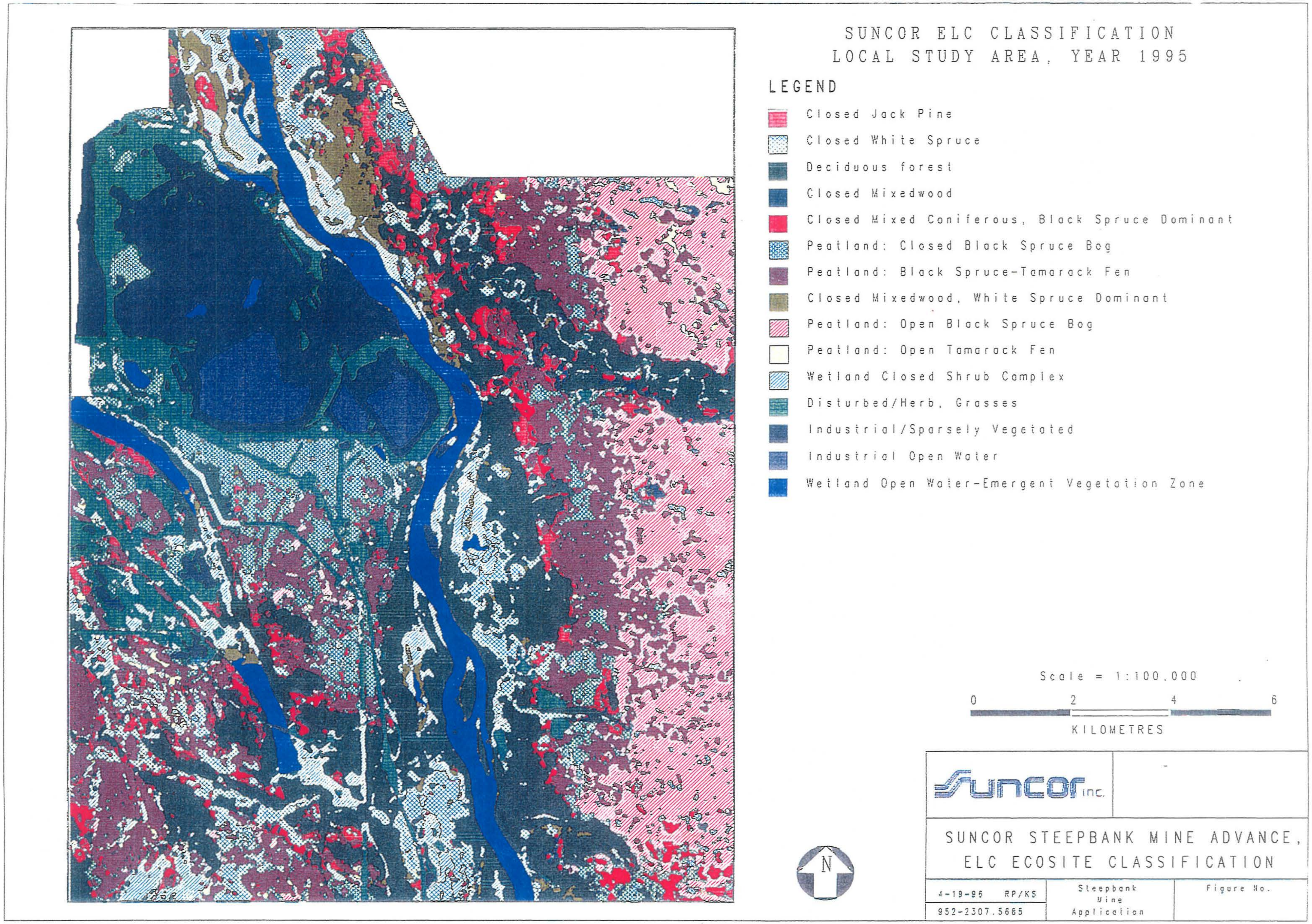


Figure IV-1 Reclamation Progression to 1995

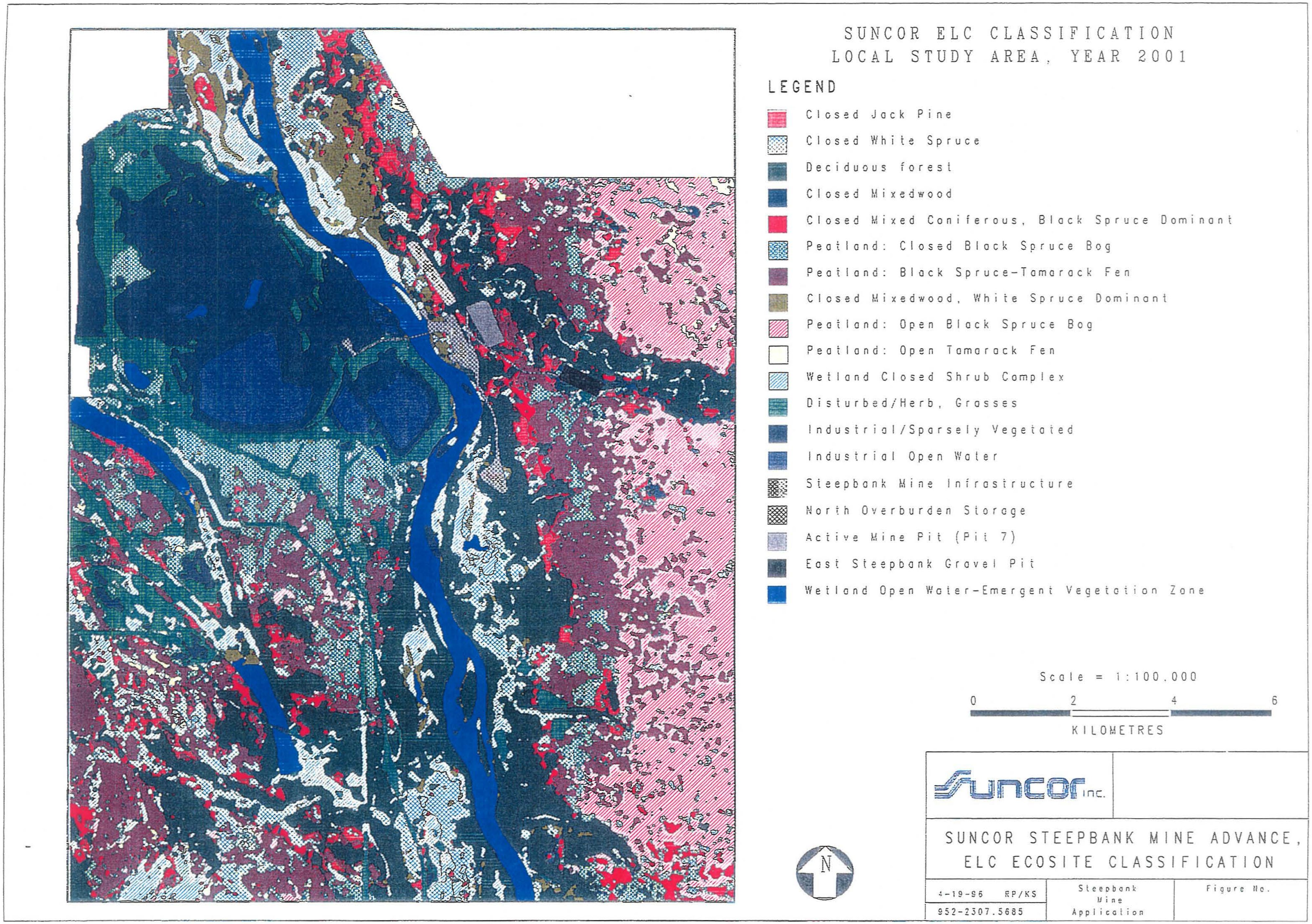


Figure IV-2 Reclamation Progression to 2001

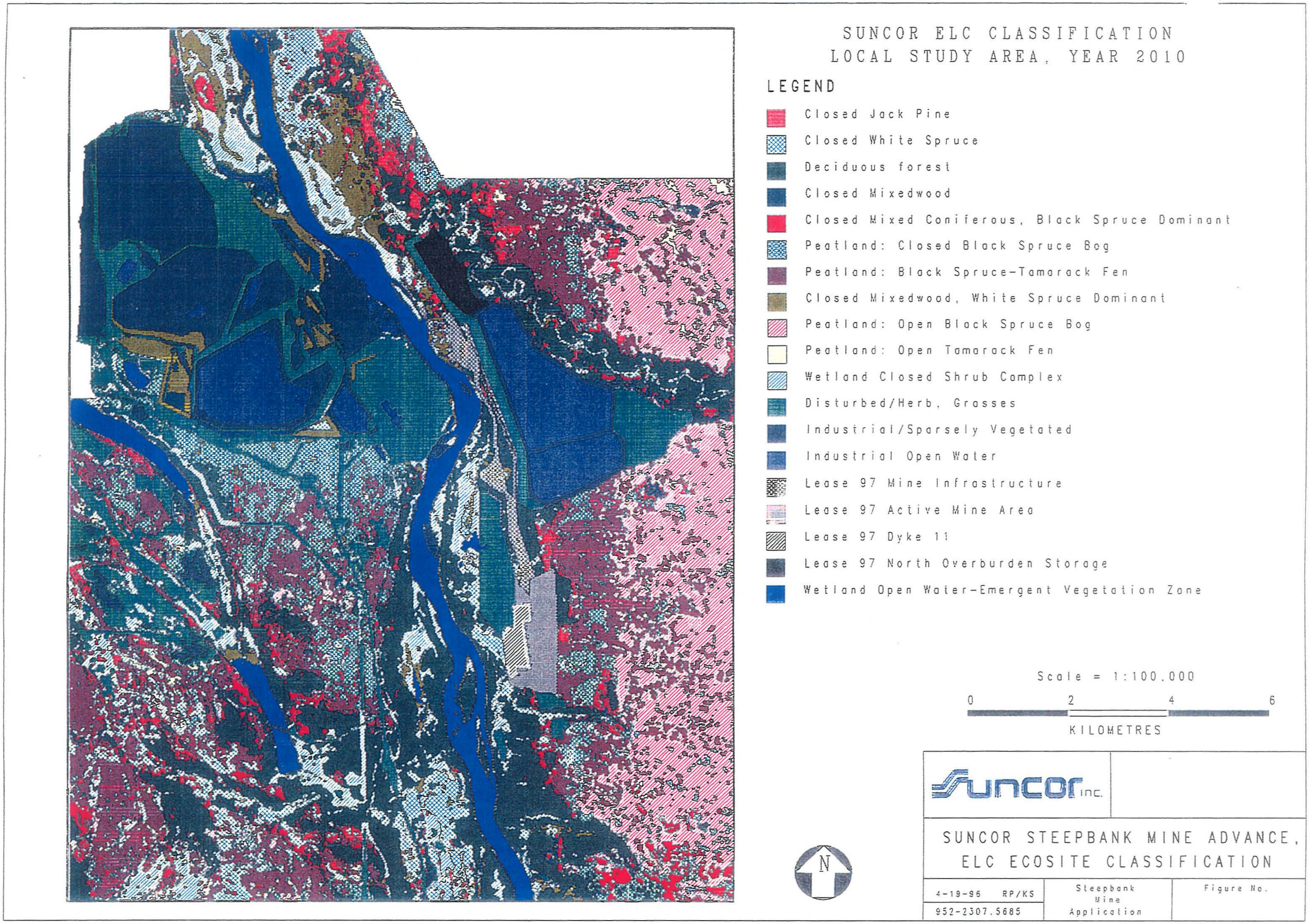


Figure IV-3 Reclamation Progression to 2010

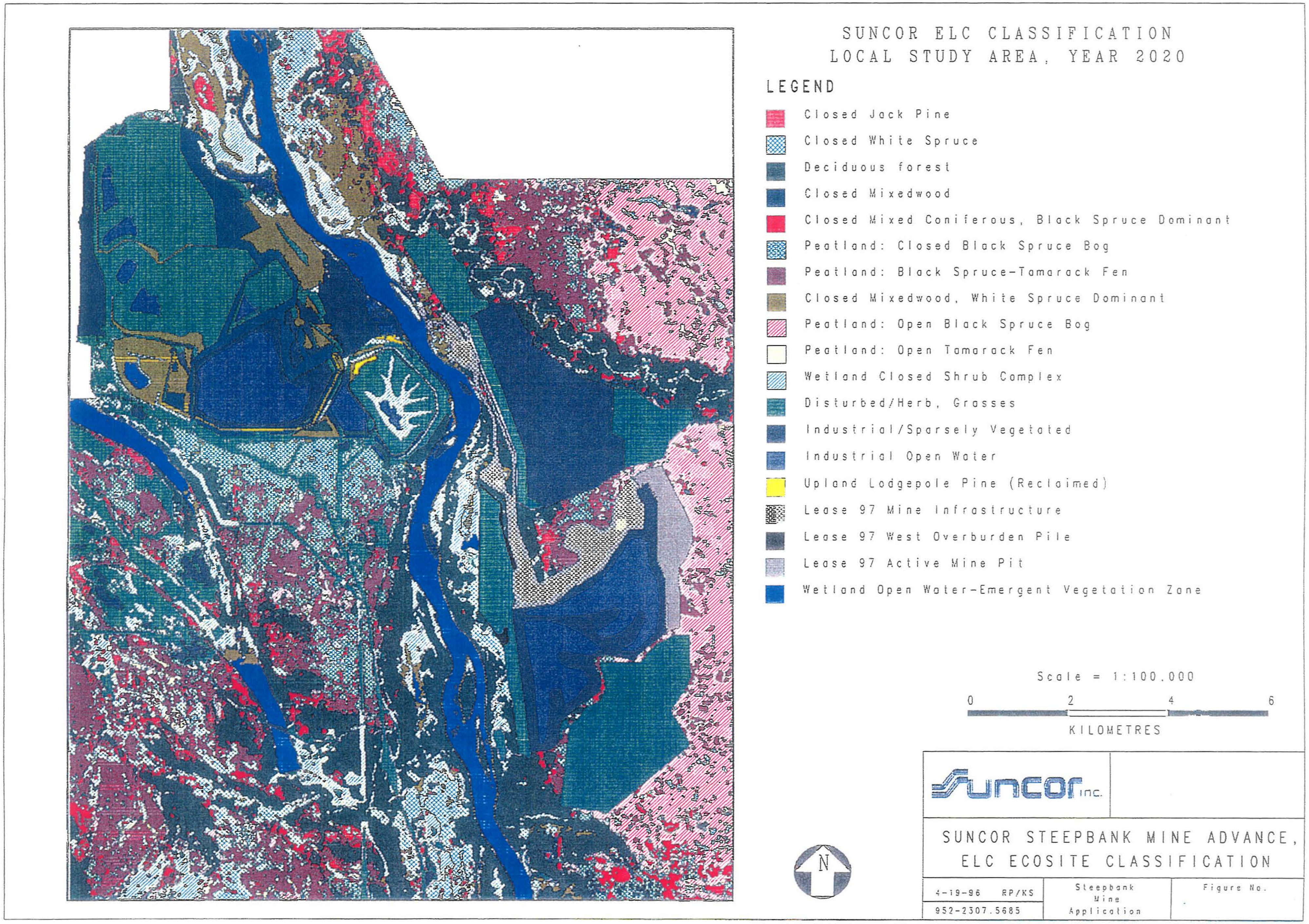


Figure IV-4 Reclamation Progression to 2020

REFERENCES

This list includes those references cited in the text and those referred to on Figure E2.0-2.

AGRA Earth and Environmental. 1995a. Proposed Remedial Measures for Visible Seepage at Toe of Tar Island Dyke, Suncor. Prepared for Suncor Inc., Oil Sands Group. Edmonton, Alberta. 9 p.

AGRA Earth and Environmental. 1995b. Seepage Study, Suncor Pond 5. Prepared for Suncor Inc., Oil Sands Group. Calgary, Alberta. 20 p.

AGRA Earth and Environmental. 1996a. Predictions of the Geotechnical Performance of the Commercial Trial and Pond 5 CT Deposits. Prepared for Suncor Inc., Oil Sands Group. Edmonton, Alberta.

AGRA Earth and Environmental. 1996b. Erosion Resistance of Reclaimed Sand Structures. Prepared for Suncor Inc., Oil Sands Group. Calgary, Alberta.

AGRA Earth and Environmental. 1996c. Summary of Lease 86/17 Groundwater Systems and Seepage Quantity Estimates. Prepared for Suncor Inc., Oil Sands Group. Calgary, Alberta. 29 p.

AGRA Earth and Environmental. 1996d. Tar Island Dyke River Bank Protection for Mine Operations. Prepared for Suncor Inc., Oil Sands Group. Calgary, Alberta. 13 p.

AGRA Earth and Environmental. 1996e. Geotechnical Assessment of Lease 86/17 Reclamation Plan. Prepared for Suncor Inc., Oil Sands Group. Edmonton, Alberta.

AGRA Earth and Environmental. 1996f Pond 1/Tar Island Dyke Water Balance Study Phase 2. Prepared for Suncor Inc., Oil Sands Group. Edmonton, Alberta. 42 p.

AGRA Earth and Environmental. 1996g. Athabasca River Geomorphic Study and Protection Plan for Tar Island Dyke Reclaimed Area. Prepared for Suncor Inc., Oil Sands Group. Calgary, Alberta.

AGRA Earth and Environmental. 1996h. Reclamation Drainage Plan for Suncor's Lease 86/17. Prepared for Suncor Inc., Oil Sands Group. Calgary, Alberta.

AGRA Earth & Environmental Limited. 1996i. Vegetation Development and Sustainability on Reclaimed Tailings Sand Structures. Prepared for Suncor Inc., Oil Sands Group and Syncrude Canada Limited. Calgary, Alberta. 99 p.

AGRA Earth and Environmental 1996j. Technical Basis for Preliminary Water Balance Analysis for Suncor's Mine Closure Drainage System. Prepared for Suncor Inc., Oil Sands Group. Calgary, Alberta.

AGRA Earth & Environmental Limited. 1996k. Athabasca River Bridge to Steepbank Mine River Hydraulics and Ice Study. Prepared for Suncor Inc., Oil Sands Group. Calgary, Alberta.

Alberta Environmental Centre. 1994. Water Quality Review and Treatment Requirements for Water Released from Suncor's Tailings. December 1994. Vegreville, Alberta. 91p.

Alberta Environmental Protection and Enhancement Act; Conservation and Reclamation Regulation. 1993. Queen's Printer, Alberta. 15p.

Alberta Environmental Protection. 1995. Draft Fort McMurray-Athabasca Oil Sands Subregional Integrated Resource Plan. Pub. No: I/358. Edmonton, Alberta. 86p.

Bishay, F.S. and P.G. Nix. 1996. Constructed Wetlands for Treatment Of Oil Sands Wastewater:Technical Report #5. Prepared for Suncor Inc., Oil Sands Group by EVS Consultants, North Vancouver, BC. 12 chapters (236 p.).

Boerger H., M.D. MacKinnon and M. Aleksiuk. 1986. Use of toxicity tests in studies of oil sands tailings water in experimental pits. Proceedings of the 11th Annual Toxicity Workshop, Vancouver, November 13-15, 1986. Canadian Technical Report of Fisheries and Aquatic Science.

BOVAR Environmental. 1996a. Sources of Atmospheric Emissions in the Athabasca Oil Sands Region. Prepared for Suncor Inc.,Oil Sands Group and Syncrude Canada Ltd. Calgary, Alberta.

BOVAR Environmental. 1996b. Ambient Air Quality in the Athabasca Oil Sands Region. Prepared for Suncor Inc., Oil Sands Group and Syncrude Canada Ltd. Calgary, Alberta.

BOVAR Environmental. 1996c. Meteorology Observations in the Athabasca Oil Sands Region. Prepared for Suncor Inc., Oil Sands Group and Syncrude Canada Ltd. Calgary, Alberta.

BOVAR Environmental. 1996d. Ambient Air Quality Predictions for the Athabasca Oil Sands Region. Prepared for Suncor Inc., Oil Sands Group and Syncrude Canada Ltd. Calgary, Alberta.

BOVAR Environmental. 1996e. Impact Analysis of Air Emissions Associated with the Steepbank Mine. Prepared for Suncor Inc., Oil Sands Group. Calgary, Alberta.

CAN-AG Enterprises Ltd. 1996a. Land Capability Classification for Forest Ecosystems in the Oil Sands Region. Second Draft. Edmonton, Alberta. 73 p.

CAN-AG Enterprises Ltd. 1996b. Baseline Soil Survey for the Proposed Suncor Steepbank Mine. Suncor Inc. Prepared for Golder Associates Ltd. March 1996. Edmonton, Alberta. 77 p.

Caughill, D.L., J.D. Scott, Y. Liu, R. Burns and W.H. Shaw 1994. 1993 Field Program on Nonsegregating Tailings at Suncor Inc. 47th Canadian Geotechnical Conference, Canadian Geotechnical Society, Publisher, Halifax, Nova Scotia, 1994. p524-533.

Fine Tailings Fundamentals Consortium. 1993. Oil Sands - Our Petroleum Future. Proceedings of the Fine Tailings Fundamentals Consortium. April 1993. Edmonton, Alberta. 24 Sections.

Fine Tailings Fundamentals Consortium. 1995. Advances in Oil Sands Tailings Research. Proceedings of the Fine Tailings Fundamentals Consortium, June 1995, Alberta Department of Energy, Oil Sands and Research Division, Publisher. 4 Volumes. 296p.

Fort Chipeywan 1996. Fort Chipewyan Community Profile and Attitudes and Perceptions 1995-1996

Fort McKay Environment Services Ltd. 1996a. A Profile of the Extended Community of Fort McKay, Alberta. Prepared for Suncor Inc., Oil Sands Group and Syncrude Canada Ltd. 31p.

Fort McKay Environment Services Ltd. 1996b. The Community of Fort McKay Traditional Uses of the Renewable Resources On the Proposed Suncor Steepbank Mine Site. Prepared for Suncor Inc., Oil Sands Group. 36p.

Fort McKay Environment Services Ltd. 1996c. Survey of Wildlife, including Aquatic Mammals, Associated with Riparian Environment Habitat on the Suncor Steepbank Mine Study Area. Prepared for Fort McKay Services Ltd. By CIRC: Crozier Information Resources Consulting Ltd. Edmonton. 33p.

Golder Associates Ltd. 1994. Oil Sands Mine Reclamation Strategies Performance Assessment. Phase III:Report 1 - Performance Assessment Summary; Report 2 - Risk Analysis of Off-Site Releases; Report 3- Engineering Reliability Assessment. Prepared for Syncrude Canada Ltd. And Suncor Inc., Oil Sands Group. Prepared by Golder Associates Ltd. April 1994. Report 1- 27 p.; Report 2 - 27 p.; Report 3 - 13 p.

Golder Associates Ltd. 1996a. Tar Island Dyke Porewater Study 1995. Prepared for Suncor Inc., Oil Sands Group. Prepared by Golder Associates Ltd. Calgary, Alberta. 6 p.

Golder Associates Ltd. 1996b. Athabasca River Water Releases Impact Assessment. Prepared for Suncor Inc., Oil Sands Group. Prepared by Golder Associates Ltd. Calgary, Alberta.

Golder Associates Ltd. 1996c. Suncor Reclamation Performance Assessment. Prepared for Suncor Inc., Oil Sands Group. Prepared by Golder Associates Ltd. Calgary, Alberta.

Golder Associates Ltd. 1996d. Aquatic Baseline Report for the Athabasca, Steepbank, and Muskeg Rivers in the Vicinity of the Steepbank and Aurora Mines. Prepared for Suncor Inc., Oil Sands Group. Prepared by Golder Associates Ltd. Calgary, Alberta.

Golder Associates Ltd. 1996e. Impact Analysis of Terrestrial Resources Associated with the Steepbank Mine. Prepared for Suncor Inc., Oil Sands Group. Prepared by Golder Associates Ltd. Calgary, Alberta.

Golder Associates Ltd. 1996f. Terrestrial Baseline Report for the Steepbank Mine. Prepared for Suncor Inc., Oil Sands Group. Prepared by Golder Associates Ltd. Calgary, Alberta.

Golder Associates Ltd. 1996g. Impact Analysis of Aquatics Issues Associated with the Steepbank Mine. Prepared for Suncor Inc., Oil Sands Group. Prepared by Golder Associates Ltd. Calgary, Alberta.

Golder Associates Ltd. 1996h. Impact Analysis of Human Health Issues Associated with the Steepbank Mine. Prepared for Suncor Inc., Oil Sands Group. Prepared by Golder Associates Ltd. Calgary, Alberta.

Golder Associates Ltd. 1996i. Impact Analysis Socio-Economic Impacts Associated with the Steepbank Mine. Prepared for Suncor Inc., Oil Sands Group. Prepared by Golder Associates Ltd. Calgary, Alberta.

Golder Associates Ltd. 1996j. Historical Resources Impact Assessment Steepbank Mine Project Permit 95-083. Prepared for Suncor Inc., Oil Sands Group. Prepared by Golder Associates Ltd. Calgary, Alberta.

Golder Associates Ltd. 1996k. Fish Flavour Impairment Study. Prepared for Suncor Inc., Oil Sands Group by Golder Associates Ltd. Calgary, Alberta.

Golder Associates Ltd. and EVS Environment Consultants. 1995. Suncor Steepbank Mine EIA: Quality Assurance and Database Management Plan. Prepared for Suncor Inc.,Oil Sands Group by Golder Associates, Calgary, Alberta and EVS Consultants, Seattle, Washington.

Gunter, C.P., P.G. Nix and Z. Knezevic. 1995. Biological Treatment Options for Consolidated Tailings Release Waters. Prepared for Suncor Inc., Oil Sands Group by EVS Consultants and Novatec Consultants Inc. North Vancouver, BC. 69 p.

HydroQual Laboratories Ltd. 1996. Laboratory Studies on Tröphic Level Effects and Fish Health Effects of Suncor Tar Island Dyke Wastewater. Prepared for Suncor Inc., Oil Sands Group by HydroQual Laboratories Ltd., Calgary, Alberta.

Kasperski, K.L. and Mikula,R. J. 1996. Modelling Suncor Recycle Water Chemistry: Impact of Consolidated Tailings. Western Research Centre, Division Report WRC 96-16 (CF), 31p

Klohn-Crippen Consultants Ltd. 1996a. Hydrology Baseline Steepbank Oil Sands Mine. Prepared for Suncor Inc., Oil Sands Group by Klohn-Crippen, Calgary, Alberta.

Klohn-Crippen Consultants Ltd. 1996b. Hydrogeology Baseline Steepbank Oil Sands Mine. Prepared for Suncor Inc., Oil Sands Group by Klohn-Crippen, Calgary, Alberta.

Klohn-Crippen Consultants Ltd. 1996c. Impact Analysis Suncor Steepbank Mine EIA Surface Water and Groundwater. Prepared for Suncor Inc., Oil Sands Group by Klohn-Crippen, Calgary, Alberta.

Levy, R. M. 1996. Visual Impact of Suncor Steepbank Mine Development. Prepared for Golder Associates Ltd., Calgary, Alberta.

MacKinnon, M., and H. Boerger. 1991. Assessment of a Wet Landscape Option for Disposal of Fine Tails from Processing of Oil Sand. Proceedings of the CIM/AOSTRA Technical Conference, 21-22 April 1991. 15 p.

McCormick, G. and D. L. Skinner. 1996. Baseline Study of Fur Trapping in the Suncor Study Area. Prepared for Suncor Inc., Oil Sands Group by Westworth, Brusnyk and Associates, Edmonton, Alberta.

Michalsky, S. 1996. Suncor Inc. Mine Expansion: Baseline Forestry Report. Prepared for Golder Associates Ltd. By EnviResource Consulting Ltd., Calgary, Alberta.

Mikula, R.J. and Kasperski, K.L. 1995. Nonsegregating Tailings Release Water Chemistry: Preliminary Report. Western Research Centre, Division Report WRC 95-26 (CF). 38p.

Munoz, V.A., Mikula, R.J. and Kasperski, K.L. 1996. Comparison of Tailings Behaviour for Several Bitumen Extraction Methods, Western Research Centre, Division Report WRC 96-19 (CF).

Nelson, L.R., M. MacKinnon and J.R. Gulley. 1993. Application of Toxicity Testing in the Evaluation of Reclamation Options for Oil Sands Fine Tails. In: Proceedings of the Fine Tailings Symposium in Oil Sands: Our Petroleum Future Conference, April 4-7, 1993. Edmonton, Alberta. Lui, J.K. (Ed). AOSTRA Publication. Paper F2. 33p.

Nix, P.G., S.H. Hamilton, E.D. Bauer and C.P. Gunter. 1993. Constructed Wetlands for the Treatment of Oil Sands Wastewater. Technical Report #2, March 1993. Prepared for Suncor Inc., Oil Sands Group. North Vancouver, BC. 75 p.

Nix, P.G., S.H. Hamilton, L. Bendell-Young, C.P. Gunter, F.S. Bishay and M.D. Paine. 1994. Constructed Wetlands for the Treatment of Oil Sands Wastewater. Technical Report #3. February 1994. Prepared for Suncor Inc., Oil Sands Group by EVS Consultants. North Vancouver, BC. 222 p.

Nix, P.G., F.S. Bishay, S.H. Hamilton and M.D. Paine. 1995. Constructed Wetlands for the Treatment of Oil Sands Wastewater. Technical Report #4. June 1995. Prepared for Suncor Inc., Oil Sands Group by EVS Consultants. North Vancouver, BC. 386 p.

Oil Sands Water Release Technical Working Group. 1996. Approaches to Oil Sands Water Releases. Emonton, AB. 34 p.

Silvacom Ltd. 1996. The Effects of Fire on Reclaimed Sites of the Oil Sands Region of Alberta. Submitted to Suncor Inc., Oil Sands Group and Syncrude Canada Ltd. January 1996.

Suncor Inc., Oil Sands Group. 1995a. Application for Renewal of Environmental Operating Approval. February 1995. Fort McMurray. 283p.

Suncor Inc., Oil Sands Group. 1995b. Preliminary Verification of the Oil Sands Reclamation Performance Assessment Framework. 31 p.

Suncor Inc., Oil Sands Group. 1996a. Application for approval of the Fixed Plant Expansion Project. Submitted to Alberta Energy amd Utilities Board and to Alberta Environmental Protection. Fort McMurray, Alberta. March 1996. 315 p.

Suncor Inc., Oil Sands Group. 1996b. 1995 Lease 86/17 Environmental Sampling Program: Sample Station Identification. 100p.

Suncor Inc., Oil Sands Group. 1996c. Long Range Tailings Plan.

Suncor Inc., Oil Sands Group. 1996d. Annual Conservation and Reclamation Report. March 1996, 50p.

Wastewater Technology Centre. 1995. Treatment Options for Tailings Pond Discharge. Burlington, Ontario. 22 p.

Westworth, Brusnyk & Associates. 1996a. Herpetofauna in the Steepbank Study Area. Prepared for Suncor Inc., Oil Sands Group by Westworth, Brusnyk & Associates, Edmonton, Alberta.

Westworth, Brusnyk & Associates. 1996b. Habitat Suitability Models for the Suncor Study Area. Prepared for Suncor Inc., Oil Sands Group by Westworth, Brusnyk & Associates, Edmonton, Alberta.

Westworth, Brusnyk & Associates. 1996c. Abundance and Distribution of Moose in the Suncor Study Area. Prepared for Suncor Inc., Oil Sands Group by Westworth, Brusnyk & Associates, Edmonton, Alberta.

Westworth, Brusnyk & Associates. 1996d. Waterfowl, Raptors and Breeding Terrestrial Birds of the Suncor Lease in 1995. Prepared for Suncor Inc., Oil Sands Group by Westworth, Brusnyk & Associates, Edmonton, Alberta.

Westworth, Brusnyk & Associates. 1996e. Impact Analysis Suncor Steepbank Mine Environmental Wildlife Component. Prepared for Suncor Inc., Oil Sands Group by Westworth, Brusnyk & Associates, Edmonton, Alberta.

Xu, J.G. (editor). 1996. Plant Growth, Dewatering and Contaminant Uptake from Oil Sands Fine Tails and Tailings (A Progress Report on the 1995 Field Experiment). Prepared by Alberta Environmental Centre, Vegreville, Alberta. Prepared for Suncor Inc., Oil Sands Group. March 15, 1996. 93p.

GLOSSARY

Adverse Effect	An undesirable or harmful effect to an organism (human, animal or plant), indicated by some result such as mortality, altered food consumption, altered body and organ weights, altered enzyme concentrations or visible pathological changes.
Airshed	A term to describe the geographic area requiring unified management for achieving air pollution control.
Aquifer	A body of rock or soil which 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.
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.
Background Concentration (environmental)	The concentration of a chemical in a defined control area during a fixed period of time before, during, or after a data-gathering operation.
Baseline	A surveyed condition which serves as a reference point to 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 the gravel, soil or other superficial material.

Benthic Invertebrates	Invertebrate organisms living at, in, or associated with the bottom (benthic) substrate of lakes, ponds and streams. Examples of benthic invertebrates include some aquatic insect species (such as caddisfly larvae) which 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 small fishes.
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 which comprise both the communities of organisms within particular habitats and the physical conditions under which they live.
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.

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 about 10%, sulphur about 5%, and nitrogen, oxygen, and trace elements the remainder.
Bottom-feeding Fish	Fish which 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.
Carcinogen	An agent that is reactive or toxic enough to act directly to cause cancer.
Chert	A fine-grained siliceous rock. Impure variety of chalcedony which is generally light coloured.
Climax	The culminating stage in plant succession for a given site where the vegetation has reached a stable condition.
Community	Pertaining to plant or animal species living in close association or interacting as a unit.
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 and describes the populations potentially at risk and exposure pathways and scenarios.
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.
Conifers	White and black spruce, balsam fir, jack pine and tamarack.

Consolidated Tailings (CT)	Consolidated tailings (CT) is a non-segregating mixture 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.
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.
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.
Dendritic Drainage Pattern	A drainage pattern characterized by irregular branching in all directions with the tributaries joining with the main stream at all angles.
Diameter at breast height (DBH)	The diameter of a tree 1.5 m above the ground on the uphill side of the tree.
Disturbance [Terrestrial]	A force that causes significant change in structure and/or composition of a habitat.
Disturbance [Historic]	A cultural deposit is said to be disturbed when the original sequence of deposition has been altered. Agents of disturbance include erosion, plant or animal activity, cultivation, excavations, etc.

Diversity	The variety, distribution and abundance of different plant and animal communities and species within an area.
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, relief, and dominant vegetation.
Ecosection	Clearly recognizable landforms such as river valleys and wetlands at a broad level of generalization.
Ecosite	Subdivisions of the ecosection described and analyzed in greater detail (e.g., subdivisions of the river valley). The focus at this level is on specific vegetation associations (e.g., wetland shrub) and the particular soil, drainage and site conditions which support it.
Ecosystem	An integrated and stable association of living and nonliving resources functioning within a defined physical location.
Environmental Impact Assessment	A review of the effects that a proposed development will have on the local and regional environment.
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 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)	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.
Exposure Scenario	A set of facts, assumptions and inferences about how exposure takes place that aid the risk assessor in evaluating, estimating and quantifying exposures.
Fine Tailings	A suspension of fine silts, clays, residual bitumen and water forms in course of bitumen extraction from oil sands using the hot water extraction process. This material segregates from coarse sand tailings during placement into 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.
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 SO_2 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 ($Ca\ SO_4$) is formed as a by-product of this process.
Fluvial	Relating to a stream or river.

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 that compose a forest.
Froth	Refers to an 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.
Geomorphology	That branch of science that 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	Geographical 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.
Glacio-Lacustrine	Relating to the lakes that formed of the edge of glaciers as the glaciers receded. Glacio-lacustrine sediments are commonly laminar deposits of fine sand, silt and clay.
Groundwater	That part of the subsurface water which occurs beneath the water table, in soils and geologic formations that are fully saturated.
Herb	Tender plant, lacking woody stems, usually small or low; it may be annual or perennial, broadleaf (forb), or graminoid (grass).

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.
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, in a water based slurry in a pipeline.
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.
Isolated Find	The occurrence of a single artifact with no associated artifacts or features.
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.
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 multilayered, multispecies 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.
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 which includes an assay of light production by a strain of luminescent bacteria (*Photobacterium phosphoreum*).
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.

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 which 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 by-product of petroleum-related industry. Aromatics are considered to be highly toxic components of petroleum products. PAHs are composed of at least two fused benzene rings, many of which are potential carcinogens. Toxicity increases along with molecular size and degree of alkylation of the aromatic nucleus.
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 which deals with the cause and nature of disease or diseased tissues.
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.
Piezometer	A pipe in the ground in which the elevation of water level can be measured.
Plant Community	An association of plants of various species found growing together.
Population	A collection of individuals of the same species that potentially interbreed.
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 waste land to a state of useful capability. At Suncor, 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 revegetations. This provides the basis for natural succession to mature ecosystems suitable for a variety of end uses.
Regeneration	The natural of 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.
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.
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 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.

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 thing as run-off, but referring to water that flows onto a property, or any piece of land of interest. Includes only those waters which have not been in contact with exposed oil sands, or with oil sands operational areas.
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.
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.
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 side stream in a secondary circuit). Tailings are removed from the bottom.
Site [Human Health]	The area determined to be significantly impacted after the iterative evaluations of the risk assessment. Also can be applied to political or legal boundaries.
Site [Historic]	Any location with detectable evidence of past human activity.
Snag	Any standing dead, or partially dead tree.

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 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.
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 (i.e., fire, logging).
Stand Density	The number and size of trees on a forest site.
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.

Wetlands	Term for a broad group of wet habitats. Wetlands 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.
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.
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.