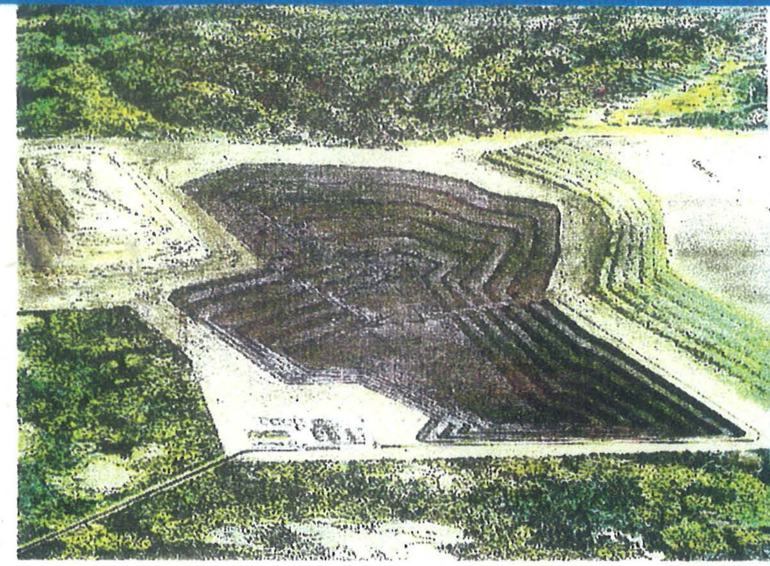
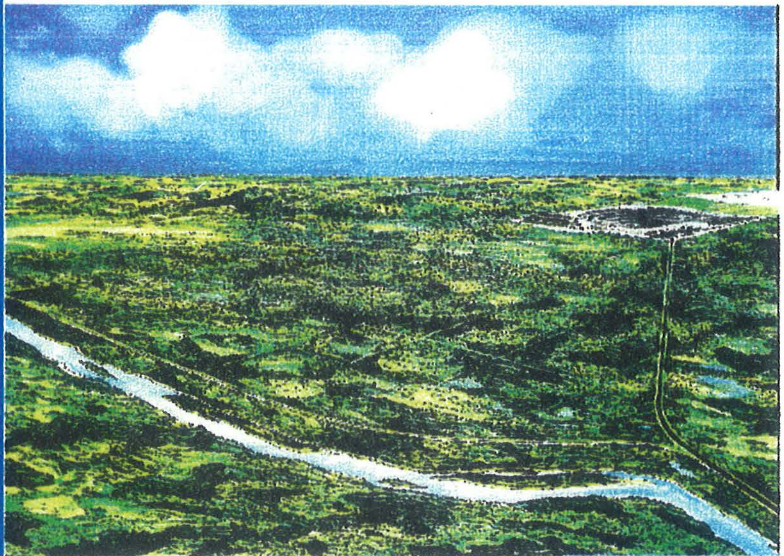
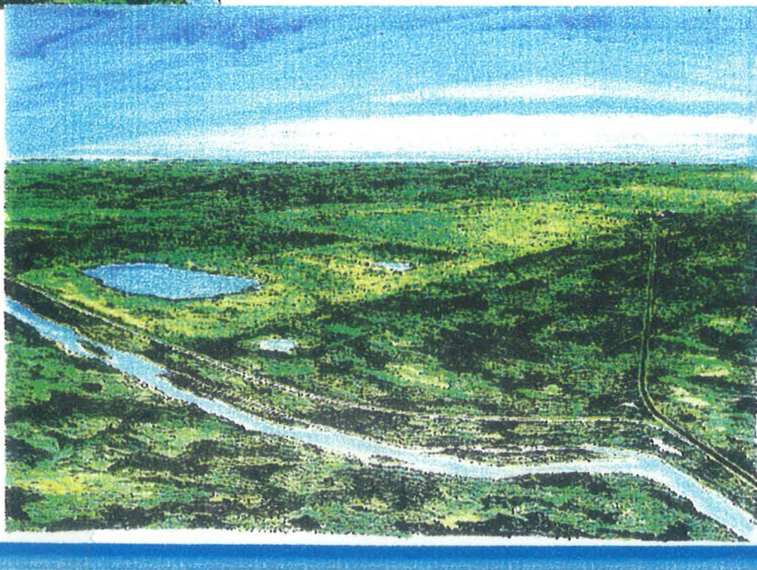


AURORA MINE APPLICATION





June 1996

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Syncrude
Securing Canada's Energy Future

AURORA MINE APPLICATION TO:

AEP/EUB

June 17, 1996

Syncrude Aurora Mine

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 Environment Protection and Enhancement Act
AEUB	Alberta Energy and Utilities Board
Al-Pac	Alberta Pacific Forest Industries Inc.
AOSERP	Alberta Oil Sands Environmental Research Program
AOSTRA	Alberta Oil Sands Technical Research Authority
API	American Petroleum Institute
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	Biochemical 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

LIST OF ABBREVIATIONS

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
$C0_2$	Carbon dioxide
COD	Chemical oxygen demand
COH	Co-efficient of haze
Conif.	Coniferous
CONRAD	Canadian Oil Sands Network for Research and Development
Consotium	Fine Tailings Fundamentals Consortium
CSEM	Continuous Stack Emissions Monitor
CT	Composite Tailings
d	Day
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
FEM	Finite Element Modelling
FGD	Flue Gas Desulphurization
ft	Feet
ft^3	Cubic Feet
g	Grams
g/cc	Grams per cubic centimetre
GDP	Gross Domestic Product
GJ	Giga-joules
GLC	Ground Level Concentration
GTG	Gas Turbo Generator
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

LIST OF ABBREVIATIONS

kg	Kilogram
kg/d	Kilograms per day
kg/ha	Kolograms per hectare
kg/hr	Kilograms per hour
KIR	Key Indicator Resouce
km	Kilometre
k m^3	Thousand cubic metres
KV	Kilovolt
L or l	Litre
ib/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	Millions cubic metres
meq	Milli-equivalents
mg	Milligrams
mg/L	Milligrams per Litre
MJ	Megajoule
mm	Millimetre
MLSB	Mildred Lake Settling Basin
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
OSG	Suncor Inc., Oil Sands Group
OSLO	Other Size Lease Owners
OSRPAP	Oil Sands Reclamation Performance Assessment Protocol
OSTG	Once Through Steam Generator
OSWRTWG	Oil Sands Water Release Technical Working Group
P	Phosphorus
PAH	Polycyclic aromoatic hydrocarbons
PMF	Probable maximum flood

LIST OF ABBREVIATIONS

ppb	Parts per billion
ppm	Parts per million
psig	Pounds per square inch
Q	Quarter (i.e., 3 months of a year)
RAQCC	Regional Air Quality Coordinating Committee
RRTAC	Reclamation Research Technical Advisory Committee
s	Second
S	Sulphur
SAGD	Steam Assisted Gracity Drainage
SAR	Solium adsorption ration
scf/d	Standard cubic feet per day
SCO	Synthetic crude oil
SEC	Supplementary Emission Control
sep cell	Separation cell
SFR	Sand to fines ration
SLC	Screening level criteria
SO_2	Sulphur dioxide
SOx	Sulphur oxides
SO_4	Sulphate
spp	Species
SSB	Syncrude Sweet Blend
SWSS	South West Sand Storage
Suncor	Suncor Inc., Oil Sands Group
Syncrude	Syncrude Canada ltd.
t/d	Tonnes per day
TDS	Total dissolved solids
THE	Total extractable hydrocarbons
THC	Total hydrocarbons
TIE	Toxicity identification evaluation
TOC	Total organic carbon
Ton	2000 pounds
Tonne	2205 pounds
TRS	Total Reduced Sulphur Emissions
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
TV/NRB	Ratio of total volume removed to net recoverable bitumen
Twp	Township
UTF	Underground test facility
USgpm	U.S. gallons per minutes
VOC	Volatile organic compound

LIST OF ABBREVIATIONS

Vol.	Volume
vs	Versus
wt%	Weight percentage
y	Year

1.0 Introduction and Background to the Application: Syncrude and the Aurora Mine

Syncrude Canada Ltd. was established to develop petroleum supplies from the Athabasca Oil Sands on behalf of its joint venture owners.* In 1978 a large surface mining, extraction and integrated bitumen upgrading complex was brought on stream at Mildred Lake, about 40 kilometres north of Fort McMurray. Since then, the Mildred Lake mine and processing plant have been expanded in several stages from the original design capacity of 6.3 million cubic metres per year. Production in 1995 was 11.9 million cubic metres. The Energy and Utilities Board (the "EUB" or the "Board") has approved further expansion of Upgrading capacity at Mildred Lake up to 17.6 million cubic metres per year. Expansion of the Mildred Lake operation is planned to commence, in stages, in 1996.

The oil sands business is undergoing profound change resulting from new technology now available for bitumen production. For bitumen from surface mines, new extraction process technology and mining equipment now available have made investment in new bitumen production practical at prevailing oil prices. These advances are due to experience gained by the oil sands industry, and intensive research and development programs undertaken over the past 30 years.

The substantial decrease in energy required for bitumen extraction also makes it more practical for oil sands mines to be located some distance from upgrading complexes and with a less costly utility supply infrastructure. Similarly, new in situ production processes that take advantage of improved horizontal drilling technology have made bitumen recovery from the deeper portions of the Athabasca Oil Sands practical. Moreover, recent announcements by the Government of Alberta respecting a generic oil sands royalty regime and the Government of Canada respecting complementary corporate income tax regulations for mining (including oil sands), have provided a fiscal environment that will allow these types of initiatives to go forward.

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* The Syncrude owners are: Alberta Energy Company Ltd., 10.00%; AEC Oil Sands Limited Partnership, 5.00%; Canadian Occidental Petroleum Ltd., 7.23%; Gulf Canada Resources Ltd., 9.03%; Imperial Oil Resources, 25.00%; Mocal Energy Limited, 5.00%; Murphy Oil Company Ltd., 5.00%; PanCanadian Gas Products Ltd., 10.00%; Petro Canada, 12.00%; Athabasca Oil Sands Investment Inc., 11.76%.

These developments have set the stage for growth of the industry. This growth will involve a move from integrated mine-extraction-upgrading complexes to:

- Regional mining and in situ bitumen production sites;
- Upgrading sites with economic lives extended indefinitely through continued bitumen supply and reinvestment in technology; and
- A variety of production streams ranging from bitumen blends to high quality synthetic crude oil blends or single components such as naphtha, mid-distillate or gas oil, available to Alberta refineries and markets beyond.

The Aurora Mine is a significant evolutionary step in this direction. It is the linchpin for Syncrude's future petroleum supply from the Athabasca Oil Sands from two primary perspectives:

- It will fulfill immediate bitumen requirements to replace existing supplies from the Mildred Lake Mine that are nearing exhaustion, as well as to provide for near term production increases; and
- It introduces economic, energy-efficient surface mining and extraction technology on a large, attractive resource base to facilitate growth of a more diverse business in the longer term.

The Aurora Mine is planned for development in four stages of investment in bitumen production. Each stage includes a high capacity (8000 tonnes per hour) Low Energy Extraction Process utilizing hydrotransport. The first two stages (Aurora North) share a common truck-shovel mine pit on Oil Sands Leases 10, 12 and 34. Stages three and four (Aurora South) will be similarly configured on Lease 31. In total, the four trains of extraction will yield approximately 25 million cubic metres of bitumen per year.

Production from the Mildred Lake West Mine will be replaced in two stages by the first two trains of Aurora North. The first stage (2000-2002) will replace production from the north quadrant of the Mildred Lake West Mine.

The second stage (2003-2007) will replace production from the south quadrant of the West Mine.

The third and fourth stages will replace the Mildred Lake North Mine when it is depleted and/or will be used to provide additional bitumen for production of bitumen blends, sour blends, or sweet synthetic crude oil blends.

There is considerable flexibility in the timing of stages two, three and four to respond to growth opportunities and the further replacement of Mildred Lake volumes. For example, development of the Aurora trains can be timed to accommodate Mildred Lake Upgrader demands, expanding bitumen markets, or both. These choices will be driven by market considerations. Figure 1.0-1 indicates the relative volumes of bitumen supply from Aurora and Mildred Lake.

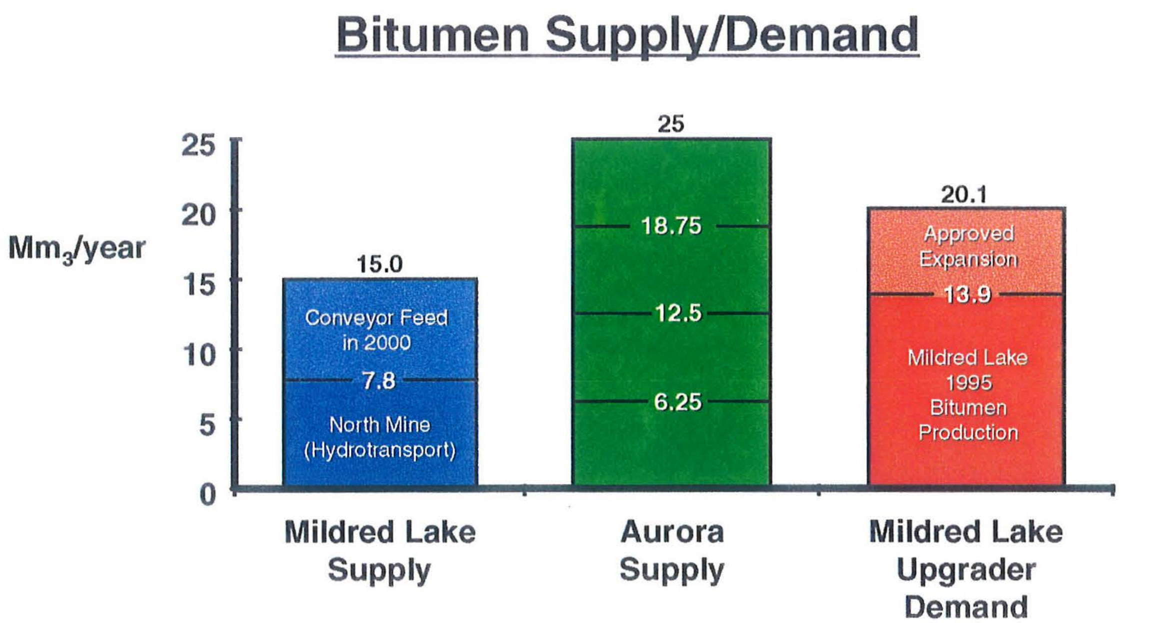

Figure 1.0-1

A key element of the Aurora Mine plan is the movement of bitumen froth to a bitumen cleaning and shipping terminal adjacent to the Mildred Lake site to handle production from the new mine and process froth production exceeding the capacity at Mildred Lake. Compared to current froth treatment technology, this bitumen cleaning technology will reduce both oil loss and air emissions, and has the potential to produce a bitumen with very low solids.

The new technology is being developed as a CONRAD (Canadian Oil Sands Network for Research and Development) project, in a partnership involving Syncrude, Suncor, Natural Resources Canada (NRCan), Bitmin Resources and Shell. The work is underway at NRCan's Western Research Centre. The rate of development of the bitumen cleaning technology, as well as the rate of growth of Aurora production, will determine the pace of its implementation.

The project area shown in Figure 1.0-2 includes the mine and out-of-pit disposal areas for tailings and overburden, the processing area, the service corridors, and the bitumen terminal. The area is based upon mining to economic pit limits where possible. In other areas (lease boundaries, Kearl Lake, Highway 963) the pit limits should be considered preliminary and could be extended when detailed mine plans have been finalized. In some cases, pit limits will not be reached for 30 years or more. Syncrude will satisfy the Board that appropriate resource conservation and environmental protection practices have been used in finalizing economic pit limits.

The south mine pit on Lease 31 essentially comprises the reserves contemplated for development as the OSLO project. The west, centre and east pits on Leases 12 and 34 comprise a large portion of the reserves proposed for the Alsands project, extended to the north for Aurora by the addition of Lease 10 which was formerly held by Suncor. All four ore bodies continue onto Lease 13, held by Shell Canada Ltd. ("Shell"). Syncrude is of the view that the developments proposed in this application considerably enhance the prospects for economic development of Lease 13, particularly if development of the area is co-ordinated to take advantage of the Syncrude infrastructure. Discussions to this end are underway with Shell.

This application requests approval of the EUB for the complete Aurora development, including the mining, extraction and reclamation plans, under the *Oil Sands Conservation Act* as well as connecting pipeline and power generation and interconnection infrastructure, pursuant to the *Pipeline Act* and the *Hydro and Electrical Energy Act,* respectively.

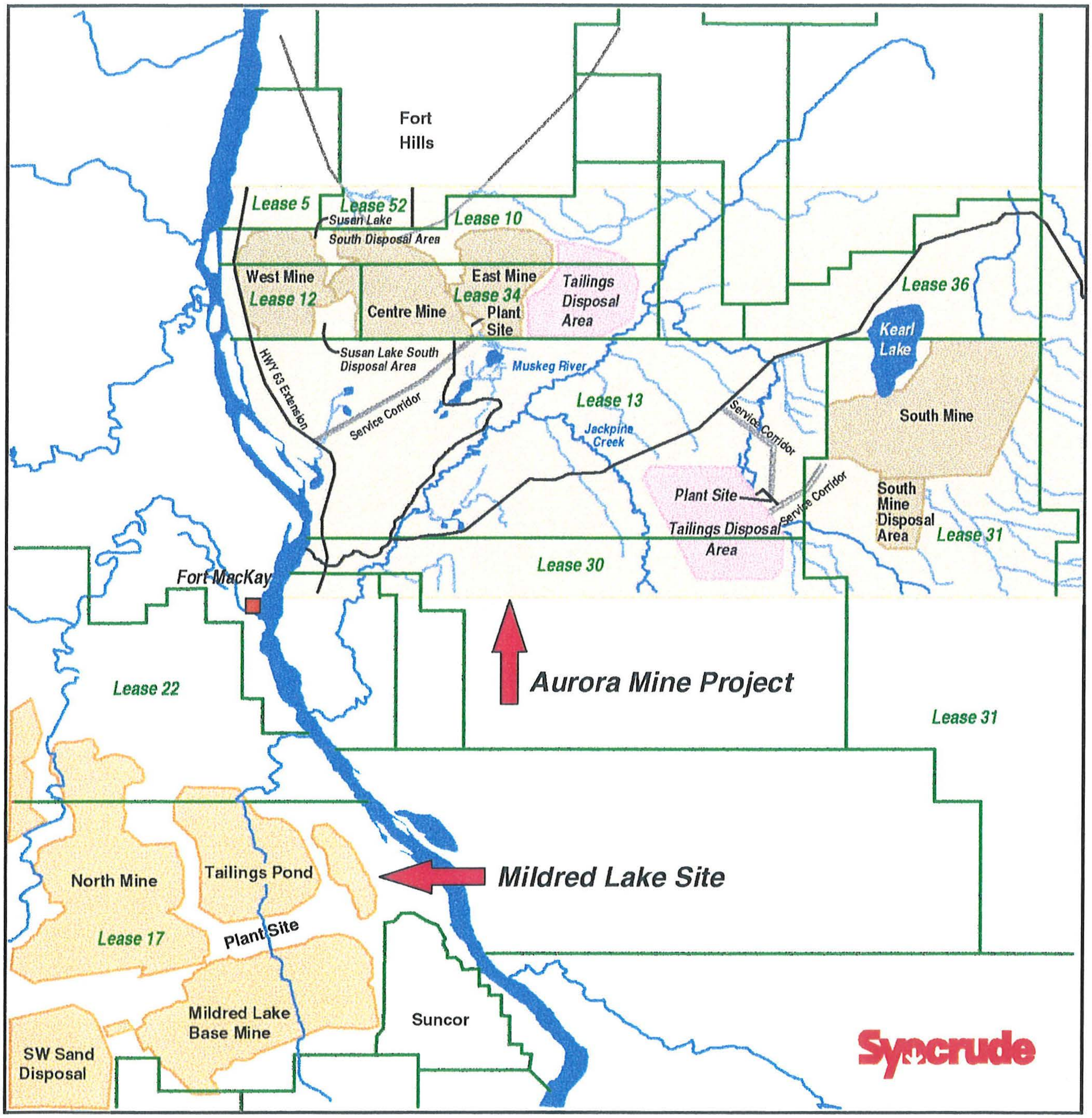

Figure 1.0-2 Aurora Mine Location

Approval by Alberta Environmental Protection is requested under the *Environmental Protection and Enhancement Act* (EPEA) and the *Water Resources Act* (WRA). Approvals available under EPEA are for a maximum of ten years. Consequently, the approvals requested under EPEA in this application are for only the first two stages of development (Aurora North). Applications for approvals under EPEA and the WRA related to Aurora South will be filed in the future, as no physical activities in relation to Aurora South are expected in the next ten years.

An Environmental Impact Assessment ("EIA") for the Aurora Mine has been prepared by independent scientists under the overall direction of Bovar Environmental. The EIA has been prepared in accordance with the Terms of Reference established by the Director of Environmental Assessment, pursuant to Division 1 of Part II of EPEA.

Both the EIA and this Application have benefited from previous work undertaken in relation to oil sands developments in this area. This work included assessments undertaken by OSLO Alberta Ltd. ("OSLO"), which investigated potential mining operations on Lease 31, and the Alsands consortium which investigated an oil sands project comprised of Leases 12, 13 and 34. In fact, clearing and surface drainage was completed by Alsands on much of the initial mining area now planned by Syncrude on Lease 34.

Production from Syncrude is a fundamental component of Canada's energy supply. Oil sands provide a reliable, secure oil supply, creating significant economic benefits for Alberta and all of Canada. Markets for bitumen blends, light-low sulphur synthetic crude oil blends and medium sour blends are all growing. At the same time, production of western Canadian conventional light and medium crude oil continues to decline.

The establishment of the Aurora mine as a low-cost supplier of bitumen allows stepwise replacement of current bitumen production at Mildred Lake as well as being essential to the long-term growth of the business. Capital expenditures of $2 billion are required to establish the two mine pits and four extraction trains. Sustaining capital expenditures of $1 billion will be made between 2002 and 2035, and operating expenditures are estimated at $20 billion from 2001-2035. Over the life of the project, Aurora is projected to contribute $2 billion in federal taxes and $3 billion in provincial taxes and royalties.

Although the economic impact is significant, careful staging of investment should not overheat the local or regional economy. Syncrude has maintained a practice of seeking competitive supply of goods and services from national and international sources. At the same time, Syncrude is also committed to working with regional and Canadian businesses to assist them in meeting Syncrude's business needs competitively, particularly those developments involving native owned businesses and employment of native people.

Through major investment in reclamation, other environmental research and process improvements, Syncrude has progressively reduced the stress on the environment from bitumen production. Syncrude is committed to continuously improving its environmental performance. This Application reflects that commitment through the detailed analyses and mitigation measures developed to identify, assess and minimize the environmental effects of mining operations.

Another example of Syncrude's commitment to environmental and resource conservation is the unit reduction in energy consumption (and therefore of greenhouse gas emissions) for the production of bitumen. New technology for the extraction of bitumen from oil sands will significantly reduce energy consumption, allowing Syncrude to more than double current extraction activity with no increase in energy usage or carbon dioxide (CO_2) emissions. The Low Energy Extraction Process to be used at the Aurora Mine uses 60% less energy than existing processes. Production of Athabasca bitumen (heavier than 9^0 API) with this energy efficiency is a considerable achievement, and a result of Syncrude's commitment to research and development.

These energy efficiency initiatives are also consistent with the Climate Change Voluntary Challenge Program Action Plan filed by Syncrude with the federal government. From 1990 to 1995, CO_2 emissions per unit of production improved by 8%. Further technology improvements to be implemented over the next five years will improve energy efficiency by 10% compared to 1990. During this same period, CO_2 emissions per unit of production are projected to decrease by 17%.

The Aurora Mine is the means by which Syncrude will complete replacement of existing 1970s technology with more efficient surface extraction technology. It will produce clear economic benefits for the Fort McMurray region, the Province of Alberta and Canada as a whole. At the same time, it can be constructed, operated and reclaimed in an environmentally responsible manner, leaving a diverse and productive final landscape for future generations.

Given the established economic benefits and the progressive improvement in technology efficiency, Syncrude respectfully submits that the development contemplated by this application represents orderly, economic development of the oil sands resources of Alberta and is therefore in the overall public interest.

Correspondence on these applications should be directed to:

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P.O. Bag 4009, M.D. X200
Fort McMurray, Alberta
T9H 3L1

Correspondence on procedural matters respecting these applications should be directed to:

Francis M. Saville, Q.C.
Milner Fenerty
30th Floor, Fifth Avenue Place 237 - 4 Avenue, S.W.
Calgary, Alberta
T2P 4X7

Dated 14 June 1996, Fort McMurray, Alberta

Alexander Hyndman, P. Eng.
Strategic Projects Executive
Syncrude Canada Ltd.

Francis M. Saville, Q.C.
Milner Fenerty

1.1 Approvals Requested

Syncrude Canada Ltd. is applying for approval for the construction, operation and reclamation of the Aurora Mine, as described in this Application. The Aurora Mine development entails the sequential opening of a series of new mining areas shown on Figure 1.0-1 and described by co-ordinates in Section 2 (the "Application Area") Activities for which authorization is sought include site preparation, mining, treatment to facilitate bitumen transport to the Syncrude Mildred Lake processing complex, and associated infrastructure. Included in the infrastructure facilities for which approval is sought are electrical power generation and transmission facilities, bitumen froth and other pipelines, overburden and tailings disposal, and road access all of which are described herein. Syncrude also seeks approval for the reclamation activities to be undertaken in association with the Aurora Mine project, as described in this Application.

Approvals Requested of the Energy and Utilities Board ("EUB")

In this Application, Syncrude seeks EUB approval for the proposed scheme or operation for the recovery of oil sands in and from the Application Area, including:

- Mining, lease development, on-site waste management and reclamation activities in respect of the Application Area, pursuant to section 10 of the *Oil Sands Conservation Act*, (1983, c. O-5.5) and pursuant to the Oil Sands Conservation Regulation, (Alta. Reg. 76/88) including sections 3, 23, 24, 25 and 26 thereof.

- Construction and operation of two tertiary treatment plants for the preparation of oil sands for transportation via a bitumen froth pipeline for processing at the existing Mildred Lake complex, and having a nominal capacity of 12.5 million cubic meters per annum each of bitumen equivalent, pursuant to sections 10 and 11 of the *Oil Sands Conservation Act*, and sections 48 and 49 of the Oil Sands Conservation Regulations.

- Shipment of bitumen equivalent from the Aurora Mine to Mildred Lake, or to such other approved processing facilities as may be authorized to accept bitumen equivalent for processing, from time to time, pursuant to section 10 of the *Oil Sands Conservation Act*.

- Construction of pipelines for the supply of fuel gas, water and diesel fuel to the Aurora Mine complex, and for the transmission of bitumen (emulsion) production from the Aurora Mine to the Mildred Lake complex for processing, pursuant to section 7 of the *Pipeline Act*, (R.S.A. 1980, c. P-8) and section 2 of the Pipeline Regulation (Alta Reg. 122/87, as amended).

- Construction, operation and connection of an electrical power plant at the Aurora Mine site and an electrical transmission line connecting same to the Mildred Lake processing complex, together with all operations preparatory thereto, pursuant to sections 9, 12 14 and 17 of the *Hydro and Electric Energy Act* R.S.A. 1980, c. H-13 and all related approvals.

Approvals Requested of Alberta Environmental Protection ("AEP")

Syncrude hereby requests that an approval be issued pursuant to s. 63 of the *Environmental Protection and Enhancement Act*, S.A. 1992, c. E-13.3 ("EPEA") and the Approvals Procedure Regulation (Alta. Reg. 113/93), in respect of the following activities to be carried out in conjunction with the Aurora Mine, as described in this Application:

- Opening up, operation and reclamation of the Aurora Mine oil sands site.

- Construction, operation and reclamation of two tertiary treatment plants with a nominal capacity of 12.5 million cubic meters each per annum of bitumen equivalent for the preparation of oil sands for transportation via bitumen froth pipeline for processing at the existing Mildred Lake processing complex.

- Oil sands site infrastructure, including works, buildings, structures, facilities, equipment, apparatus, mechanism, instrument or machinery belonging to or used in connection with the proposed mine, pipeline, disposal site, access roads, telecommunication lines, etc.

Syncrude also requests of Alberta Environmental Protection, under section 11.1 of the *Water Resources Act,* a fence line approval for the collection and diversion of surface waters as described herein, including:

- Impoundment of surface and groundwater for process water use.
- Diversion of Natural surface waters around or away from the lease area.
- Muskeg dewatering
- Process water ditching
- Granular resource dewatering
- Mine depressurization.
- Approvals, under Section 11.1 (e) of the WRA, for authorization of overhead pipeline and power line crossings of the Athabasca River.

The legal description of the area to be covered by this approval can be found in Table 1- 1 and the Area of Influence Map, Figure 3.7.1.

Table 1-1

TWP	Range	Section	Meridian (west of)
95	9	31,32	4
95	10	35,36,26, 27, Portions of 17, 18, 19 20, 21, 22, 23, 24, 25, 34, 28,	4
96	9	5, 6, 7, 8, 9, 17, 18 Portions of 4, 16, 19	4
96	10	1, 2, 11, 12, 13, 14, 15, Portions of 3, 10, 16, 21, 22, 23, 24	4

Other Required Approvals

The Aurora Mine will also require additional agreements, approvals or licences from the provincial government and which will be applied for in a timely fashion as development proceeds. These include:

- *Alberta Public Lands Act*, (R.S.A. 1980, c. P-30), and Regulations regulate the administration of public lands through permits and leases including the accumulation of waste, soil erosion, damage to watersheds capacity and weed invasion.

- A Mineral Surface Lease ("MSL") issued by AEP is required for clearing and developing the mine and the plant site. Additional surface dispositions, including Easements, Licenses of Occupation and Pipeline Agreements, may be required for linear developments such as roads, pipelines and electrical transmission lines.

- *Alberta Forests Act*, (R.S.A. 1980, c. F-16) (Timber Management Regulation, Alta Reg. 60/73) requires the minimization of soil erosion, avoidance of pollution of water and salvage of timber during clearing of land. A permit issued by AEP is required for site clearing and timber harvest.

- *Public Highways Development Act* (R.S.A. 1980, c. P-28) and the Highway Development Control Regulation (Alta. Reg. 242/90) controls activities over or connecting to controlled highways. A development permit must be obtained from the Minister of Transportation and Utilities for any road connecting to Highway 63, or any structures (such as an electrical transmission line) constructed over a controlled highway, pursuant to s. 28 of the *Public Highways Development Act* and s. 11 of the Highway Development Control Regulation.

No municipal or federal approvals are required, with the possible exception of a development permit from the Regional Municipality of Wood Buffalo, and approval under the federal *Radiocommunications Act*, should it be necessary to install and operate communications towers and apparatus at the site.

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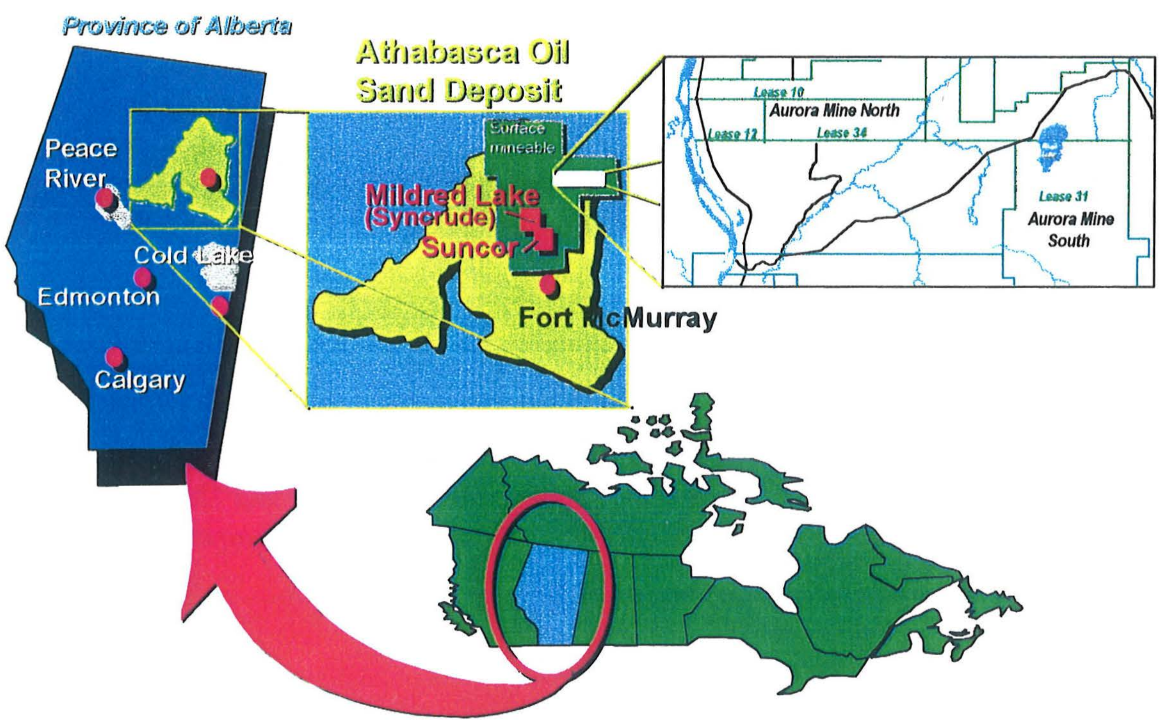
2.0 Activity Location, Capacity and Size

2.1 Aurora Mine

2.1.1 Location

Syncrude's Aurora Mine is situated on oil sands leases 10, 12, 31 and 34. Aurora North includes mining on Leases 10, 12 and 34. Aurora South consists of Lease 31, with plant and tailings disposal activities on portions of Leases 13 and 30.

Figure 2.1-1 - Location



The mining areas are located east of the Athabasca River, approximately 70 kilometres north of the City of Fort McMurray in the Municipality of Wood Buffalo, Alberta and approximately 500 kilometres northeast of the city of Edmonton, Alberta. The closest community to the Aurora Mine, Fort McKay, is located on the west bank of the Athabasca River, to the southwest, approximately 15 kilometres from the project site.

Access from Edmonton to Fort McMurray is by all-weather highway and air. Current road access to Aurora North is via the extension of Highway 963 along the east side of the Athabasca River, and along an unpaved road leading to the AGT tower at the Fort Hills. Access to Aurora South is also via Highway 963, and along an unpaved road known locally as the Canterra Road.

2.1.2 Legal Descriptions: Oil Sands Leases and Surface Lease Requirements

Oil Sands Lease 10

Oil Sands Lease 7276050T10 (lease 10) is comprised of:
in Township 96, Range 9, west of the 4th Meridian: Sections 16 to 21 inclusive and Sections 28 and 29, AND
in Township 96, Range 10, west of the 4th Meridian: Sections 13 to 18 inclusive and Sections 23 and 24, AND
in Township 96, Range 11, west of the 4th Meridian: Section 13 and that portion of the east half of Section 14 lying to the east of the right bank of the Athabasca River, AND all statutory road allowances, and what would be statutory road allowances if the lands were surveyed pursuant to the Surveys Act, lying within the outer limits of the above described lands,
containing an area of 4,490.8 hectares.

Oil Sands Lease 12

Oil Sands Lease 7276030T12 (Lease 12) is comprised of:
in Township 96, Range 10, west of the 4th Meridian: Sections 5 to 8 inclusive, AND
in Township 96, Range 11, west of the 4th Meridian: Sections 1 and 12, and those portions of Sections 2 and 11 lying east of the Athabasca River, comprising an area of 1,669.6 hectares.

Oil Sands Lease 34

Oil Sands Lease 7280110T34 (Lease 34) is comprised of:
in Township 96, Range 9, west of the 4th Meridian: Sections 4 to 9 inclusive, AND
in Township 96, Range 10, west of the 4th Meridian: Sections 1, 2, 3, 4, 9, 10, 11, and 12.
The leases stretch in the east-west direction in a narrow strip of 3.3 kilometres in width and 10 kilometres in length, comprising an area of 3,651.48 hectares.

Oil Sands Lease 31

Oil Sands Lease 7280100T31 (Lease 31) is comprised of:
Aggregate area: 19 948.28 hectares

Description of Location: 4-07-095: 6, 4-08-093: 1:2:11-14:23-26:27M:34-36, 4-08-095: 1-5; 6E: 7E 8-17; 18SE; 20-29; 32-36, and all statutory road allowances lying within the outer limits of the above described lands.
Leased Substances: Oil Sands in the Wabiskaw-McMurray as designated in 2D 3412
Interval: 233.00 to 500.00 feet, Key Well: AA/03-01-088-09W4/0, Log Type: Electrical
Interval: 632.00 to 839.00 feet, Key Well: 00/06-13-091-18W4/0, Log Type: Electrical
Special Provisions: Nil.
Lease 31 comprises an aggregate area of 19 948.28 hectares.

Surface lease requirements for defined area on Lease 13

(See Figure 1.0-2)
Muskeg dumps
Reclamation material
Drainage ditches from lease 34
Aurora South plant site
Aurora South tailings disposal area, including perimeter road
Aurora South waste storage

Surface lease requirements for defined area on Lease 30

(See Figure 1.0-1)
Aurora South tailings disposal area, including perimeter road

Location of initial activities

The mine located on Leases 10, 12 and 34 is called the Aurora Mine north pit. Aurora North consistis of the west, centre and east mine ore zones. Mining activities will commence in the eastern ore zone in the central area of Lease 34, in Township 96, Range 10, in portions of Sections 1, 2 ,11, and 12, west of the Fourth Meridian.

Initial Tailings deposition will occur on the eastern end of Lease 34 in Township 96, Range 9, Sections 6 and 8 and portions of Sections 5, 7, 9, 16, 17, and 18, west of the Fourth Meridian.

The plant site will be located in the south central area of Lease 34 in Township 96, Range 10, in Section 2, west of the Fourth Meridian.

2.2 Mildred Lake Plant

The service corridors connect the Aurora Mine to the Syncrude Mildred Lake site located approximately 40 kilometres north of Fort McMurray, Alberta on portions of Township 93, Ranges 10 and 11, west of the Fourth Meridian.

2.3 Status of negotiations

2.3.1 Oil Sands leaseholders

Oil Sands Lease 13

Oil Sands Lease 13 has been held by Shell Canada Ltd. for several decades. It was part of the area investigated for development by the Alsands project, which also included reserves on Leases 12 and 34, now part of the proposed Aurora North Mine.

Lease 13 is due to expire in 1998, and to date there has been no new development proposal presented for consideration by stakeholders in this area. However, Shell has been informed of the Aurora Mine project and in particular the surface uses proposed by Syncrude on portions of Lease 13 that are believed not to contain economically recoverable bitumen reserves.

To the extent that development plans are presented by Shell for other portions of Lease 13 that can benefit from the extension of infrastructure to this area as part of the Aurora project, Syncrude will work with Shell to identify opportunities for cooperation and mutual assistance. Syncrude will keep the Board and AEP apprised of these discussions as they proceed.

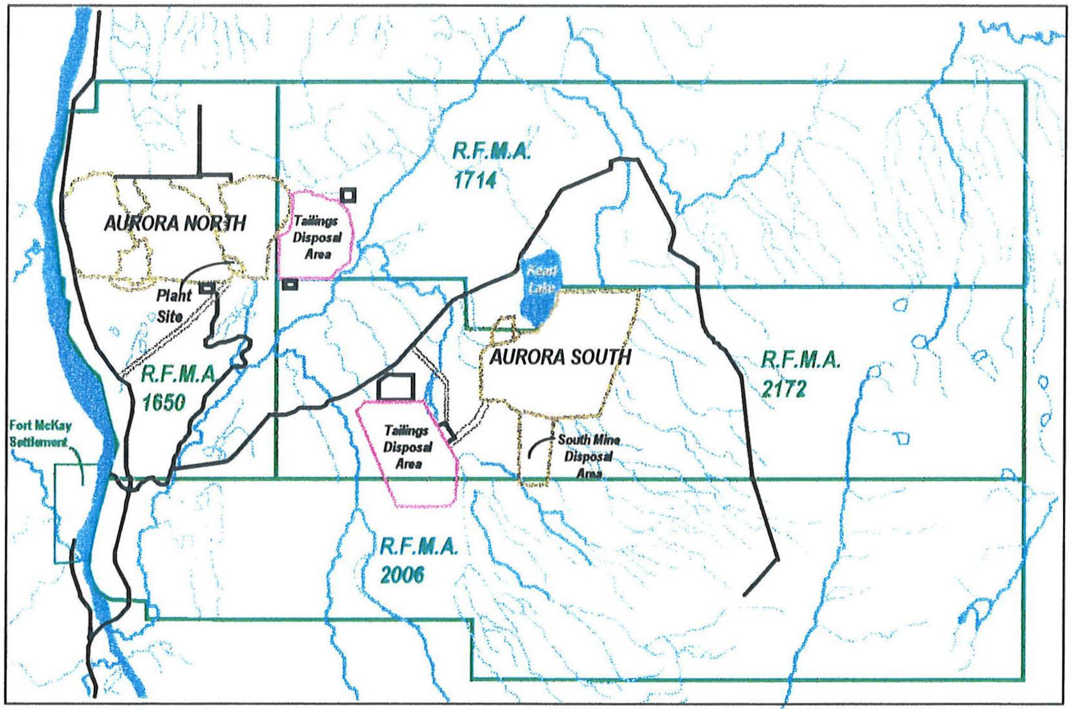
Oil Sands Lease 30

Oil Sands Lease 30 is held by Sandalta. The proposed Aurora Mine has surface impacts on this lease. Discussions with Gulf Canada Resources, the agent for Sandalta, indicate that they have no difficulties with the proposed Aurora Mine plans as they affect Lease 30. Documentation of this position is forthcoming.

2.3.2 Registered fur management areas

Registered fur management areas 1650, 1714, 2006 and 2172 are impacted by Aurora Mine operations to some degree as shown in Figure 2.3-2. Syncrude has signed agreements in place with the holders of each of the registered fur management areas.

Figure 2.3-2 - Registerd Fur Management Areas Relative to Aurora Mine



2.3.3 Forest Management Areas

Syncrude has reviewed development plans with holders of Forestry Management Agreement operators in the impact areas — ALPAC and Northlands. The practice of informing Forestry and the operators in advance of necessary tree clearing so that the areas can be scheduled into annual allowable cuts will be followed.

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3.0 NATURE OF ACTIVITY

3.1 Overview

The Aurora Mine covers an area consisting of oil sands Leases 10, 12, 31 and 34 with a recoverable bitumen content in excess of 700 million cubic metres of bitumen. Two mine pits will be opened: Aurora North on Leases 10, 12 and 34, and Aurora South on Lease 31. Each mine pit will supply two extraction trains, individually capable of producing 6.25 million cubic metres of bitumen per year for a total annual capacity of 25 million cubic metres. Each pit will also have support utilities and staff facilities. A service corridor will contain power connections to the Alberta grid, natural gas pipelines, product lines to Mildred Lake, hot water transport lines from Mildred Lake and road connections to Highway 63.

Bitumen froth product will be transported from the Aurora Mine to Mildred Lake. This stream will then either be upgraded to synthetic crude oil at Mildred Lake or cleaned and shipped to market as a bitumen blend or in a sour blend. The first two extraction trains of Aurora (located in Aurora North) will essentially replace bitumen currently produced from the Mildred Lake West Mine and will provide additional bitumen for the already approved Mildred Lake synthetic crude expansion. Trains 3 and 4 in Aurora South will provide additional quantities of bitumen for sale and will replace remaining Mildred Lake bitumen production as the remaining mining areas are depleted.

Aurora will acquire a heated water stream from the Mildred Lake facility. This heated water stream will be used as make-up process water for the Aurora Mine and will also be used to transport surplus waste heat to the Aurora Mine. The use of process make-up water from Mildred Lake eliminates the need to build a water intake structure on the Athabasca River for Aurora and minimizes the water removed from the Athabasca River for Aurora operations. The use of surplus heat is both cost effective and energy efficient.

Minor changes in the Mildred Lake froth treatment plant will be required to handle the additional volume and maintain product quality. Transport of froth to Mildred Lake eliminates the need for and potential risk of transporting naphtha (diluent) to the Aurora site and makes use of existing facilities.

3.1.1 Aurora Mine

A schematic typical of each of the four process trains proposed for the Aurora Mine operation is shown in Figure 3.1-1

The Aurora North mine pit has estimated recoverable bitumen reserves in excess of 400 million cubic metres. Provisional pit limits are shown later in this section. Expected mine life is more than 30 years at planned mining rates.

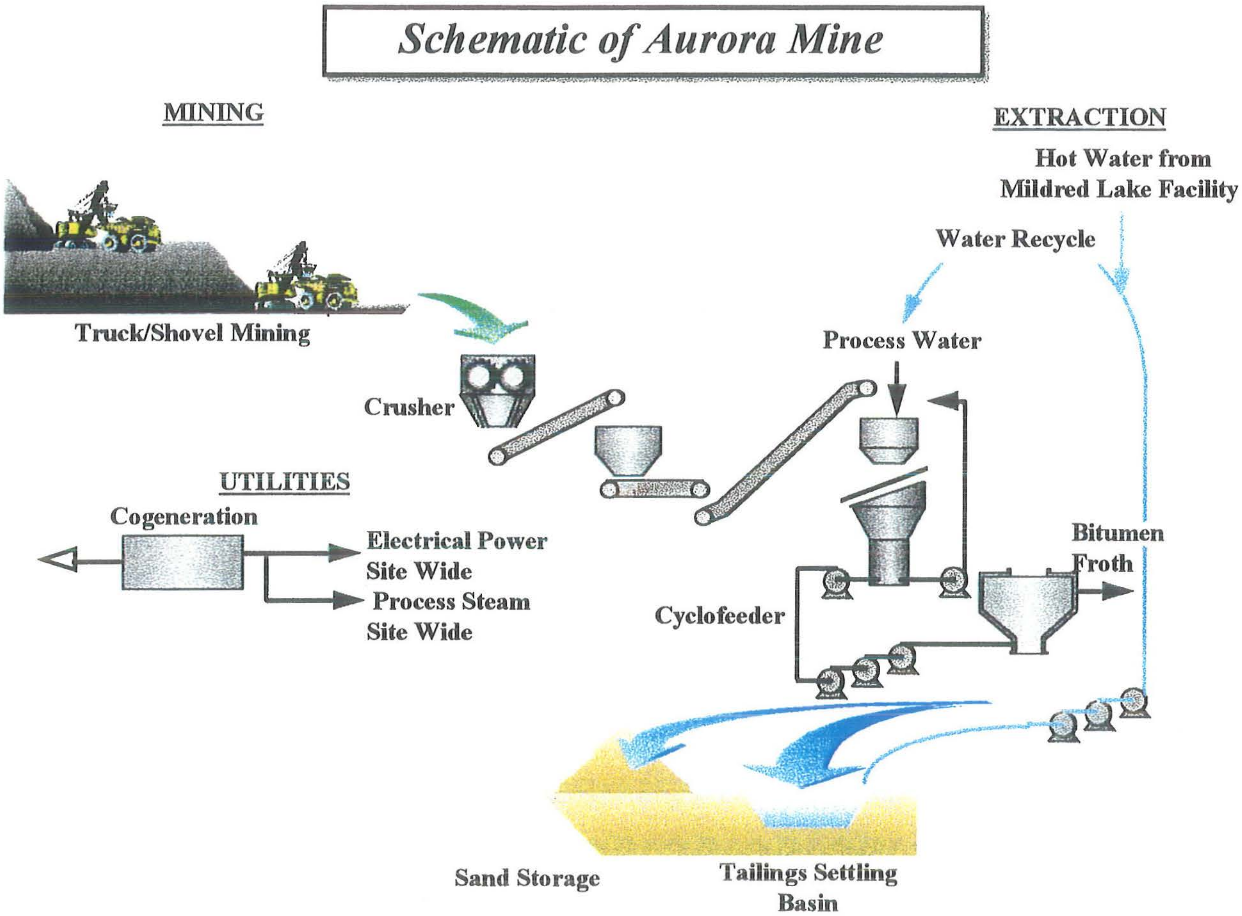

Figure 3.1-1 Schematic of Aurora Mine

The Aurora South mine pit has estimated recoverable bitumen reserves in excess of 300 million cubic metres. Provisional pit limits are shown later in this section. Expected mine life is more than 25 years at planned mining rates.

Mining and Overburden Removal

Overburden removal and mining will be carried out by a shovel/truck operation. Oil sand will be transported to a crusher for sizing and then screened, slurried and pumped to the extraction plant.

Aurora Extraction and Froth Transport

The Aurora Mine is scheduled to open with construction and operation of a single extraction train in 2001. A second extraction train will be built one to five years after the initial opening (assumed as 2005 in this Application).

A low energy extraction process for separating bitumen from oil sand is proposed. The extraction process is designed to operate at 25°C and is expected to recover approximately 92% of the bitumen in oil sand from the mine. The two-stage separation process will produce a bitumen froth. The froth will be deareated and heated for shipping by pipeline.

The 60% bitumen froth stream will be pumped by pipeline to Mildred Lake for further processing. A single bitumen froth pipeline will support the two Aurora North extraction trains. Trains 3 and 4 will require a second pipeline.

Utilities and Infrastructure

Process water for Aurora will be recycled with make-up water recovered from mine surface and basal drainage operation plus an imported heated water stream. Electric power will be generated from gas turbine co-generation units balanced through interconnection with Mildred Lake and the Alberta grid. The heat recovery section of the co-generation facility and the heat contained in the imported water stream will provide most of the extraction heat requirement. This will be supplemented as necessary with heat generated in the small Aurora boiler plant.

Facilities for operating staff and contractors will be located at the plantsite. Personnel and maintenance facilities, including potable water and sewage treatment, will be provided at each mine site. Once two extraction trains are operating, it is expected that Aurora North will require a staff of 120 per shift and an additional 60 to 90 employees on days. With two operating extraction trains, it is expected that Aurora South will require a staff of 120 per shift and an additional 30 to 60 employees on days.

Plot plans for Aurora North (Figure 3.4-2) and Aurora South (Figure 3.4-3) are included later in this application.

A service corridor from Mildred Lake will provide the Aurora Mine with road access, fuel, water and power. Figure 2.1-4 (General arranagement Aurora Facilities) in the previous section shows the service corridor routing. The southern terminus of the service corridor is the Mildred Lake site. The corridor for Aurora North and South is common for two-thirds of the distance at which point it divides with one branch going directly to the Aurora North plant site and the other following the existing Canterra Road before turning south to the Aurora South plant site.

3.1.2 Mildred Lake Facility

Syncrude operates a large oil sands mine, bitumen extraction plant, utilities plant and upgrading facility at Mildred Lake. Production began in 1978 at a design capacity of 6.3 million cubic metres per year of synthetic crude oil production. This capacity has significantly increased over the years. In 1995, Syncrude shipped 11.8 million cubic metres of synthetic crude oil. Oil Sands

Conservation Act Approval #7550 provides for the shipment of 17.6 million cubic metres per year of synthetic crude oil from the Mildred Lake facility.

Bitumen is extracted from the oil sand using steam and hot water (80°C), and upgraded into a synthetic crude oil called Syncrude Sweet Blend (SSB) by fluid coking, hydroprocessing, hydrotreating and reblending. The final product is delivered by pipeline to three Edmonton area refineries and two pipeline terminals which in turn ship it to refineries in Canada and the U.S.

The ore reserves at Mildred Lake will support another 20 years of production at present rates of nearly 15 million cubic metres per year of bitumen, without opening another mining location. However, ore quality at Mildred Lake is declining and overburden thickness is increasing. These factors combine to restrain production and increase costs.

Opening the Aurora Mine provides a stable, long-term economic bitumen supply for both growth and replacement of Mildred Lake supplies. Phased replacement of Mildred Lake supplies will reduce congestion in mining areas, allow mining and reclamation to take place over a longer period of time, and permit a longer period of monitoring of reclamation progress at Mildred Lake. The increased time also allows for greater opportunity to implement improvements in tailings management and reclamation techniques on the Mildred Lake site.

Oil sand production from the Mildred Lake North Mine will replace the existing Mildred Lake East Mine production over the next three years. Mining in the Mildred Lake North Mine area will last for about 35 years of two train operation at anticipated mining rates. For this to occur, two trains of mining must be replaced with bitumen supply from Aurora.

Production from the Mildred Lake West Mine will be replaced in two stages by two trains of Aurora. The first stage will take place when the north quadrant of the Mildred Lake West Mine is depleted. This will occur in the period 2000 to 2002. The second stage will take place when the south quadrant of the West Mine is depleted. This will occur between 2003 and 2007.

The other two trains at Aurora will replace the Mildred Lake North Mine when it is eventually depleted and will be used to provide additional bitumen for production of bitumen blends, sour products or sweet synthetic crude oil blends. Market evaluations indicate a growing demand for these products.

Water required for the Mildred Lake facility is obtained from the Athabasca River through a system of pumps and reservoirs. Water withdrawal is regulated under Licence to Operate No. 07921 issued by the Water Resources Administration Division of Alberta Environmental Protection. Water withdrawal levels will remain within the existing permitted amounts with full operation of the Aurora Mine.

3.1.3 Socio-economic summary

The socio-economic study included in the EIA shows that the Aurora Mine provides numerous socio-economic benefits. Capital expenditures of $2 billion are required to establish the two mine pits and four extraction trains over the period of 1998 to 2015. Sustaining capital expenditures of $1 billion are spread out between 2002 and 2035 and operating expenditures of $20 billion are spread out between 2001 and 2035.

The overall return on the project is positive when calculated in 1996 dollars at an oil price of $18 U.S. per barrel of West Texas Intermediate. Over the life of the project, Aurora is projected to contribute $3 - $6 billion in taxes to the federal government and $5 - $6 billion in taxes and royalties to the provincial government over the life of the project.

The impact on the infrastructure of the Municipality of Wood Buffalo is also positive. Over a 35-year operating period, Aurora will provide from 280 jobs for the first extraction train operation to about 750 jobs for the four train operation. As many of the operating jobs replace those associated with mine areas approaching completion, the impact is primarily on the stability of the workforce in the Municipality of Wood Buffalo with additional construction service requirements.

Some adverse social impacts could occur during the construction periods. These have been minimized by spreading the $2 billion capital expenditures over four construction periods. The first of these periods occurs between 1998 to 2000.

The peak construction workforce at Aurora is expected to be about 500 people. This will occur over an 18 month period in each of the four phases. A camp will be provided for this construction work. Adverse impacts on Fort McMurray and Fort McKay are expected to be minimal.

Without Aurora, the Mildred Lake upgrading facility would require an alternate economic source of bitumen feedstock.

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3.2 MINING

3.2.1 Introduction

In 1992, Syncrude began assessing potential bitumen supplies to replace existing depleting resources and to provide a strategy for growth. *In situ* bitumen was considered to have potential supply costs similar to the most attractive surface mining areas. However, it was not deemed to be ready to supply large volumes in a short time frame due to uncertainties in applying steam assisted gravity drainage ("SAGD") technology to the Athabasca resource. Thus, Syncrude assembled a surface mineable resource position of a size and quality to act as a replacement supply for current production as well as to allow for significant growth.

Leases 10, 12, 34, and 31 now held by Syncrude contain recoverable mining reserves sufficient to recover 700 million cubic metres of bitumen. This will support two surface mining areas with capacity to feed four extraction trains, each producing 6.25 million cubic metres per year for more than 30 years.

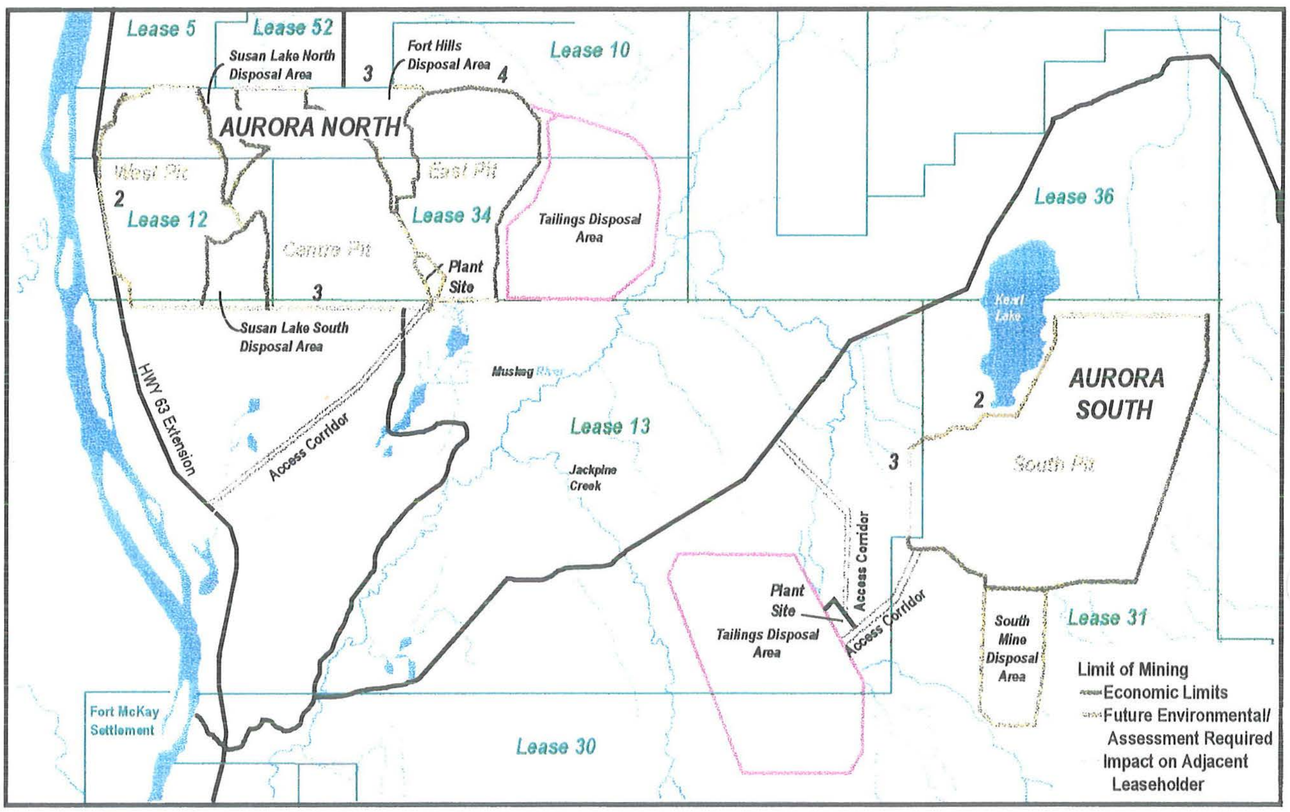
The design of the Aurora Mine is based on recovery of the economic bitumen resources using large-scale truck-shovel mining and oil sand hydrotransport-low temperature extraction technology.

In evaluating mining options for Aurora the following criteria were used:

- Mining ore to economic pit limits or other limits (as discussed in 3.2.4).
- Tree removal and dewatering of the smallest practical area throughout the life of the operation.
- Mining strategies that work with extraction and tailings approaches to allow progressive reclamation to begin as soon after land disturbance as is practical.
- Placement of disturbed material in its final location with the minimum number of moves consistent with final mine closure strategy.
- Minimize losses of oil sand through spillage or rejects by (1) minimizing the number of transfer points between mine face and extraction plant and (2) optimizing crushing and screening design.
- Selection of mining equipment and mine design techniques to maximize economic ore recovery.

Where possible, pit limits were established using ore criteria as defined in section 3.2. The exception areas are shown in Figure 3.2-1.

Figure 3.2-1 - Status of Mining Pit Limits



The limiting factors, other than ore criteria, that contributed to the definition of pit limits are as follows. The numbers relate to the corresponding numbers on Figure 3.2-1.

1) **Economic limits**
Mining reaches the limit of economic ore on the mine face.

2) **Provisional limit shown; future resource conservation, engineering and environmental assessment is required**
On the west side of the west pit, the limit is 100 metres east of Highway 963. Mining to the bottom of ore results in a mine pit floor elevation below the level of the Athabasca River. The set back shown, which is greater than 1000 metres, provides a sufficient safety margin relative to the Athabasca River, and is consistent with guidelines shown in

the proposed Integrated Resource Plan for northeast Alberta. However, strict adherence to the setback could leave significant volumes of economic ore unmined. Therefore, an assessment at the time of opening the west pit will evaluate additional ore recovery, environmental impacts, protection of the mine from the Athabasca River, requirements for roads and services and other matters included in the proposed Integrated Resource Plan to determine whether adjustments to this limit can safely be made. More specific engineering information will be collected prior to reassessment.

Similarly, additional assessment is required on the northwest corner of Aurora South in the Kearl Lake area. Further drilling is needed to define the amount of economic ore not included within the pit limits shown. Following the drilling, the resources and environmental impacts will be assessed to determine if revised pit limits are warranted. Mining to this pit limit is expected to take place after 2025.

3) **North and south boundaries of Aurora North**
Economic pit limits cross the oil sands lease boundaries. Syncrude will work with adjacent leaseholders as plans are developed to attain economic resource recovery at lease boundaries, which could result in pit limit extensions across these boundaries. Syncrude's goal is to resolve these planning issues at least five years prior to mining.

4) **East pit of Aurora North**
A proposal for a provincial park in the Fort Hills has been submitted to the Special Places 2000 process. The pit limit for the east pit overlaps that proposal. If a park were established to the proposed boundaries, between 10 and 25% of the recoverable bitumen from the east pit would be not be mineable. Syncrude believes the intent of the proposed boundaries was to avoid impacting mineable oil sands, and notes minor changes would eliminate this potential resource loss. Syncrude understands the expected review date for protected areas in the Boreal Forest Region is in 1997.

The following sections provide geology and mining information specific to each mine pit. Aurora North is covered in Sections 3.2.1 through 3.2.4, and Aurora South is covered in Sections 3.2.5 through 3.2.8.

Reclamation and closure aspects are discussed in Section 11.

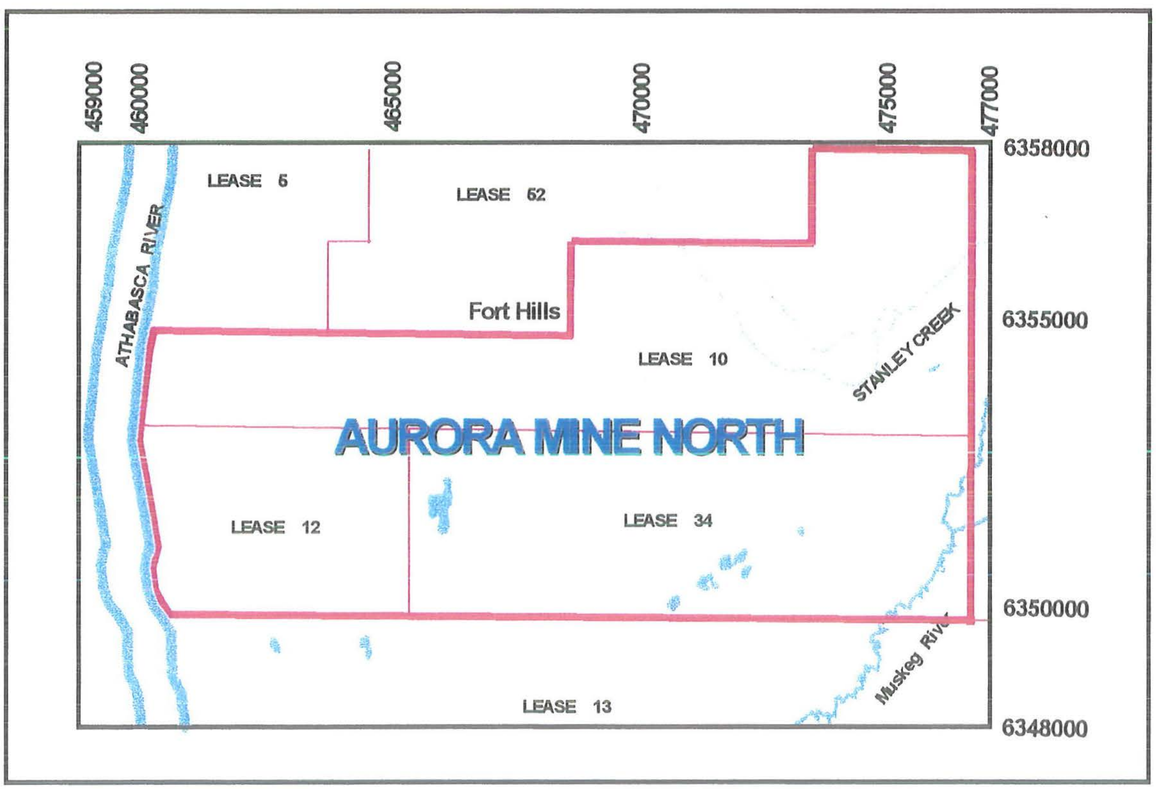
3.2.1 Geology - Aurora North

Surficial Geology

Topography

Aurora Mine North occupies a level plain bounded on the east by the Muskeg River and on the west by the Athabasca River (Figure 3.2-2). The ground rises abruptly to the north into the kame moraine known as the Fort Hills. The Muskeg River crosses only the southeast corner of the Lease 34. The river valley is very shallow along the entire course until it approaches the Athabasca River escarpment. Stanley Creek drains from the Fort Hills south and east to the Muskeg River.

Figure 3.2-2 - Aurora Mine North



Pleistocene Glacial Deposits and Holocene Deposits

The Quaternary overburden in this area consists of Holocene organic and Pleistocene glacial deposits that unconformably overlie Lower Cretaceous sediments — predominantly McMurray Formation except in the north and west where a thin layer of Clearwater Formation is present. Table 3.2-1 is the general stratigraphy of overburden on Aurora North.

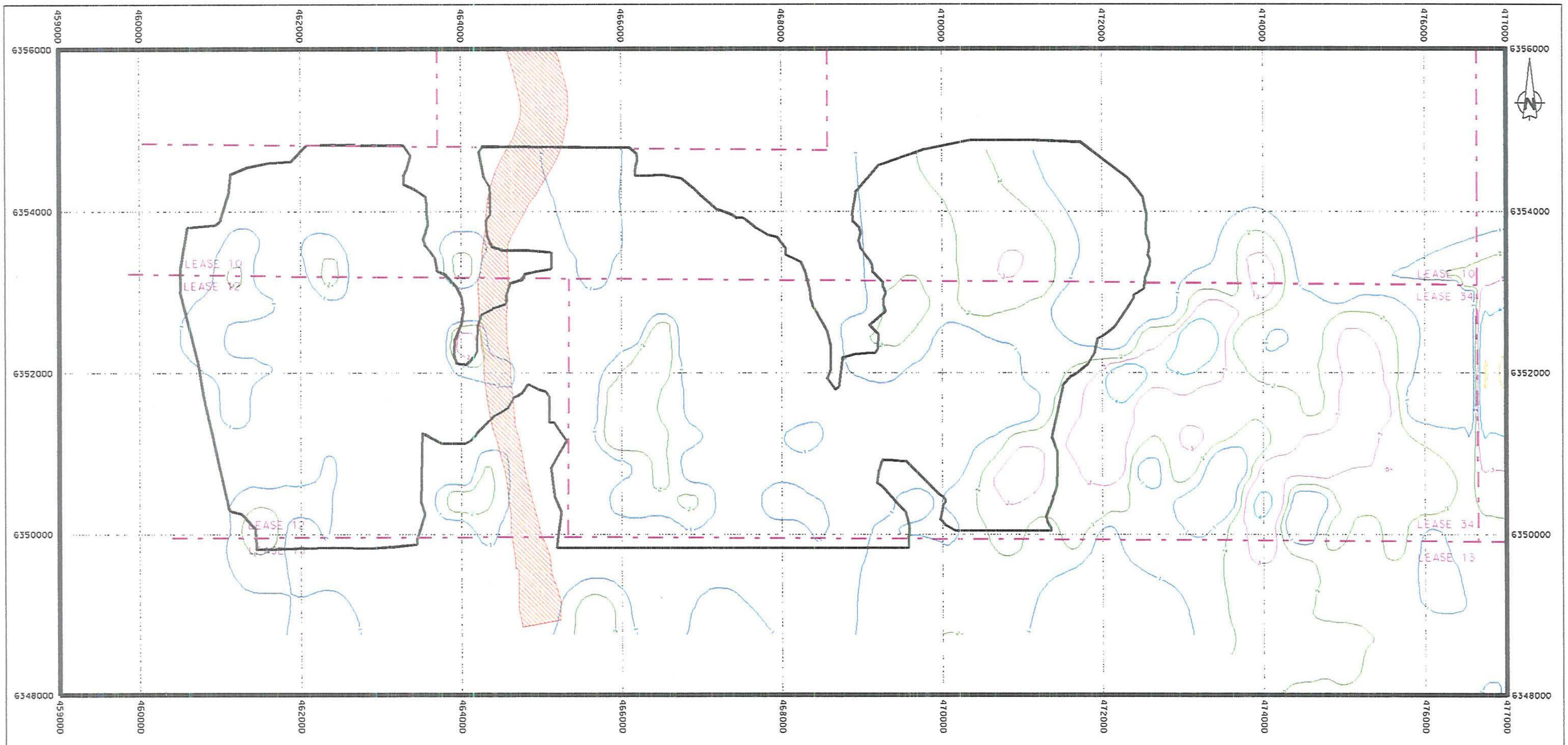
Table 3.2-1 - Overburden Stratigraphy

Holocene Units	Ho_2 Muskeg/Peat Ho_1 Organic Mineral Soil Hfl Fluvial Sand & Silt Hae Aeolian Sand
Pleistocene Units	Pl_2 Glaciolacustrine Mixed Clay, Silt, & Sand Pl_1 Glaciolacustrine Silt and Clay Pf_5b Glaciofluvial Sandy Gravel Pf_5a Glaciofluvial Sand Pf_4 Glaciofluvial Outwash Sand Pf_3 Glaciofluvial Outwash Sandy Gravel Pg_3 Ablation Till Pg_1 Lodgement (Basal) Till
Lower Cretaceous Units	Clearwater Formation Clay & Shale McMurray Formation Oil Sand

On Leases 12 and 34, Holocene deposits range in thickness from 0.5 to 3.5 metres with an average of 1.3 metres. The muskeg thickness is shown in Figure 3.2-3. The thickness of Pleistocene deposits is in the range of zero to 28 metres with an average of six metres. Overburden on Lease 10, which was acquired in January 1996, has not been fully evaluated. The average thickness of Holocene and Pleistocene deposits on this part of Aurora North is estimated to be 13 metres, based on the limited drilling information. Total thickness of overburden to the top of economic ore which includes lean oilsand is shown in Figure 3.2-4.

Significant Overburden Geology Features

Fingers of Pleistocene glacial material mark the southernmost extent of a kame moraine on Lease 10 and the northern edge of Lease 34. A north/south trending glacial meltwater channel occurs just west of the Lease 12/Lease 34 boundary. The channel cuts across Lease 12 in an area where top reject is thick. It appears to be a shallow surface feature with very limited depth. Muskeg is up to 3.5 metres thick in the channel. Cretaceous bedrock is usually intersected within 15 metres of the surface.



LEGEND

Lease Limit	
Pit Limit	
Muskeg Channel	
1 m	
2 m	
3 m	
4 m	
5 m	

SCALE

0 2000 4000 m

NO	DATE	REVISION	BY	CHK	ENG	APPD

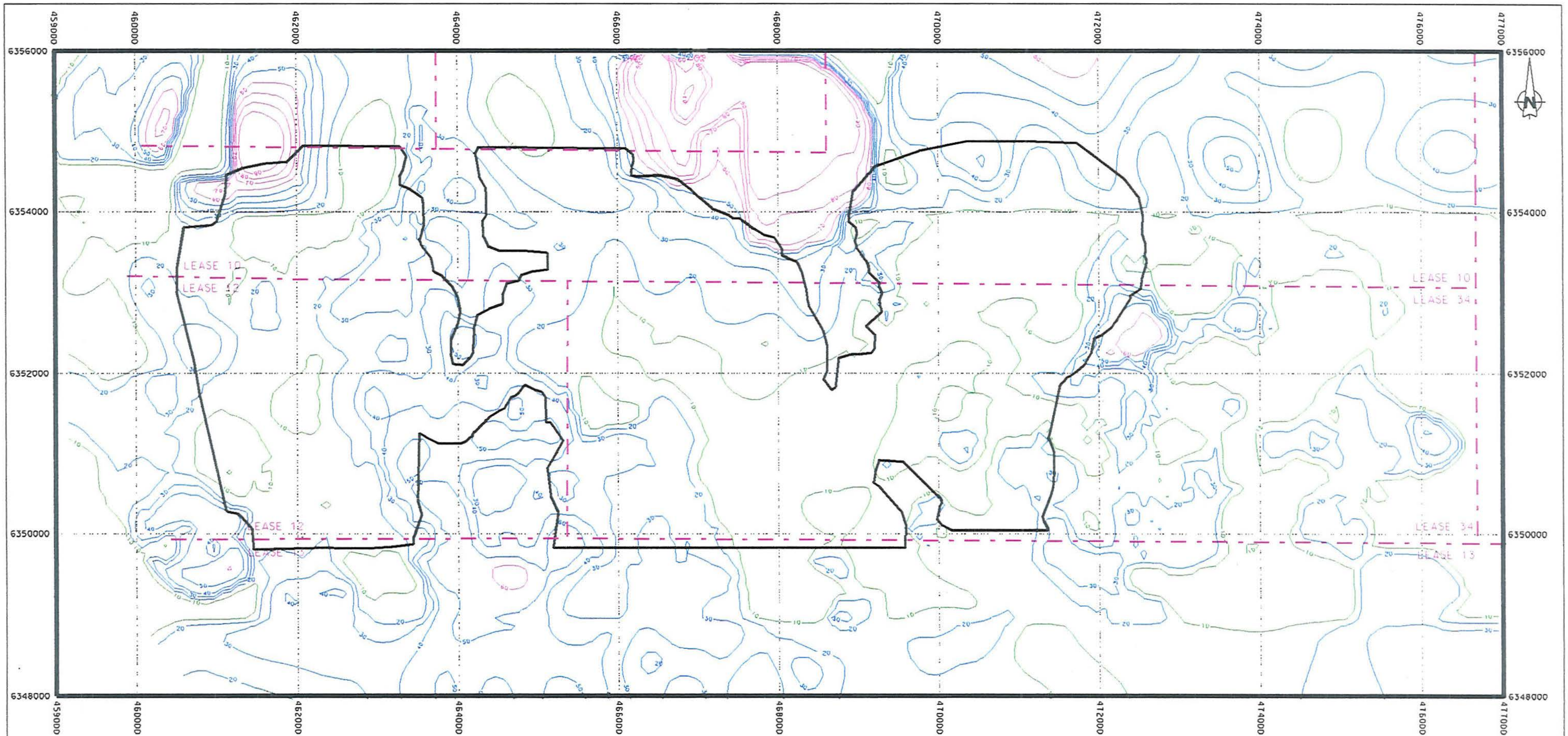
SCALE: DRAWN BY SF DATE APR/96 CHECKED: LP DATE 7/6/96

Syncrude AURORA MINE NORTH

DRAWING TITLE:

MUSKEG THICKNESS (m)

DRAWING NUMBER: Figure 3.2 - 3 REV. 0



LEGEND

Lease Limit	- · -
Pit Limit	——
10 m	——
20.30.40.50 m	——
60.70.80.90 m	——

SCALE

0 2000 4000 m

NO	DATE	REVISION	BY	CHK	ENG	APPD
SCALE:	DRAWN BY: SF	DATE: APR/96	CHECKED	DATE	ENGINEER	DATE / APPROVED / DATE

Syncrude AURORA MINE NORTH

DRAWING TITLE:

OVERBURDEN THICKNESS (m)

DRAWING NUMBER:

Figure 3.2- 4

REV.

0

Oil sands Geology

Depositional Sequence of the McMurray Formation

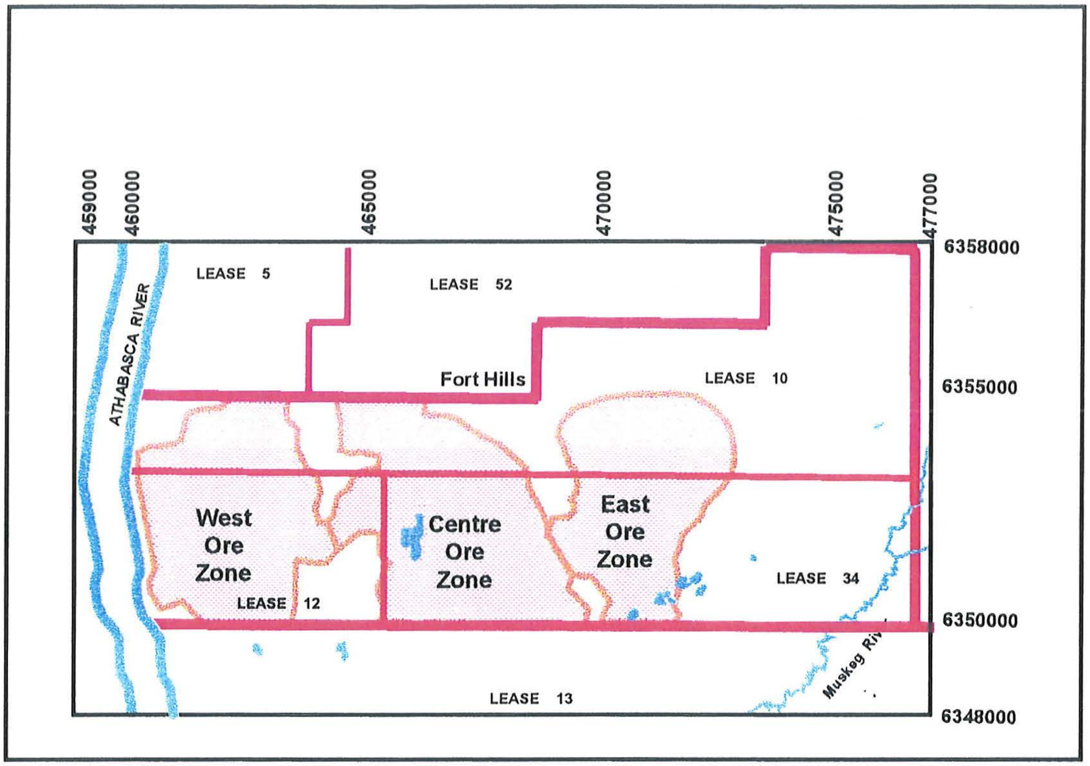
The McMurray Formation was deposited as a transgressive sequence on the eroded surface of Devonian carbonates and calcareous shales. Syncrude recognizes three main stages of transgression, each characterized by a unique facies assemblage.

- Lower McMurray was deposited in a continental fluvial floodplain environment and consists of coarse-grained cross-bedded sands and pebbly sands with interbeds of overbank silts, crevasse splay and pond mud/marsh deposits, often with a high organic content.

- Middle McMurray estuarine sediments consist of sand-dominated channel deposits. Channel lags or channel breccia are often present at the base of the channels. Clay drapes often separate the layers of sand. All the estuarine sediments show evidence of having been extensively reworked as the tidal/fluvial channels meandered back and forth across the estuary.

- Upper McMurray marine sediments overlie the estuarine deposits. In places the transition from estuarine to marine is gradual with characteristics of both environments. In other parts of the deposit, notably the centre orebody, there is a deep incision in the Middle McMurray which has been infilled with coarse grained sand deposited under marine conditions.

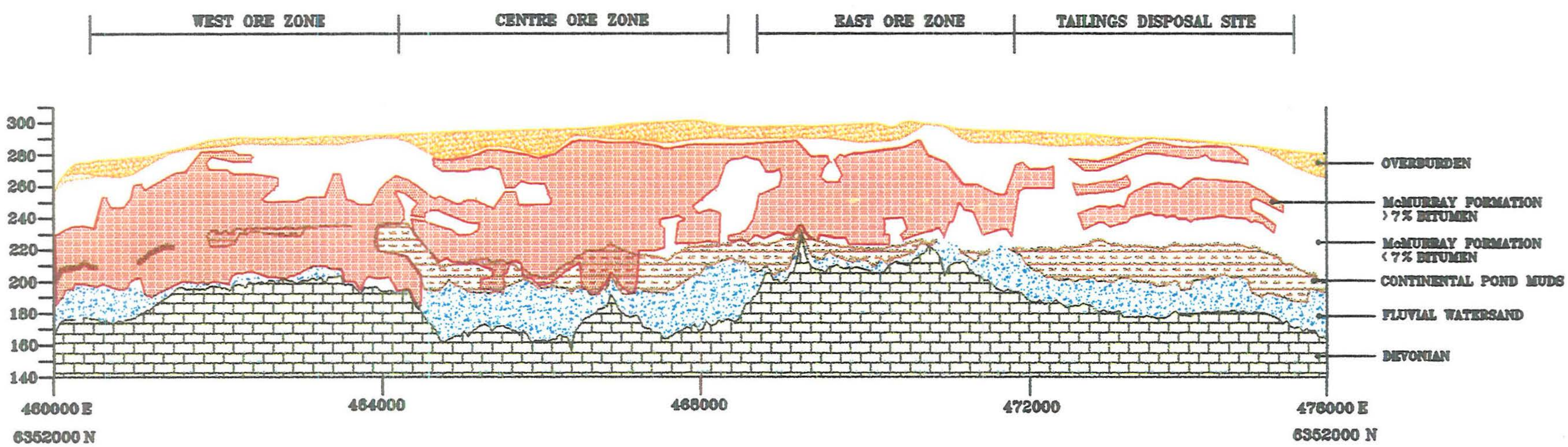
Figure 3.2-5 - Aurora Mine North - Main Ore Zones



The three orebodies that make up the Aurora Mine North are distinctly different from one another (Figure 3.2-5). The ore in the eastern zone is overwhelmingly hosted by Middle McMurray estuarine sands. The centre ore zone is dominated by Upper McMurray ore deposited in the marine channel incised into the Middle McMurray sediments. In the west ore zone, one third of the ore is in Lower McMurray and the balance of the ore is predominantly estuarine. A generalized geological section through these ore zones is shown in Figure 3.2-6.

Ore quality in the three ore bodies is shown in the Table 3.2-2. Ore thickness and diluted ore grades are shown in Figures.3.2-7 and 3.2-8 respectively.

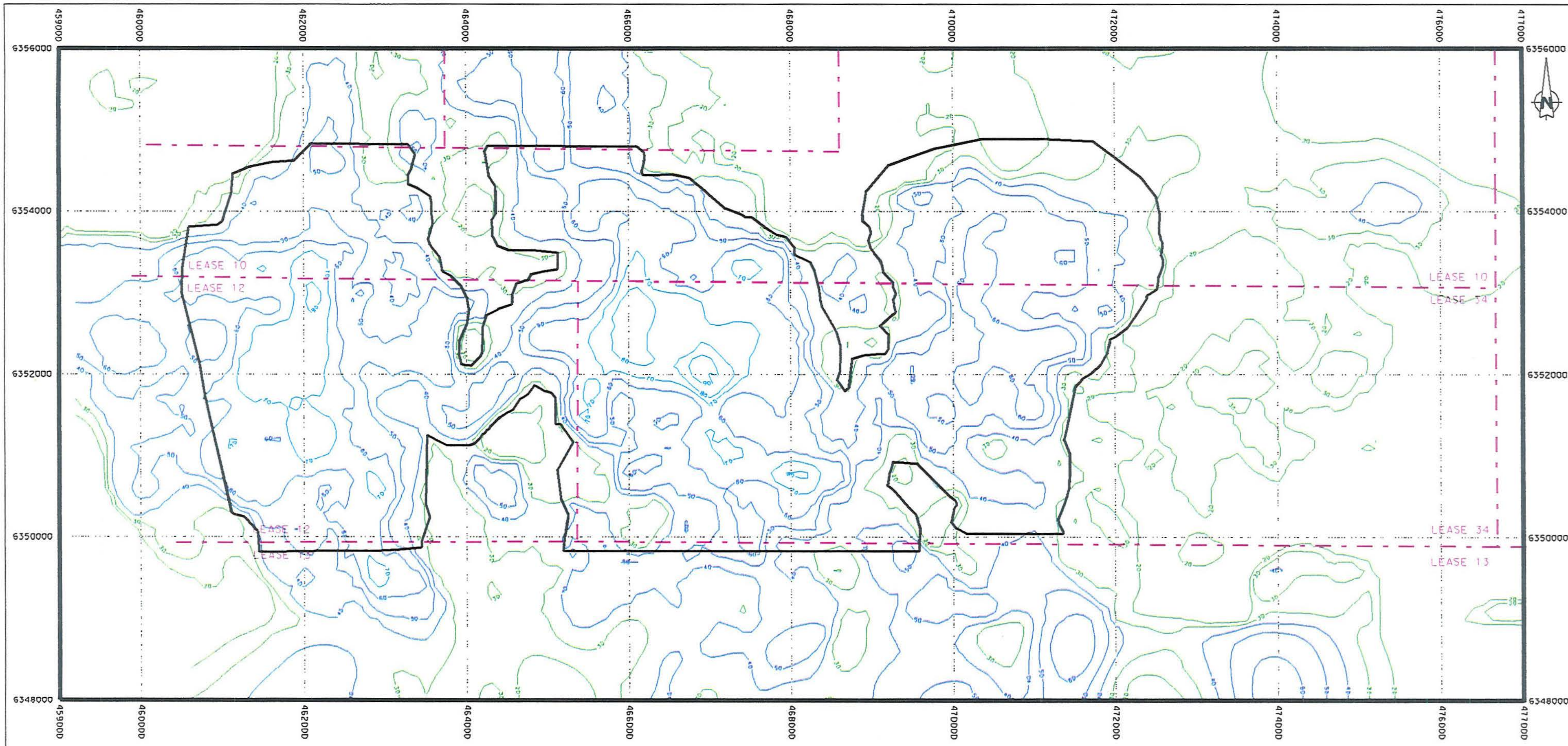
SCHEMATIC SECTION OF AURORA MINE NORTH (LOOKING NORTH)



Syncrude AURORA MINE NORTH

GENERALIZED GEOLOGICAL SECTION

FIG. 3.2-6 REV. 0



LEGEND
- Lease Limit
- Pit Limit
- 20.30 m
- 40.50.60 m
- 70.80.90 m

SCALE
0 2000 4000 m

NO	DATE	REVISION	BY	CHK.	ENG.	APPD.

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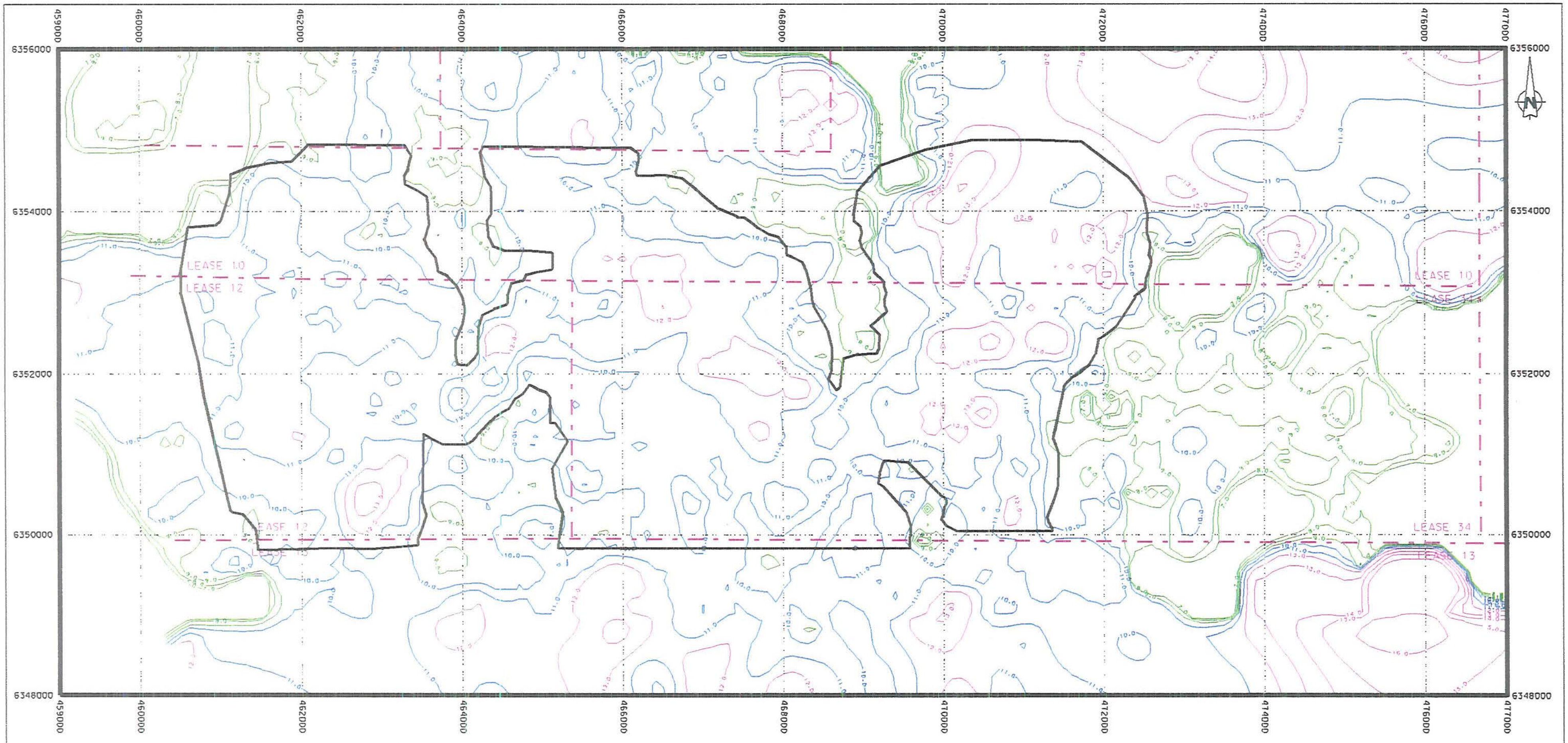
	SF APR/96	7/6/96		

Syncrude AURORA MINE NORTH

DRAWING TITLE:
ORE THICKNESS (m)

DRAWING NUMBER: Figure 3.2 - 7
REV. 0



LEGEND
Lease Limit
Pit Limit
7.0, 8.0, 9.0 %
10.0, 11.0 %
12.0, 13.0 %

SCALE
0 2000 4000 m

NO	DATE	REVISION	BY	CHK	ENG	APPD.

SCALE: | DRAWN BY: SF | DATE: APR/96 | CHECKED: | DATE: 7/6/96 | ENGINEER: | DATE: | APPROVED: | DATE:

Syncrude AURORA MINE NORTH

DRAWING TITLE:

DILUTED ORE GRADE (%)

DRAWING NUMBER: Figure 3.2 - 8

REV. 0

Table 3.2-2 - Ore Quality

		ORE (m)	OBDN (m)	Centre Reject (m)	*In Situ* GRADE	FINES*
EAST	MIN	0.0	1.7	0.0	7.0	5.4
	AVG	**41.7**	**14.8**	**6.8**	**11.6**	**12.8**
	MAX	66.9	50.8	37.7	13.7	24.2
CENTRE	MIN	0.0	0.5	0.0	7.1	7.7
	AVG	**52.0**	**18.1**	**8.5**	**11.2**	**14.7**
	MAX	74.0	57.6	37.2	13.5	24.5
WEST	MIN	2.0	0.2	0.0	7.2	4.2
	AVG	**53.7**	**21.6**	**6.5**	**11.2**	**9.4**
	MAX	72.3	52.0	31.5	14.1	16.6

* Relatively few core holes have been analyzed for fines (-44 μm). The values in the table are from Syncrude's 1995 core program and were determined using wet sieving and hydrometers. Laser scattering techniques (Microtrac or Coulter Counter) tend to indicate about 5-7% more fines on an average than sieves and hydrometers.

Structural Geology

Structural features include deep seated faults within the Precambrian and Palaeozoic units, palaeotopographic irregularities, primary sedimentary structures (mainly channel fill deposits), and structures reflecting subsidence and collapse of the Devonian strata.

Airborne magnetic surveys, including one conducted by Syncrude in 1995, are often capable of detecting Precambrian structures. Seismic surveys conducted in 1995 and 1996 indicate offset of Devonian strata over some of these Precambrian features. This may indicate reactivation of faults or gradual upward propagation of cracks over geologic time.

Palaeotopographic lows on the weathered surface of the Devonian influence the thickness of the Lower McMurray unit. During early McMurray time, sediments first accumulated in existing valleys. Therefore these sediments tend to be thick over Devonian lows. In the Aurora Mine North area, this is obscured by effects related to collapse and subsidence involving the underlying Devonian strata that took place during deposition of the McMurray Formation.

The Devonian surface has significant local relief. Seismic sections suggest closely spaced, sub-parallel fractures in the Devonian consistent with collapse. These failures were probably triggered when the weight of the accumulating McMurray Formation exceeded the strength of the roof rock over voids or caverns within the Devonian strata.

The pit floor is expected to be much less variable in elevation than the Devonian surface. Where the Devonian is deep, watersand is thick. Where the Devonian is shallow, the Lower McMurray is often oil saturated. This phenomenon, together with the effects of reworking the McMurray sediments in meandering estuarine channels, tends to lessen the significance of collapse.

Syncrude routinely runs dipmeter logs on all core holes for mapping structural dips. These structures are mapped in increasing detail as the mine advances and infill drilling and mine face mapping becomes available.

Hydrogeology

The regional hydrogeology of the oilsands area of northeastern Alberta was investigated by the Alberta Research Council (ARC) in the mid to late 1970s. During this investigation, 15 boreholes were drilled in the Fort McMurray area and 75 observation wells were installed. Some of those observation wells are still in use at the Aurora Mine. The results of the ARC investigations, in conjunction with additional hydrogeological data obtained from oil companies operating on various oilsand leases, were used to develop a regional conceptual hydrogeological model. Since that time additional data have been gathered on a local scale for the OSLO project (Lease 31), Alsands' hydrogeological investigation at Daphne Leases 96 (now Lease 12) and 34, and more recently by Syncrude on Leases 12 and 34.

The regional hydrostratigraphy on the east side of the Athabasca River can be simplified into two main units: the Post Cretaceous and Cretaceous sediments and the Upper and Middle Devonian Formations.

In the Aurora Mine area the post Cretaceous and Cretaceous sediments can be subdivided into four main hydrostratigraphic units as follows:

Overburden (Surficial Aquifer)

This hydrostratigraphic unit includes the Holocene, Pleistocene and Clearwater Formations. These deposits form an unconfined aquifer which has a water table close to the surface. The hydraulic conductivity varies widely with lithology, ranging from greater than 10^{-3} m/s for clean sands and gravels to less than 10^{-8} m/s for clay tills and lacustrine clays. These results are based on single well (slug) tests conducted in various overburden units at Aurora North. Ground water flow is mostly horizontal in this aquifer and often mirrors the topography.

The Oilsands (Upper and Middle McMurray Formation)

The hydraulic conductivity of the oilsands is very strongly influenced by the presence and percentage of bitumen which reduces, but does not completely eliminate, the permeability of this formation with respect to water. A reported value of permeability is 4×10^{-8} m/s for the Aurora area. Within the oilsand there are isolated lenses of clean sands which are water-bearing and are confined. These lenses are difficult to map and so are of concern during mining operations. However, they are not specifically targeted for depressurization.

Basal Clays

These are mainly overbank silts, crevasse splays and pond muds deposited under fluvial regimes. They occur directly below the middle McMurray Formation. The hydraulic conductivity of basal clays was estimated at 3.5×10^{-9} m/s by Hackbarth in 1979 and at 1×10^{-13} m/s from a single well response test completed at Syncrude's Mildred Lake mine. The permeability values are predominantly controlled by the percentage of silt of the clays. Analysis of the pump test results indicate that there is very little leakage of water through these clays.

Water Sands (Basal Aquifer)

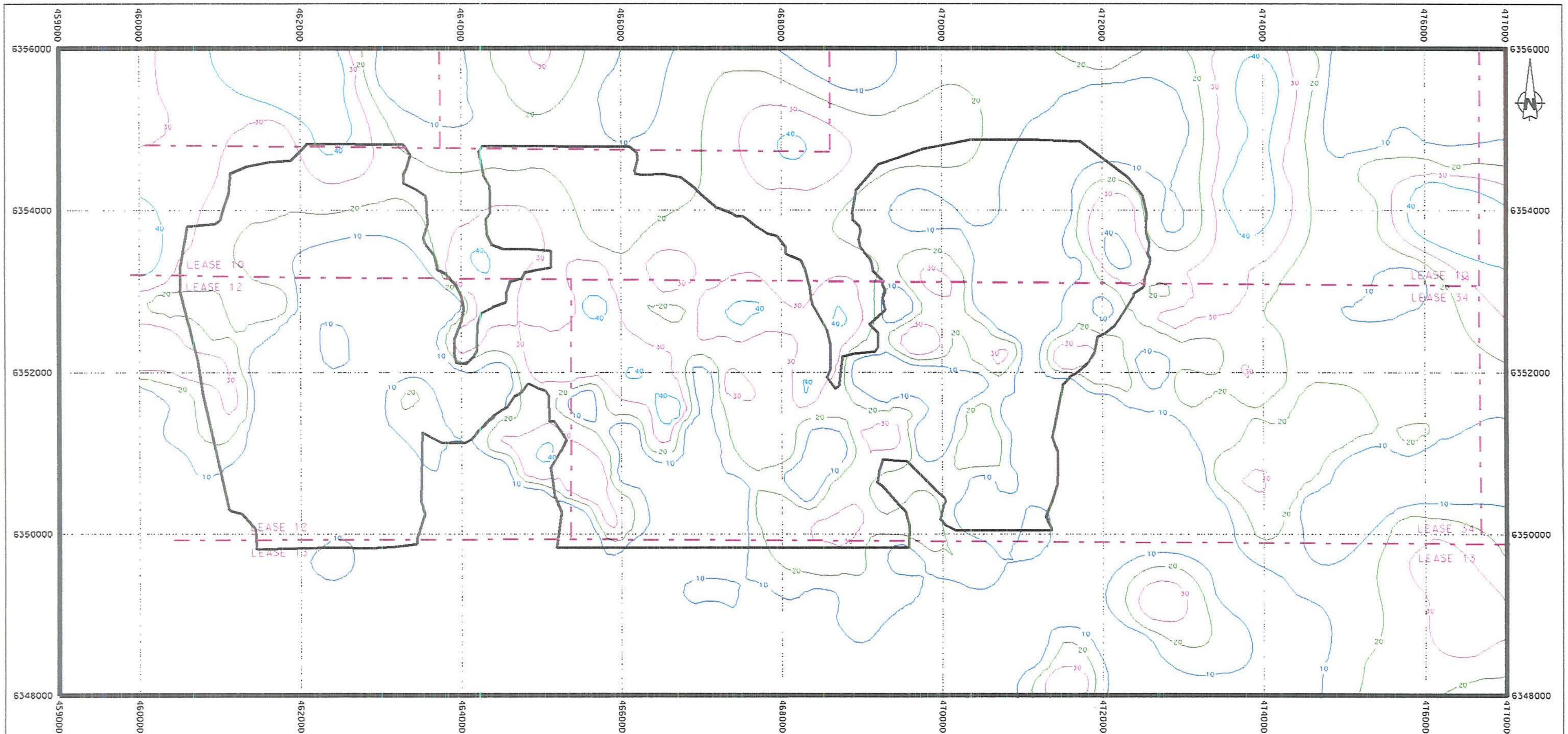
The water sands form the main aquifer and consist of coarse grained sands and pebbly sands. This aquifer is confined by the underlying Devonian Formations and the overlying basal clays and oilsand. The piezometric head is at approximately 280 metres elevation on Lease 34 and rises to the east. Less than a kilometre east of the Athabasca River there is a high on the Devonian surface, and west of this Devonian high the piezometric level is around 237 metres. Flow of groundwater in the basal aquifer is generally from east to west. The Post Cretaceous collapse in the Bitumount area does not appear to have significant impact on water levels and flow direction in the basal aquifer at Aurora. Much lower water levels and flow direction in a more northwesterly direction would be expected if this collapse resulted in the creation of significant vertical hydraulic conductivity between the basal aquifer and the Athabasca River.

Transmissivity values of the basal zone range from 43 to 200 m^2/day based on an analysis of pumping tests conducted at Aurora South and by Alsands. Based on an average aquifer thickness over the influence of the pumping tests, the hydraulic conductivity of the water sands were estimated to range from 2.2×10^{-5} m/s to 1.0×10^{-4} m/s. For the Lease 12/34 area,the transmissivity value was estimated at 68 m^2/day . Syncrude recently completed a 27 day pumping test. The results of the pumping test data will be used to better calibrate a numerical hydrogeological model. The numerical model will be used to simulate groundwater flows to design and implement a depressurization program before the commencement of mining activities. This is discussed Section 3.7

Based on the current information the thickness of the watersands range between zero and 47 metres. Basal watersands isopachs are shown in Figure 3.2-9.

Groundwater Quality

Basal aquifer water is generally brackish with total dissolved solids (TDS) typically less than 2000 mg/l. Hydrogen sulphide gas has been observed during pumping tests at Aurora North, although in smaller quantities than those reported at Aurora South. This is discussed in detail in Section 3.7



LEGEND

Lease Limit	- · -
Pit Limit	———
10 m	———
20 m	———
30 m	———
40 m	———

SCALE

0 2000 4000 m

NO	DATE	REVISION	BY	CHK	ENG	APPD

SCALE: DRAWN BY: GJK DATE: APR /96 CHECKED: DATE: 7/6/96 ENGINEER: DATE: APPROVED: DATE:

Syncrude AURORA MINE NORTH

DRAWING TITLE:

ISOPACH OF BASAL WATERSANDS

DRAWING NUMBER: Figure 3.2 - 9

REV. 0

Geological Resource Evaluation

A total of 300 core holes were drilled by various companies on Leases 12 and 34 between 1946 and 1985. The data obtained from 193 of these core was determined to be reliable and that information was used in the geological model developed for Leases 12 and 34. The drilling information available on Lease 10, which was added to Aurora North last January, is limited. A drilling program will be carried out by Syncrude on this part of Aurora North to gain additional information prior to the start of the mining activity.

Syncrude drilled 85 core holes early in 1995. They were cored from the top of Cretaceous to about 12 metres into the Devonian and were sufficient for the Devonian to register on all geophysical logs.

All holes were logged using a Phasor induction SFL, a Compensated Neutron/ Litho-Density, a dipmetre and a gamma ray log. In addition, several holes were logged using a borehole compensated sonic tool to produce synthetic seismograms to calibrate surface geophysical surveys.

Cores were described and sampled in our operations lab using methods developed for Lease 17/22 core holes. Samples were analyzed for oil, water and solids using hot solvent extraction (Dean and Stark method) and in duplicate by Nuclear Magnetic Resonance (NMR) to confirm the suitability of the latter method for future programs. Fines were determined using a combination of sieves and hydrometre. Chlorides and other soluble ions were measured for 230 samples.

Surface and airborne geophysical surveys were run over the area to aid in the interpretation and to help target future infill drilling.

In the first three months of 1996 an additional 137 holes were cored and logged. Results from these holes are not currently available. If there are significant changes in the geological information, they will be provided in the Fourth Quarter of 1996.

The method of ore reserves calculations is shown in Section 3.2.2.

Granular Resources

Gravel occurs in the glacial fluvial outwash deposits and "fingers" extending from the Fort Hills kame deposit. The Susan Lake borrow pit is located on Township 95 Range 10, immediately south of the Lease 12/Lease 13 boundary on a prominent gravel ridge. The ridge crosses Lease 12. Overburden drill holes and exposures along Highway 14-963 confirm that gravel and coarse sand occur near surface in this area. The fingers in the east and centre part of Lease 34 also contain granular material mainly fine aggregate with relatively little gravel.

Further delineation of granular resources will be carried out prior to the start of construction.

Geotechnical characteristics

Within the proposed mining limits there exists a wide variation in soil types and their modes of deposition. Therefore, the engineering properties such as moisture content, hydraulic conductivity, drained and undrained shearing strengths, compressibility, particle size distribution, and density vary greatly. Given the project is at its early stage of development, laboratory determinations of these engineering properties are limited. To proceed with the basic engineering designs, most of the geotechnical parameters proposed herein are based on the experience and performance records from Mildred Lake mine site.

Overburden

There are five general types of subsoil conditions in the proposed mine site, each of which may require specific design attention.

Soft Organic Soils

The peat or muskeg thickness in the mine site varies from 0.5 metre to 3.5 metres. The soft organic clay layer usually encountered at the base of muskeg is very thin to non-existent in the Leases 12 and 34 but measures 0.5 metre to 1.0 metre thick towards Lease 10. From a mining point of view, this soil unit poses no problem as it is generally stripped and stockpiled for reclamation use. Reclamation material balance shows that there is no need to salvage muskeg from the tailings embankment site and the overburden disposal sites. The muskeg left in place will be a factor in designing lift thickness and the rate of construction of these disposal sites. For preliminary design purposes it is assumed that the initial undrained shear strength is in the range of 10 to 30 kPa.

Glaciofluvial Sands and/or Gravels

Together these deposits are up to 13 metres thick. The sands are coarse to fine grained in a compact to very loose density state with minor silt and clay content. The gravels vary from dirty sandy silty gravel to well-washed sandy gravel with cobbles and boulders. The estimated hydraulic conductivity ranges from 10^{-2} to 10^{-5} cm/sec. In general the deposit is saturated and will be drained before excavation can proceed.

Glaciolacustrine Clay

The clay is medium to high plastic in nature. The moisture content varies from 15 to 35%. Standard penetration tests carried out during the 1995 overburden drilling program indicate blow counts in the range of 8 to 16 blows per 30.5 centimeters of penetration. Laboratory test results of samples taken from the Mildred Lake mine site show peak angle of shearing resistance of 20 to 25 degrees with a residual angle of shearing resistance of about 16 to 18 degrees. There is no stability problem anticipated in this unit. Because of the high moisture content this material will not be used for construction.

Glacial Till
The till thickness varies from zero to 20 metres. There are two distinct till units identified: Ablation Till and Lodgment Till. The two differ in the source material and in the amount of gravel and boulder content. The Lodgment Till has a distinct bitumen odour reflecting its origin. For practical engineering purposes, these two units are considered to be the same. Split spoon blow counts on the tills range in the 30 to 40 blows per 30.5 centimetres of penetration. This material is excellent for general all purpose fill use.

Clearwater Clay or Clearwater Clay Shale
The Clearwater formation is largely restricted to the three proposed overburden disposal sites. It is a highly plastic marine deposit exhibiting liquid limits in excess of 100. X-ray refraction on samples taken from the Mildred Lake site shows the clay may contain up to 25% smectite. The clay is very stiff to hard in consistency and has been heavily over-consolidated in its geological history. The presence of slickenslides as a result of the glacial activities is common. Based on past experience at the Mildred Lake mine site, this material possesses low shear strength. Back analysis of failed slopes and laboratory tests indicate a residual angle of shearing resistance of about 6- 8°. The estimated peak angle of shearing resistance is about 12-16°. This information will be used to design slopes for the overburden disposal sites.

McMurray Formation
For the purpose of this discussion, the McMurray formation is divided into three distinct zones: Upper McMuuray, Middle McMurray and Lower McMurray.

Upper McMurray
This part of the McMurray formation is characterized by the numerous clay sand interbeds. The clay beds range in thickness from a few millimetres to several centimetres. Bitumen impregnation in the sand beds is sporadic. Dipmeter logs from downhole geophysical tools indicate these clay beds are dipping as much as 20-25° to the west as well as to the east in some places. Given these very steep dips, there is a high probability of block slide type failure occurring along the clay beds. Laboratory tests are underway to determine the shearing strength of some of these clays. It is anticipated the marine clays, the weakest of the clays, will have peak angle of shearing resistance in the range of 12-16° and a residual angle of shearing resistance of about 8-10°.

Middle McMurray
The Middle McMurray formation is primarily comprised of sands with very few clay beds. The sands are medium to fine grained increasing to coarser grain with depth. Bitumen impregnation is high and consistent. The sands have steep cross bedding angles but it is not expected to pose any stability problems. Depending on the amount dissolved gas in the bitumen it is possible there may be some bulging of the pit walls as the result of gas exsolution.

Lower or Basal McMurray
The basal zone consists mainly of continental muds and a thick fluvial sand bed. The muds or clays are firm to stiff in consistency and evidence of previous shear movements is prevalent. X-ray analysis indicates the clays may contain up to 20% smectite. The sands are generally water

saturated but may occasionally be bitumen saturated. The piezometric head in the water sands measured in number of open standpipes indicates an artesian condition. Careful evaluation of the water sands will be carried out in detailed engineering stage to address potential pit wall stability and trafficability problems and remedial measures will be put in place prior to mining.

Devonian
Drilling and surface geophysics results reveal evidence of pre- and post-Cretaceous collapse features affecting the Devonian strata. These will be handled accordingly to ensure pit wall stability.

Soil Properties
The soils encountered in Leases 12, 34 and 10 are very similar to those found at Lease 17. Since very limited geotechnical testing has been conducted to date on the soil samples from Leases 12, 34 and 10, the soil geotechnical properties used in the preliminary mine design have been extrapolated from the Lease 17 data.

3.2.2 Reserves evaluation - Aurora North

Ore reserves calculation method
Syncrude used the EAGLES geological modelling and mine planning software for calculating Aurora Mine reserves. This computer system has been used for mine planning by Syncrude.

EAGLES uses block modelling to represent oilsands height and fixed X,Y dimensions. The Aurora North model uses blocks that are 50 metres by 50 metres in plan view. Block height varies to conform to stratigraphic and lithologic layering. Blocks are assigned to individual stratigraphic units (Lower, Middle or Upper McMurray) and the most likely lithofacies is determined for each block from the surrounding holes.

Grades are interpolated to each block using a file generated by compositing the assay data for all the cored drill holes from top to bottom, splitting composites at facies contacts and splitting these further where the grade changes by more than two percent. Composite assays are weight averaged to block centroids using an the reciprocal of distance from the centroid raised to a user specified power as a weight function. The system is designed to prevent interpolating block grades using assay data from different stratigraphic units or unrelated lithofacies.

The mining model is developed by imposing mining benches, cut-off grades, minimum mining selectivity and dilution /reduction criteria on the geological model. An algorithm written specifically for oil sand mining uses these input parameters to divide the model of the McMurray Formation into alternating layers of ore and waste. Mining efficiency represented by dilution/reduction criteria, is modelled as thickness of ore lost to adjacent waste and thickness of waste dilution mined along with adjacent ore. "As mined" or diluted grades and volumes are calculated accordingly.

Mining ore criteria
Mining ore criteria are applied to determine the initial mining pit limits and to determine mineable reserves within those limits. These criterias are site specific and are dependent on the geological characteristics of the oil sands deposit and on the economic and operating constraints. Actual short range mining plans include using and processing materials which fall outside these criteria should it prove economical to do so. Syncrude would support both the development and use of industry-wide criteria in this area. The following are the major considerations taken into account in developing the ore criteria for the Aurora Mine.

- Bitumen recovery optimization.
- Material handling costs.
- Extraction recovery.
- Equipment selection.

The major parameters for mining ore criteria are:

- Mining cut-off grade, which is defined as the minimum bitumen content in the oilsands considered to be economically mineable.
- Minimum mining thickness, which is the thinnest layer of ore that is economically mineable using the selected mining equipment.
- Ratio of total volume removed to net recoverable bitumen (TV/NRB). Total volume includes oil sands, overburden and interburden. Recoverable bitumen is calculated by applying mining dilution /reduction and the extraction recovery to the bitumen in place.

Syncrude has examined the impact of varying cut-off grades, minimum mining thickness and TV/NRB on resource recovery, mining and extraction costs and operability. Syncrude uses the following guidelines:

- Mining cut-off grade of 8% for the top ore bench
- Mining cut-off grade of 7% for all other benches
- Minimum mining thickness of 5 metres
- TV/NRB of 2.2

The top bench, which contains large percentages of low grade ore, must be developed first. Since this is when there are limited blending options, it is difficult to consistently supply acceptable ore grade feed to the extraction plan at this time. Syncrude has experienced very poor extraction bitumen recoveries at grades below 9%. Therefore this is the rationale for using the cut-off of 8% grade for the top ore bench, which will improve the overall plant feed grade during mining of the top bench. In the short term planning process, mine plans will be optimized to account for the actual availability of higher grade ore for blending.

The following guidelines form the basis for mining cut-off grade of 7% for all other benches:
- Optimum balance between project economics and resource recovery (Figure 3.2-10).
- High level of resource recovery as shown in Figures 3.2-11 and 3.2-12

Figure 3.2-10 - Aurora Mine North - Ore Grade Cuttoff NPV vs Recovered Bitumen

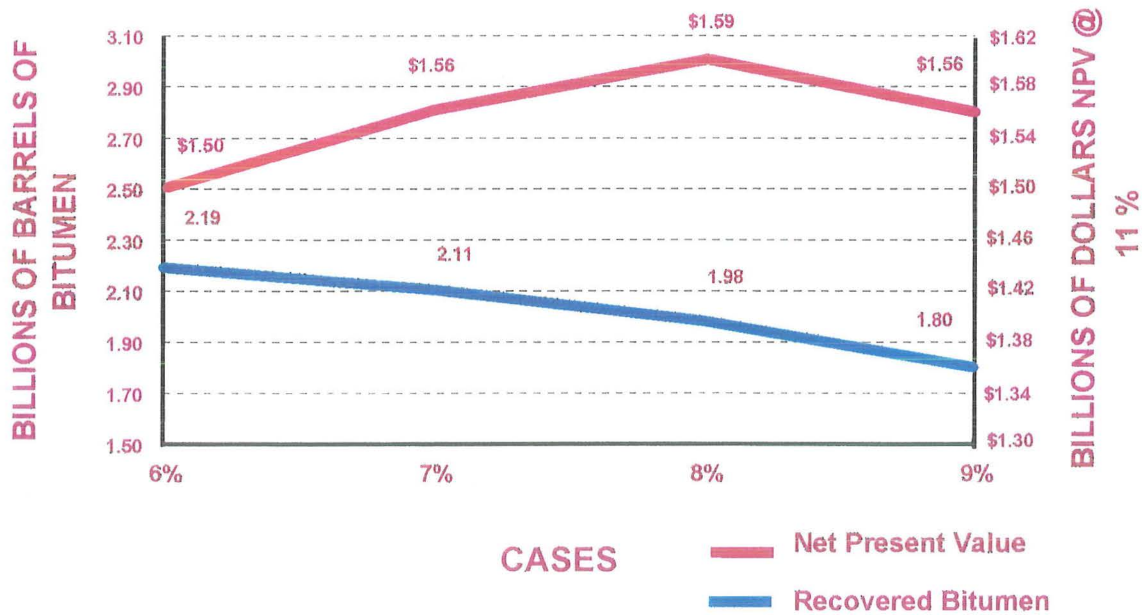


Figure 3.2-11 - Aurora Mine North - Mined Ore Volume vs. Cut Off Grade

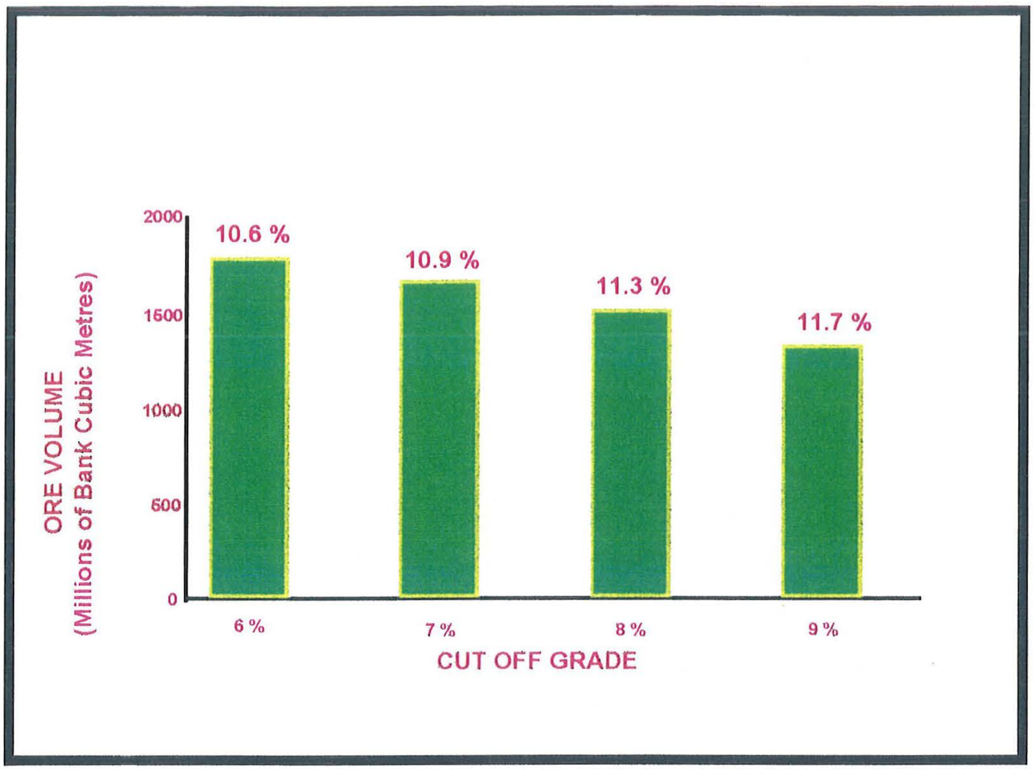
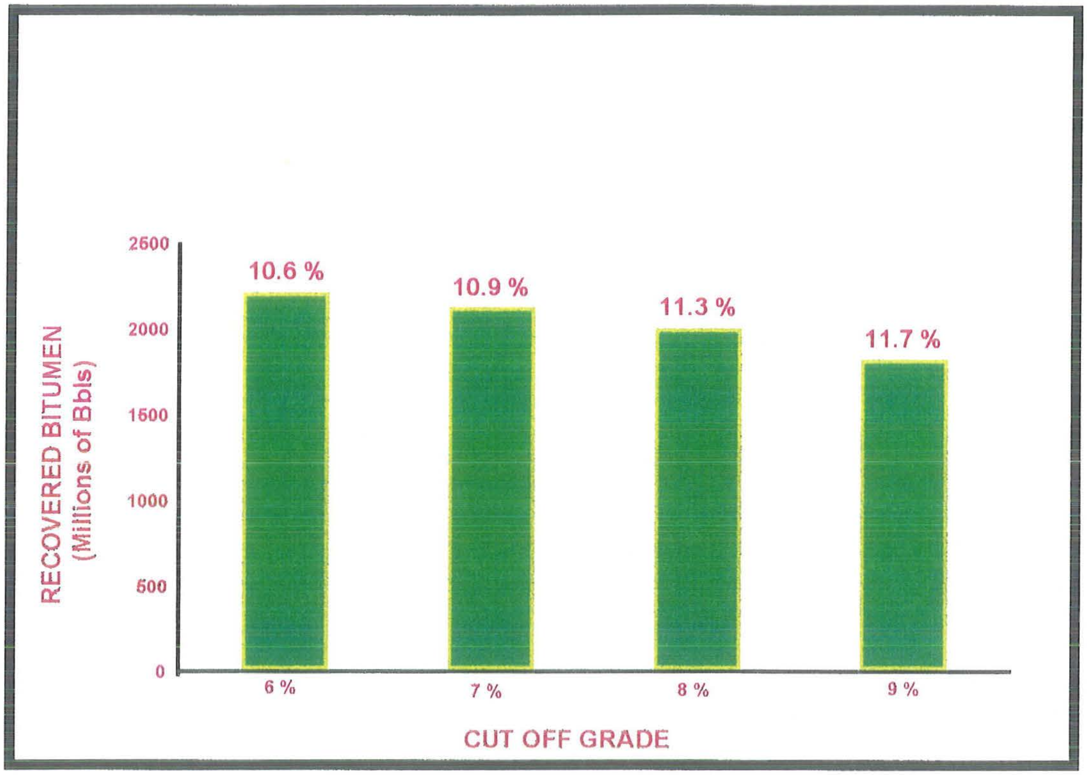


Figure 3.2-12 - Aurora Mine North - Recovered Bitumen vs Cut Off Grade



The minimum mining thickness of five metres was arrived at on the following basis:

- An analysis of three metres vs five metres minimum mining thickness showed that the recovered bitumen remains essentially the same at 7% grade cut-off with an increase in selectivity from three metres to five metres as shown Table 3.2-3.
- Industry standard shovels are most efficient in mining bands greater than five metres in thickness.

The bench heights will be engineered where practical to have the waste zones at the top or bottom of the bench where three metres selectivity will be applied.

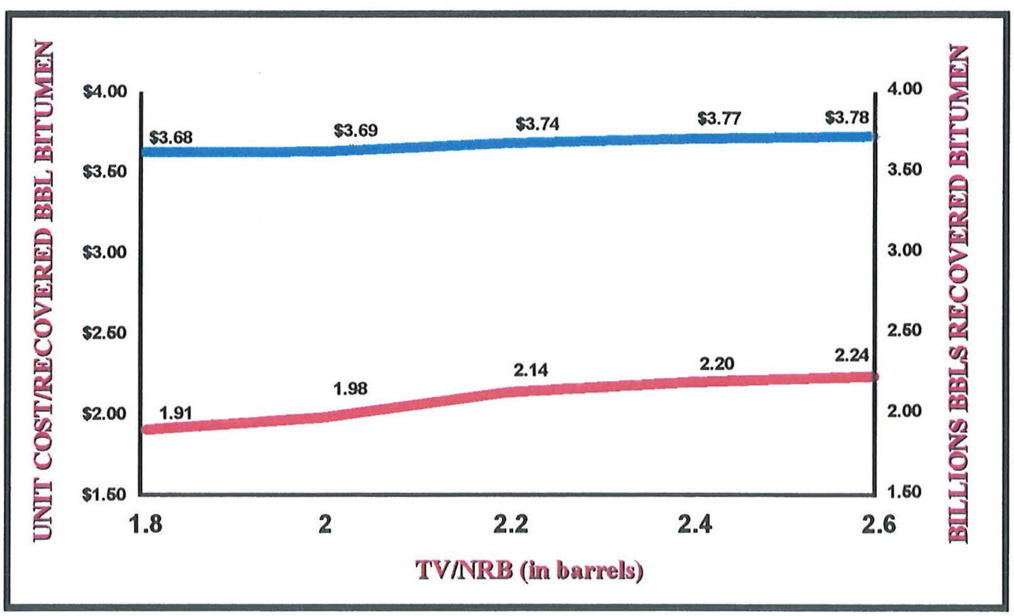
Table 3.2-3 - **Impact of increases in Mining selectivity from 3 metres to 5 metres**

	@ 7% cut-off	@ 8% cut-off
Ore volume increase	2%	1%
Ore grade change	< -1%	< -1%
Change in recovered bitumen	no change	< -1%

A TV/NRB criterion of 2.2 was arrived at on the following basis:

- Optimum balance between project economics and resource recovery (Fig.3.2-13 and 14).
- High level of resource recovery.

Figure 3.2-13 - Unit Costs / Recovered Bitumen vs TV/NRB



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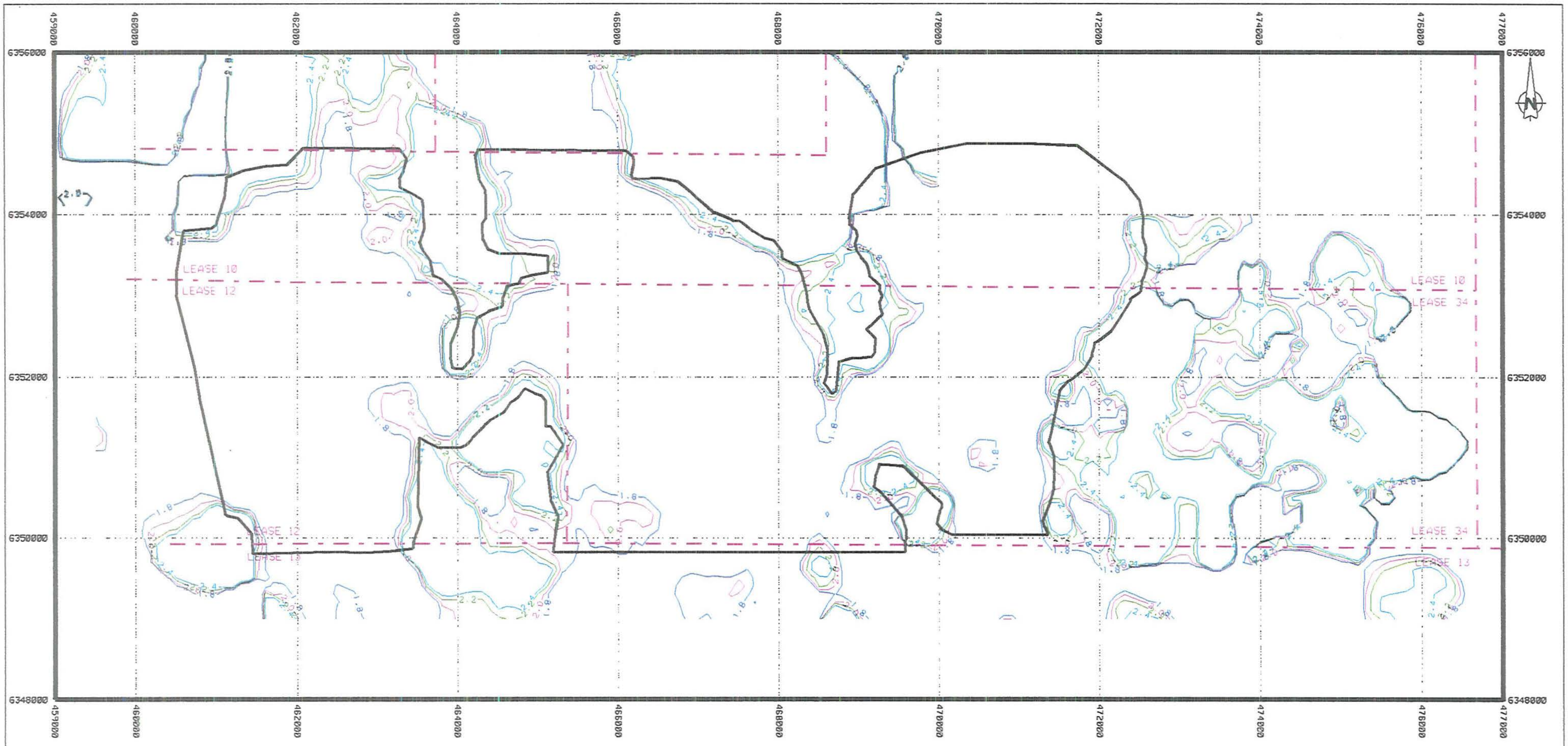


LEGEND

Lease Limit	
Pit Limit	
1.8	
2.0	
2.2	
2.4	

SCALE

0 2000 4000 m

NO	DATE	REVISION	BY	CHK.	ENG.	APPD.
SCALE:	DRAWN BY: DATE	CHECKED: DATE	ENGINEER: DATE	APPROVED: DATE		
	SF APR/96					

Syncrude AURORA MINE NORTH

DRAWING TITLE:

TOTAL VOLUME : NET RECOVERED BITUMEN
(m ^{3}:BBL)

DRAWING NUMBER: Figure 3.2 - 14

REV. 0

Extraction Bitumen Recovery

Extraction bitumen recoveries are described in Section 3.5.

3.2.3 Mine opening location -- Aurora North

Selection criteria

The initial mine opening in Aurora North was selected by evaluating the most economic location that best fits with a progressive reclamation strategy. The following criteria have been applied in selecting the initial mine opening location.

Economic Considerations

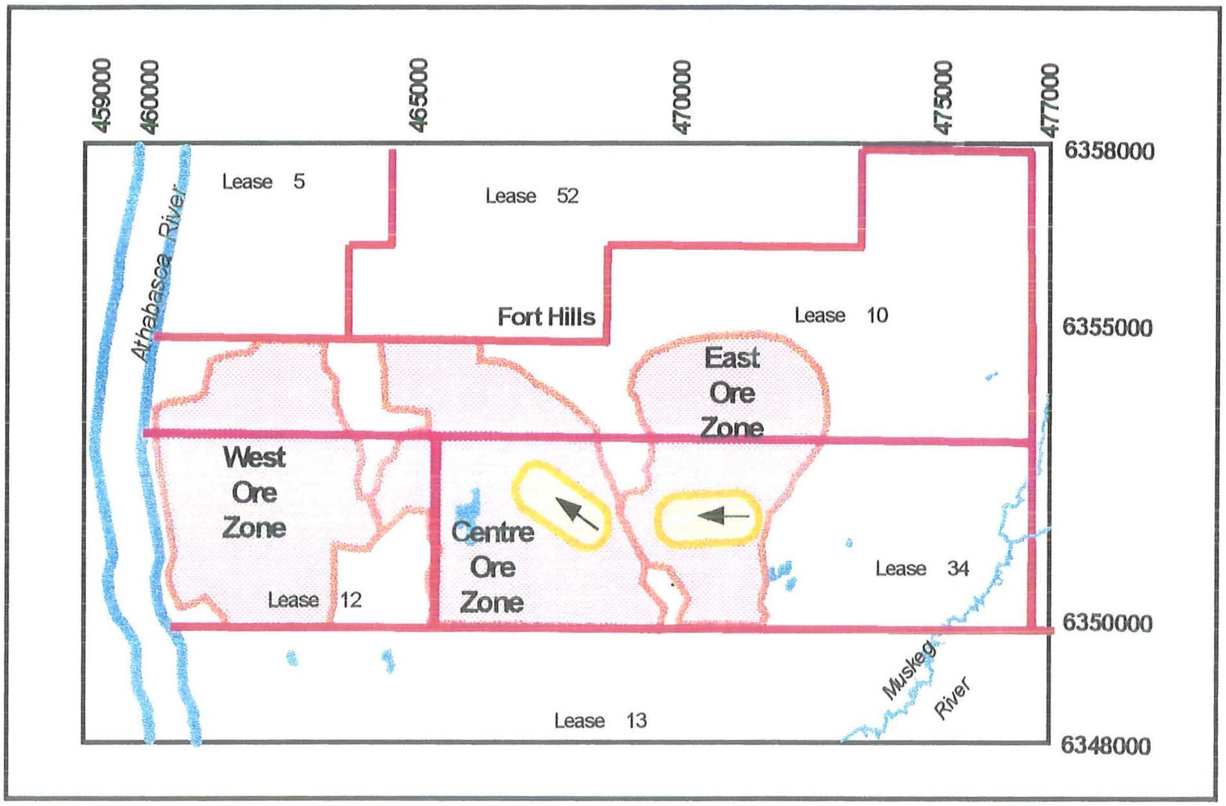
- Operating costs per barrel of bitumen
- Ore grade
- Ore thickness
- Overburden thickness
- Waste to ore ratio
- Ratio of total volume to net recovered bitumen
- Distance to plant site

Environmental Considerations

- Early overburden and tailings disposal inpit
- Compatibility with progressive reclamation strategy

Three potential mine openings were evaluated for the Aurora North: the east ore zone, centre ore zone and west ore zone.

Figure 3.2-15 - Aurora Mine North - Mine Opening Locations



Mine opening in the west ore zone was eliminated in the initial screening for the following reasons:

- Need for additional drilling along Athabasca River to provide basis for designing of barrier.
- Potential up-front major expenditures to construct a barrier to control seepage from the Athabasca River.
- Longer distance from all potential tailings disposal sites.
- Lower quality of ore than the other two ore zones.

A detailed evaluation was done for initial mine openings in the east ore zone and centre ore zone. These locations are shown in Figure 3.2-15. Quality of the ore and the cost per barrel of bitumen produced were compared for the two sites. Early disposal of waste (overburden and interburden) and tailings in-pit and time to start significant reclamation were other major factors taken into consideration.

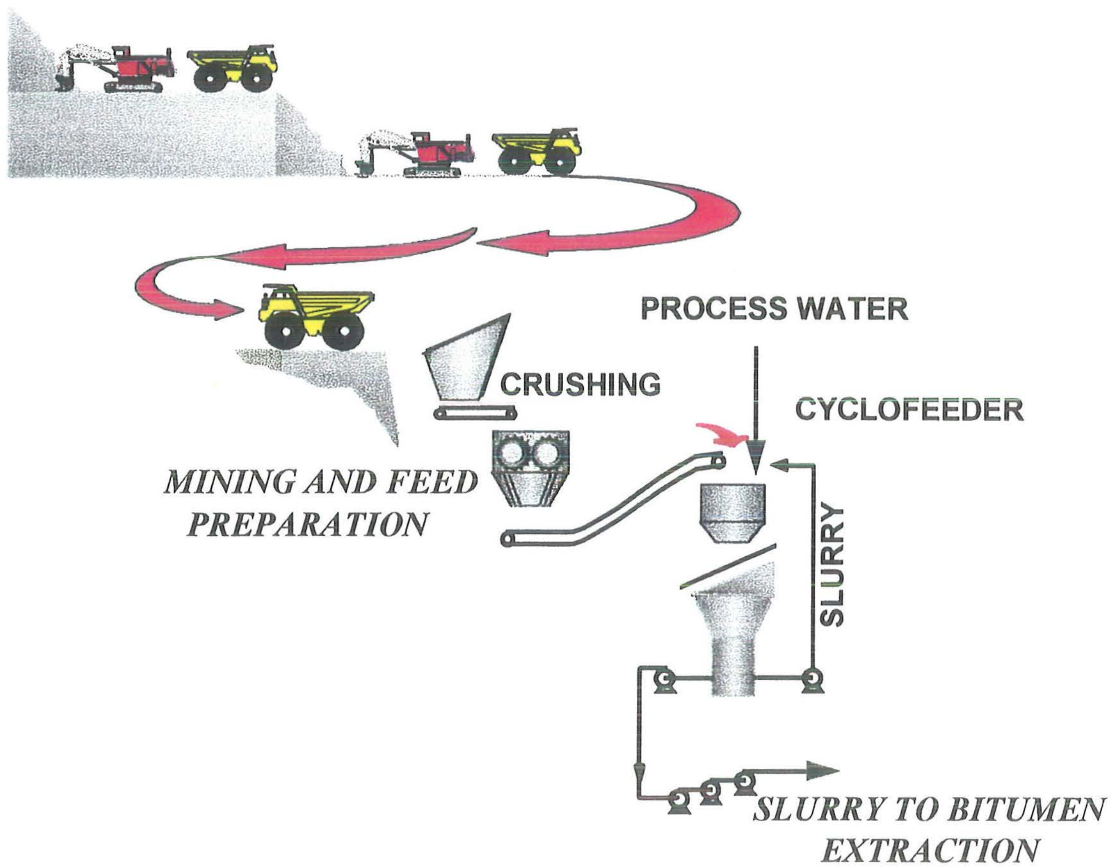
As a result of this evaluation, initial mine opening in the east ore zone was selected. Early tailings disposal inpit, which results in a smaller footprint of the out-of-pit tailings disposal site and earlier start of reclamation, were the significant advantages. Further details are contained in Appendix A.

3.2.4 Mining Operation - Aurora North

Overview

Aurora Mine will use a truck and shovel operation to mine the oil sands and strip overburden. After an in-depth evaluation, Syncrude concluded that a truck and shovel operation is the superior method of mining at Aurora, both economically and operationally. The oil sand will be hauled a short distance to an inpit crusher. The crushed material will then be transported to the cyclofeeder where it will be mixed with water to create a slurry for hydraulic transportation to the extraction plant. Figure 3.2-16 shows the major steps in Oilsand Mining.

Figure 3.2-16 - Schematic of 1st Train



No surge facility is planned between the crusher and the cyclofeeder for the operation of Train 1. With the addition of Train 2, a surge bin may be installed between the crushers and cyclofeeders to serve both trains.

Development of all mining areas will take advantage of established industry procedures and practices. The sequence of activities is as follows: tree clearing, dewatering reclamation material salvage and use, overburden removal, oilsand mining, backfilling of minedout area of the pit, final grading and reclamation. These activities are shown on the status maps at the end of this section (Figures 3.2-17 to 3.2-31).

Mine Development Planning Criteria

Syncrude's mine development plans are based on the following objectives:

- Tree removal and dewatering of the smallest practical area throughout the life of the operation.
- Efficient mining of oil sands reserves on Syncrude's leases.
- Optimum sequence and location of material disposal (including overburden and tailings).
- Identification and planning of final reclamation.
- Minimum economic time between land disturbance and the start of reclamation.
- Tailings deposited in-pit as soon as practical.

Geotechnical Design Considerations

The ground behavior in response to mining excavation at the Aurora North site is not expected to be different from that observed at Mildred Lake. The modes of failure anticipated include flow slumps, slabbing, bulging, block slides, shallow circular and deep-seated rotational failure involving the basal units. Flow slumps and shallow circular or composite slip surface types of failure are generally associated with the overburden units and waste dumps, while slabbing, bulging, block slides and deep seated failures occur in the McMurray Formation. Of these modes of failure, block slides pose the most concern as they tend to occur very quickly with little or no warning and there is usually no visible sign of distress at the surface. The others develop slowly allowing time to respond.

Aurora North will continue to follow the observational approach design philosophy which has been used successfully in the Mildred Lake operation. This requires a good understanding of ground behavior and the need for constant re-evaluation of the design parameters to optimize the design. For preliminary design purposes, the following pit geometry and assumptions are used:

Pit Slopes

- 3 Horizontal : 1 Vertical (3H : 1V) in the overburden (as low as 8H : 1V if Clearwater clays are present).
- 0.7H : 1V intermediate and 2H : 1V overall slopes in the McMurray Formation.
- 14 metre high benches with 10 metre wide safety berms.

Overburden Disposal Sites Slopes

- 3H : 1V intermediate and 4H : 1V overall with no Clearwater clays present at the base and as low as 8H : 1V if Clearwater is present.

Offsets

- 300 metres provisional offset distance from the tailings facility.
- 100 metres to 150 metres offset distance from the plantsite (150 metres for critical and 100 metres for non-critical structures).
- 100 metres offset from Highway 963 on the west side.

Mining Method and Equipment

Aurora will utilize a truck and shovel operation for mining and a crusher to size the oil sand, which will then be transported to the Extraction plant using hydrotransport technology. These technologies — truck and shovel mining and the hydrotransport of oil sand — combined with low temperature extraction technology translate into the most efficient and cost-effective production process for Aurora.

Oil sand hydrotransport is a process that prepares, transports and conditions the oil sand and water slurry. It does not require the long conveyor systems or tumblers that are currently employed. Instead, Aurora will utilize:

- a high density oil sand slurry preparation system located in the mine area,
- a pipeline system to condition and transport the oil sand slurry to the Aurora extraction separation circuit, and
- a bitumen froth heating and pumping facility to deliver froth to the Mildred Lake froth treatment plant.

The major mining equipment proposed for the Aurora Mine North are listed in Table 3.2-4.

Table 3.2-4 - Aurora Mine Major Equipment List

Equipment	One Train	Two Trains
56 yd Hydraulic Shovel	3	6
320 Ton Haul Truck	12	22
Large Track Dozers	2	4
10,000 tph Crushers	1	2
Various support equipment		

Site Preparation

Tree Clearing, Timber Salvage, Surface and Muskeg Drainage

Tree clearing and timber salvage will begin approximately two years before mining. After tree clearing and surface drainage, basal aquifer depressurization and muskeg drainage can commence. This interval between drainage initiation and the start of mining activities is necessary to:

- create operable conditions for the mining equipment,
- decrease the moisture content of the overburden to ensure its suitability for construction of tailings structures,
- facilitate the salvage of appropriate reclamation materials, and

- decrease the moisture content of the muskeg underlying the proposed overburden dump locations to ensure dump stability.

Appropriate approvals will be obtained for the tree clearing plans. Clearing will be conducted in accordance with Forestry regulations and any specific conditions. The tree clearing requirements are summarized in Table 3.2-5.

Table 3.2-5 - Tree Clearing Requirements

Time Period	Area Cleared (Ha)
1998-2000	2,075
2001-2005	733
2006-2010	808
2011-2015	1,513
2016-2020	452
2021-2025	598
2026-2030	737
TOTAL	**6,916**

Soil Salvage Plan

A preliminary material balance has indicated an abundance of suitable reclamation material available in the Aurora Mine North. Consequently, Syncrude will have some flexibility concerning timing and size of reclamation material stockpiles. Any reclamation material that is not required for placement or stockpiles will be hauled to an overburden disposal site.

Mining operations preclude any reclamation activities until 2005, at which time the lower slopes of the tailings disposal site will be reclaimed by direct haul. Timing of reclamation activities over the entire tailings disposal site make it attractive to establish two stockpiles between 2007 and 2010 close to the tailings disposal site (shown on the status maps) to minimize haulage costs. Overburden disposal sites will be reclaimed using primarily direct haul material. In later years, two additional stockpiles will be required to ensure sufficient suitable material is available to complete mine closure plans. The first stockpile (shown on the status map) will be established in the 2021 to 2025 timeframe to take advantage of reclamation material with greater than 20% muskeg content, as shown in Tables 11-6 in Section 11. This material will be used to reclaim mined-out areas in the east and center pits. The second stockpile (shown in the status map) will be established beyond 2030 to reclaim the west pit when it is completed.

Waste Disposal

The material handling and disposal plan takes into account three different types of material: overburden, interburden, and cyclofeeder rejects. Overburden removal is planned to progress in advance of oilsand mining, utilizing shovel andtruck technology. The waste disposal sites will consist of: overburden disposal sites situated on relatively uneconomic oil sand resource, tailings dykes, and mined-out pits. Material suitability and the most economical haul strategy will dictate the timing of the various disposal sites.

Overburden and Interburden Disposal

In pre-production years, overburden from the opening pit area in the east pit will be utilized to construct the tailings starter dyke. This advanced stripping necessary for dyke construction will eliminate the need for overburden stripping in the first two years of production. Waste material from the east pit between 2004 and 2006 will be placed in the northwest corner of the tailings dyke, the tailings toe berm, and the Fort Hills Overburden Disposal Site (shown in the status maps), until the pit bottom is sufficiently exposed to allow construction of inpit tailings dykes. These in pit dykes are necessary for initial containment of CT. If the tailings dykes are not available for construction, or if the waste is unsuitable for construction, the waste material will be transported to overburden disposal sites or disposed of in pit. The Fort Hills Overburden Disposal Site will be completed to a final design height of 60 metres by 2012.

Waste materials from the centre pit will be required to complete the tailings dyke for the out-of-pit disposal site over the east pit adjacent to the plant site, as well as in-pit dykes in the Centre Pit for CT containment. During the life of the centre pit, both Susan Lake North and South Overburden Disposal Sites (shown in the status maps) will be filled to capacity, approximately 60 metres in height.

The west pit will not require in-pit structures as it will not be used for the tailings disposal. The lease closure plan shows a lake in this area at end of mine life. Waste material from this pit will be required to complete construction of a very large in pit structure in the center pit at the southern border of the Aurora leases. Any waste not used for construction will be placed at the pit bottom.

Out-Of-Pit Overburden Disposal Sites

Three overburden disposal sites are identified in the mine plan. These sites are shown in the status maps.

Fort Hills Overburden Disposal Site

Fort Hills Disposal Site is designed with an overall slope of 6:1 to a height of 60 metres. Approximately 55 million bank cubic metres of overburden material will be placed in this site. The volume of oil sands under this site is estimated at 125 million bank cubic metres with *in situ* ore grade of 9.9.

Susan Lake North Overburden Disposal Site

This overburden disposal site is designed with an overall slope of 6 : 1 to a height of 60 metres. Approximately 28 million bank cubic metres of overburden will be disposed of in this site. It is estimated that 117 million bank cubic metres of oil sands with *in situ* ore grade of 10.2 underlie this site.

Susan Lake South Overburden Disposal Site

An overall slope of 6:1 is used to design Susan Lake South Overburden Disposal Site to a height of 60 metres. This site will have a capacity for a disposal of 59 million bank cubic metres of overburden. The volume of oil sands underlying this site is estimated at 120 million bank cubic metres at a in-situ ore grade of 10.4. Current geological information shows a deposit of granular material under this site. The quality and the quantity of the granular material will be further evaluated and appropriate plans put in place to deal with this resource well before this area is used as an overburden disposal site

Cyclofeeder Rejects Disposal

The cyclofeeders are anticipated to produce rejects totaling 3% (by weight) of the oil sand feed. During the first train operation, the cyclofeeder rejects will be disposed of at the eastern edge of the east pit opening cut. Limited pit floor space will require the cyclofeeder rejects to be placed in an out of pit in a toe berm alongside the western flank of the tailings disposal site, between 2006 and 2007. Subsequent disposal will be in pit either in distinct dumps or as part of tailings dykes, depending on the suitability of the material.

Volumes of all waste material per time period are shown in Table 3.2-6.

Waste Volumes

Table 3.2-6 - Waste Volume

Time Period	Overburden (Mbcm)	Interburden (Mbcm)	CF Rejects (Mbcm)	TOTAL (Mbcm)
1999-2000	13.0	0.0	0.0	13.0
2001-2005	26.9	17.6	3.7	48.2
2006-2010	45.9	61.0	8.5	115.4
2011-2015	121.9	57.5	8.5	187.9
2016-2020	45.5	47.0	8.5	101.0
2021-2025	73.4	104.0	8.5	185.9
2026-2030	87.3	108.0	8.5	203.8
TOTAL	413.9	395.1	46.2	855.2

Oil Sand Mining

The Aurora Mine North consists of three distinct orebodies. Mining operations will begin in the east pit with a single production train starting around 2001, and a second train around 2005. Initial mining will develop a boxcut to establish the mine benches and expose pit floor for waste disposal and for construction of in pit containment structures.

Mining will progress south in the early years until reaching the limits of Lease 34, and then progress north towards the Fort Hills, until reaching an economic pit limit which is in 2012 in the current plan.

On completion of the east pit, mining will progress in a westerly direction in the centre pit, starting just north of the plant site. This pit will be mined out to pit limits by approximately 2028.

In 2029, mining in the west pit will begin and be completed to pit limits by approximately 2039 to 2040. For the purposes of this application a provisional western pit limit was assumed 100 metres east of Highway 963.

Crushers will be designed to be easily relocated closer to working faces to minimize haul costs. In the early years of operation, the crusher facility will be located at the surface of the mine until there is sufficient space available at the pit bottom to accommodate the crusher and cyclofeeder. Moving the cyclofeeder in pit will reduce mining costs.

All pits will have temporary haul roads built on the mining benches with more permanent roads in the final pit walls for access to the crushers and maintenance shops.

Status maps for Aurora North are included at the end of this section. These show prime pit, waste locations and locations of areas in the process of reclamation. The initial status map is for 1998 and is Figure 3.2-17. Annual status maps are included for the first ten years. Status maps are then included at five year intervals from 2010 to 2030. The final status map for Aurora North is Figure 3.2-31 Aurora Mine North Closure. Table 3.2-7 shows oilsand production volumes and grades over the life of the mine.

Table 3.2-7 - Oilsand Production - Aurora South

Time Period	Oilsand Volume (Mbcm)	Oilsand Grade (%)	Bitumen (Mbbls)
2001-2005	119.8	11.5	169.6
2006-2010	276.0	11.7	398.3
2011-2015	276.0	11.4	389.4
2016-2020	276.0	11.1	376.1
2021-2025	276.0	10.7	361.6
2026-2030	276.0	10.7	360.7
TOTAL	**1,499.8**	**11.2**	**2,055.7**

Granular Resources

Granular resources on the Aurora leases will be required to construct and maintain several types of roads needed to maintain an efficient and cost-effective operation. The pit operations will have haul roads along the pit walls, on ramps and access routes to the in pit crushers, on all mine benches and to all overburden disposal sites, both in-pit and out of pit. Also included are major arteries between the plant and the pit operations, and perimeter roads around the tailings disposal site.

The first two years of the plan (1999 and 2000) will require granular resources to be supplied by an external supplier to assist in start-up operations. Beyond 2000, suitable granular resources within the overburden material will be salvaged or used as encountered depending on the need. Crushed gravel and pit run will be supplied by commercial operations as needed. When available, pit run from the overburden material will be used. Further work is required to improve the delineation of the granular deposits on the Aurora site. In addition, the operation will endeavour to salvage as much placed gravel from haul roads as is practical prior to abandonment of the road. Sand is readily available from the overburden material and from tailings disposal sites. Allowances have been made for each time period for granular requirements other than for haul roads.

3.2.5 Geology - Aurora South

Surficial Geology

Topography

There are two significant topographical features near the Aurora South site on Lease 31: (1) a gentle rise eastward to Muskeg Mountain, and (2) Kearl Lake which straddles the northern boundary of Lease 31. A network of small streams drains northwest from Muskeg Mountain, across Lease 31. These streams flow into and around Kearl Lake and discharge into the Muskeg River.

Based on the surficial geology, the area can be divided into two areas: an upland area above 340-metre elevation, which is lies to the southeast, and a lowland area below 340 elevation, which includes the mine site. Slopes in the upland area range between 1- 3% compared to 0.2- 0.5% in the lowlands.

Pleistocene Glacial Deposits and Holocene Deposits

The Quaternary overburden consists of Holocene organic and Pleistocene glacial deposits. These overlie Lower Cretaceous sediments — predominantly McMurray Formation except to the east and south of the proposed mine where Clearwater Formation subcrops.

The Aurora MineSouth facies descriptions are essentially the same as those provided in the description of the Aurora MineNorth area. In summary, the McMurray Formation and the scattered outliers of Clearwater Formation are overlain by glacial and glaciofluvial Pleistocene sediments and a thin veneer of reworked Pleistocene material capped by organic deposits of Holocene age.

Significant Overburden Geology Features

Near the end of the final glacial retreat, meltwaters flowing from the ice front cut a network of principal and tributary channels into pre-existing tills, outwash deposits, and the exposed Cretaceous surface. The relationship between till deposition and glaciofluvial channel development was dynamic. Several periods of advance and retreat resulted in the development of a succession of drainage systems. These Pleistocene channels are infilled both with glaciofluvial deposits and till, reworked to varying degrees by the outwash flow. They are the most significant overburden features in the Aurora South area.

Oil Sands Geology

The generalized depositional history of the McMurray Formation is reviewed in the section on the Aurora North geology.

Lease 31 consists of three reserves areas:

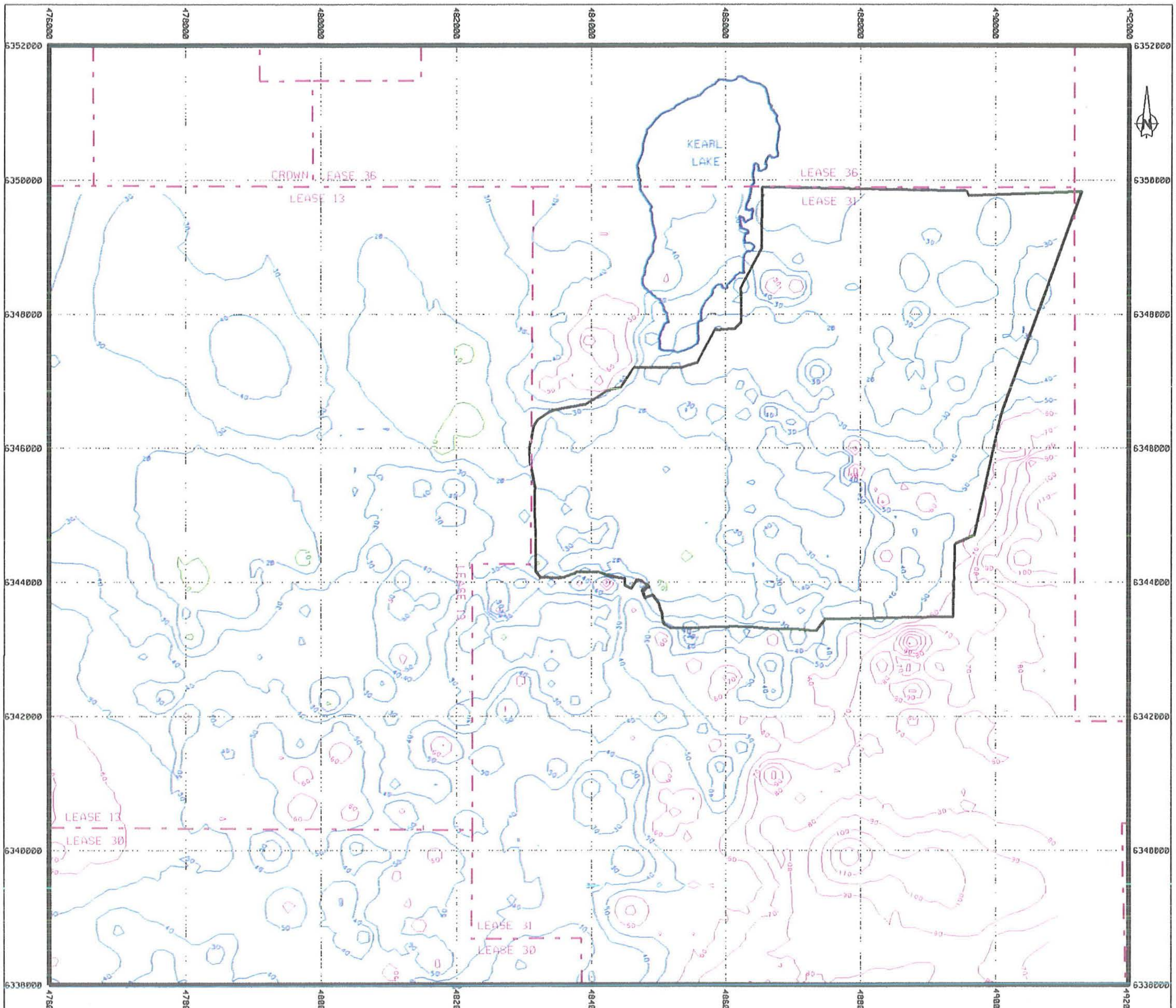
- The initial OSLO mine area.
- The northeast and east extension of the OSLO mine area.
- The balance of the lease.

Present estimates of resource parameters are shown in Table 3.2-8.

Table 3.2-8 - Estimates of Resource parameters

	THICKNESS of ORE (m)	AVERAGE GRADE	THICKNESS of OVERBURDEN (m)
OSLO Mine Area	54.3	11.7%	21.0
North East Block	40.7	11.6%	23.6
East Extension	49.1	11.8%	46.2
TOTAL	47.7	11.7%	24.9

The following maps provide geological information for the Aurora South area:
Figure 3.2-32 provides the overburden thickness
Figure 3.2-33 provides the oilsand ore thickness
Figure 3.2-34 provides the *in-situ* ore grade
Figure 3.2-35 provides a generalized geological section through Lease 31 looking north, and
Figure 3.2-36 provides total volume to bitumen in place contours.



SCALE

0 2000 4000 m

LEGEND

Pit Limit	
Lease Limit	
10 m	
20,30,40,50 m	
60,70,80,90,100 m	

SCALE: 5F MAY /96

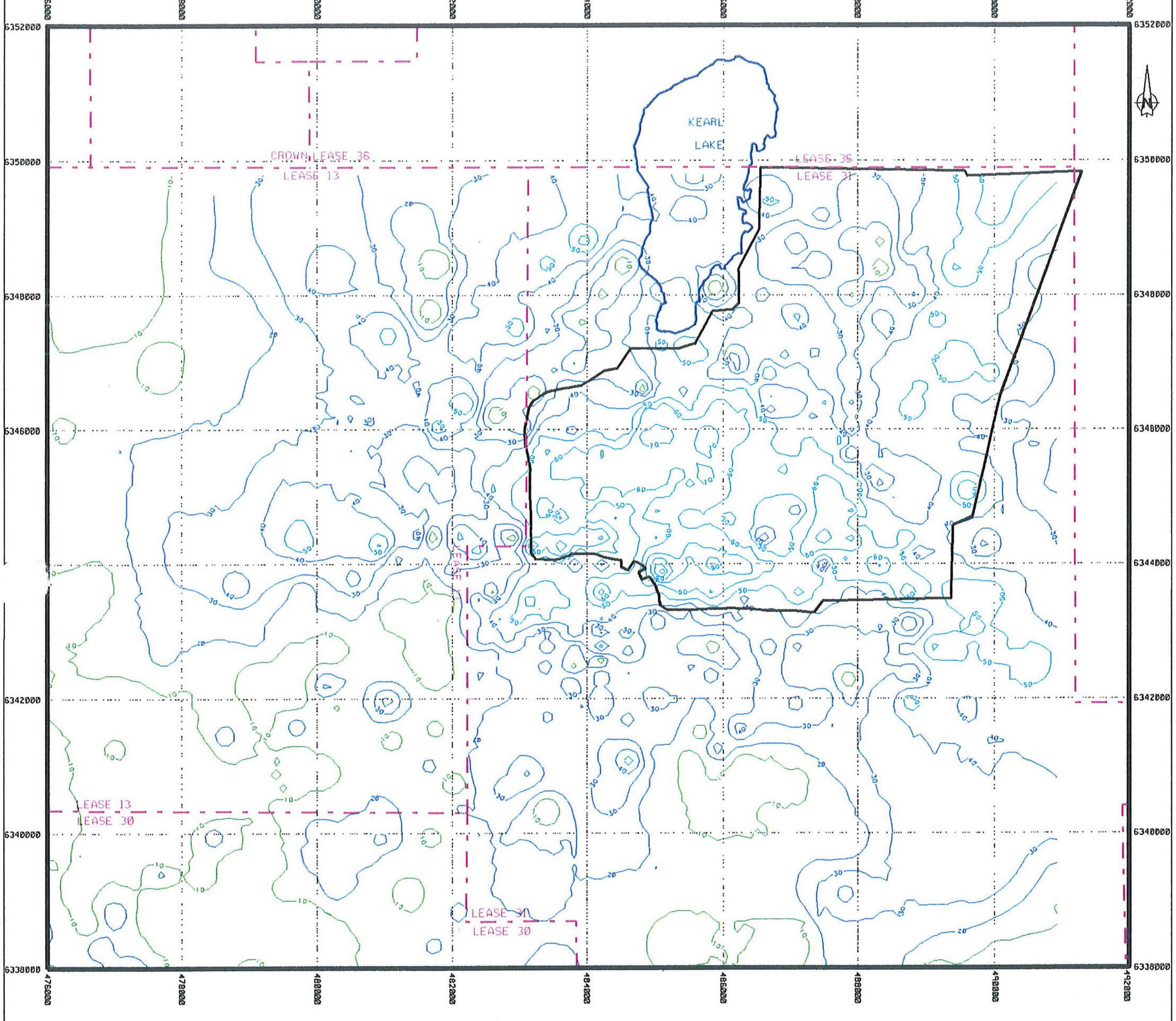
Syncrude AURORA MINE SOUTH

DRAWING TITLE:

OVERBURDEN THICKNESS (m)

DRAWING NUMBER: Figure 3.2 - 32

REV. 0



LEGEND

- Pit Limit
- Lease Limit
- 10 m
- 20,30,40 m
- 50,60,70 m

SCALE

0 2000 4000 m

NO	DATE	REVISION	BY	CHK.	ENG.	APPD.

SCALE: 5F MAY /96

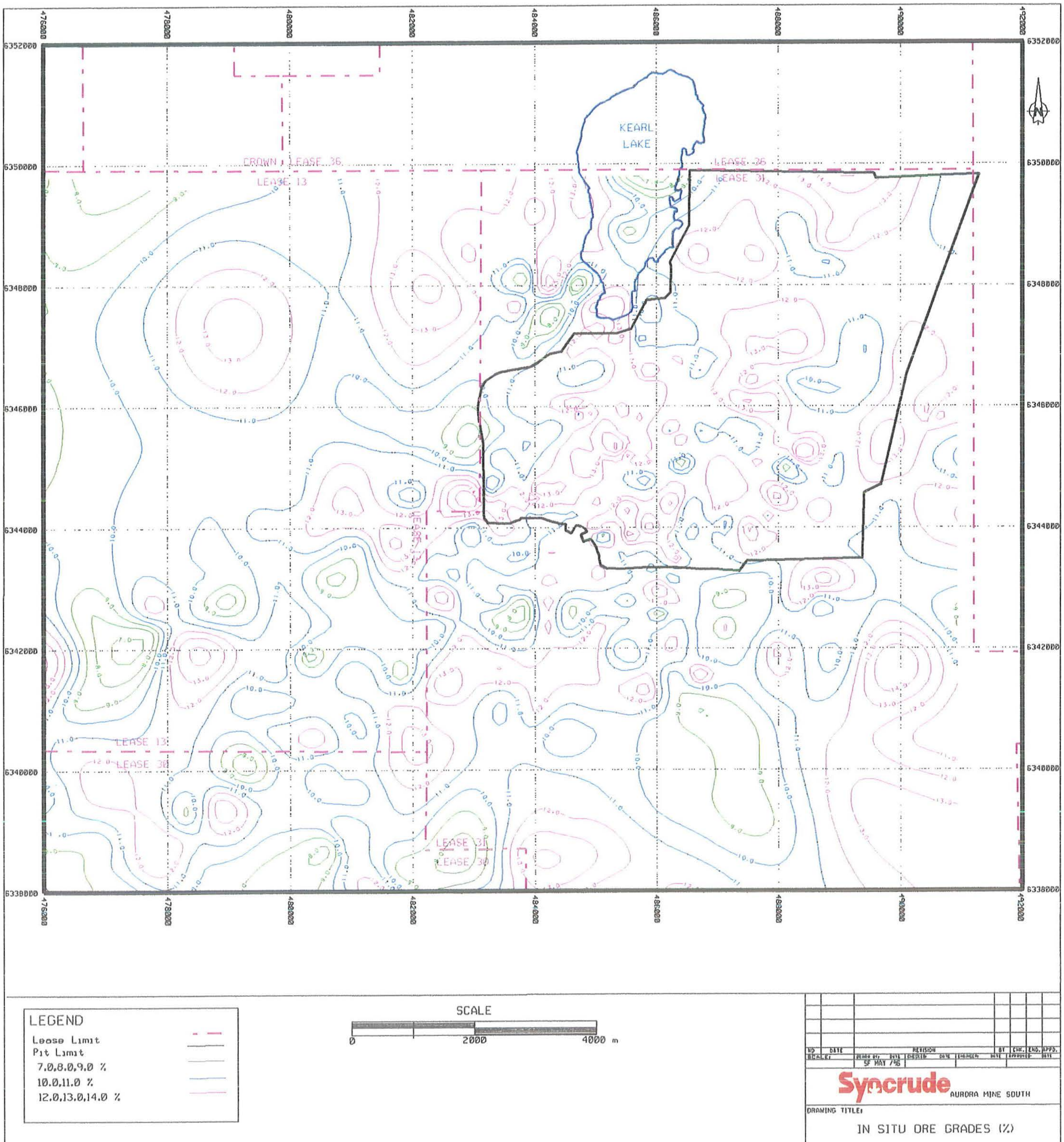
Syncrude AURORA MINE SOUTH

DRAWING TITLE:

ORE THICKNESS (m)

DRAWING NUMBER: Figure 3.2 - 33

REV. 0



Syncrude AURORA MINE SOUTH

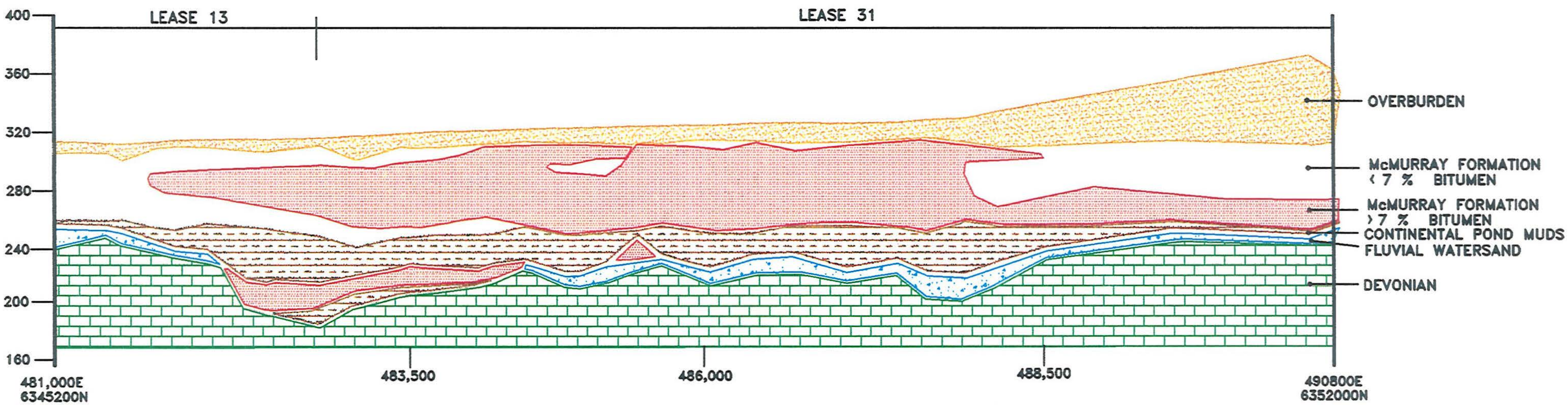
DRAWING TITLE: IN SITU ORE GRADES (%)

DRAWING NUMBER: Figure 3.2 - 34

REV. 0

5F MAY /96

SCHEMATIC SECTION THROUGH AURORA MINE SOUTH (LOOKING NORTH)

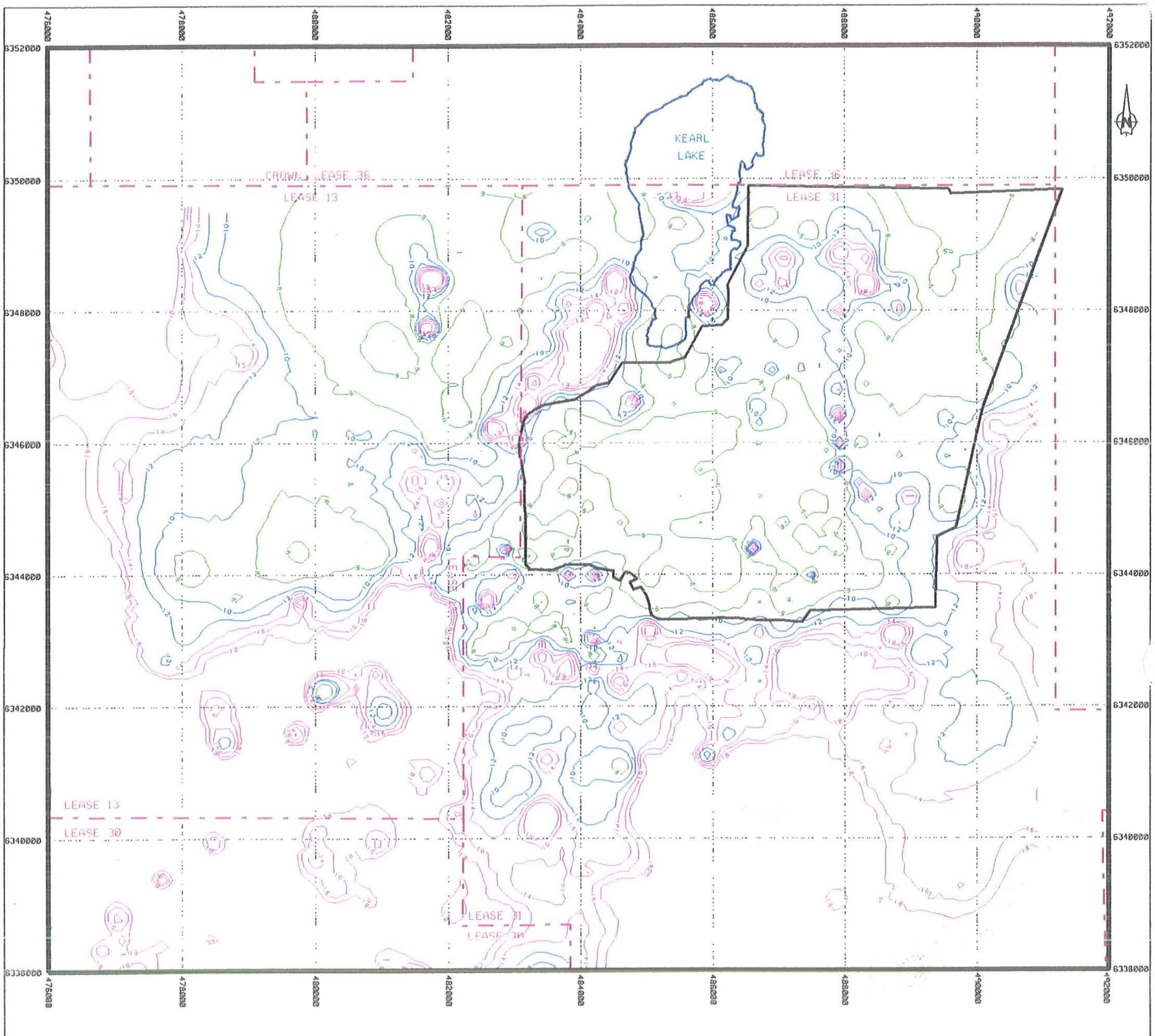


Syncrude AURORA MINE SOUTH

GENERALIZED GEOLOGICAL SECTION

FIG.3.2-35

REV. 0



LEGEND

Pit Limit	
Lease Limit	
8	
10,12	
14,16,18	

SCALE

0 2000 4000 m

NO	DATE	REVISION	BY	CHK.	ENG.	APPD.

SCALE: DRAWN BY: SF DATE: MAY /96

Syncrude AURORA MINE SOUTH

DRAWING TITLE:

TOTAL VOLUME : BITUMEN IN PLACE ($m^3 : m^3$)

DRAWING NUMBER	REV.
Figure 3.2 - 36	0

Structural Geology

Aurora South does not appear to be subject to any unique structural stability risks. The geologic history of this site includes periods of tectonic tilting and uplift, erosion, faulting, and subsidence.

During the time period between the Devonian and Cretaceous, an erosional surface developed on the underlying Devonian rocks resulting in development of a drainage network. Local hills and valleys eroded into this surface partially govern the thickness of the overlying McMurray Formation.

Fault planes within the Precambrian were detected through seismic surveys and no evidence of movement since pre-Devonian time has been found. An orthogonal system of north-south and east-west striking faults has been linked to a regional stress field. The orientation of joints in northern Alberta is controlled by the same stress fields that influenced the faulting.

Where groundwater and meteoric water intersected the erosional edge of the soluble Devonian strata, it leached soluble minerals. The salt of the Muskeg (Prairie Evaporite) Formation was especially susceptible to removal. As evaporites and carbonates were removed, the overlying strata subsided to fill the void. A hole drilled through the Devonian on Lease 31 confirms the absence of soluble minerals in the Muskeg Formation.

Hydrogeology

Within the Aurora South mine area are four distinct horizons which have the potential to behave as aquifers.

- Surficial — water contained mostly within muskeg material.
- Pleistocene — water occurring locally in till sheets and in sandy zones of meltwater channels.
- McMurray Formation (Cretaceous) — basal water sands, which is a confined aquifer below the oil sand and the Devonian.
- Devonian aquifers, mainly Keg River Formation (Methy) which is a reefal and La Loche formation, an arkosic of sandstone at the base of Devonian sequence.

Surficial Aquifer

The surficial aquifer at the Aurora South mine site consists of a thin veneer of muskeg which has a local maximum thickness of 7.5 metres in the mine site area. The muskeg is recharged by precipitation and snowmelt. It has a high water retention capacity.

Pleistocene Aquifers

The glacial sediments west and north of the Aurora South site are coarsely granular and permeable at surface. The mine site area and Muskeg Mountain to the east are covered by impermeable lacustrine clay layers and clay rich tills which restrict vertical fluid transmission.

However, in some areas glacial meltwater eroded the clay and deposited sandy gravel in meltwater channels and outwash plains. These are now water saturated.

Cretaceous Aquifers

Within the McMurray Formation, two horizons are aquifers: the intra-orebody sands and the basal sands. The basal sands, which lie between the oil bearing part of the McMurray Formation and the Devonian sediments below, are the most significant. These sands are generally coarse and contain little or no bitumen. They are by far the most permeable of the lithofacies present in the area.

Devonian Aquifers

There is little likelihood that Devonian aquifers will have an effect on mining of the oil sands in Lease 31. No hydraulic connection was demonstrated from any of the test work; that is, there was no noticeable change in the piezometric head of the Devonian aquifers during the basal McMurray Formation aquifer pump test.

Geological Resource Evaluation

A combination of tools and techniques were used to evaluate the bitumen resource potential of Lease 31. Core holes and auger holes were supplemented by surface geophysics and test pits. Aerial photography and satellite imagery were also used to assist in the interpretation.

In total, 455 core holes have been drilled on Lease 31 of which 246 are within the proposed mine area. An additional 99 were drilled on the adjacent Lease 13 and 54 holes on Lease 30 to evaluate the tailings disposal site on the Lease 13/30 boundary.

Core description and sample assay results were depth corrected using wireline geophysical logs and entered into a comprehensive database used to develop a geological model and mine plans.

All the holes drilled were logged with various geophysical wireline tools including gamma ray, resistivity, neutron porosity, lithol-density, and spontaneous potential. About 250 holes in the mine site area were logged using a dipmeter. Sonic logs were also run in a few holes to provide synthetic seismograms to aid the seismic interpretations.

Surface geophysical surveys consisting of seismic reflection, seismic refraction, transient EM and fixed frequency EM were conducted on Leases 31 and the neighbouring Leases 13 and 30.

Post-Cretaceous soils were investigated by auger drilling. These holes were used to predetermine the core point in advance of core hole drilling. The soils were sampled by Shelby tube and by split spoon. Samples were analyzed for moisture content, Atterberg limits, grain size distribution, density, soil chemistry, and other geotechnical parameter.

Granular Resources

Three small granular deposits were identified about 10 kilometres east of the mine site in Township 95 Range 7. The deposits will yield about four million cubic metres of granular material.

Geotechnical Characteristics

Geologically, Lease 31 is very similar to Leases 12, 34 and 10. The area is covered with a mantle of Holocene and Pleistocene deposits underlain by Cretaceous Clearwater clays, which in some places have been eroded away. Beneath the Clearwater Formation lies the McMurray Formation, which in turn is underlain by the Devonian Formation.

The main differences between Aurora North and Aurora South are:

- the thickness of the individual soil units,
- the presence of Clearwater clays on the east perimeter of the proposed tailings facility and on the eastern one-third of the proposed mine pit versus the general absence of Clearwater clays in Aurora North,
- the presence of a buried Pleistocene Channel underneath the footprint of the proposed tailings facility which has incised up to 90 metres into the McMurray Formation. The southern part of the channel is till filled while the northern part is sand and gravel filled.

The impact of more frequent occurrences of Clearwater clays will mean flatter overall slope angles for both the pit walls and dykes. The major concerns with the buried channels are the seepage of the process water into the groundwater regime and the possible connection with the basal aquifer which could impact the depressurization scheme. The latter is considered unlikely since the deepest part of the channel is still filled. Potential for leakage of process water into the groundwater regime will be addressed further during the detailed engineering design stage.

3.2.6 Reserves Evaluation - Aurora South

Ore Reserves Calculation Method

The same method for calculating the ore reserves at Aurora North, including mine ore criteria and extraction bitumen recovery, was used for Aurora South. The final outline was manually selected, keeping in mind the need for a reasonable width of the pit for operability as well as the surficial features and other physical constraints. The Pleistocene channels in the south- and north-west were avoided.

3.2.7 Mine Location - Aurora South

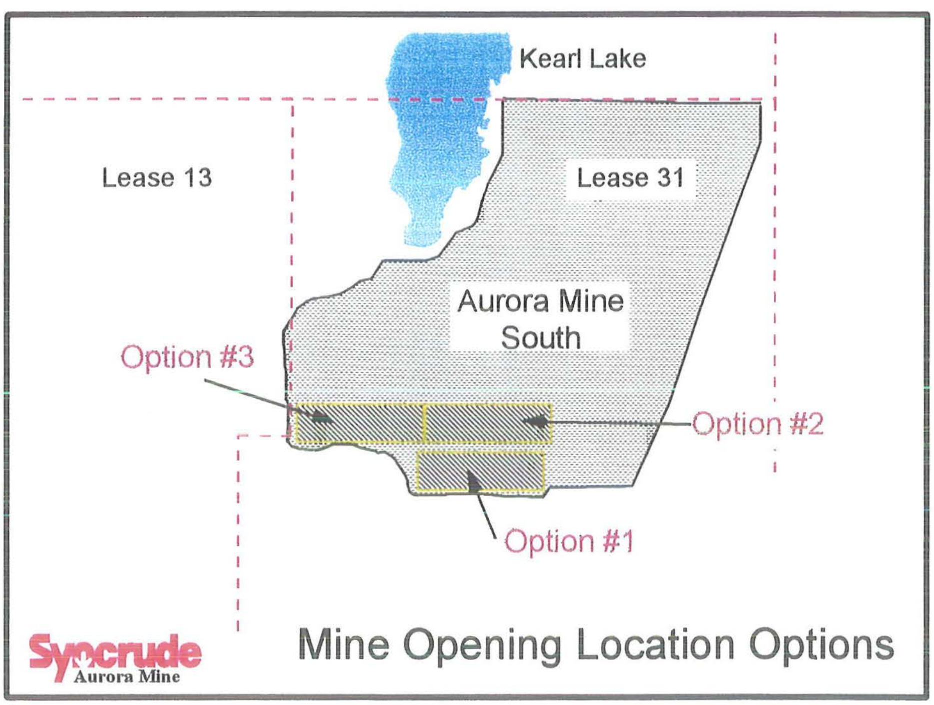
Mine Site Selection

The northern portion of Lease 31 contains the surface mineable ore for Aurora South. This mining area includes the OSLO mine area as well as ore zones within Lease 31 to the east and north east. There are sufficient reserves for the mining to continue to 2035 for the two train operation at the rates of 58 million tonnes per train per year.

Initial Mine Opening Alternatives
The initial Aurora mining activity will be in approximately the same location as was selected by the OSLO Project. The criteria used to select the initial opening are the same as for the Aurora North (Section 3.2.3).

Three potential sites for the initial opening were considered: (1) along the south edge of the mine pit, (2) in the centre of the mine pit, and (3) at the southwest corner of the mine pit. Based on this evaluation, the third option was selected The evaluation of these three sites is discussed further in Appendix A.

Figure 3.2-37 - Mine Opening Location Options



Mine Location and Infrastructure

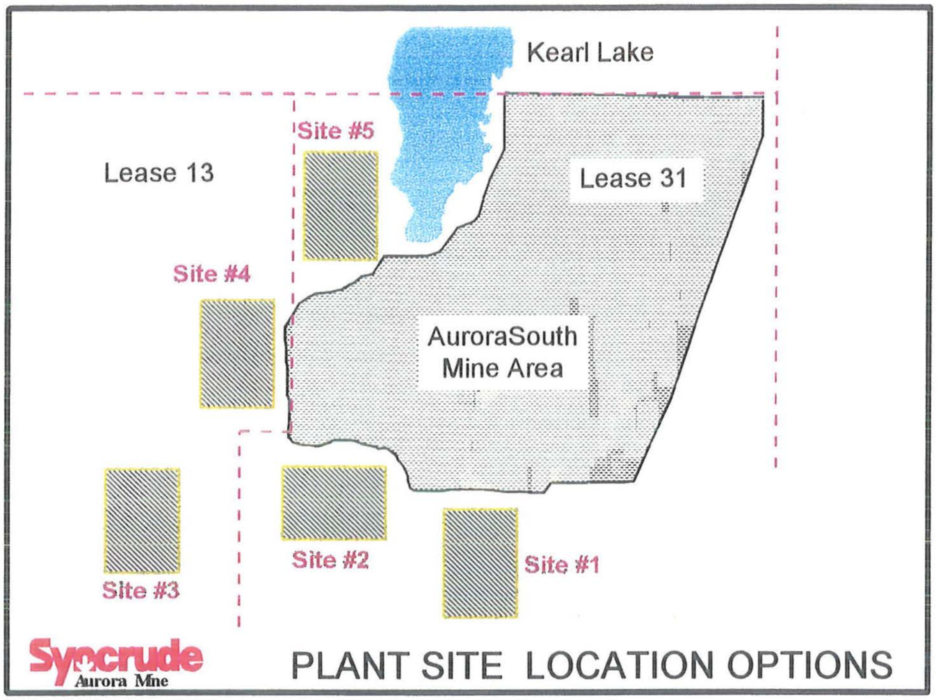
The schematic flow sheet of the facilities for Aurora South is the same as for Aurora North and is shown in Figure 3.2-16. The Mine is located on the northern part of Lease 31; the Extraction Plant on Lease 13 adjacent to the east side of the tailings disposal site. There will be three overburden disposal sites: one south of the mine site on Lease 31, one north of the mine site on Lease 31, and one north of the tailings disposal site on Lease 13. The latter two sites are temporary.

Plant Site Selection

Plant Site Selection Criteria

Five alternative sites were considered for the Aurora South plant site shown in Figure 3.2-38. The inclusion of hydrotransport technology resulted in selection of site 3 which provides an optimum location from the perspective of total material handling costs. The summary of the evaluation is included in Appendix A

Figure 3.2-38 - Plant Site Location Options



3.2.8 Mining Operations - Aurora South

Overview

Aurora Mine South will also use shovel and truck method for mining of oil sands and removal of overburden. Feed preparation and the transportation will be carried out in the same manner as for the Aurora North. Operation of the third extraction train (the first train at Aurora South) is estimated to commence in 2008 with the fourth extraction train estimated for 2015. Development of all activities for the first train at Aurora South are shown in Status Map Figure 3.2-39 in the back of this section. Also contained in the back of the section is a lease closure plan Figure 3.2-40.

Mine Development Planning Criteria

Mine development criteria for the Aurora North were discussed in section 3.2.4. The same criteria will be used for the Aurora Mine South.

Geotechnical Design Considerations

Geotechnical criteria for the Aurora Mine South will not differ significantly from the Aurora North, except in areas where there is a greater presence of Clearwater clays which necessitates flatter slopes.

Pit Slopes

For the design of final pit wall, the same overall slope will be used as for the Aurora North: 3H:1V in the overburden and 2H:1V for the ore benches. Intermediate slopes will also be designed in the same way as Aurora North. In areas where there is a presence of Clearwater clays, slopes will be designed to an appropriate angle.

Overburden Disposal Sites

A major part of the out-of-pit overburden disposal site is on the Clearwater material. As a result, this disposal facility has been designed to a overall slope of 8H:1V. This design parameter will be re-evaluted at the detail design stage.

Offset from Kearl Lake

The Aurora South Mine is located in the northern portion of Lease 31, directly to the south and east of Kearl Lake. It is a shallow lake in a muskeg region which will need a barrier dyke to be constructed along its south and east sides. A detail design will be carried out well in advance of the mining activities in this area.

Site Preparation

Tree Clearing, Timber Salvage, Surface and Muskeg Drainage

Site preparaion activities including tree clearing, timber salvage and surface and muskeg drainge have been discussed for Aurora North in Section 3.2.4. The same criteria and strategy will be used to develop these activities at the Aurora Mine South.

Soil Salvage and Muskeg Stockpiling

All muskeg and reclamation material necessary for the reclamation of the site will be salvaged and will be either directly hauled to a reclaimed site or stockpiled until needed. The mine will have a site-wide material balance completed prior to the commencement of mining and the necessary quantities of salvaged soil will be designated.

Waste Disposal

The initial quantities of overburden will be hauled to either the south disposal site or west to the starter dyke for the tailings disposal site.

South Overburden Disposal Site

The south overburden disposal site shown on the status map was selected due to its proximity to the mine and the fact it is located over a non-minable area. This disposal site has a capacity of 50 million cubic metres of material with a final slope of 8 horizontal to 1 vertical. The design of the disposal site will be detailed prior to the start-up of mining as the base is on predominantly Clearwater clays which require extensive investigation to ensure a stable design.

In-Pit Dykes and In-Pit Waste Disposal.

Once the pit is open to the base of feed, the overburden and centre reject material will be placed in pit. It will be necessary to construct containment dykes as are designed for the Aurora Mine North for the containment of composite tailings (CT). The ore zone extends west from the pit onto Lease 13 and will require a dyke built along the western boundary of Lease 31 prior to the placement of tailings in pit.

Cyclofeeder Reject Disposal.

The rejects from the cyclofeeder will initially be disposed of in the tailings disposal area until the mine pit is large enough to allow for disposal in pit.

Oil Sand Mining

The mining of oil sand will commence in 2008 with the mine opening in the southwest corner. The bench height will be nominally 14 metres. Mining will progress in a northeasterly direction with the final pit walls being designed to maximize the recovery of the resource.

Production will increase from 15 million tonnes in 2008 to 58 million tonnes in 2009 and will continue at that rate until 2035. The ore zone numbers for the ore and waste in the northeast extension of the main ore zone on the east side of Kearl Lake as well as for extension of the main ore zones eastward into Muskeg Mountain were all estimated using the EAGLES 2-D model.

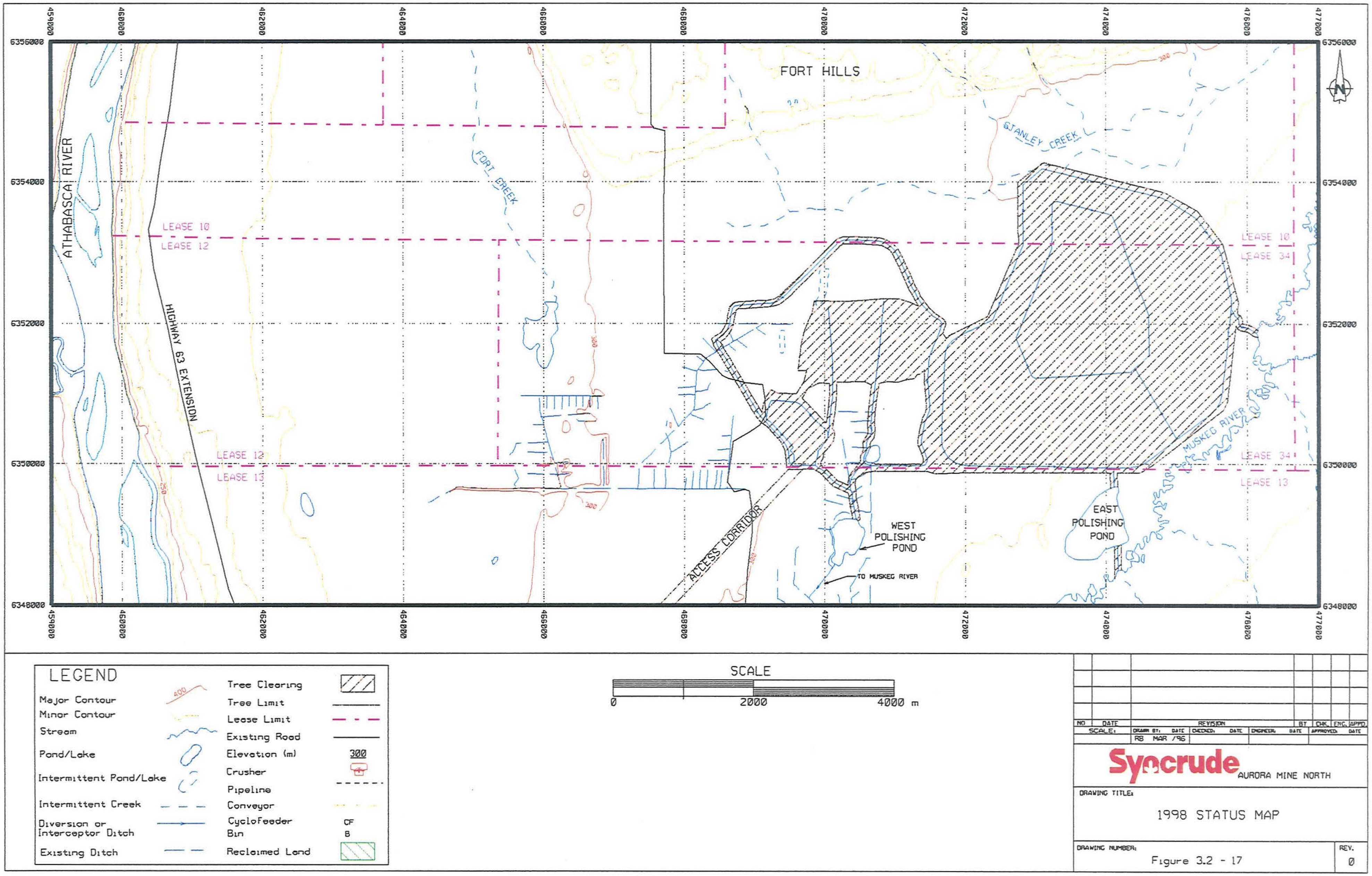
Train 4, the second of the two trains in Aurora South, starts production in 2015. It will increase from 15 million tonnes in 2015 to 57 million tonnes in 2016. Production will remain constant to the year 2035. Mining material volumes are summarized in Table 3.2-9.

Table 3.2-9 - Oilsand Production - Aurora South

Year	Oilsand Volumes (MBCM)	Diluted Grade	Overburden Volume (MBCM)	Interburden Volume (MBCM)	Total Waste Volume (MBCM)
2008-2010	61.4	11.25	38.8	27.8	66.6
2011-2015	142.8	11.02	50.0	48.7	98.7
2016-2020	276	11.72	51.8	58.1	109.9
2021-2025	276	11.32	117.2	95.9	213.1
2026-2030	276	11.10	196.8	125.0	321.8
2031-2035	276	11.40	251.4	103.2	354.7
TOTAL	**1308.2**	**11.34**	**706.1**	**458.7**	**1164.8**

Granular Resources

A detailed evaluation of granular material availability and requirements will be conducted well in advance of the construction activity. The Aurora Mine South will utilize the gravel found to the east on Lease 87. Any excess granular requirement from other sources will be identified.


ATHABASCA RIVER
HIGHWAY 63 EXTENSION
FORT HILLS
FORT CREEK
STANLEY CREEK
MUSKEG RIVER
LEASE 10
LEASE 12
LEASE 13
LEASE 34
ACCESS CORRIDOR
WEST POLISHING POND
EAST POLISHING POND
TO MUSKEG RIVER
459000
460000
462000
464000
466000
468000
470000
472000
474000
476000
477000
6356000
6354000
6352000
6350000
6348000
LEGEND
Major Contour
Minor Contour
Stream
Pond/Lake
Intermittent Pond/Lake
Intermittent Creek
Diversion or Interceptor Ditch
Existing Ditch
Tree Clearing
Tree Limit
Lease Limit
Existing Road
Elevation (m)
300
Crusher
Pipeline
Conveyor
CycloFeeder
CF
Bin
B
Reclaimed Land
SCALE
0
2000
4000 m
NO
DATE
REVISION
BY
CHK
ENG
APPD
SCALE:
DRAWN BY: RB
DATE MAR /96
CHECKED:
DATE
ENGINEER:
DATE
APPROVED:
DATE
Syncrude
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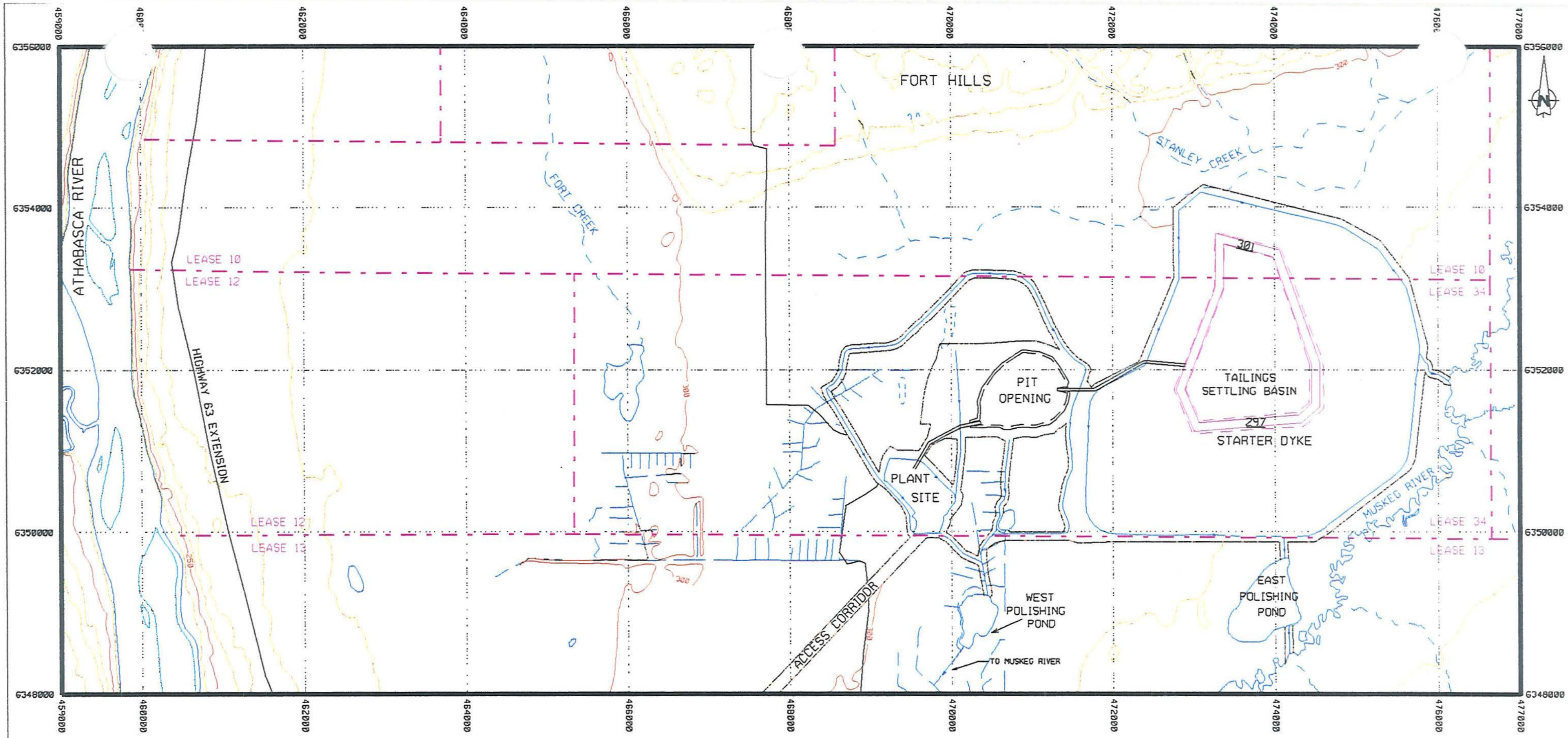

LEGEND

Major Contour		Tree Clearing	
Minor Contour		Tree Limit	
Stream		Lease Limit	
Pond/Lake		Existing Road	
Intermittent Pond/Lake		Elevation (m)	300
Intermittent Creek		Crusher	
Diversion or Interceptor Ditch		Pipeline	
Existing Ditch		Conveyor	
		Cyclofeeder	CF
		Bin	B
		Reclaimed Land	

SCALE

0 2000 4000 m

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Syncrude AURORA MINE NORTH

DRAWING TITLE:

1999 STATUS MAP

DRAWING NUMBER: Figure 3.2 - 18

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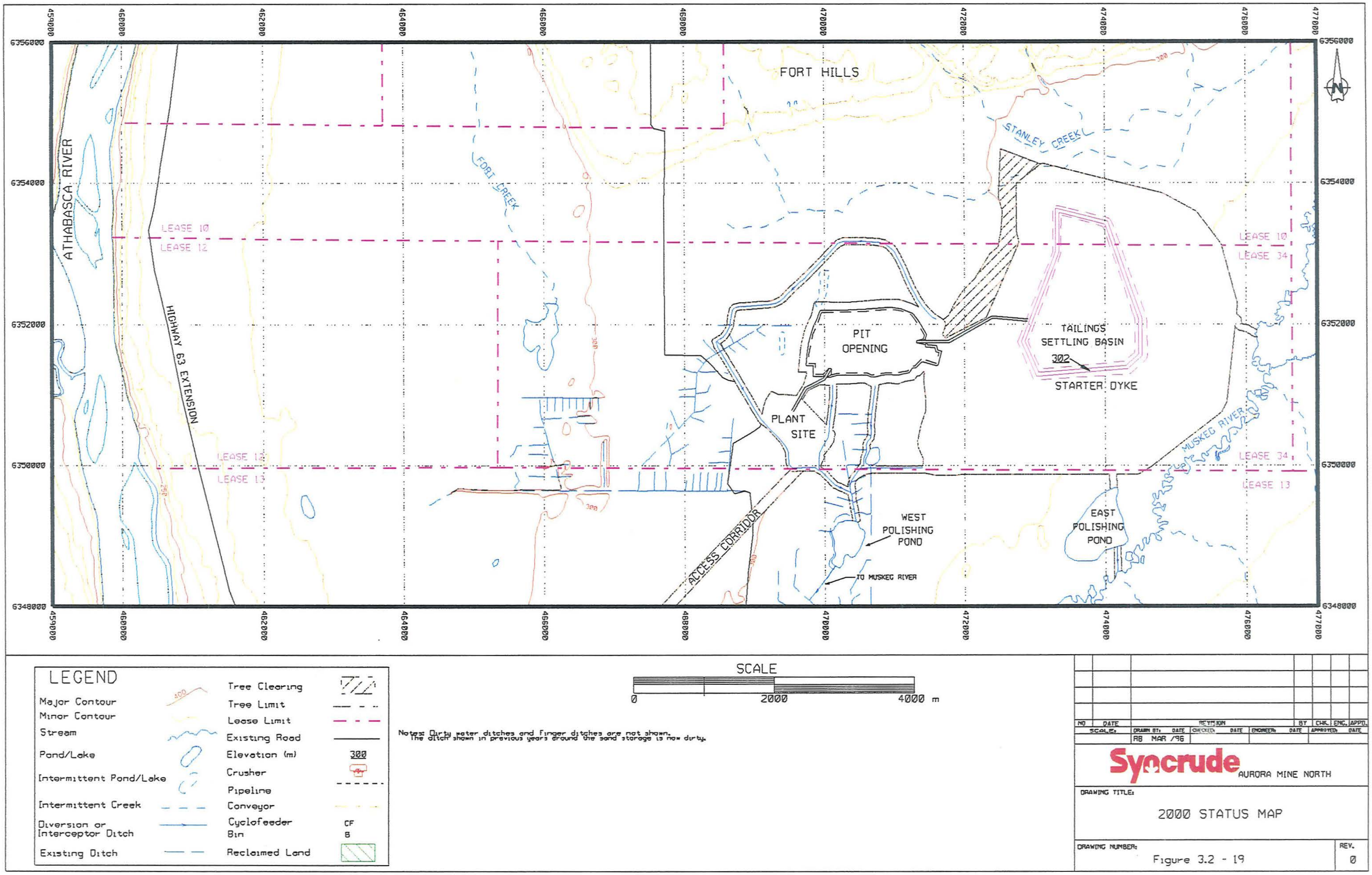

FORT HILLS
STANLEY CREEK
FORT CREEK
ATHABASCA RIVER
HIGHWAY 63 EXTENSION
LEASE 10
LEASE 12
LEASE 13
LEASE 34
PIT OPENING
TAILINGS SETTLING BASIN
302
STARTER DYKE
PLANT SITE
MUSKEG RIVER
ACCESS CORRIDOR
WEST POLISHING POND
EAST POLISHING POND
TO MUSKEG RIVER
300
6356000
6354000
6352000
6350000
6348000
459000
460000
462000
464000
466000
468000
470000
472000
474000
476000
477000
LEGEND
Major Contour
Minor Contour
Stream
Pond/Lake
Intermittent Pond/Lake
Intermittent Creek
Diversion or Interceptor Ditch
Existing Ditch
Tree Clearing
Tree Limit
Lease Limit
Existing Road
Elevation (m)
Crusher
Pipeline
Conveyor
Cyclofeeder CF
Bin B
Reclaimed Land
SCALE
0
2000
4000 m
Notes: Dirty water ditches and finger ditches are not shown.
The ditch shown in previous years around the sand storage is now dirty.
Syncrude
AURORA MINE NORTH
DRAWN BY: RB
DATE: MAR /96
DRAWING TITLE:
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DRAWING NUMBER:
Figure 3.2 - 19
REV.
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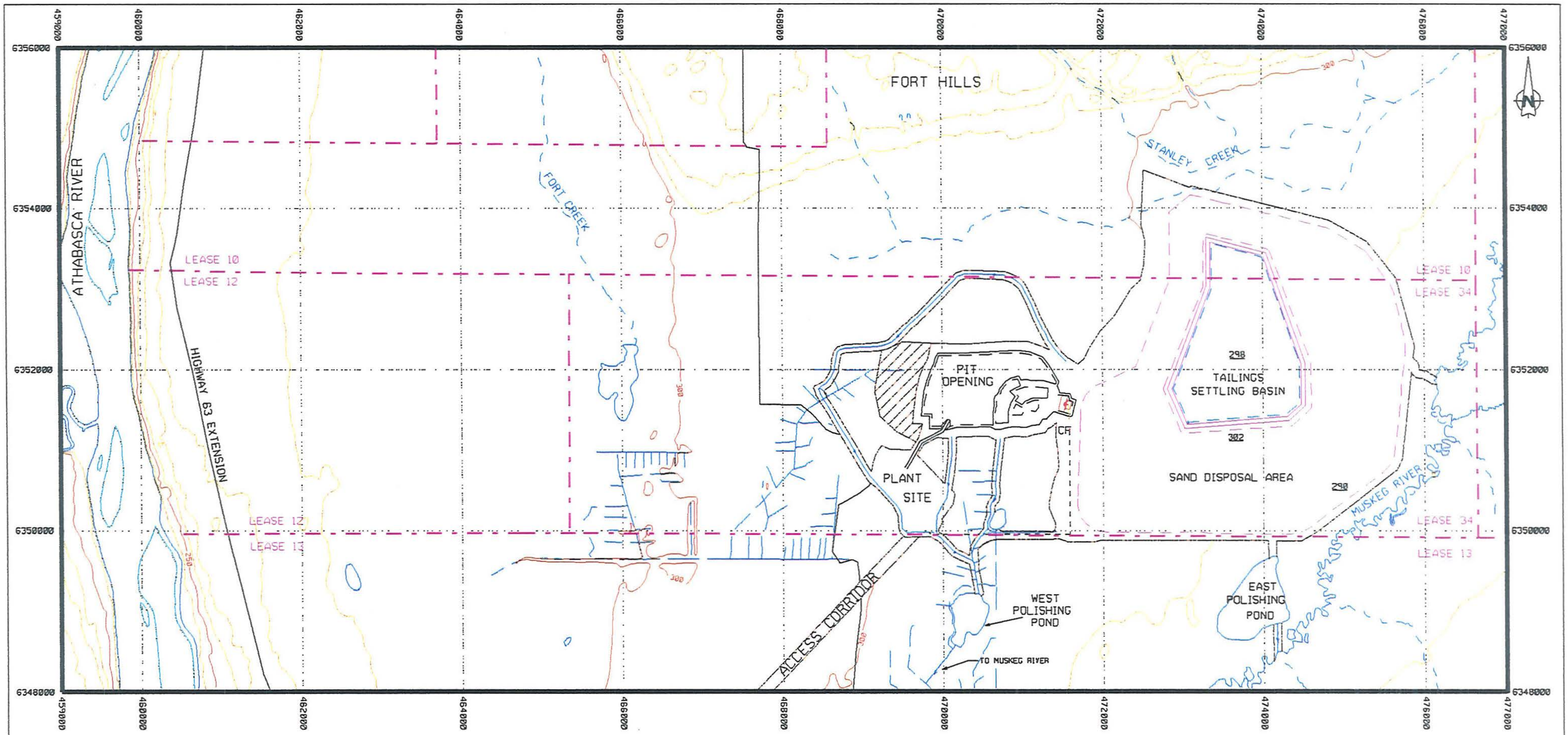


LEGEND

Major Contour	400	Tree Clearing	
Minor Contour		Tree Limit	
Stream		Lease Limit	
Pond/Lake		Existing Road	
Intermittent Pond/Lake		Elevation (m)	300
Intermittent Creek		Crusher	
Diversion or Interceptor Ditch		Pipeline	
Existing Ditch		Conveyor	
		Cyclofeeder	CF
		Bin	B
		Reclaimed Land	

SCALE

0 2000 4000 m

Notes: Dirty water ditches and finger ditches are not shown.
The ditch shown before 2000 around the sand storage is now dirty.

NO	DATE	REVISION	BY	CHK.	ENG.	APPD.
SCALE:	DRAWN BY: RB	DATE: MAR /96	CHECKED:	DATE:	ENGINEER:	DATE:

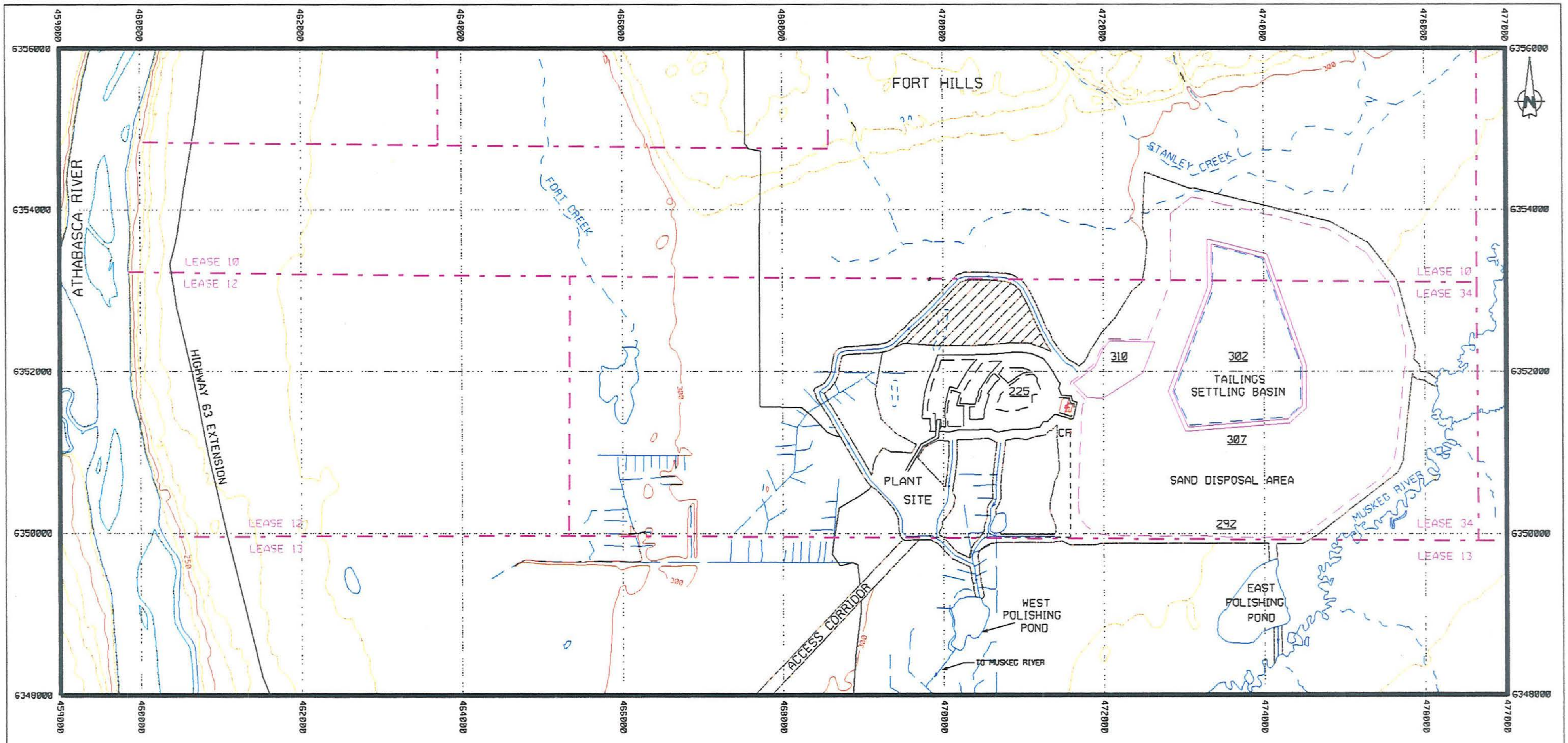
Syncrude AURORA MINE NORTH

DRAWING TITLE:

2001 STATUS MAP

DRAWING NUMBER: Figure 3.2 - 20

REV. 0



LEGEND

Major Contour	400	Tree Clearing	
Minor Contour		Tree Limit	
Stream		Lease Limit	
Pond/Lake		Existing Road	
Intermittent Pond/Lake		Elevation (m)	300
Intermittent Creek		Crusher	
Diversion or Interceptor Ditch		Pipeline	
Existing Ditch		Conveyor	
		Cyclofeeder	CF
		Bin	B
		Reclaimed Land	

SCALE

0 2000 4000 m

Notes: Dirty water ditches and finger ditches are not shown.
The ditch shown before 2000 around the sand storage is now dirty.

NO	DATE	REVISION	BY	CHK.	ENG.	APPD.

SCALE: DRAWN BY: RB DATE: MAR /96 CHECKED: DATE ENGINEER: DATE APPROVED: DATE

Syncrude AURORA MINE NORTH

DRAWING TITLE:

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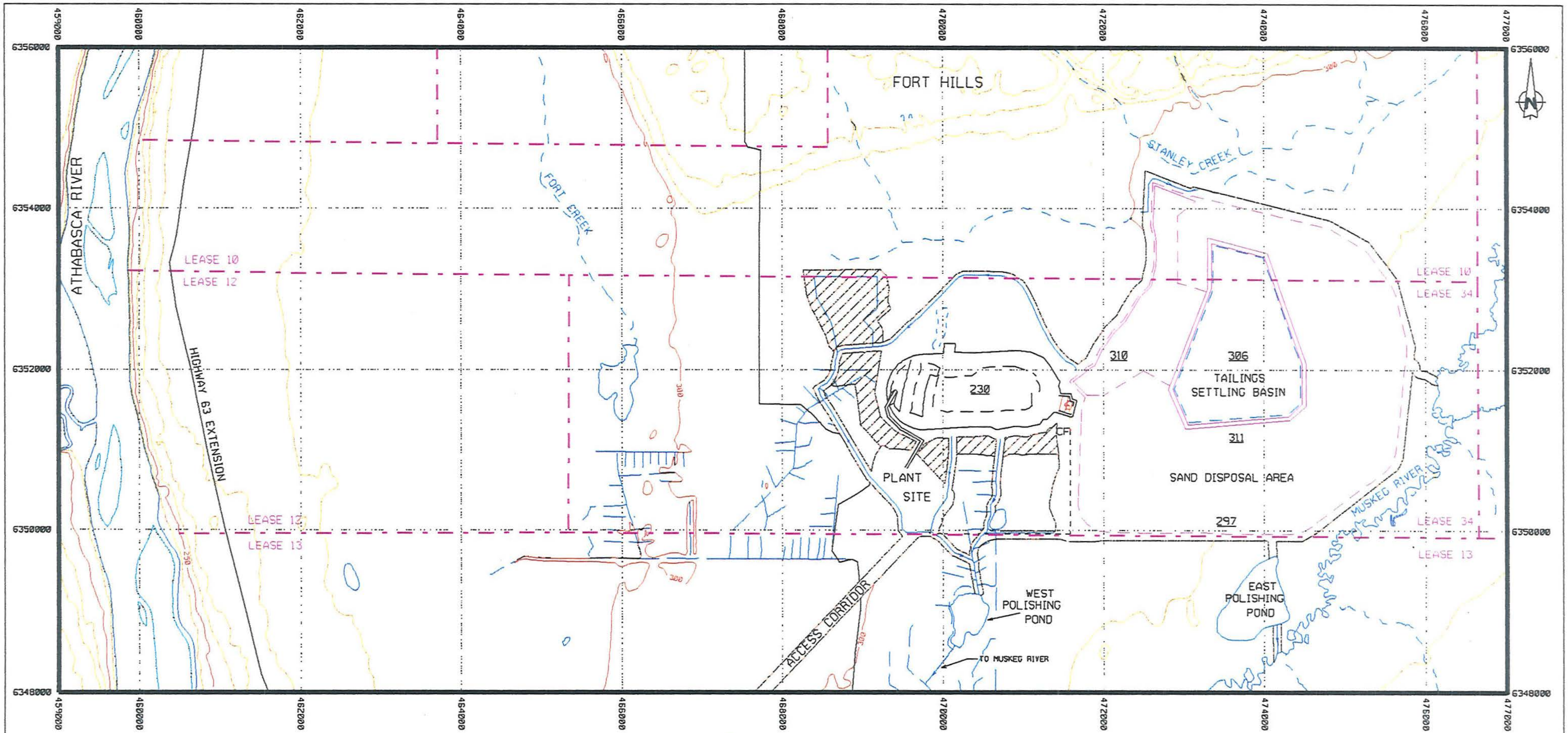
DRAWING NUMBER: Figure 3.2 - 21 REV. 0



LEGEND

Major Contour		Tree Clearing	
Minor Contour		Tree Limit	
Stream		Lease Limit	
Pond/Lake		Existing Road	
Intermittent Pond/Lake		Elevation (m)	300
Intermittent Creek		Crusher	
Diversion or Interceptor Ditch		Pipeline	
Existing Ditch		Conveyor	
		Cyclofeeder	CF
		Bin	B
		Reclaimed Land	

SCALE

0 2000 4000 m

Notes: Dirty water ditches and finger ditches are not shown.

NO	DATE	REVISION	BY	CHK.	ENG.	APPD.
SCALE:	DRAWN BY: RB	DATE: MAR /96	CHECKED:	DATE	ENGINEER:	DATE	APPROVED:	DATE

Syncrude AURORA MINE NORTH

DRAWING TITLE:

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DRAWING NUMBER: Figure 3.2 - 22

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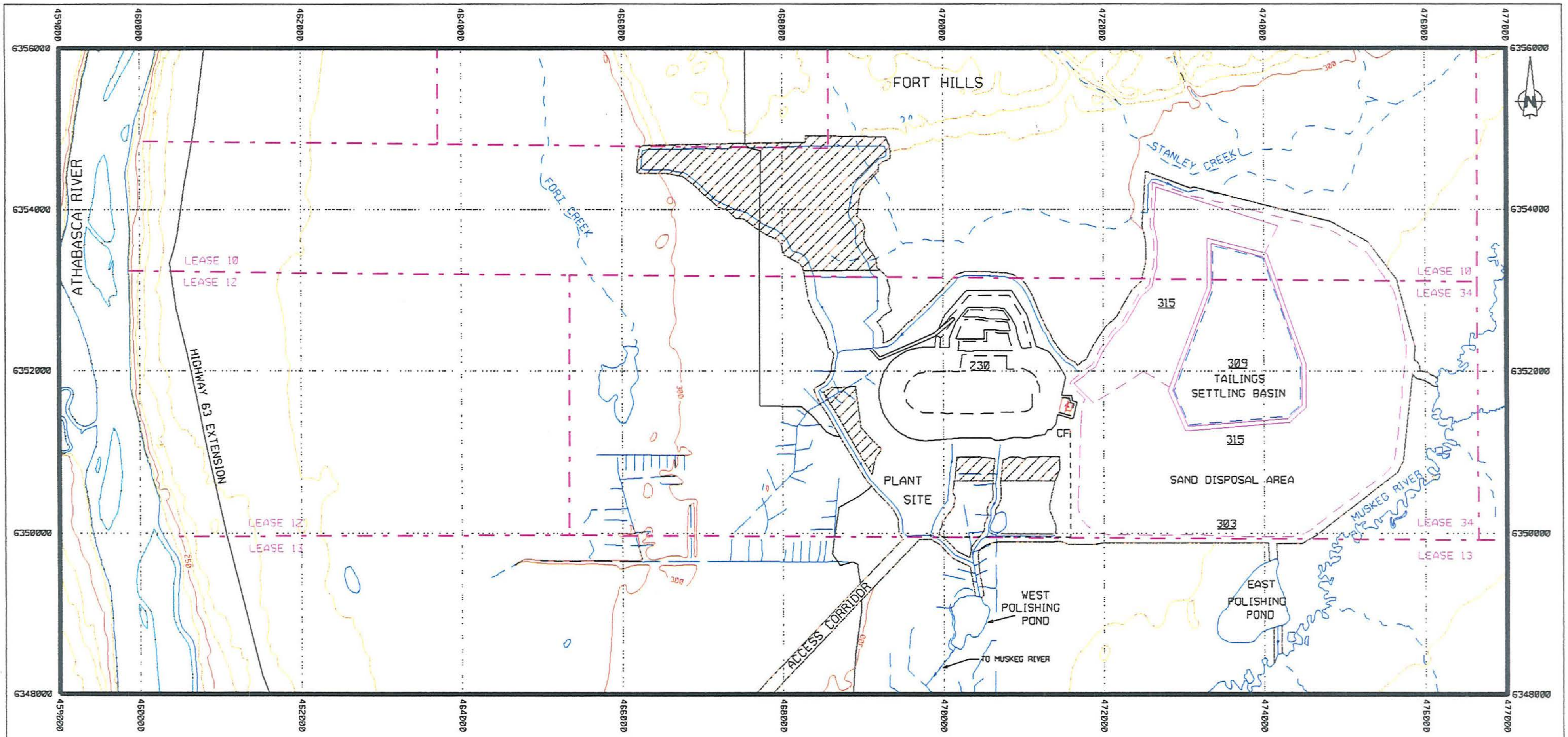

LEGEND

Major Contour		Tree Clearing	
Minor Contour		Tree Limit	
Stream		Lease Limit	
Pond/Lake		Existing Road	
Intermittent Pond/Lake		Elevation (m)	300
Intermittent Creek		Crusher	
Diversion or Interceptor Ditch		Pipeline	
Existing Ditch		Conveyor	
		Cyclofeeder	CF
		Bin	B
		Reclaimed Land	

SCALE

0 2000 4000 m

Notes: Dirty water ditches and finger ditches are not shown.

NO	DATE	REVISION	BY	CHK.	ENG.	APPD.
SCALE:	DRAWN BY: RB	DATE: MAR /96	CHECKED:	DATE	ENGINEER:	DATE	APPROVED:	DATE

Syncrude AURORA MINE NORTH

DRAWING TITLE:

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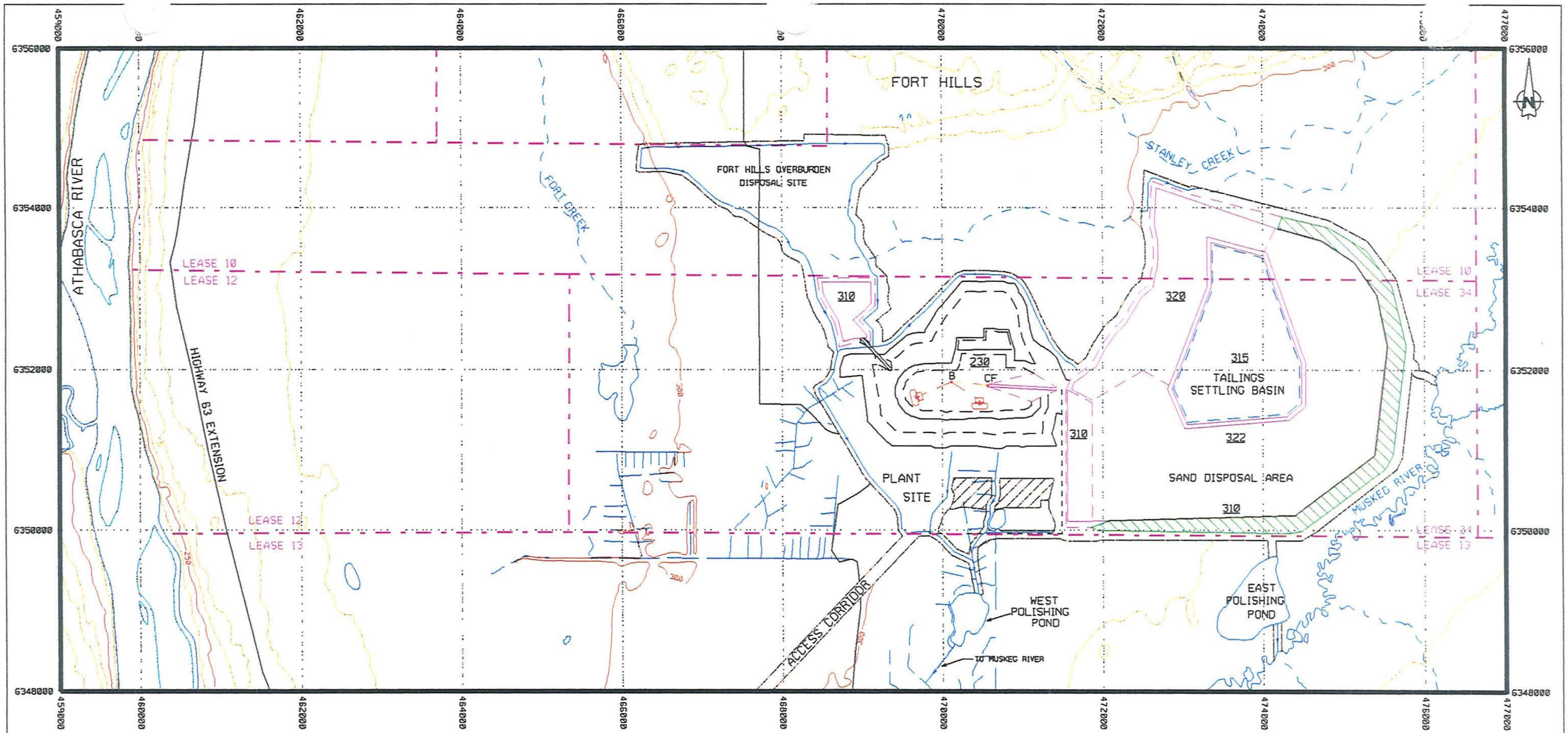

LEGEND

Major Contour	Tree Clearing
Minor Contour	Tree Limit
Stream	Lease Limit
Pond/Lake	Existing Road
Intermittent Pond/Lake	Elevation (m) 300
Intermittent Creek	Crusher
Diversion or Interceptor Ditch	Pipeline
Existing Ditch	Conveyor
	Cyclofeeder CF
	Bin B
	Reclaimed Land

SCALE

0 2000 4000 m

Notes: Dirty water ditches and finger ditches are not shown.

NO	DATE	REVISION	BY	CHK.	ENG.	APPD.

SCALE: DRAWN BY: RB DATE: MAR /96 CHECKED: DATE ENGINEER: DATE APPROVED: DATE

Syncrude AURORA MINE NORTH

DRAWING TITLE:

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DRAWING NUMBER: Figure 3.2 - 24

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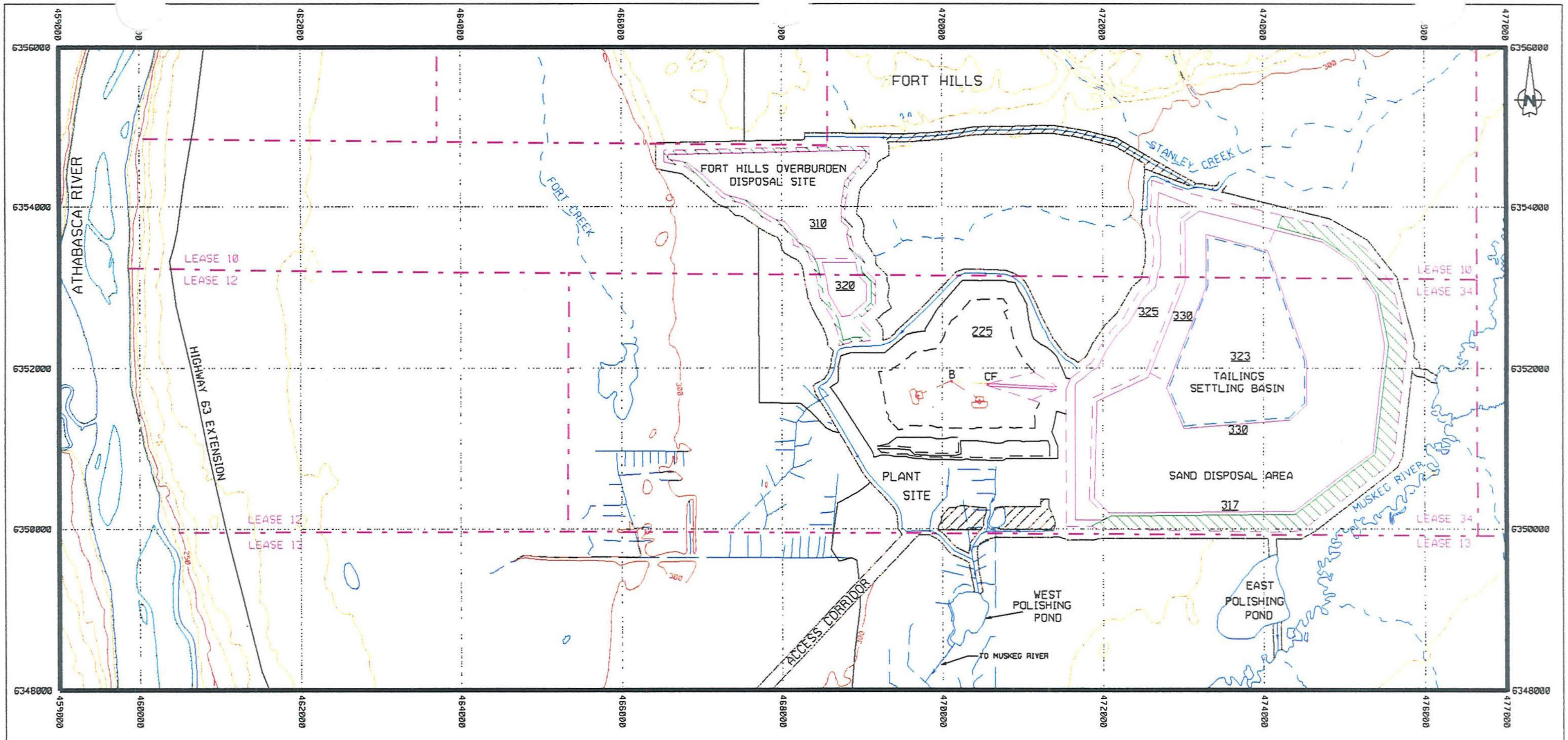

LEGEND

Major Contour		Tree Clearing	
Minor Contour		Tree Limit	
Stream		Lease Limit	
Pond/Lake		Existing Road	
Intermittent Pond/Lake		Elevation (m)	300
Intermittent Creek		Crusher	
Diversion or Interceptor Ditch		Pipeline	
Existing Ditch		Conveyor	
		Cyclofeeder	CF
		Bin	B
		Reclaimed Land	

SCALE

0 2000 4000 m

Notes: Dirty water ditches and finger ditches are not shown.

NO	DATE	REVISION	BY	CHK.	ENG.	APPD.
SCALE:	DRAWN BY: RB	DATE: MAR /96	CHECKED:	DATE	ENGINEER:	DATE	APPROVED:	DATE

Syncrude AURORA MINE NORTH

DRAWING TITLE:

2006 STATUS MAP

DRAWING NUMBER: Figure 3.2 - 25

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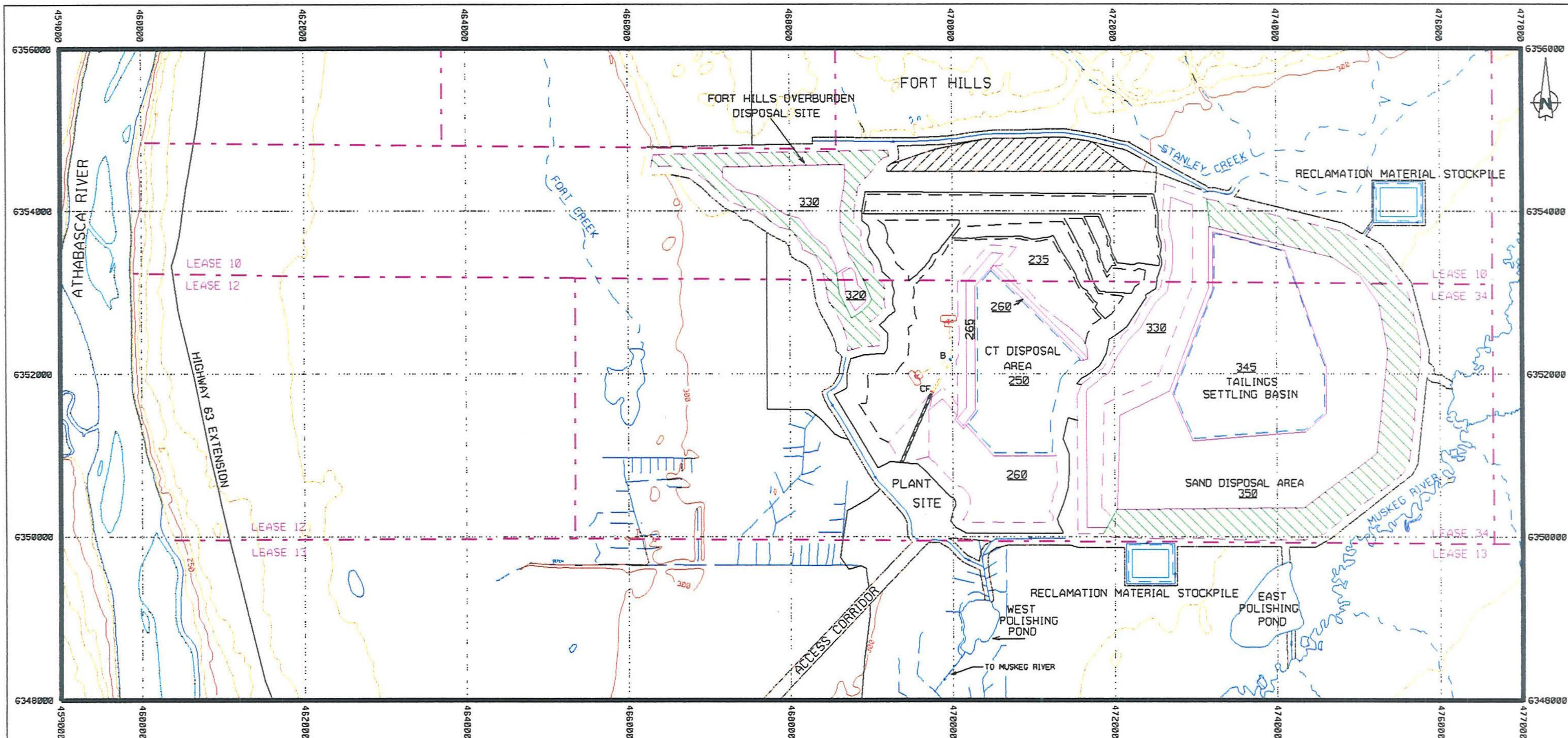

LEGEND

Major Contour		Tree Clearing	
Minor Contour		Tree Limit	
Stream		Lease Limit	
Pond/Lake		Existing Road	
Intermittent Pond/Lake		Elevation (m)	300
Intermittent Creek		Crusher	
Diversion or Interceptor Ditch		Pipeline	
Existing Ditch		Conveyor	
		Cyclofeeder	CF
		Bin	B
		Reclaimed Land	

SCALE

0 2000 4000 m

Notes: Dirty water ditches and finger ditches are not shown.

NO	DATE	REVISION	BY	CHK.	ENG.	APPD.

SCALE: DRAWN BY: SF DATE: MAR /96 CHECKED: DATE: ENGINEER: DATE: APPROVED: DATE:

Syncrude AURORA MINE NORTH

DRAWING TITLE:

2010 STATUS MAP

DRAWING NUMBER: Figure 3.2 - 26

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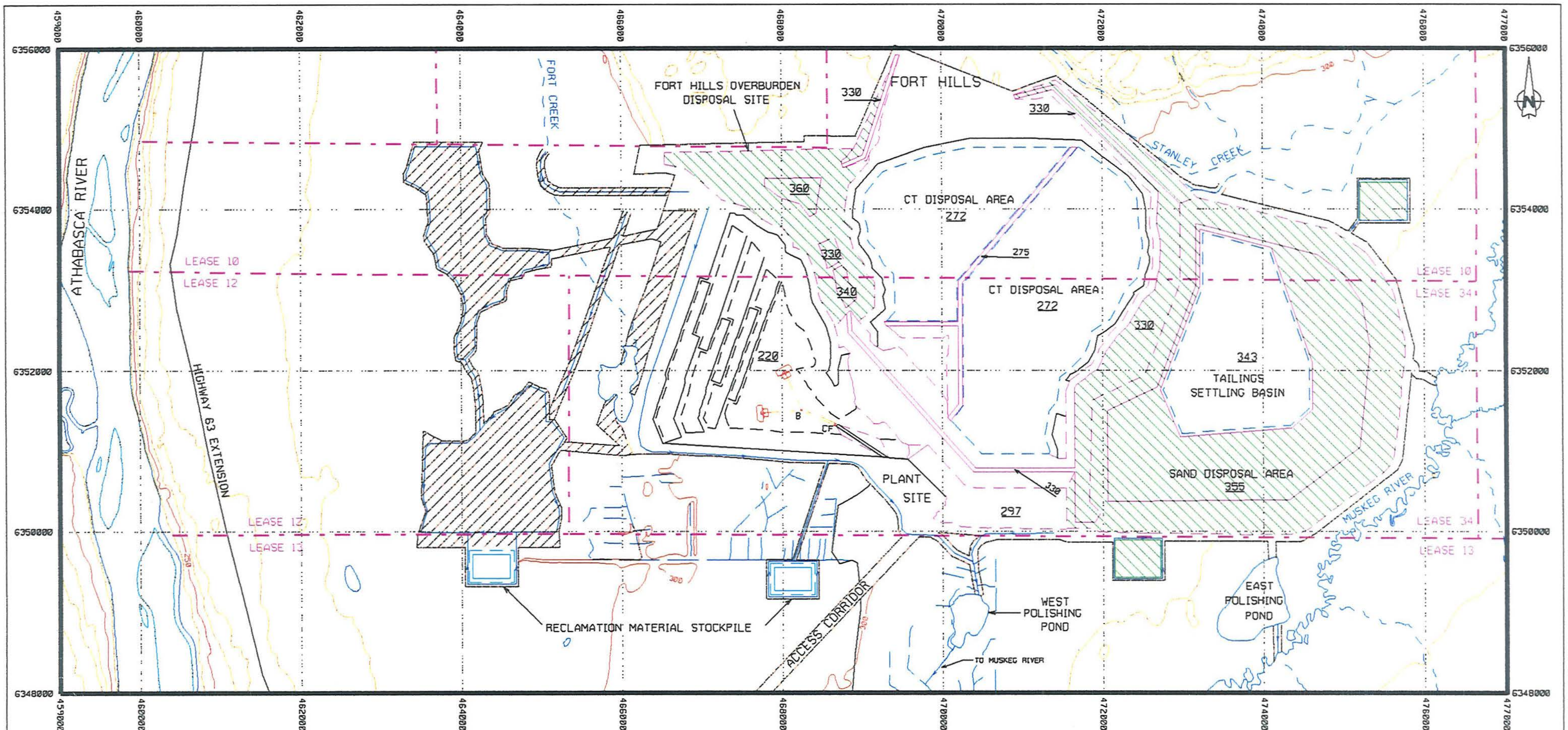

LEGEND

Major Contour	400	Tree Clearing	
Minor Contour		Tree Limit	
Stream		Lease Limit	
Pond/Lake		Existing Road	
Intermittent Pond/Lake		Elevation (m)	300
Intermittent Creek		Crusher	
Diversion or Interceptor Ditch		Pipeline	
Existing Ditch		Conveyor	
		Cyclofeeder	CF
		Bin	B
		Reclaimed Land	

SCALE

0 2000 4000 m

Notes: Dirty water ditches and finger ditches are not shown.

NO	DATE	REVISION	BY	CHK.	ENG.	APPD.

SCALE: DRAWN BY: SF DATE: MAR /96 CHECKED: DATE ENGINEER: DATE APPROVED: DATE

Syncrude AURORA MINE NORTH

DRAWING TITLE:

2015 STATUS MAP

DRAWING NUMBER: Figure 3.2 - 27

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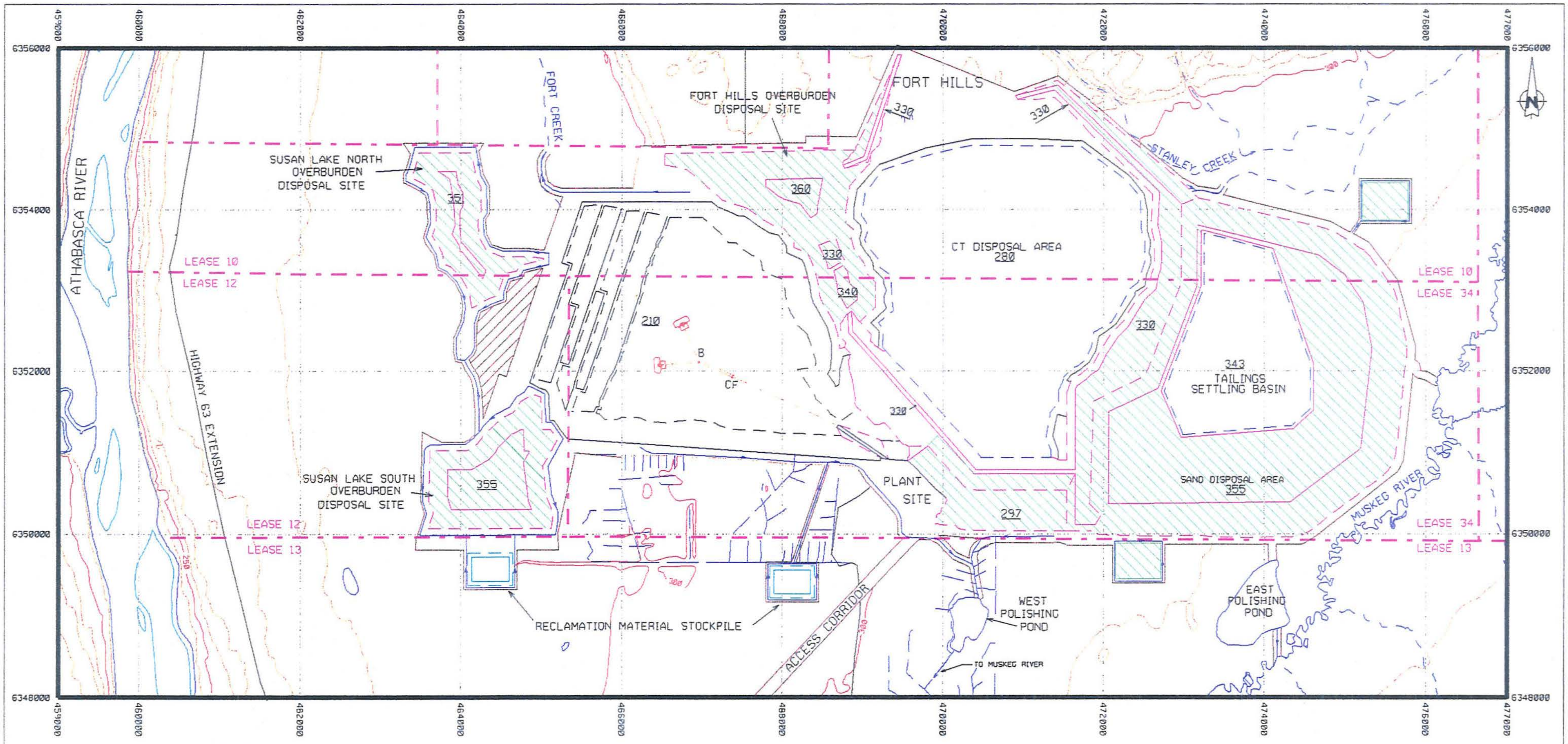

LEGEND

Major Contour		Tree Clearing	
Minor Contour		Tree Limit	
Stream		Lease Limit	
Pond/Lake		Existing Road	
Intermittent Pond/Lake		Elevation (m)	300
Intermittent Creek		Crusher	
Diversion or Interceptor Ditch		Pipeline	
Existing Ditch		Conveyor	
		Cyclofeeder	CF
		Bin	B
		Reclaimed Land	

SCALE

0 2000 4000 m

Notes: Dirty water ditches and finger ditches are not shown.

NO	DATE	REVISION	BY	CHK.	ENG.	APPD.
SCALE:	DRAWN BY: SF	DATE: MAR /96	CHECKED:	DATE	ENGINEER:	APPROVED:

Syncrude AURORA MINE NORTH

DRAWING TITLE:

2020 STATUS MAP

DRAWING NUMBER: Figure 3.2 - 28

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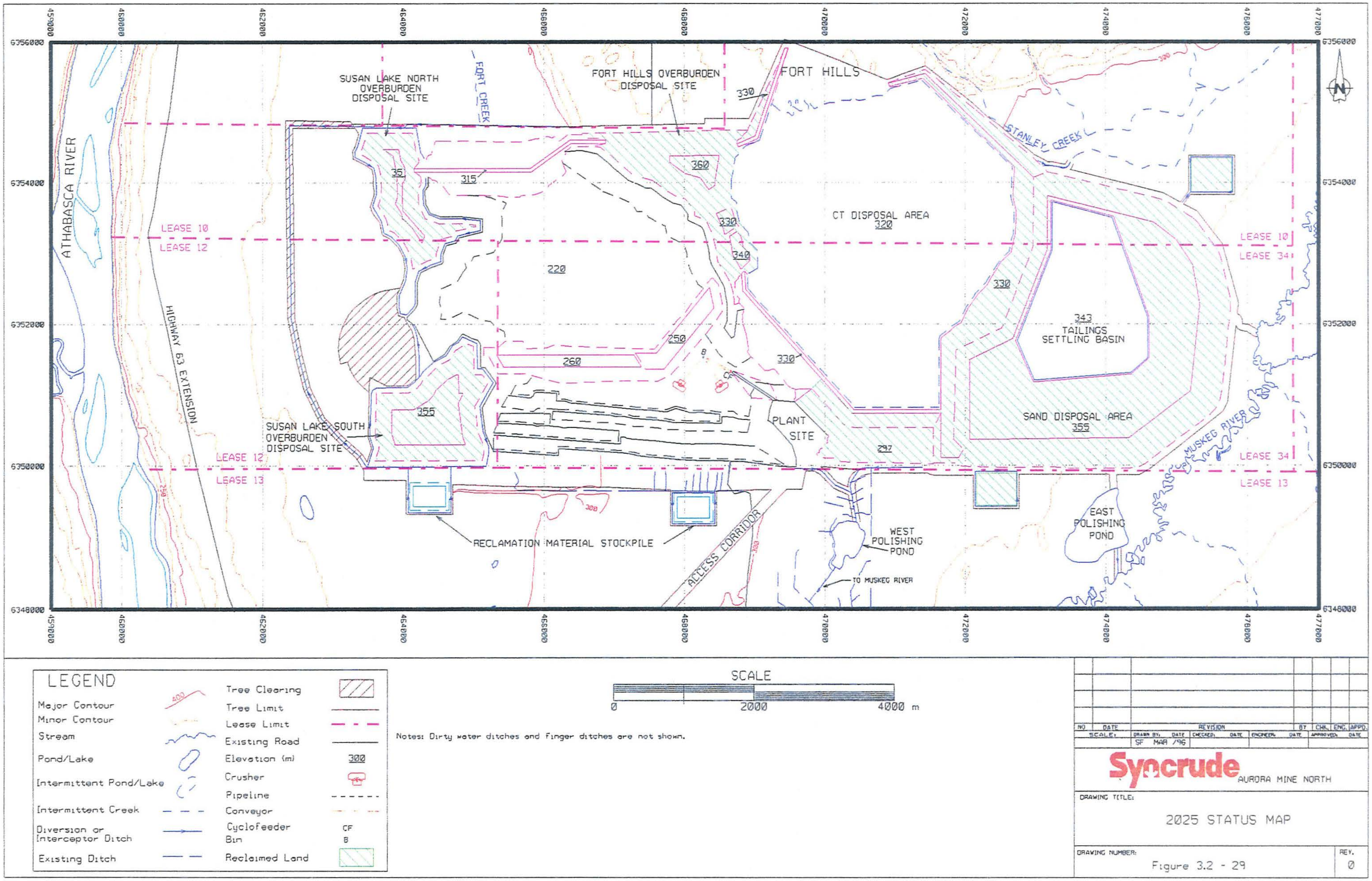
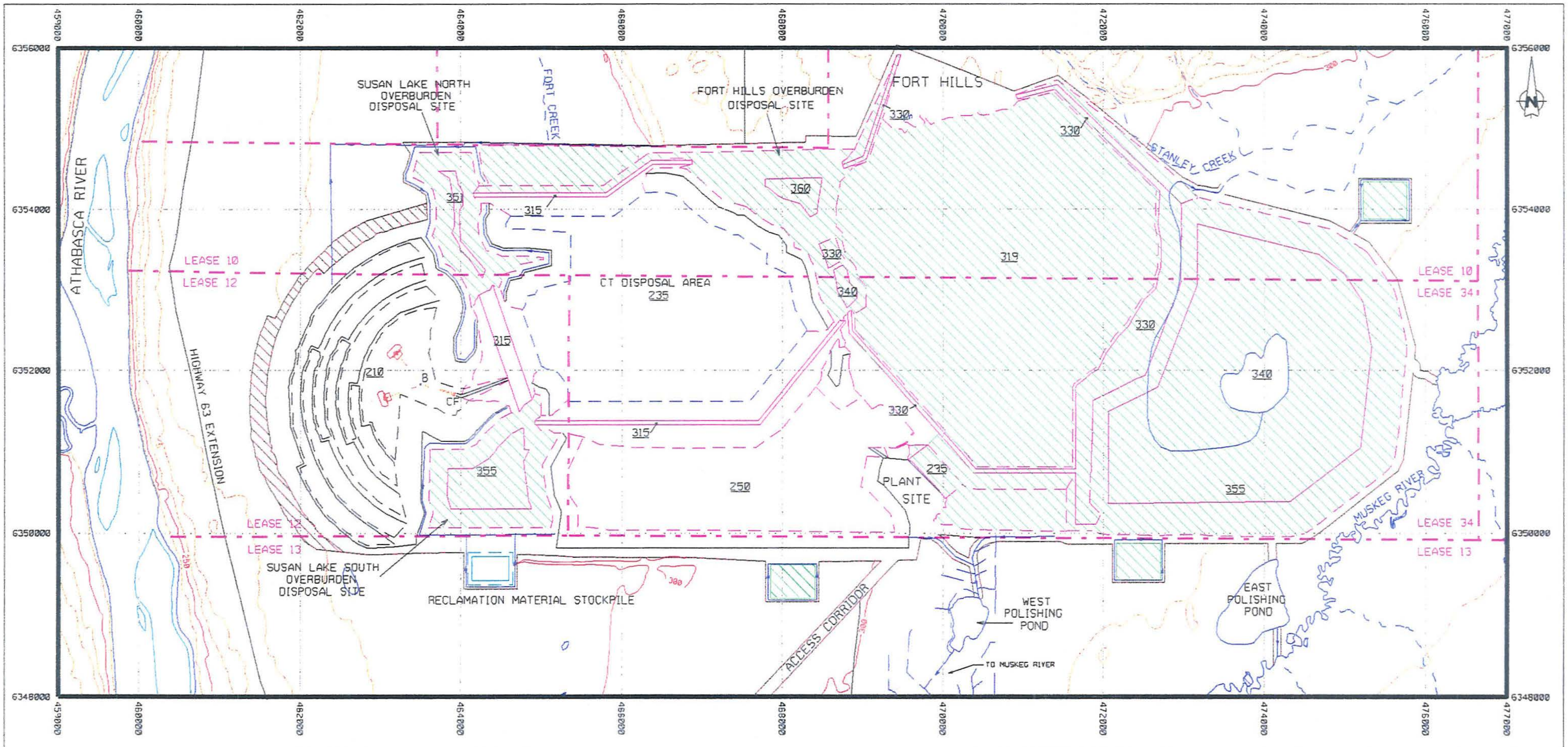


ATHABASCA RIVER
HIGHWAY 63 EXTENSION
LEASE 10
LEASE 12
LEASE 34
LEASE 13
SUSAN LAKE NORTH OVERBURDEN DISPOSAL SITE
FORT CREEK
FORT HILLS OVERBURDEN DISPOSAL SITE
FORT HILLS
STANLEY CREEK
CT DISPOSAL AREA 320
343 TAILINGS SETTLING BASIN
SAND DISPOSAL AREA 355
MUSKEG RIVER
SUSAN LAKE SOUTH OVERBURDEN DISPOSAL SITE
PLANT SITE
RECLAMATION MATERIAL STOCKPILE
ACCESS CORRIDOR
WEST POLISHING POND
TO MUSKEG RIVER
EAST POLISHING POND
35
315
360
330
340
220
250
260
355
297
300
LEGEND
Major Contour
Minor Contour
Stream
Pond/Lake
Intermittent Pond/Lake
Intermittent Creek
Diversion or Interceptor Ditch
Existing Ditch
Tree Clearing
Tree Limit
Lease Limit
Existing Road
Elevation (m) 300
Crusher
Pipeline
Conveyor
Cyclofeeder CF
Bin B
Reclaimed Land
SCALE
0 2000 4000 m
Notes: Dirty water ditches and finger ditches are not shown.
Syncrude AURORA MINE NORTH
DRAWING TITLE:
2025 STATUS MAP
DRAWING NUMBER:
Figure 3.2 - 29
REV. 0
SF MAR /96



LEGEND

Major Contour	Tree Clearing
Minor Contour	Tree Limit
Stream	Lease Limit
Pond/Lake	Existing Road
Intermittent Pond/Lake	Elevation (m) 300
Intermittent Creek	Crusher
Diversion or Interceptor Ditch	Pipeline
Existing Ditch	Conveyor
	Cyclofeeder CF
	Bin B
	Reclaimed Land

SCALE

0 2000 4000 m

Notes: Dirty water ditches and finger ditches are not shown.

NO	DATE	REVISION	BY	CHK.	ENG.	APPD.
SCALE:	DRAWN BY: SF	DATE: MAR /96	CHECKED:	ENGINEER:	APPROVED:	

Syncrude AURORA MINE NORTH

DRAWING TITLE:

2030 STATUS MAP

DRAWING NUMBER: Figure 3.2 - 30

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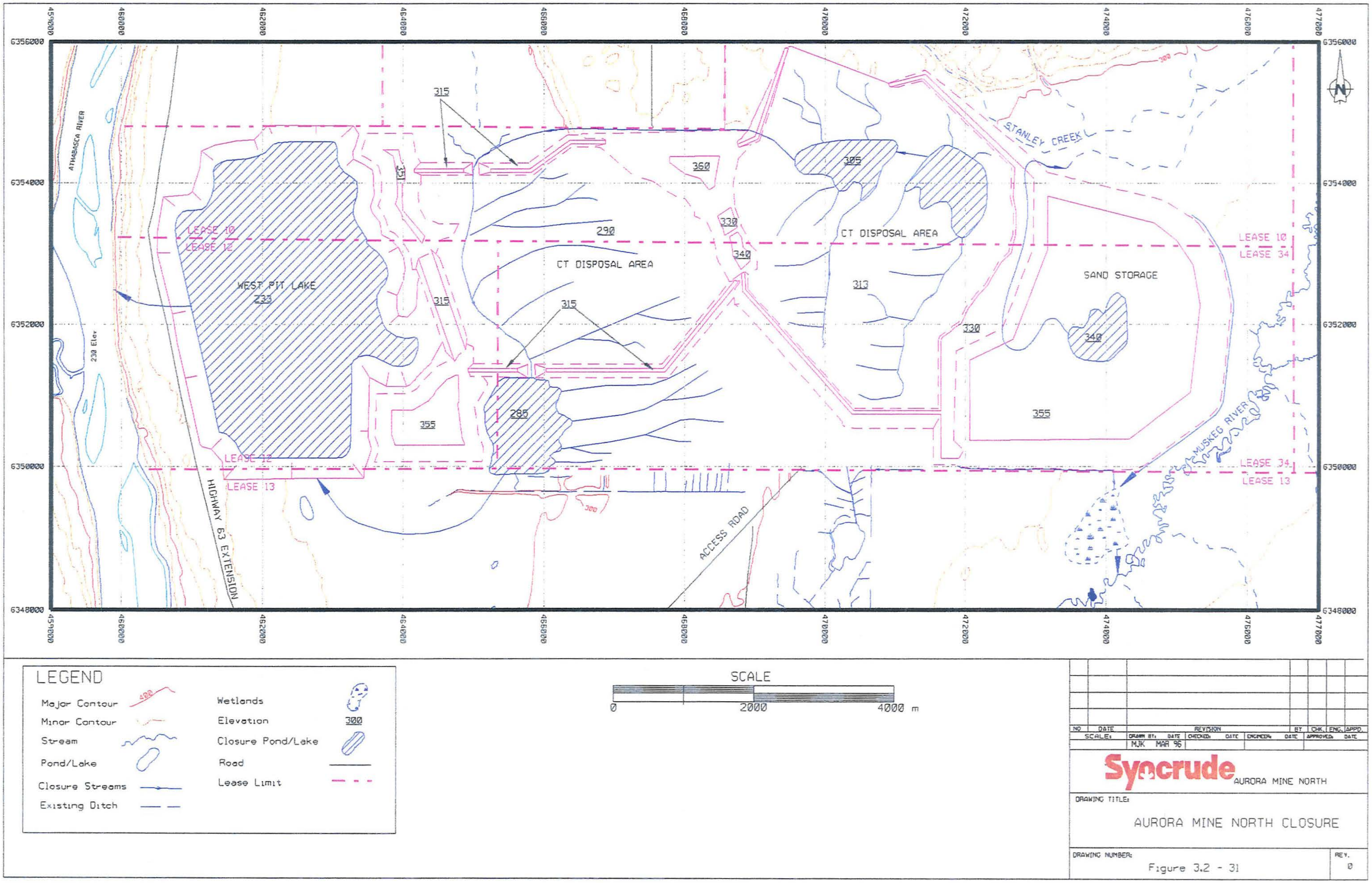
ATHABASCA RIVER
230 Elev
HIGHWAY 63 EXTENSION
WEST PIT LAKE
233
LEASE 10
LEASE 12
LEASE 13
LEASE 34
CT DISPOSAL AREA
SAND STORAGE
STANLEY CREEK
MUSKEG RIVER
ACCESS ROAD
315
351
360
305
290
330
340
313
355
285
LEGEND
Major Contour
Minor Contour
Stream
Pond/Lake
Closure Streams
Existing Ditch
Wetlands
Elevation
Closure Pond/Lake
Road
Lease Limit
SCALE
0
2000
4000 m
MJK MAR 96
Syncrude
AURORA MINE NORTH
DRAWING TITLE:
AURORA MINE NORTH CLOSURE
DRAWING NUMBER:
Figure 3.2 - 31
REV.
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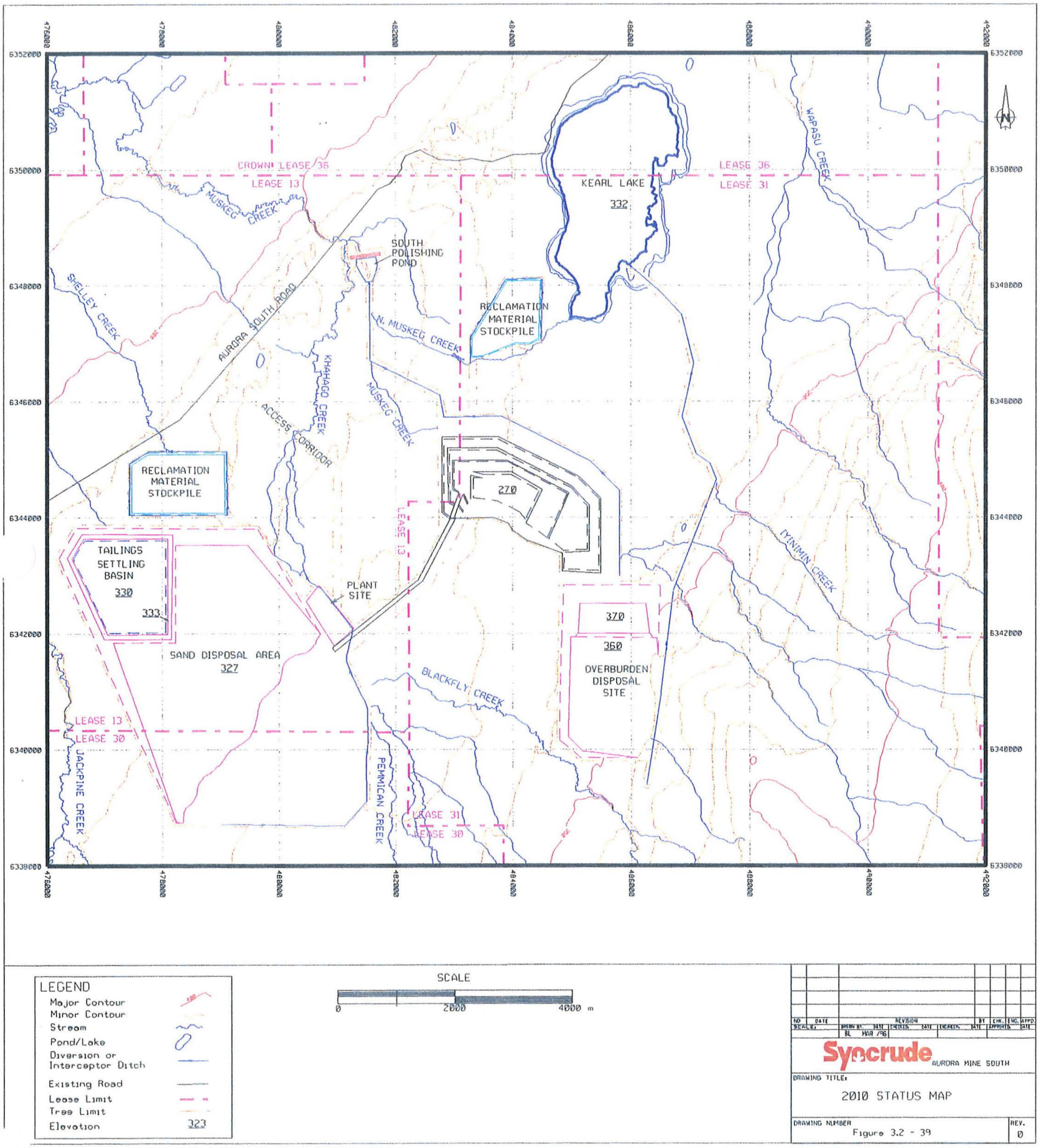

CROWN LEASE 36
LEASE 13
LEASE 36
LEASE 31
LEASE 30
MUSKEG CREEK
KEARL LAKE
332
WAPASU CREEK
SOUTH POLISHING POND
SHELLEY CREEK
AURORA SOUTH ROAD
RECLAMATION MATERIAL STOCKPILE
N. MUSKEG CREEK
KHAHAGO CREEK
ACCESS CORRIDOR
270
IYINIMIN CREEK
TAILINGS SETTLING BASIN
330
333
PLANT SITE
370
360
OVERBURDEN DISPOSAL SITE
SAND DISPOSAL AREA
327
BLACKFLY CREEK
JACKPINE CREEK
PEMMICAN CREEK
476000
478000
480000
482000
484000
486000
488000
490000
492000
6352000
6350000
6348000
6346000
6344000
6342000
6340000
6338000
LEGEND
Major Contour
Minor Contour
Stream
Pond/Lake
Diversion or Interceptor Ditch
Existing Road
Lease Limit
Tree Limit
Elevation
323
SCALE
0
2000
4000 m
Syncrude
AURORA MINE SOUTH
DRAWING TITLE:
2010 STATUS MAP
DRAWING NUMBER
Figure 3.2 - 39
REV.
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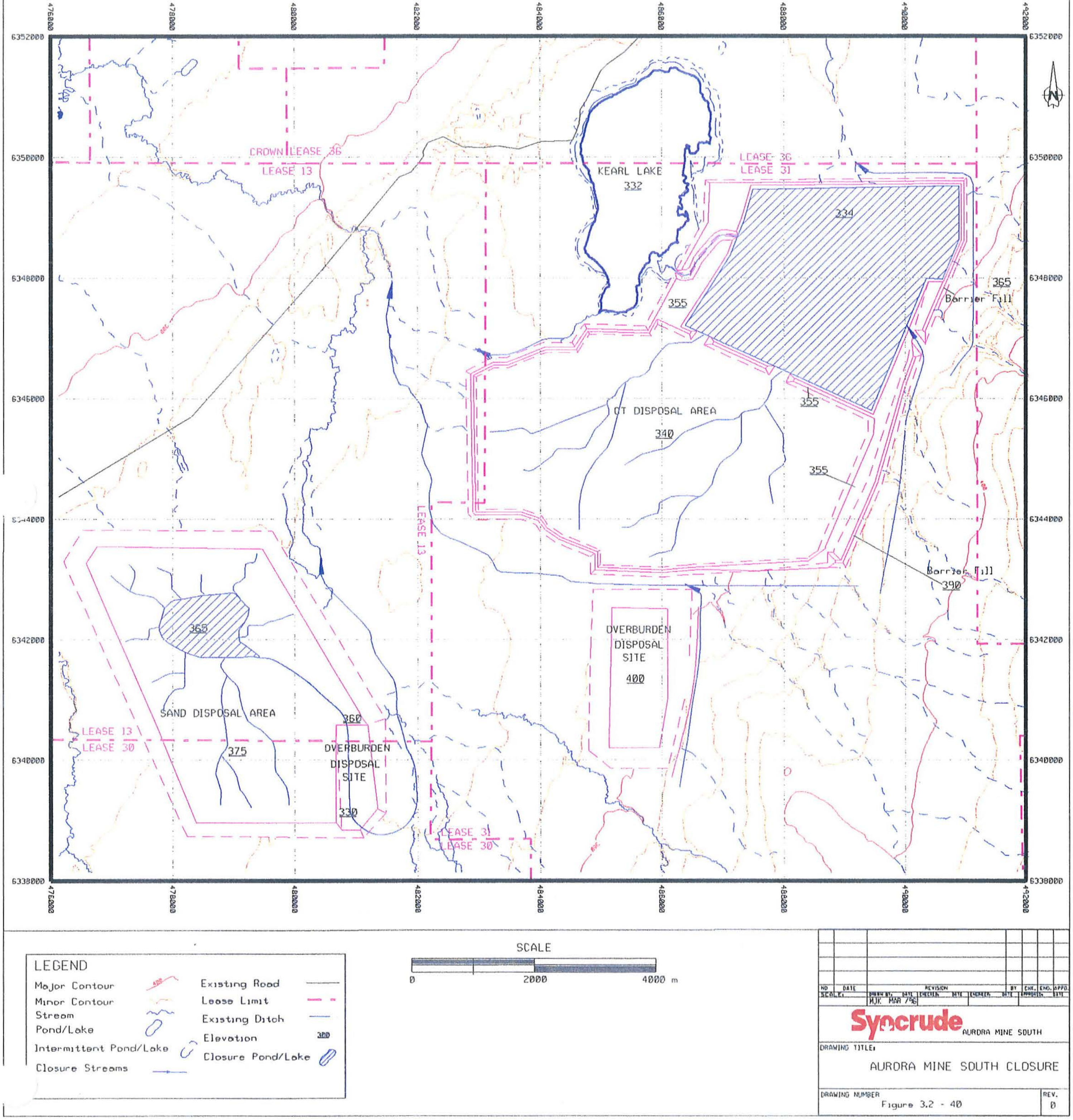
CROWN LEASE 36
LEASE 13
KEARL LAKE
332
LEASE 36
LEASE 31
334
365
Barrier Fill
355
CT DISPOSAL AREA
340
Barrier Fill
390
LEASE 13
365
SAND DISPOSAL AREA
375
360
OVERBURDEN DISPOSAL SITE
330
OVERBURDEN DISPOSAL SITE
400
LEASE 30
LEASE 31
LEASE 30
LEGEND
Major Contour
Minor Contour
Stream
Pond/Lake
Intermittent Pond/Lake
Closure Streams
Existing Road
Lease Limit
Existing Ditch
Elevation
Closure Pond/Lake
SCALE
0
2000
4000 m
MJK MAR 7/96
Syncrude AURORA MINE SOUTH
DRAWING TITLE:
AURORA MINE SOUTH CLOSURE
DRAWING NUMBER
Figure 3.2 - 40
REV.
0

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3.3 Tailings

3.3.1 Overview of Tailings Operations

Syncrude is committed to conducting its operations in an environmentally acceptable manner, with the goal of restoring the productive capability of the land once mining of the resource has been completed. An integral component of Syncrude's reclamation plans is the management of tailings materials in the final landscape. The goal of reclamation planning and technology development is the development of cost effective landscape components that meet the following criteria:

- biologically self-sustaining,
- geotechnically stable,
- maintenance free within a short period after mine closure, and
- having a productive capability at or above that of the land before disturbance.

The large volume of oil sands processed in an operation such as the Aurora Mine results in the need to dispose of correspondingly large volumes of tailings materials. Historically, for oil sands surface mining, this has meant management of large volumes of three tailings components: sand, process water, and fine tailings. Coarse sand is transported and placed in disposal sites by utilizing well developed slurry transport technology. Process water is managed by clarification in a settling pond and recycle to the bitumen separation process, with no current need for discharge to the regional river system. Fine tailings — consisting of water, sand, silt and clay particles— collect in the bottom of a settling basin and consolidate to an approximate 30% solids level within a few years, with further consolidation taking place very slowly over subsequent years.

This continuous consolidation process creates three layers in the settling basin: clear water on top, water and settling clay particles in the middle, and fine tailings on the bottom. Fine tailings remain in a liquid state indefinitely if stored separately. They must be contained within stable structures during plant operation, and placed in secure locations in the final reclaimed landscape. Consequently, the fine tailings component of the oil sand separation process is an undesirable by-product because it occupies significant volume and area during mining operations and in the reclaimed minesite.

Fine tailings management has been a topic of considerable interest to the oil sand industry and its stakeholders. Syncrude has made a significant investment in developing reclamation techniques for fluid fine tailings and has been successful in demonstrating the effectiveness of the water-capping method at a pilot scale and in evaluating the projected performance in a full-scale setting. In 1994 and 1995 Syncrude received regulatory approval for a reclamation plan at its Mildred Lake operation that included disposal of a large volume of fluid fine tailings in a mine pit, capped by a six square kilometre lake.

Building on the successful development of the water-capping method, Syncrude has continued research and development work on alternative tailings disposal methods in an effort to develop additional options for restoring disturbed land to an acceptable and sustainable use. The focus of these efforts has been to develop economic options to reduce the volume of liquid fine tailings by incorporating them in solid landscape components.

Research and development work has focused on a number of novel tailings disposal methods including composite (non-segregating) tailings, freeze-thaw consolidation, fine tailings spiking, tailings filtration, and tailings thickening, as well as further improving on the water-capping method.

In the past few years the work on composite tailings technology has proved very promising at the pilot scale. Composite tailings, formed by the addition of fine tailings and calcium to densified coarse tailings streams, creates a homogeneous deposit that locks the fine tailings particles into the coarse sand matrix. The deposit consolidates quickly, releasing most of the porewater within a few days, allowing for reclamation of a solid surface within 10 to 50 years. Syncrude believes that composite tailings is a feasible tailings disposal method, which can be considered for mine planning as a complement to or alternative to the water capping method. Commercial-scale demonstration of the process is underway at Mildred Lake.

3.3.2 Assessment of Tailings Disposal Alternatives

A number of alternatives were assessed prior to selection of the Aurora tailings design. The assessment took into account extensive experience with disposal of tailings from the hot water bitumen separation process and with this knowledge base, adjusting for the Aurora Mine ore characteristics. A low-energy separation process will be used to recover bitumen at Aurora. Evaluation of fine tailings produced from this process indicate that they are similar to those produced over the past 30 years from the Clark Hot Water separation process. The following tailings and fine tailings disposal alternatives were considered in the selection process for the Aurora Mine:

- **Coarse sand placement and water-capping of all fine tailings.** This combination of methods is currently approved for use in the Mildred Lake operation, and includes construction of fluid containment structures, disposal of sand, and disposal of fine tailings. The water-capping method involves transferring fine tailings to a mined-out pit and capping it with clean water to form an environmentally acceptable lake. This method has been extensively evaluated and field tested, allowing Syncrude to conclude the method will be successful in producing such a lake. The Mildred Lake reclamation scheme includes a commercial scale demonstration lake, now under construction, to provide a definitive full-scale demonstration of the method.

- **Spiked tailings.** This method involves the addition of fine tailings into a coarse tailings stream to reduce the net accumulation of fine tailings. Field testing at Syncrude has shown that spiking at a moderate to high rate reduces the geotechnical stability of the resulting sand deposit without attaining the degree of capture possible with composite tailings. Spiking requires further field evaluation before it can be considered as a proven disposal method.

- **Composite tailings.** This method refers to an engineered tailings product made by adding fine tailings and calcium in specific quantities to a densified tailings stream. The resulting mixture remains as a homogeneous mixture at the deposit site, with the fine tailings locked in the voids of the sand matrix. The deposit immediately begins to release clear water, and continues to release water as consolidation proceeds. A solid consolidated deposit is created within 10 to 50 years.

  The success achieved with composite tailings in the past few years has come as a result of many years of research and several years of concerted development. Work on addition of flocculant chemicals to tailings has been carried out since the 1970s. Through a collaborative initiative of the University of Alberta's Department of Civil Engineering, Syncrude and Suncor, a concerted effort was commenced in the early 1990s to develop this method. Bench scale work was conducted at the University and the Syncrude Research Centre. Success with the initial bench scale work led to a field program that included a test of 7,500 cubic metres at Suncor in 1994 and a test of 100,000 cubic metres at Syncrude Mildred Lake in 1995. This tailings disposal method is now considered to be viable, with further development work needed to define all aspects of its application.

- **Dry tailings.** This category of disposal methods involves the removal of water from tailings by using either filters or thickeners. It creates a relatively dry material of 60% to 80% solids initially, with the fine particles remaining within the sand matrix. Filtration has been tested for oil sand application in the past, with some success noted. Thickeners are used commercially on tailings in other industries, with little work done to date on oil sand applications. Water release and consolidation issues would be similar to composite tailings.

The above tailings disposal methods were evaluated for use in the Aurora Mine design as detailed in Appendix A, Section 4. Environmental, geotechnical, operational and economic factors were used in the evaluation. Based on this qualitative assessment, and current knowledge on the disposal methods, the composite tailings method was determined to be the most suitable on the basis of economics, deposit stability, environmental acceptability, and minimization of land disturbance. In addition, by using a composite tailings disposal plan, it is projected that final land reclamation can more readily occur on a progressive basis across the leases, minimizing the time required to return the land to other uses.

The other alternatives received a lower assessment rating than composite tailings. Dry tailings is felt to be technically feasible for oil sand application, but requires high capital cost to handle high throughput rates, high energy input, and high operating cost for chemicals and dry material handling. Spiking provides a potential means of marginally reducing total fine tailings volumes. However these reductions are marginal and difficult to achieve.

3.3.2 Aurora Tailings Disposal Method

The proposed Aurora tailings design includes a combination of the composite tailings technology and existing practice (coarse sand placement) to achieve an optimum plan. Conventional tailings placement technology is utilized during the initial years of operation while excavating the initial mine pit. Recycle water and fine tailings are impounded for, respectively, clarification and consolidation in a settling basin constructed of coarse tailings. As sufficient space becomes available in the mine pit, composite tailings technology is employed. By employing available technology in plans from the outset, the following features are attained in the Aurora design:

- Composite tailings technology is used to consume the fluid fine tailings production by capturing fine tailings within the sand deposits.
- In-pit tailings disposal is initiated as soon as practical thereby minimizing out-of-pit surface disturbance area for both sand and fluid storage during initial operations.
- The small volume of fine tailings remaining at the completion of the Aurora Mine is probably contained in-pit and water-capped by an end-of-pit lake.
- Progressive reclamation on tailings materials is commenced as soon after land disturbance as practical.
- Landforms that will provide habitat for local area wildlife are created.

Composite tailings technology provides a tool for attractive, flexible tailings design options for the Aurora Mine. It has performed well in laboratory and small-scale field tests, over the past four years. It has yet to be proven operationally and environmentally on a commercial scale over a significant period of time. Continued research and development work is planned to address a number of outstanding issues:

- Management of the quality and quantity of the large volumes of water released from composite tailings during operation and draining from the reclaimed land forms during the initial post-closure period.
- Development of reclamation techniques to manage the ongoing subsidence of composite tailings deposits.
- Assessment of the long term impact of composite tailings materials on water systems and surface vegetation.

It is Syncrude's view that these challenges can be overcome such that composite tailings can be employed as a significant component of tailings management plans. It is prudent, however, to maintain a viable alternative in the event the proposed strategy proves unworkable. The alternative is to utilize fine tailings water-capping as the only well-demonstrated disposal technology at this time. The design proposed for the Aurora Mine has sufficient flexibility to facilitate this alternative, if necessary. The initial years of reclamation for the water-capping or composite tailings options are the same. During this time, large-scale demonstration and evaluation of the composite tailings technology will continue.

3.3.4 Aurora Tailings Disposal Sites

Selection of Tailings Disposal Sites
The tailings disposal sites for the Aurora North and South were selected from the list of possible sites based on the following criteria:

- adequate size to contain necessary disposal volumes
- minimal impact on future economically mineable oil sands
- minimal impact on the environment
- conformance with site closure plans
- adequate foundation conditions for construction stability
- economical integration with other aspects of the project design

Assessment and selection of the potential sites was carried out against environmental, geotechnical, resource recovery, and economic factors, as shown in Appendix A, Section 3. The sites at both Aurora locations received a combination of positive and negative ratings in the assessment, with the final site selection based on a total of all ratings received by each site. The assessment indicated a few sites were of similar quality, and these are described in more detail below.

It was determined early in the disposal site selection process that separate sites would be required to accommodate the Aurora North and South tailings operations due to the necessary size and proximity to the operations.

Aurora Mine North Tailings Disposal Site
The selected Aurora Mine North external tailings site, entitled Site 1 in Appendix A, is shown on Figure 3-3 . The site lies primarily on the eastern half of Lease 34, between the east pit and the Muskeg River. The southern limit of the site is the Lease 13 boundary, with the northern limit extending onto Lease 10. The topography and phytogeography of site are described in the EIA, Section 5.0. The site has an average elevation of 295 metres and is typified by low relief and large areas of poorly drained muskeg. The area surrounding the site is drained by the Muskeg River and its tributaries. The Muskeg River itself flows through the southeast corner of Lease 34, and Stanley Creek drains the Lease 10 portion of the Fort Hills before discharging into the Muskeg River. The east limit of the selected tailings site will be offset from the Muskeg River by 300 metres. The north limit of the site extends into Lease 10 without intercepting the main course of Stanley Creek.

With the selection of this tailings site, approximately 250 million barrels of recoverable bitumen will not be accessible to mining. Generally, the quality of this particular resource is low, having an average Total Volume to Net Recoverable Bitumen ratio (TV/NRB) of 14 compared with an average of 7 for the Aurora Mine North mining areas. All other potential sites result in a similar loss of accessibility to mining, with the exception of Site 4, the Jackpine Creek site, which results in a loss of approximately 40 million barrels of bitumen The resource calculation for Site 4 is based on poorly defined oil sand resources. This site is also environmentally sensitive due to the necessary relocation of Jackpine Creek, and is located much further from the operation than Site 1, impacting significantly on project costs.

Aurora Mine South Tailings Disposal Site

The external tailings site selected for Aurora Mine South, entitled Site 4 in Appendix A, is shown on Figure 3-3. The site lies primarily on Leases 13 and 30.

The topography and phytogeography of the area are described in the EIA, Section 5.0. The area has an average elevation of 320 metres, and is typified by low relief with a cover mixture of forest and muskeg. A small, unnamed creek runs through the northeast corner of the site and discharges into Muskeg Creek. Jackpine Creek flows near the western limit of the site, with a 300-metre offset maintained between the tailings structure and the Creek. The selected tailings site has minimal impact on oil sand resources, with negligible recoverable bitumen lying under the site. It was determined to be the preferred location after consideration of a combination of economic and environmental reasons. More detail on tailings site selection is in Appendix A, Section 3.3.

3.3.5 Development Strategy

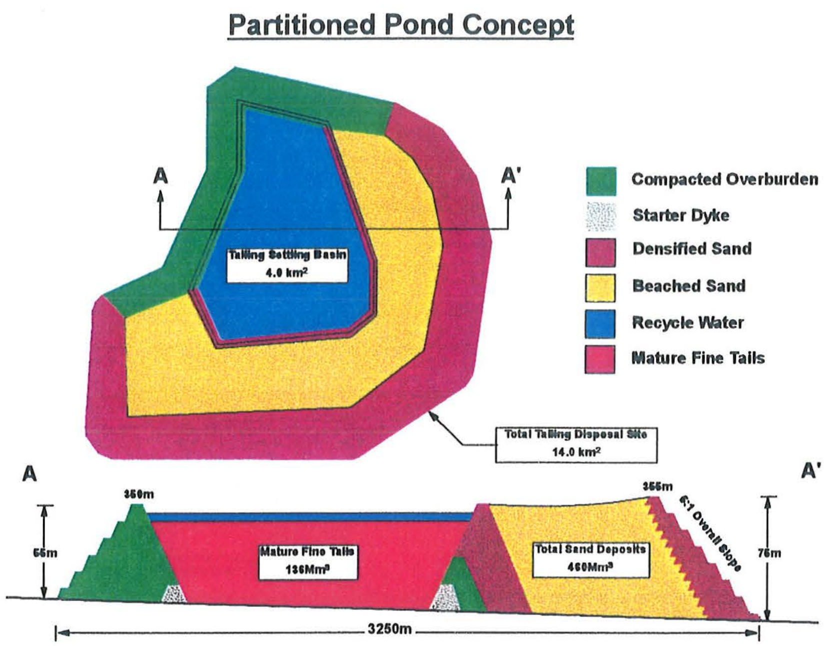
General Development Strategy

The proposed Aurora tailings strategy initially requires the use of an external sand disposal structure as per existing Mildred Lake tailings practice. This technology is utilized only during the early years of operation while excavating the initial mine pit. When sufficient space becomes available in the pit, composite tailings technology is utilized to dispose of all subsequent tailings materials in mined-out pits.

The initial out-of-pit tailings disposal takes place in a combination settling basin and sand disposal structure referred to as a partitioned pond (Figure 3.3-1). The tailings water released during deposition of the tailings stream in the sand disposal structure will drain into the settling basin for clarification and recycle to the plant. The settling basin carries out multiple roles in the tailings disposal strategy, including water clarification, storage of the fine particles that settle to the bottom of the basin, and supply of mature fine tailings necessary for the composite tailings process.

The proposed tailings strategy is based on minimizing the surface disturbance area for the out-of-pit disposal site. The initial out-of-pit tailings structure is sized to allow adequate time for the mining operation to develop in-pit space for placement of composite tailings on a continuous basis thereafter. The entire out-of-pit, above-ground tailings structure will be reclaimed as a stable and dry landform. This includes infilling of the settling basin with tailings sand after in-pit space is available for a new settling basin.

Figure 3.3-1 Partitioned Pond Concept



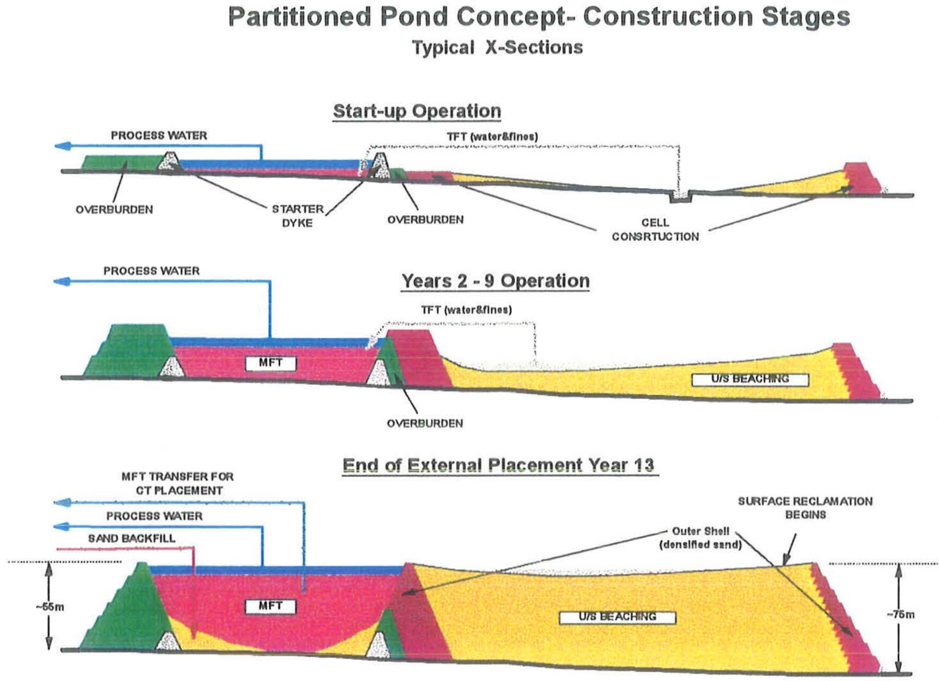
With introduction of the composite tailings process, the volume of fine tailings stored in the settling basin begins to decrease, with a small volume remaining upon completion of operations. Acceptable disposal options exist for reclamation of the residual fine tailings volume, including water-capping. A final decision on the best option for dealing with the remaining fine tailings volume can be made at an appropriate time prior to completion of operations.

The surface of the composite tailings deposit becomes trafficable with time, currently estimated to be 10 to 50 years after completion of tailings disposal. A one-metre capping layer of sand may be required to improve or speed up development of surface-bearing capability for reclamation. If required, this capping layer would be placed after completion of composite tailings disposal. The final surface is planned to be reclaimed as a gently undulating terrain, possibly achieved through placement of tailings sand forming sand ridges. Seepage from the composite tailings deposit (declining in volume over time) and surface runoff will drain through a wetland, allowing for attenuation of peak flows and potentially enhancement of water quality.

3.3.5.2 Aurora Mine North Development Strategy

Table 3.3-1 defines the overall sequencing of tailings development for Aurora Mine North. The partitioned pond concept described above and shown in Figure 3.3-1 will be used for the initial 13 years of disposal of sand tailings. The out-of-pit structure will be constructed over the thirteen year period as shown in Figure 3.3-2 to contain all sand and fine tailings produced by the operation. It will be constructed on muskeg deposits one to five metres thick. The muskeg will consolidate into a relatively impervious layer, limiting seepage from the bottom of the disposal site. A perimeter ditching system will intercept and collect any seepage that does occur.

Figure 3.3-2 Partitioned Pond Concept - Construction Stages



Composite tailings disposal will be initiated approximately ten years after Aurora North start-up in the east pit as mining progresses towards the northern limits of this pit. Temporary in-pit structures will contain the composite tailings during this initial placement period. With completion of the east pit, a major structure will be constructed to isolate tailings disposal in the east pit from mining operations in the centre pit. A similar sequence will occur when tailings disposal progresses into the centre pit and mining progresses into the west pit. The mined-out west pit will become a freshwater lake.

Starter Dyke and Perimeter Road

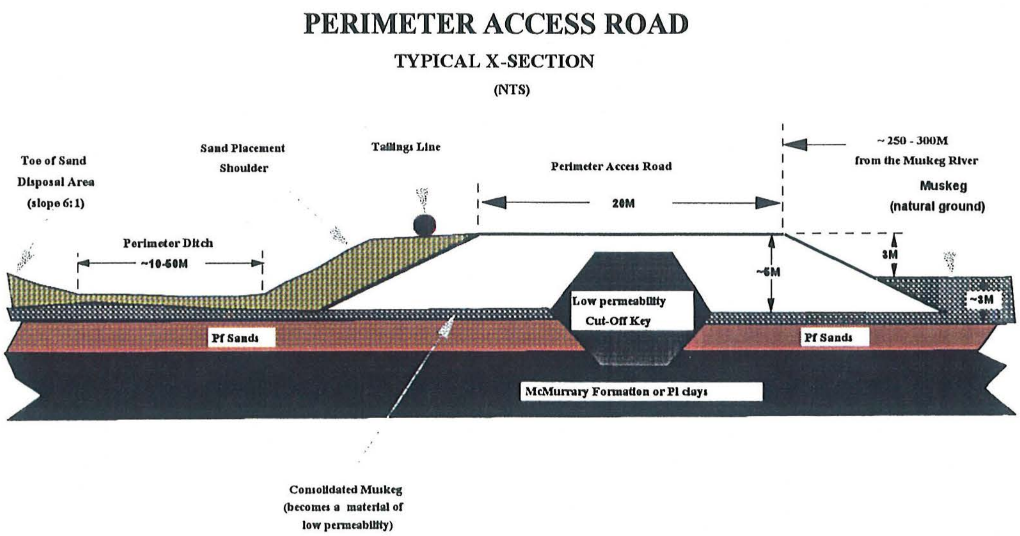
A starter dyke will be required around the settling basin portion of the out-of-pit tailings structure to contain both the water released from the initial process start-up and the fine tailings produced from the initial years of operation. The settling basin starter dyke will be 6.5 kilometres long and enclose an area of approximately 235 hectares.

A perimeter road will be require around the outer limit of the total tailings structure, in conjunction with the starter dyke, to allow upstream beaching into the sand disposal area (Figure 3.3-3). The perimeter road will be 14 kilometres long and enclose an area of approximately 1400 hectares.

Table 3.3-1 Aurora Mine North - Tailings Activity Sequencing

Location	Timeline (years)	Activity
External disposal	2001-2010	Conventional disposal (cell, beach and tailings settling basin)
	2010-2013	Mature fine tailings transfer for CT & regular operations at a reduced rate of 50%
East In-pit	2010-2013	CT operations at 50%
	2013-2019	CT operations at 100% - CT level to original ground
	2019-2026	CT operations at 100% (reduced fines consumption) - CT level above surface to about 25 to 30 metres higher than the original ground
Centre In-pit	2027-2035+	CT operations at 100% (reduced fines consumption) - CT level above surface to about 5 to 10 metres higher than the original ground

Figure 3.3-3 Permister Access Road



Construction of the starter dyke and perimeter road will start in 1999, allowing approximately two years to complete the construction on top of the muskeg base prior to operations start-up. Starter dyke construction will begin in the northwest part of the site and progress towards the southeast to allow for management of water released during loading of the muskeg base. Later, this water will be drained from the immediate area into the natural drainage system via a network of dewatering ditches. Construction of the starter dyke will progress along the northeast and southwest arms until the settling basin is enclosed. The perimeter road will follow a similar construction sequence.

Mine overburden will be used to construct both the starter dyke and the perimeter road. The fill material will be placed in engineered lifts, and located as needed to build competent structures. The starter dyke will be built with 3:1 slopes on both sides with the highest section planned to about nineteen metres above original ground. The perimeter road will contain a core of low permeability fill which will be keyed into an underlying low-permeability formation such as the McMurray, as shown in Figure 3.3-3. The road surface will be located about three metres above original ground.

Tailings Deposition Plans

The sand disposal portion of the out-of-pit structure will be constructed using hydraulically deposited tailings pumped from the extraction plant. The outer shell of the sand disposal area, initiated 200 metres wide at ground elevation, will be constructed using centerline and upstream hydraulic construction methods. This construction will occur only during summer months and only the coarser fraction of the sand material will be used. During winter months, the hydraulically deposited tailings will be overboarded from the shell into a contained beach area, minimizing the effects of freezing. Water draining from the sand construction activity will be pumped from the center of the sand disposal area to the settling basin. A minimum depth of water will be impounded in the sand disposal area to allow normal pumping operations to proceed. Tailings lines will be moved upward as the shell and beach is formed. Grading is employed on the outer surface of the shell to maintain the designed overall slope of 6:1.

The settling basin containment structures will be constructed using two different methods. The north and west sections of the settling basin containment will be built using mine overburden mechanically placed in three-metre lifts. The south and east sections will use hydraulic cell construction similar to the sand disposal shell, with the starter dyke forming the initial placement platform.

Composite tailings disposal will commence in 2010 in the south mined-out area of the east pit as shown on the 2010 status map. This disposal method will continue to fill the remainder of the east pit area, with the deposit reaching an approximate elevation of 315 metres, or 15 metres above original ground.

In the centre pit area, the composite tailings deposit reaches an elevation of approximately 302 metres, equivalent to original ground. The progression of tailings placement is shown on the status maps in Section 3.2.

Aurora Mine South Development Strategy

The Aurora Mine South will utilize an out-of-pit partitioned disposal structure and composite tailings similar to Aurora Mine North description above. Construction procedures will also be similar for starter dyke, perimeter road, sand disposal area, and settling basin.

Start-up of composite tailings placement in the Aurora South mined-out pit will occur 13 years after start-up. The Aurora South orebody contains a single deep zone that requires additional time, compared to Aurora North, for development of adequate space and containment structures for in-pit tailings disposal.

The progression of tailings placement is shown on the status maps in Section 3.2, including maps for 2010 and closure.

3.3.6 Size and Capacity of Tailings Disposal Sites

General Concepts

The size and capacity of out-of-pit tailings structures are controlled by the following factors:

- timing for in-pit disposal determined by orebody depth and shape
- fine tailings accumulation rate as defined by ore production rate, orebody characteristics, tailings characteristics from the selected bitumen separation process, and rate of fine tailings consolidation
- environmental impact from footprint area and structure height
- surface area availability based on surface conditions and underlying resources
- stability of tailings structures based on underlying deposits

Each of these factors has influenced the Aurora design to some extent. The size and capacity of the Aurora out-of-pit structures are minimized by selecting the earliest possible date for in-pit disposal. The fine tailings accumulation rate has been estimated based on Mildred Lake experience, Aurora ore samples, and research results, as well as details of the planned Aurora operation. Footprint size has been minimized to reduce oil sand resource sterilization and environmental impact. Height of structures then becomes dependent to a great degree on acceptable outer slopes, stability, and disposal volume required prior to in-pit disposal.

The size of in-pit disposal areas are controlled by the size of mined-out areas, with the final height of deposits determined by disposal volumes and the ability to blend the resultant landforms into the surrounding area.

Aurora Mine North

The overall footprint area of the external tailings disposal area for Aurora North is planned to be 1400 hectares. The height of the completed structure, as shown in exaggerated vertical scale on Figure 3.3-2, ranges from 55 to 75 metres above original ground.

Table 3.3-2 provides a schedule of tailings activity for Aurora North including the volumes of each type of tailings material placed and the associated timing. Figure 3.3-4 graphically shows the cumulative volumes of tailings materials for the east and centre pit areas and the external structures.

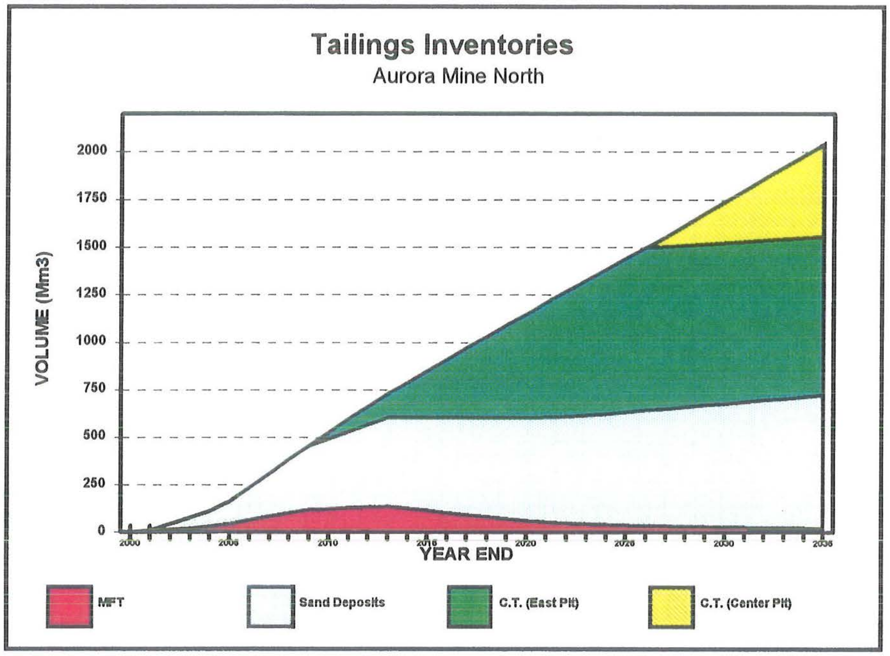
Table 3.3-2 Aurora North - Tailings Placement

AURORA MINE NORTH -TAILINGS PLACEMENT

				Tailings Settling Basin							Sand Storage Area			East Inpit			Central Inpit		
	Annual SAND mcm	Annual CT mcm	Annual MFT mcm	O/B mcm	Dyke Sand mcm	Beach Sand mcm	Cumm MFT mcm	Cumm Water mcm	Pond ELEV	Dyke ELEV	Dyke Sand mcm	Beach Sand mcm	Dyke ELEV	Annual CT mcm	Cumm CT mcm	CT ELEV (avg)	Annual CT mcm	Cumm CT mcm	CT ELEV (avg)
pre 2001				13.0						303									
2001	7.0		3.0	0.5	2.0	1.0	3.0	10.0	303	306		4.0	285						
2002	24.6		10.3	2.0	8.5	1.0	13.3	10.0	307	310		15.1	288						
2003	24.6		9.0	4.0	7.0	1.6	22.3	10.0	311	314		16.0	292						
2004	24.9		8.6	4.0	2.5		30.9	10.0	315	318	6.0	16.4	295						
2005	36.9		13.6	2.5	7.7		44.5	10.0	321	324	5.0	24.2	305						
2006	54.8		20.5	-	11.5		65.0	10.0	328	331	5.0	38.3	315						
2007-2010	196.6	33.1	58.8		12.7	1.4	123.8	10.0	343	347	17.0	166.9	347	33.1	33.1	243			
2011-2015	119.5	213.7	-9.7		1.5	33.6	114.1	10.0	347	350	8.0	86.6	355	213.7	246.8	262			
2016-2020	53.7	299.7	-52.7		-	53.7	61.4	10.0	345	-	-	-	-	299.7	546.4	302			
2021-2025	53.7	263.2	-23.5			53.7	37.9	10.0	342					263.2	809.7	319			
2026-2030	53.7	264.7	-8.9			13.9	29.0	-	340					46.9	856.6	322	217.8	217.8	240
plus 2030 to end	107.3	532.2	-11.4			-	17.6		340					-	-	-	532.1	749.9	306
TOTAL	757.3	1606.5	17.6	26.0	53.4	159.9					41.0	367.5		856.6			749.9		

Note: 135.5 mcm sand placed to cap East & Center Pits

Figure 3.3-4 Volumes Of Material Placement With Time



Aurora Mine South

The footprint of the external tailings disposal area for Aurora South is shown on the status maps with an overall area of 1930 hectares. The volume of tailings placed and associated timing, and the elevations of the tailings structures, are shown in Table 3.3-3.

3.3.7 Tailings Disposal Design

Geotechnical Design Criteria

The geotechnical design criteria for Aurora Mine North tailings activity are shown in detail on Tables 3.3-4, 3.3-5, and 3.3-6 — they cover the external, east pit, and centre pit structures respectively. The criteria are based on experience gained from the Mildred Lake operation, from completed research programs, and from Aurora geological information available to date. Data from the most recent drilling program carried out in the winter of 1995/1996 will be incorporated into the geotechnical design as it becomes available.

Geotechnical design criteria will be finalized for Aurora Mine South tailings activity over the next few years. In the interim, current information available on Aurora South suggests that design criteria will be very similar to that detailed for Aurora North.

Table 3.3-3 Aurora Mine South - Tailings Placement

AURORA MINE SOUTH -TAILINGS PLACEMENT													
				Tailings Settling Basin / Sand Disposal Area							Inpit		
	Annual SAND mcm	Annual CT mcm	Annual MFT mcm	O/B mcm	Dyke Sand mcm	Cumm MFT mcm	Cumm Water mcm	Dyke/Beac Sand mcm	Pond ELEV	Dyke ELEV	Annual CT mcm	Cumm CT mcm	CT ELEV
pre 2008				15.0									
2008	6.8		3.1	3.0	2.0	3.1	10.0	4.8	326	329			
2009	26.5		11.4	5.0	9.0	14.5	10.0	17.5	327	330			
2010	26.7		8.6	4.0	8.0	23.2	10.0	18.7	330	333			
2011-2015	140.8		41.0	-	31.0	64.1	10.0	109.8	345	348			
2016-2020	269.0		72.0		10.0	136.1	10.0	259.0	362	365			
2021-2025	52.6	272.4	-52.0		-	84.1	10.0	52.9	365	370	272.4	272.4	275
2026-2030	52.6	265.0	-46.9			37.2	10.0	52.6	365	370	265.0	537.4	295
plus 2030 to end	104.9	523.8	-21.0			16.2	10.0	-			523.8	1061.2	335
TOTAL	679.9	1061.2	16.2	27.0	60.0						1061.2		

Pumping and Pipelines

The distance from the extraction facilities to tailings disposal sites will necessitate a number of booster pumps along the tailings lines. Design details are being developed at present to determine the preferred layout and siting of booster pumps. Pump configuration is also being evaluated based on the possible use of single-staged to multi-staged units that best suit the system hydraulics.

The tailings flow rate of about 8300 cubic metres per hour per train requires a 914 millimetre pipe diameter. Leaks or spills that may occur along the tailings pipelines will be isolated from the surrounding environment by a series of ditches. Any spilled material will be pumped into a tailings disposal area.

Return Water Barge

A barge-mounted pumping system similar to current operations on the Mildred Lake Settling Basin, will provide recycled process water for the Aurora North extraction plant at rates of about 3800 cubic metres per hour. The return water line will be approximately 762 millimetres in diameter and run a distance of 5600 metres to the plant. This system will rise with the increasing elevation of the settling basin fluid.

Seepage Control

An empirical evaluation of seepage rates projected from observations of tailings structures at Mildred Lake indicates that water flows from the toe of out-of-pit structures will be approximately 4000 to 6000 cubic metres/day.

The main control structure in the seepage water collection system is the perimeter road. The design of the road will allow it to act as a barrier, preventing seepage water from reaching the Muskeg River. A series of ditches along the perimeter road will direct water to an internal collection sump located at the southeast corner of the tailings area for recycle to the operation.

Table 3.3-4 - External Tailings Facility - Design Criteria

FEATURE	DESCRIPTION	KEY DESIGN ASSUMPTIONS	COMMENTS
Tailings Settling Basin: General	• Internal pond for storage of mature fine tailings (MFT) and recycle water. • MFT pumped into internal pond from beaching operation for perimeter sand placement. • Formed by constructed 3H:1V dyke slopes - no beaching into pond.	• MFT volumes based on Syncrude sludge-make model. • 10 Mm^3 of water required for plant recycle • Required dyke heights around internal pond driven by "year end" fluid volumes, 3 m freeboard and storage of 6 months of MFT production for following year.	• Volume of water on top of MFT will be maintained at the minimum required 10 Mm^3
All Overburden Section (north&west) / Starter Dyke (south&east) & Sand Section above Overburden	• Short Term Overburden Dyke • Typical height 11m, maximum height 19 m • 2 year design life before buttressed on downstream by tailings beach. • compacted cell tailings sand used in addition to overburden	• 3H:1V external slope, 3H:1V internal slope • 2 year construction (summer + winter) to get to initial height at SE end. • Selective fill placed in thin lifts, compacted and overburden section zoned into clean sand. • No prestripping of muskeg required, some pre-drainage may be necessary, fill placement on muskeg acceptable. • All sand section 100 m wide compacted cell	• 2 year construction may be reduced by contingency actions. • More detailed site investigation required to establish clay thickness and strength.
Sand Disposal Area: General	• 60 to 75 m high dykes, running around perimeter of external tailings facility.	• 6H:1V external dyke slopes. • No pre-stripping of muskeg required. • Planned construction rate of 60 - 75 m in 13 years is acceptable for the dyke foundation	• 4H:1V slopes are supportable geotechnically. • Karsting in limestone is not considered to be a design issue. • Geology evaluation underway
All Overburden Section (north&west) / All Sand Section (south&east)	• 55 m high overburden dyke impounding MFT and water up to year 2026. • 15 to 30 m high buttressing overburden dump to be placed on downstream • 60 to 75 m high tailings sand dyke formed by upstream construction with a large upstream beach above water.	• Planned 300 m toe offset to the East Mine crest & Muskeg River • Zonation of overburden required with clean sand section to act as a crack-stopper, filter and drain. • Density of sand in downstream portion of perimeter slope must be sufficient for dilative behaviour. Width of section at base of dyke would be about 200 m.	• Obtaining good densities of initial lifts over muskeg will be critical. • Some compacted cell with an adjacent zone to the beach below water maybe required • Further drilling and testing required to better establish foundation properties , but observational method will remain as key aspect of design.

FEATURE	DESCRIPTION	KEY DESIGN ASSUMPTIONS	COMMENTS
Seepage Collection	• Seepage from external tailings site will occur at first from tailings construction water and water pond; and in long term from infiltration of precipitation. • Seepage cutoff required for near surface sand and gravel. Would consist of 5 m wide zone of low permeablility compacted fill.	• Seepage will be handled by a perimeter collection ditch system and vary between 0.2 to 0.8 m^3/day/m for tailings sand dyke sections and 0.01 to 0.02 m^3/day/m for overburden dyke segments. This process water will be kept on inventory as part of recycle water. • Long term seepage discharge estimated at 0.3 - 0.7 m^3/day/m for sand sections and 0.01 to 0.02 m^3/day/m for overburden sections.	• During initial years of construction water from muskeg dewatering etc. will be isolated from water affected by the process. • All process contaminated water will be kept in the recycle system during the operational life.

Table 3.3-5 East Pit - In-Pit Containment - Design Criteria

FEATURE	DESCRIPTION	KEY DESIGN ASSUMPTIONS	COMMENTS
In-pit Dykes: South Perimeter	• Overburden dyke at south mine limit buttressed against ultimate pit wall and rising to 330m elevation, up to 35 m above adjacent natural ground.	• 4H:1V external (south) slope, for 30 to 35 m high dyke section above original ground surface. • 2H:1V internal slope adjacent to composite tailings (CT). • Moderately compacted, thick (3 to 5 m) lift interburden and overburden fill. • No zonation of dyke fill material required, but preferential placement of more pervious material in downstream area, moisture control required • 50 m wide compacted shell section required at upstream of slope face. No water allowed to pond against dyke or active working faces.	• 2H:1V upstream slopes assume CT rise closely follows dyke rise. • Both the internal and external slopes could be made steeper than the stated inclinations, depending on quality of fill, level of compaction and control over CT level for use as an upstream buttress.
In-pit Temporary Internal Dykes	• Overburden dykes up to 45 m high that form temporary barriers between internal CT ponds in pit. • Would be formed of a combination of interburden and overburden	• 6H:1V downstream and 2H:1V upstream slopes. • Presence of weak pond muds in dyke foundation is crucial variable controlling 6H:1V slopes. • Fill constraints as listed above. • Water from CT operation WILL NOT be allowed to pond against dyke.	• Observational approach adopted for pond muds, 8H:1V possible to control adverse performance . • Additional work required to refine foundation details • 2H:1V upstream slopes assume CT rise closely follows dyke rise.
Barrier Pillar: Barrier between East and Centre Pits	• A 1 km gap in in situ pillar will be filled in by constructed dyke • Differential height between CT deposits East to Centre is about 15 m	• 3H:1V upstream, 5H:1V downstream currently planned acceptable only if pond muds not present in downstream area. • 3-5 m lift overburden/interburden fill with no selectivity or zonation should be acceptable. • No water ponding against dyke.	• Evaluation of foundation required to assess suitability of 5H:1V for plan. 8H:1V would be more appropriate if pond muds present near surface.
CT Settlement:	• + 90 m deep CT deposit filling pit to about elevation 320 m will continue to settle after filling phase.	• Ultimate settlement of CT deposit is about 5 m, mid point of settled deposit projected at 315 m. • Time required to reach ultimate settlement is about 50 years after filling is complete.	• Total settlement could range from 2 to 23m, and time to complete settlement could range from 20 to 160 years, depending on k (permeability). SFR is a key variable affecting predictions.

FEATURE	DESCRIPTION	KEY DESIGN ASSUMPTIONS	COMMENTS
Seepage: Seepage Flow from Base and Sides of CT Deposit into Natural Strata	• Seepage that will flow from the consolidating CT mass into the surficial sand and gravel layer and the basal aquifer.	• 0.14 m^3/m^2 of pond bottom/yr of flux through the basal aquifer during pond filling with pumps on & 0.03 m^3/m^2 of pond bottom/yr in the long term related to steady state seepage conditions with pumps off. • 70 - 210 m^3/day/lineal metre of pit perimeter into surficial sand and gravel at end of filling and 30 to 100 m^3/day/m in the long term. • Above predictions based on "best fit" k-(permeability) parameters and assumed SFR.	• Basal flux estimates are based on assumption of unimpeded access of CT to basal aquifer. Where pond muds are present. the estimated flux quantities would decrease. • Given permeability distribution. CT would likely remain saturated up to or near the ground surface with the anticipated infiltration rates.

Table 3.3-6 Center Pit - In-Pit Containment - Design Criteria

FEATURE	DESCRIPTION	KEY DESIGN ASSUMPTIONS	COMMENTS
In-pit Dykes: South and North Perimeter	• Overburden dyke at south mine limit buttressed with overburden between dyke and ultimate pit wall and rising to 315 m elevation, up to 15 m above adjacent natural ground.	• 4H:1V external (south) slope, for 10 to 15 m high dyke section above original ground surface. • 2H:1V internal slope adjacent to CT. • Moderately compacted, thick (3 to 5 m) lift interburden and overburden fill. • No zonation of dyke fill material required, but preferential placement of more pervious material in downstream area, moisture control required. • 50 m wide compacted shell section required at upstream of slope face. No water allowed to pond against dyke or active working faces.	• Both the internal and external slopes could be made steeper than the stated inclination, depending on quality of fill, level of compaction and control over CT level for use as an upstream buttress.
Barrier Pillar: Barrier between Centre and West Pits	• Mainly formed by $\pm$1 km wide in situ pillar with overburden dump to 315 m • 500 m gap in in situ pillar will be filled in by constructed dyke.	• Planned 3H:1V upstream slope, 200 m crest and 5H:1V downstream slope is acceptable. • 3.5 m lift overburden acceptable for dyke; sand overburden preferable.	• If predominantly sand overburden used for dyke, may be able to decrease crest width. • Sand would lead to lower phreatic surface and reduced long term CT runout potential
CT Settlement:	• $\pm$ 70 m deep CT deposit filling pit to elevations ranging from about 285 m to 306 m to approximately match natural ground.	• Ultimate projected settlement of CT deposit is less than 1 m. • Time required to reach ultimate settlement is up to about 4 years after filling is complete.	• Total settlement could range from less than 1 to 9 m ,and time to complete settlement could range from 2 to 40 years, depending on permeablility (k) function adopted.
Seepage: Perimeter Seepage Discharge	• Seepage discharge that will report to the toe of the perimeter dykes rising above the adjacent natural ground.	• Seepage quantities of up to 0.04 m^3/day/m both during operational phase and in the long term	• Low CT permeabilities preclude any significant seepage flow from CT through OB dykes into toe region. Most of quoted flow is from surface infiltration into OB dykes.
Seepage Flow from Base and Sides of CT Deposit into Natural Strata	• Seepage that will flow from the consolidating CT mass into the surficial sand and gravel layer and the basal aquifer.	• 260,000 m^3/yr. through to the basal aquifer at the end of pond filling for pumps on for total pond area. • 50,000 m^3/yr. through to the basal aquifer in the long term for the total pond area related to steady state seepage conditions (pumps off) • 26 M^3/day/lineal metre of pit perimeter into the surficial sand and gravel during filling and 10 m^3/day/m in the long term	• Seepage estimates are based on "best fit" k parameters and assumed SFR ratio.

This system will operate throughout the active life of the tailings structure, and for a number of years afterward until seepage ends or seepage water is of a quality that allows release directly to the environment. This will require regular monitoring of seepage water quality.

During the placement of composite tailings in-pit, depressurization wells will remain operating on the perimeter of the mined-out pit to minimize seepage of tailings water to the basal aquifer. The EIA provides additional information on tailings water seepage at closure.

Erosion Control

Ditching and drainage control practices are well established in the oil sands industry to minimize erosion. All tailings working surfaces and slopes will be graded to minimize erosion from run-off water. Progressive reclamation will be carried out as quickly as possible on these surfaces and slopes during operation. Further information is available on reclamation and the closure landscape in Section 11.

Performance Monitoring

The "observational approach" to performance monitoring of tailings structures has been employed in oil sands operations for the past 20 years, and will form the basis of the Aurora Mine performance monitoring system. Initially, inclinometers are installed in the foundation layers at the disposal structure toe to measure horizontal displacements. The spacing of these inclinometers will be based on experience, taking into consideration variations in foundation geology, dyke geometry and rates of construction. Piezometers will be installed at selected locations in the foundation layers to adequately monitor pore water pressure in the various foundation units and subunits. The spacing of piezometers will initially be similar to that utilized at the Mildred Lake Settling Basin.

The monitoring program will be continuously reviewed and modified if required. Any changes in observed performance of the tailings structures will dictate changes to the operating practice. Application of the observational approach requires considerable flexibility in the operating practice and monitoring program to be successful.

3.3.8 Contingency Planning

Mature Fine Tailings Accumulation Rate

Tailings settling basin size is determined by a number of factors including the rate of accumulation of mature fine tailings. Prediction of the accumulation rate is based on the expected characteristics of Aurora tailings and Mildred Lake tailings experience. Variation in the actual accumulation rate during Aurora operation, especially if the rate proves to be higher than predicted, could have an impact on the design and operation of the settling basin.

A higher than predicted accumulation rate would require faster vertical construction of the structure and a higher final elevation, but within the same footprint area. This construction could be accomplished within reasonable limits by either using additional overburden or a combination of overburden and hydraulically-placed sand.

A monitoring program of actual against predicted generation of fine tailings will commence from the start-up of operations. This program will provide lead time should it become necessary to make design changes based on the true accumulation rate for mature fine tailings.

Composite Tailings Process

The predicted performance of composite tailings at Aurora has been based on research and development work carried out by the oil sands industry at a bench and pilot scale. Although Syncrude is confident that the process will be commercially successful, there is uncertainty respecting the rate of consolidation of commercial-sized deposits. For this reason Aurora tailings design, and environmental impact assessment, has been based on conservative performance factors for the composite tailings process. However, the composite tailings process is known to have considerable flexibility, and the potential exists to engineer the process further to meet the necessary design parameters.

Contingency planning for the composite tailings process involves possible modification of the process to change material characteristics as well as design of the deposits. The process could be modified for the use of alternate chemicals and dosages, and for adjustment of the sand and fines mixture. The disposal areas could be adjusted by changing the timing, size, and location of in-pit containment structures without altering the out-of-pit tailings structure. Additional knowledge will be available on these factors well in advance of Aurora start-up as a result of the implementation of composite tailings at Suncor, which began in 1995, and at Syncrude Mildred Lake, which begins in 1999. After start-up of Aurora, the "observational approach" will be employed to continuously monitor and evaluate composite tailings activity to allow ample reaction time for any necessary changes.

Contingency planning also takes into account the possible variation in the consolidation rate for composite tailings, affecting the rate and volume of water released from the deposits. Achieving more or less release water from the deposits may require adjustments to the process water system for more recycle or additional water import.

On a broad perspective, if composite tailings proves to be undesirable for the Aurora site for reasons that cannot be resolved, alternate tailings disposal methods that can meet the reclamation criteria will be utilized. These methods have been discussed previously in the Application.

Other

The Aurora Mine will employ bird deterrents on tailings water bodies as per existing successful practice in industry.

Syncrude is committed to continuation of a strong research and development program in the areas of tailings and reclamation as described in Section 8. This work will proceed in conjunction with Aurora Mine development, construction, and operation to ensure the best available demonstrated technology is available and employed in a responsible economic and environmental manner.

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3.4 Plant Site Selection

3.4.1 Plant Site Selection Criteria

The plant sites were selected by evaluating the most economic location between the tailings disposal site and the mine location with maximum access to ore. While the mine site and tailings disposal site selection process includes avoidance of sensitive environmental areas, this is again examined for process plant site selection. The following plant site selection criteria have been used in locating the processing site in relation to optimal mine and disposal sites.

Environmental Considerations:

- Protection of the environment from adverse impacts, particularly to the surface and sub-surface waters

Economic Considerations:

- Minimum feed delivery costs from the mine to the plant and tailings transportation costs from plant to disposal site;
- Good foundation requiring minimum sub-excavation and backfill; and,
- Meets minimum distance requirement for the hydrotransport slurry pipeline

Resource Management

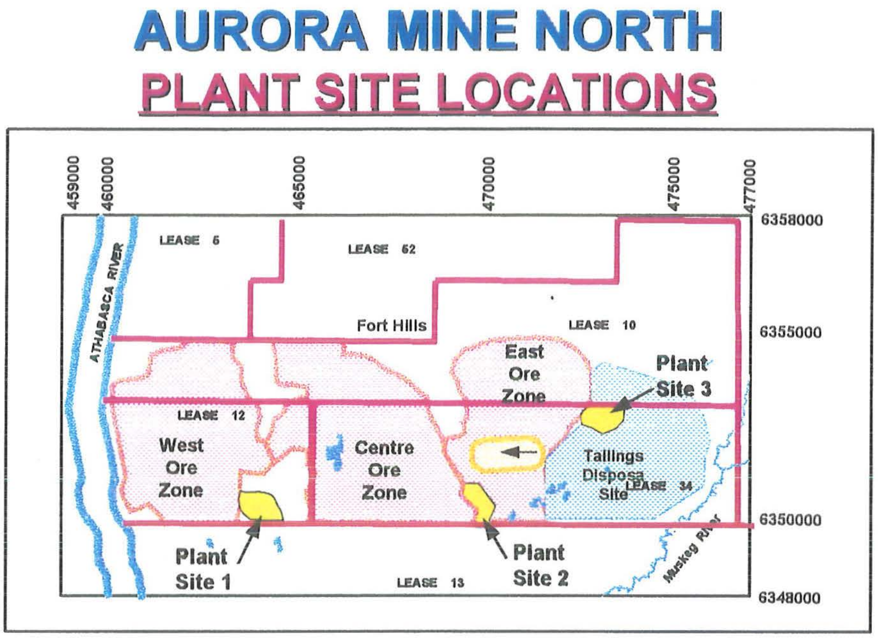
- Maximum access to ore reserves.

3.4.2 Aurora North Site

Three potential plants sites were evaluated for the Aurora North as shown in Figure 3.4-1.

- Plant Site 1
- Plant Site 2
- Plant Site 3

Figure 3.4-1 - Aurora Mine North - Plant site locations



Plant Site 3 was eliminated in the initial screening for the following reasons:

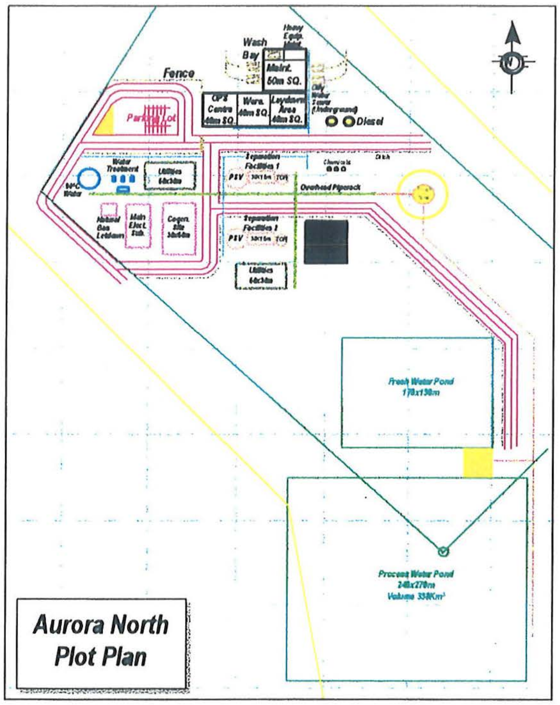
- It encroaches on the selected tailings disposal site. This tailings disposal site was significantly better than the second option. Locating the plant on this site would reduce the tailings storage capacity by two to three years
- Longer distance from the mining activities in later years, i.e., from the Centre Ore Zone and the West Ore Zone

A detailed evaluation was done for Plant Site 1 and 2. As a result of this evaluation, Plant Site 2 was selected on the following basis.

- Lower overall capital costs
- Shorter distance to the tailings disposal site
- Shorter distance to the mine opening in the East Ore Zone
- Maximum access to ore reserves

The plant site plot plan is shown in Figure 3.4-2.

Figure 3.4-2 - Aurora North Plot Plan

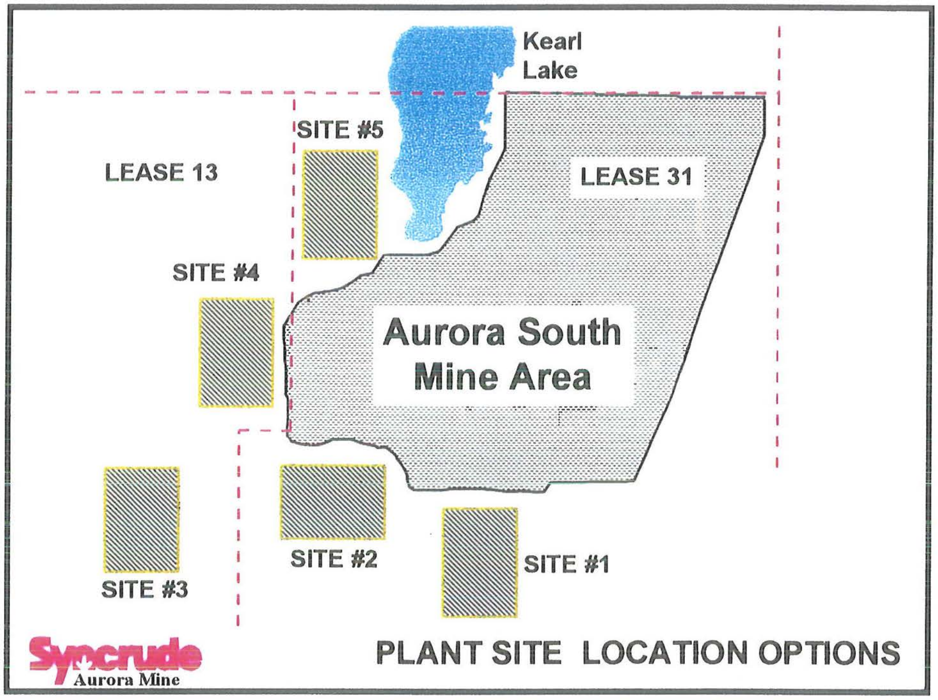


Please refer Appendix A for detailed analysis

3.4.3 Aurora South Site Selection

For the Aurora South area, Syncrude examined five potential plant site locations were examined. (Figure 3.4-3). These were previously examined by OSLO.

Figure 3.4-3 - Aurora South Plant Site Options

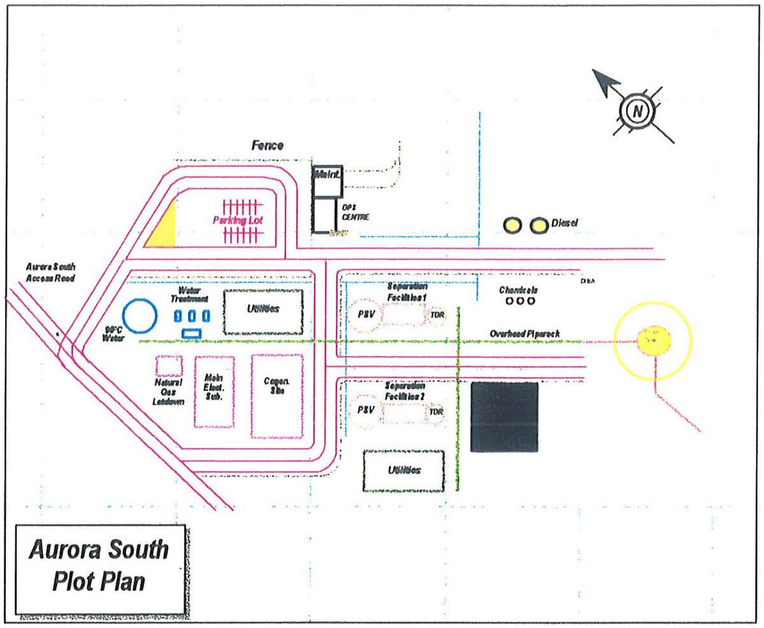


Plant Site 4 was eliminated because of its distance from the tailings area, proximity to the mine and its position on a natural extension of the mine ore zone. Plant Site 5 was eliminated because of its distance from the tailings disposal site and low overall score.

The three remaining sites (1, 2, and 3) all received similar scores based on the unweighted criteria used for the South Mine plant analysis. However, Plant Site 3 was selected as being clearly superior from an economic perspective. This is primarily due to its close proximity to the tailings disposal area.

The plant site plot plan is shown in Figure 3.4-4.

Figure 3.4-4 - Aurora South Plot Plan



3.4.4 Out-of Pit Overburden Disposal Sites

Conceptual Design, Location and Capacity

The overburden disposal site was chosen as it is within close haulage distance to the mine and is located over a non-mineable area. The capacity of the site is over 50 million placed metres of overburden at a safe geotechnical slope. The design has been done at a conceptual level. Detailed design will be completed prior to the commencement of mining.

Oil Sands Reserves under Disposal Sites

The location of the disposal site was chosen to minimize the possibility of covering mineable reserves. The site is rated in the TV:BIP (Total Volume to the Bitumen in Place) as being over 19 for the southern half. A small portion in the northern part which that meets the mineable screening criteria is too small and irregular in shape to be mineable using current technology for open pit mining. The site is also overlain with Clearwater Formation which would require shallow side slopes for a stable mine design. This would increase the stripping ratio of an already minimal quality resource.

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3.5 Extraction and Bitumen Transfer

3.5.1 Introduction

The Aurora Mine project provides the opportunity to bring together a number of attractive process elements that have been under development over the past 15 years. One of them is a new bitumen extraction process — the Low Energy Extraction Process. It is an energy efficient process that can operate with high capacity, efficient material handling technology. The suite of technologies to be utilized at the Aurora Mine include:

- Continuous feed systems for large-scale truck-shovel mining have been developed to higher capacities through co-operative work between Syncrude and equipment suppliers since the early 1980s. Syncrude now feels confident in designing process capacities of at least 8000 tonnes/hour.

- Two-stage bitumen recovery with primary recovery and froth formation in the first vessel and a second stage (tails oil recovery) on all middlings and sand tailings was developed by Syncrude as the warm slurry(~50^0C) extraction process.

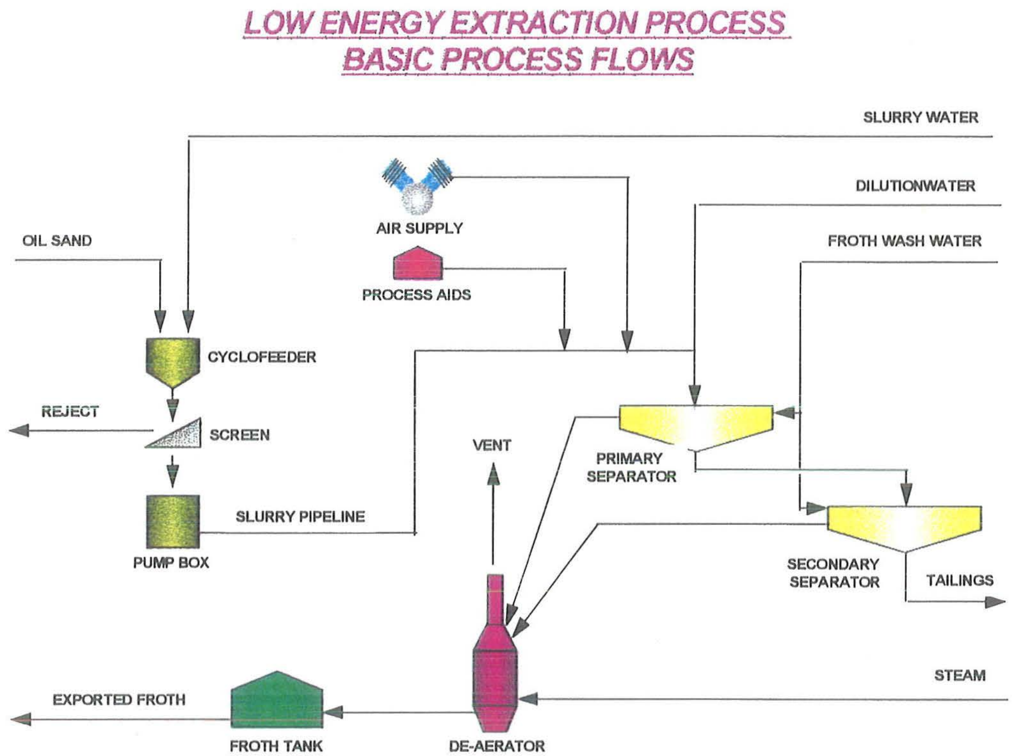
- High density oil sand slurry pipeline transport and conditioning technology (hydrotransport) was made feasible with the development of the cyclofeeder slurry preparation system at a research scale in 1988. This system has since been demonstrated on a commercial scale.

- Cold water separation technology using coal flotation chemicals has recently been demonstrated to be workable at high density and in conjunction with pipeline slurry conditioning. Below 40-45^0C the air flotation mechanisms relying on natural surfactants do not function. Beginnning in 1986, work by the OSLO group demonstrated that kerosene-methyl-isobutyl-carbinol (MIBC) could be used as a flotation aid at lower temperatures. Recent tests conducted by Syncrude have shown that high density hydrotransport operation is possible and that froth quality can be managed with the appropriate design features in the separation vessels.

3.5.2 Overview of the Low Energy Extraction Process

Figure 3.5-1 shows the Block Flow Diagram for the process. Figures 3.5-2 to 3.5-7 show mass balances on a calendar day basis for one, two and four Aurora trains producing 6.25, 12.5 and 25 million cubic metres of bitumen per year respectively at the average expected ore grade of 11%. Mass balances are shown for both summer and winter operation.

Figure 3.5-1 -Low Energy Extraction Process



Oil sand delivered by truck from the mine is fed at rate of 8000 tonnes/ hour to a crusher in which it is crushed to a maximum lump size of 600 millimetres. The crushed feed is mixed with water at 40°C in a cyclofeeder (Figure 3.5-8) to form a slurry at 25°C with a density of 1.6 tonnes/cubic metre. The formed slurry is screened to a size of 100 millimetres. The oversize material (reject) from the screening operation is removed as solid by truck.

Figure 3.5-2 - Mass Balance for Aurora Train 1 (Summer)

FOR ANNUAL PRODUCTION RATE OF 6.25 MCuM/Yr SUMMER OPERATIO

(Units of Measurement are Tonnes per Calendar Day for 11% Ore)

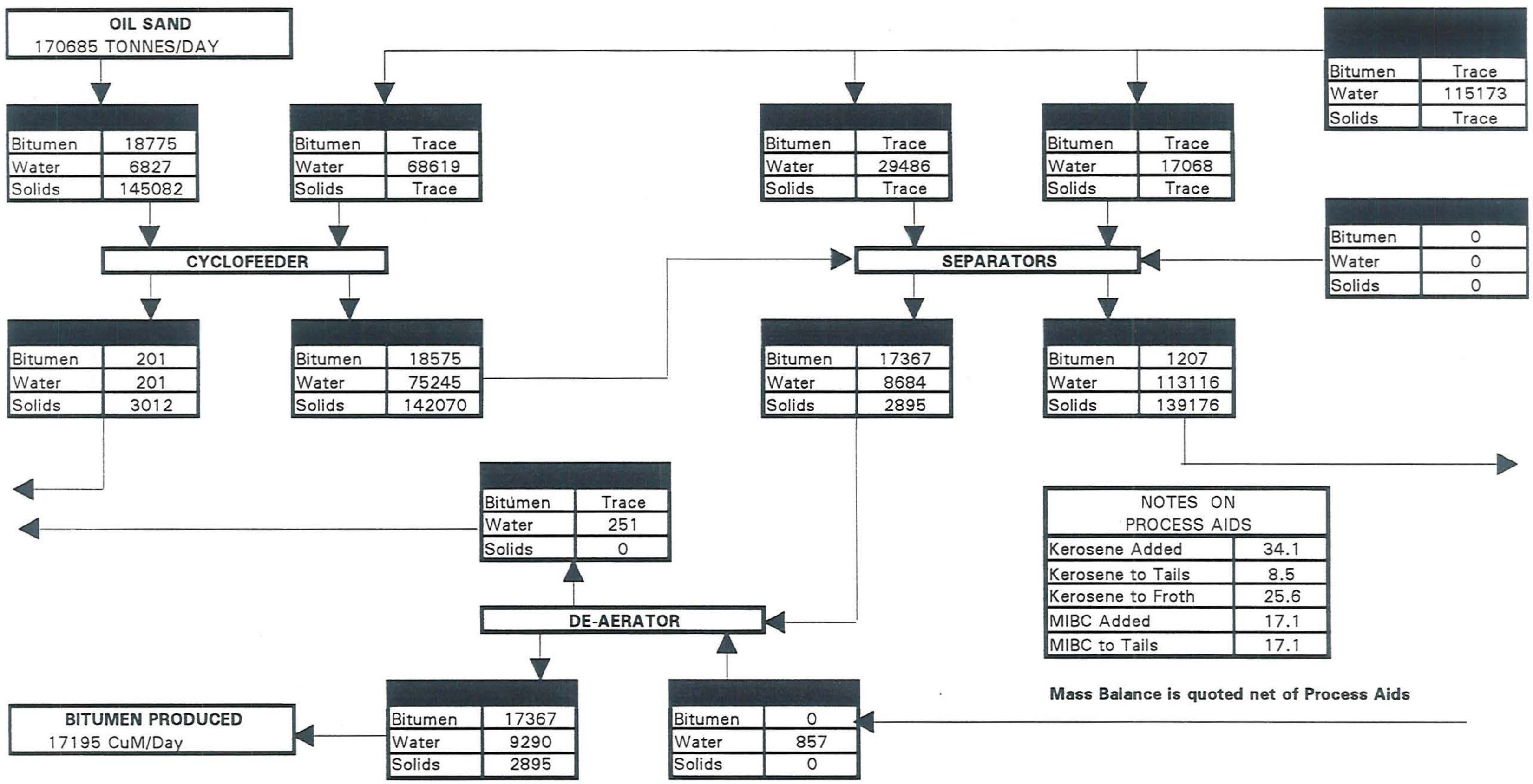


Figure 3.5-3 Mass Balance for Aurora Train 1 (Winter)

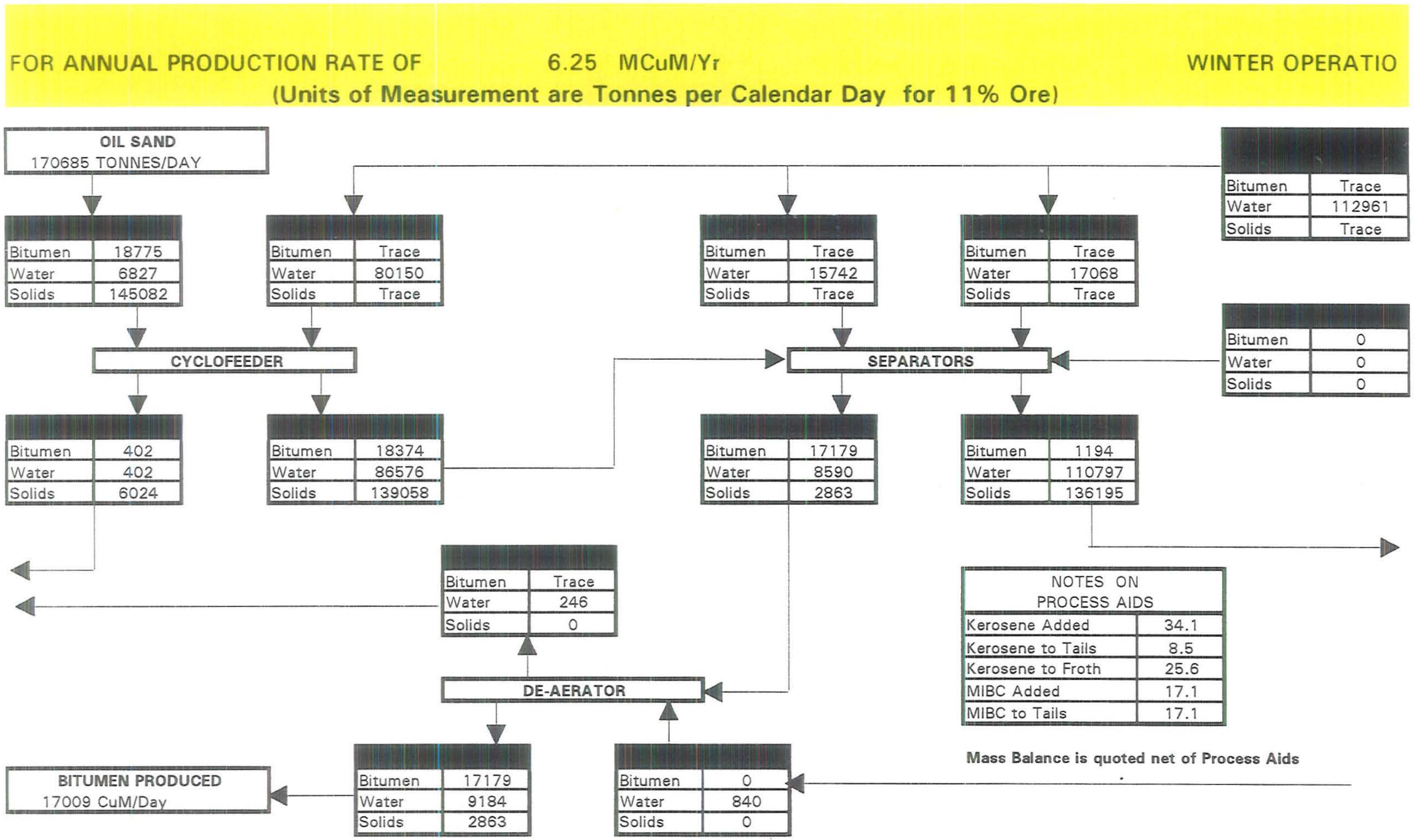


Figure 3.5-4 Mass Balance for Aurora Trains 1 & 2 Combined (Summer)

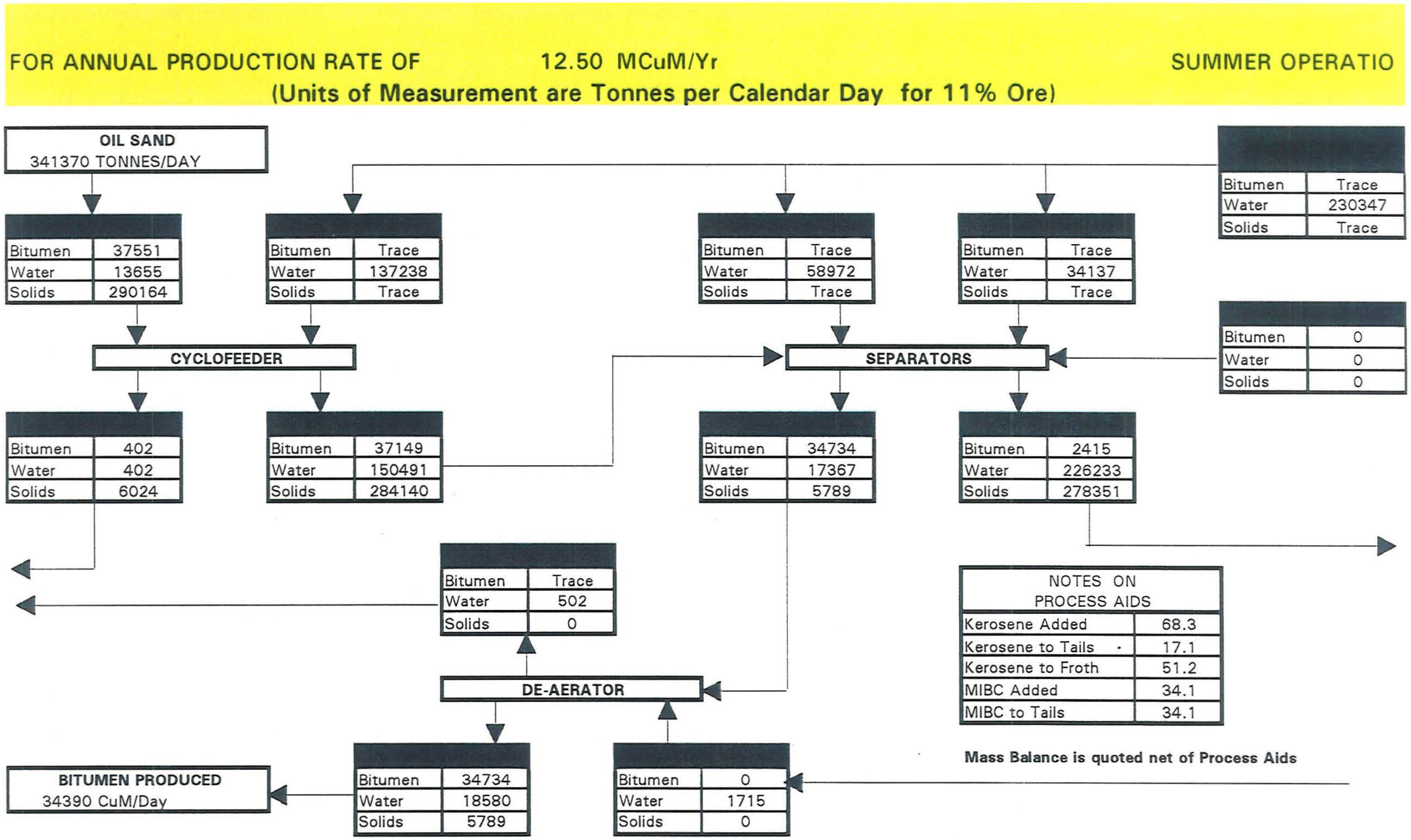


Figure 3.5-5 Mass Balance For Aurora Trains 1 & 2 Combined (Winter)

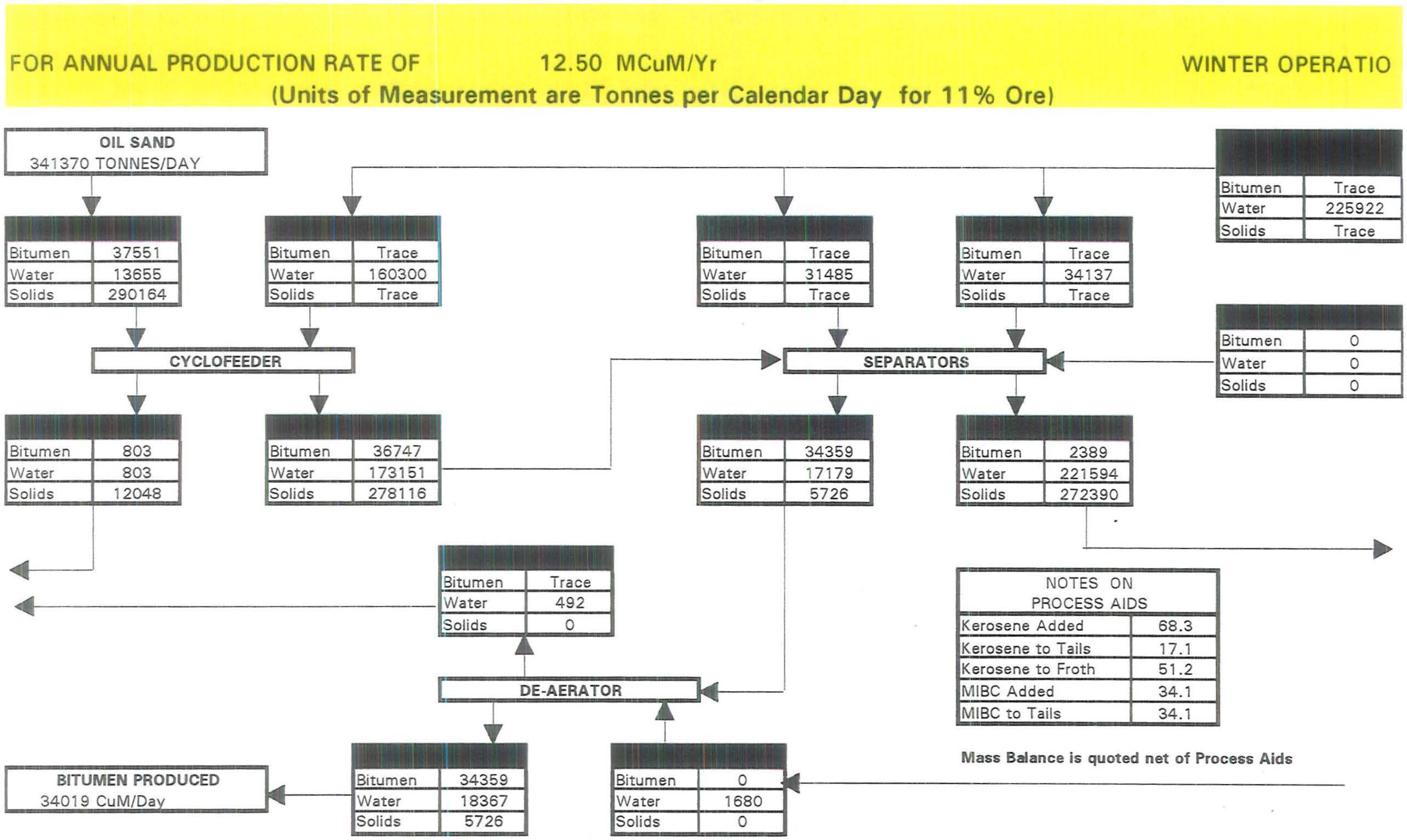


Figure 3.5-6 - Mass Balance for Four Aurora Trains Combined (Summer)

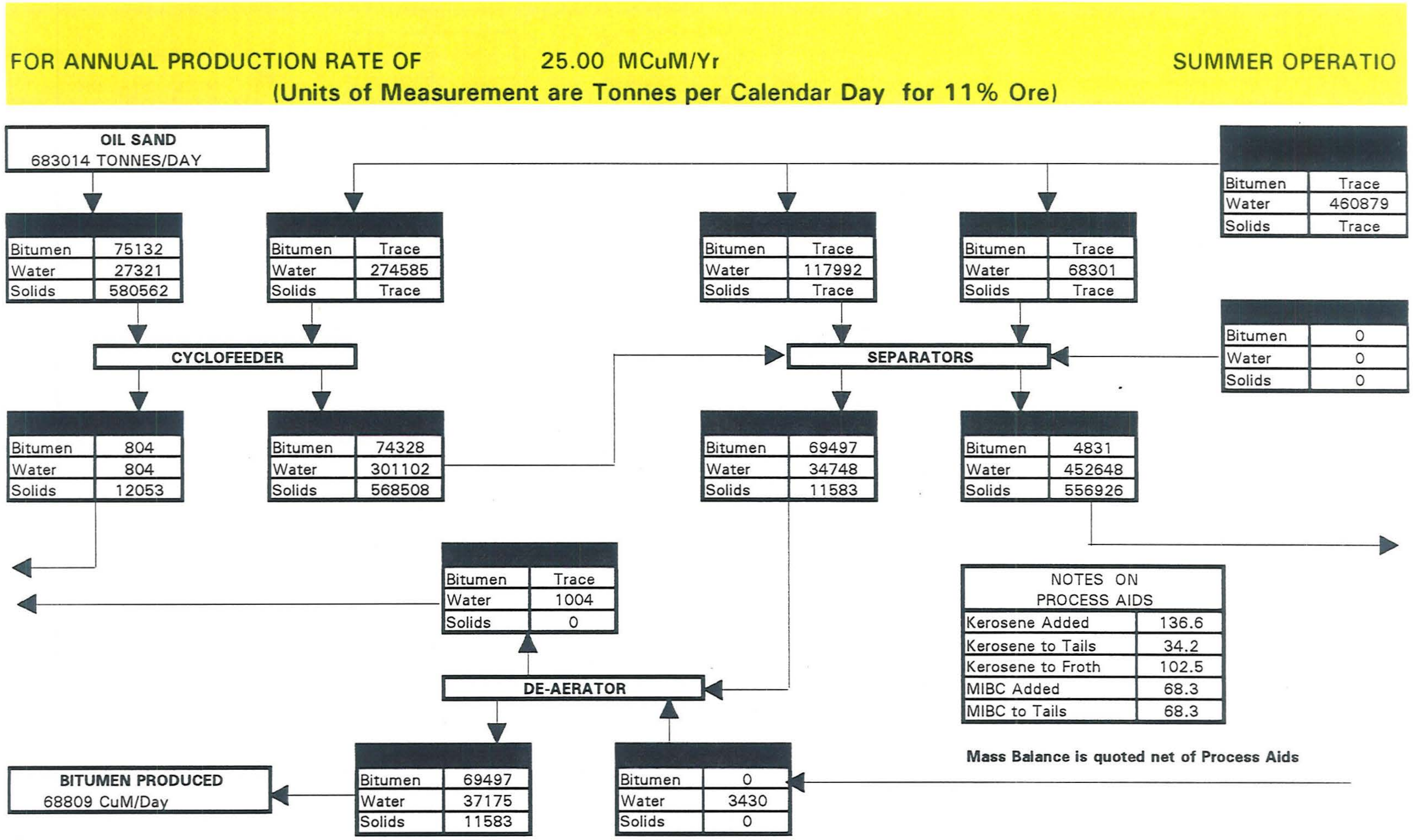


Figure 3.5-7 - Mass Balance for Four Aurora Trains Combined (Winter)

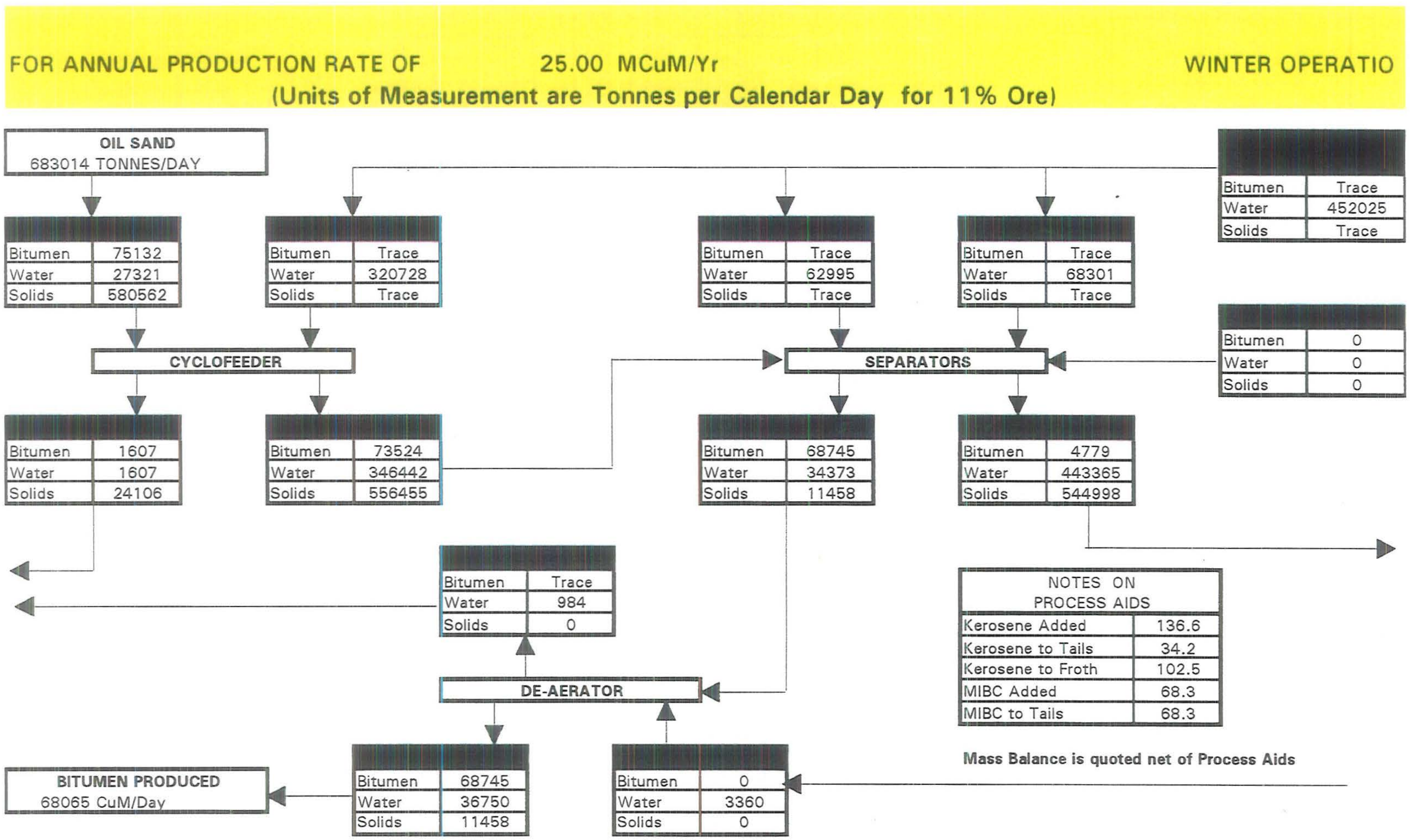
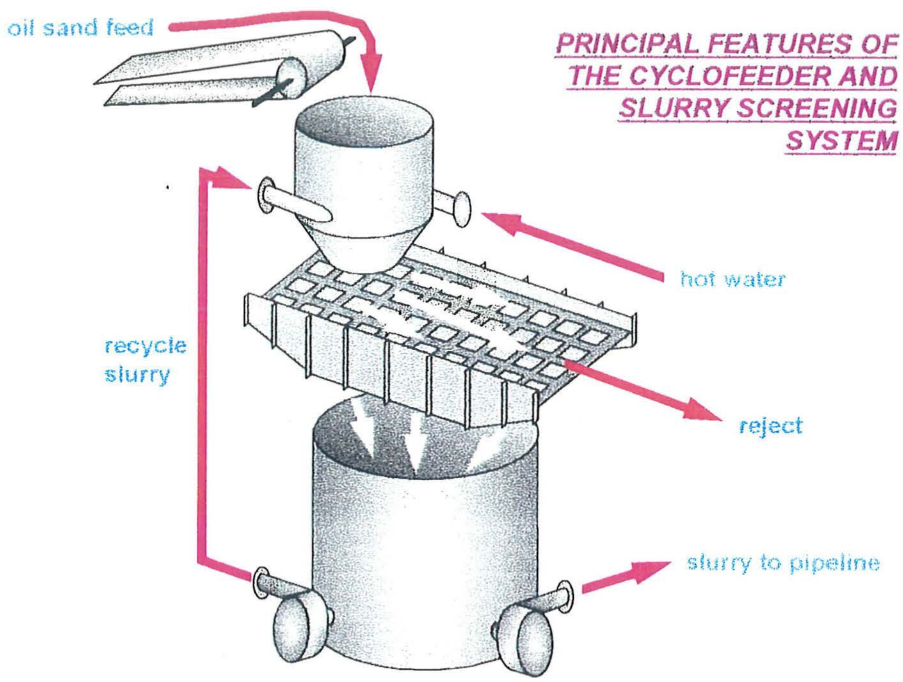


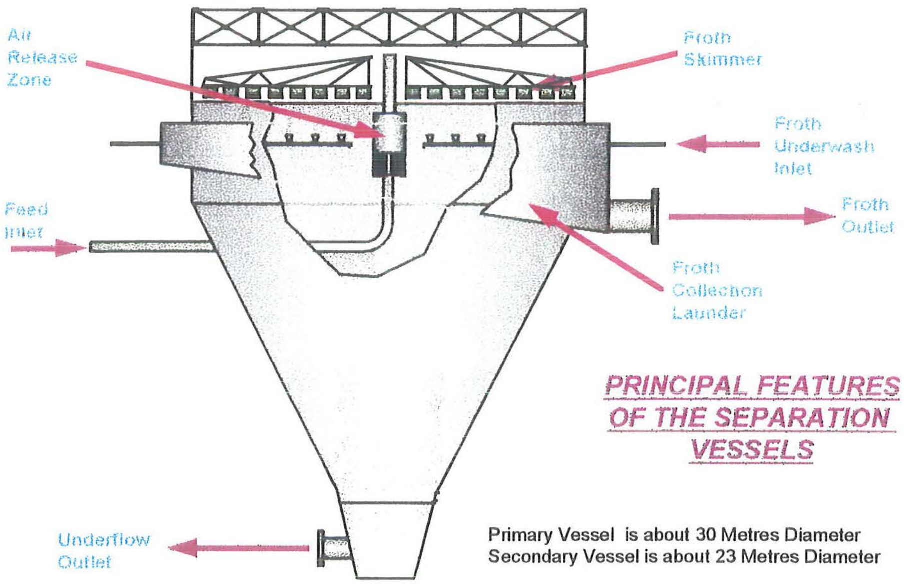
Figure 3.5-8 - Principle Features Cyclofeeder/Slurry Screening System



The screened slurry is pumped to the Extraction Plant in a single pipeline about five kilometres long. The slurry is conditioned in the pipeline so that the bitumen is released from the sand grains. A few hundred metres before the slurry reaches the Extraction Plant, air and process aids are added to aid the bitumen flotation process. The chemicals used in the process are kerosene or diesel and MIBC (methyl-isobutyl-carbinol).

The bitumen separation process takes place in two gravity separation stages — primary separation and secondary separation. A typical separation vessel is shown in figure 3.5-9. The underflow from the primary separator is re-aerated and passed to the secondary separator for maximum bitumen recovery. The froth from both separators is heated and cleaned as it flows out of the vessels by injection of hot water between the middlings zone and the froth layer (Froth Underwash). The froth flows by gravity into a vessel and is then deaerated and heated to 55°C.

Figure 3.5-9 - Principle Features of Separation Vessels



The resulting de-aerated froth is pumped to short-term storage in a surge tank before entering the bitumen transfer pipeline. The expected volume of froth in storage will be sufficient to stabilize the operation of the pipeline. The tank will be level controlled and bermed in accordance with accepted industry standards to contain potential spillage and overflows.

Spills and overflows from the process will be initially contained in sumps under the separators and will be returned to the process. If the separators have to be drained, their contents will be drained to an emergency drainage pond.

The key advances over the technology currently in use are:

- Hydrotransport and pipeline conditioning of oil sand slurry. This replaces conveyors and tumblers.
- Lower temperature of the process which leads to a reduction in thermal energy.
- Use of hot froth underwash to produce a warmer froth with lower mineral solids.
- Replacement of caustic as a process aid which leads to less dispersion of fine solids in the slurry and a faster initial consolidation rate in the settling basin.

3.5.3 Extraction Bitumen Recovery

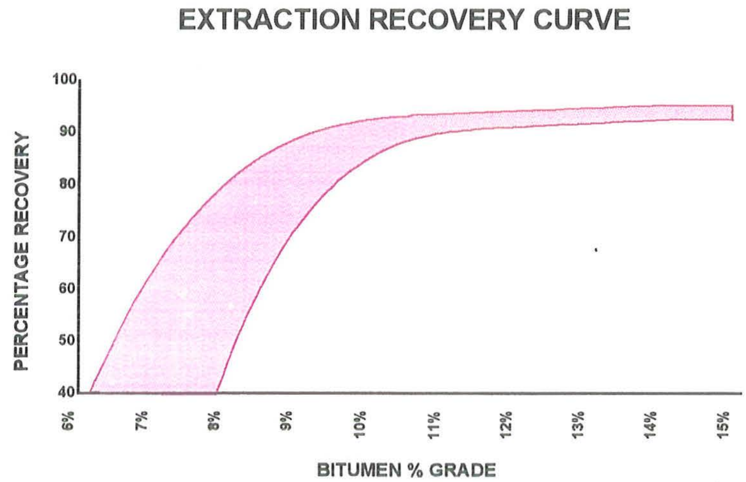
The new oil sand transport and bitumen separation technology for the proposed Aurora Mine project is significantly more energy efficient than current technologies. The entire process train (from shovel to tailings) will have comparable recovery performance to a bucketwheel-conveyor-hot water extraction system. While it is expected that the process will exhibit a similar recovery/grade/fines relationship as the current technology, there is insufficient data to determine the precise recovery performance over the entire range of ore grades and fines levels anticipated for each area of oil loss — tailings and oversize reject.

Once sufficient experience, data and understanding is obtained from the commercial operation of this process including potential trade-offs between various factors such as recovery and process temperature and cut-off grade and scaled up process performance, a recovery curve can be defined more specifically and related to a more detailed understanding of the ore characteristics.

Results from pilot plant work are useful in helping to determine the relationships between factors such as recovery and temperature. Nonetheless, commercial experience is still necessary to establish a benchmark for the relational data generated in pilot plants. Syncrude will continue its work on expanding the level of understanding of the Low Energy Extraction Process. Translation of this information into more precise commercial performance standards will occur after start-up and refinement of the first train at the Aurora Mine.

Because of the uncertainties inherent in a new process, Syncrude has used a conservative estimate for calculating bitumen recovery for the purposes of this Application. Improving bitumen recovery is a critical factor to maximize the economic performance of the Aurora Mine investment. This provides the incentive to continuously improve recovery. Syncrude will keep the Board apprised of performance and progress. The expected relationship between recovery and grade is illustrated in Figure 3.5-10.

Figure 3.5-10 - Extraction Recovery Curve



For the purposes of material balances and mine plans this general relationship has been modelled with the following equations:

i) for ores with less than 11% bitumen:
Recovery = $-1160.47 + 379.7055*G - 42.805*G^2 + 2.125539*G^3 - 0.03921*G^4$
ii) for ores between 11% and 14% bitumen:
Recovery = $0.625*G + 85.2$
iii) for ores with greater than 14% Bitumen:
Recovery = 94%

3.5.4 Chemicals used in Extraction

Process Aids

The following chemicals will be used as process aids in the Extraction process (quantities are for Aurora Train 1 and Train 2 combined):

- **Kerosene/Diesel** - At the approximate rate of 31000 tonnes/year (39000 cubic metres/year)
- **Methyl-isobutyl-carbinol (MIBC)** - At the rate of approximately 15600 tonnes/year (19500 cubic metres/year)

These chemicals are not regulated under the Canadian Environmental Protection Act or the Priority Substances List.

MIBC will be delivered to site by road tanker and stored in a tank which will contain sufficient chemical for about three days production. Diesel will be deliveried to site via pipeline from Mildred Lake. Expected maximum volumes in storage will be approximately 550 tonnes (650 cubic metres) of kerosene/diesel and 275 tonnes (325 cubic metres) of MIBC after the start-up of Aurora train #2.

The tanks will have level indicators and will be bermed in accordance with accepted industry standards to contain potential spillage and overflows. The truck off-loading area will drain to a sump to contain potential leaks and spillage.

Other Chemicals

Table 3.5.1 shows those chemicals that will be used on Aurora in the Extraction Plant in a full operating year. Amounts quoted are for Aurora Trains 1 and 2. These chemicals will be delivered in drums by truck.

Table 3.5-1 - Other Chemicals used in the Extraction Area

CHEMICAL	AMOUNT	USED FOR	DISPOSAL
Varsol	6 m^3/yr	Cleaning and Degreasing of Mechanical Parts	Disposed off site
Citrikleen	8 m^3/yr	Degreaser for Plant Cleaning	Disposed off site
Citro-Solve Plus	5 m^3/yr	Degreaser for Plant Cleaning	Disposed off site
Toluene	3 m^3/yr	Analysis of Lab Samples	Disposed off site

3.5.5 Selection of the Extraction Process

Table 3.5-2 summarizes the extraction processes that Syncrude evaluated during the past 18 months as part of the extraction technology selection process for the Aurora Mine project. Solvent-based extraction processes were not evaluated during this time as they showed little promise in 1993, however a number of new water based processes were evaluated and are included in this table. For reference purposes the 1993 extraction process comparison is also attached. More detailed information on the extraction technology selection process can be found in Appendix A.

Table 3.5-2 - Comparison of Altrenative Extraction Process to the Warm Slurry Extraction Process
(Syncrude 1995/6 Assessment)

	Water Flotation Based								New Processes Evaluated in 1995/6				
Assessment Factors	Warm Slurry Process (WESP)	Clark Hot Water	WSEP With Hydrotransport	OSLO Hot Water (OHWE)	RTR/Gulf	Low Density Cold Water (OWE)	High Density Cold Water	Oleophilic Sieve	Bitmen	Zefte	PWS Process	Sand Reduction Technology	GeoSol
Capital & Operating Costs	Base	Similar	Lower	Similar	Higher	Higher	Lower	Higher	Higher	Similar	Higher	Higher	Higher
Energy Consumption	Base	Higher	Similar	Similar	Similar	Higher @ Piloted Conditions	Lower	Similar ?	Lower	Lower	Higher	Similar	Similar
Demonstrated Recovery	Base	Similar	Similar	Higher	Less	Less Than Or Equal	Similar	Less in Tested Configuration / Application	Lower	Similar	Higher (predicted)	Lower	Lower
Tailings/Reclamation Impact	Base	Similar	Similar	Unknown	Claimed to Produce A Paste For Fines	Unknown	Similar	Similar	Less	Similar	Less	Similar	Similar
State of Development	Commercial Ready	Highest	Full System 4500 tph	Commercial Scale Testing	2 Tonne Pilot	20 tonnes Per Hour	1.5 Tonne Pilot	1.5 Tonne Pilot	20 tph Pilot	Small Scale Pilot	Never Tested On Oilsand	Bench Scale Testing	Bench Scale Testing
Rejects/Oil Loss Impact	Base	Similar	Similar To Base	Similar	Similar	Similar	Similar	Similar	Similar	Similar	Lower	Similar	Similar
Environmental Factors	Base	Similar	Similar	Similar	Similar	Similar	Similar	Slightly better	Similar	Similar	Similar	Similar	Similar
Cost of Tails Disposal	Base	Similar	Similar	Similar	Higher	Similar	Similar	Similar	Higher	Lower	Higher	Higher	Similar
Other Factors	---	---	Mine Planning Flexibility Conveyor Savings	---	Complex Water Recycle Process	Lower Froth Quality	Good Remote Mine Option	Applicable To Fine Tails Bitumen Recovery	---	---	Very Complex	---	---

NOTE: Comments are made in reference to the Warm Slurry Extraction Process (i.e. similar means the alternative process is similar to the Warm Slurry Extraction Process).

Table 3.5-3 - Comparison of Alternative Extraction Processes to the Warm Slurry Extraction Process
(Syncrude 1993 Assessment)

	Water Flotation Based								Solvent Extraction Based			Direct Thermal Treatment Based
Assessment Factors	**Warm Slurry Process (WESP)**	**Clark Hot Water**	**WSEP With Hydrotransport**	**OSLO Hot Water (OHWE)**	**RTR/Gulf**	**Low Density Cold Water (OWE)**	**High Density Cold Water**	**Oleophilic Sieve**	**SESA**	**COSECO**	**SOLV-EX**	**UMATAC**
Capital & Operating Costs	Base	Similar	Lower	Similar	Higher	Higher	Lower if process works	Higher	Higher	???	Higher	Higher
Operating Complexity & Flexibility	Base	Similar	Similar	Similar	More Complex	Similar If Process Works	Simpler if Process Works	More Complex	More Complex	Chlorinated Solvent Containment	More Complex	Multi Trains Special Equipment
Energy Consumption	Base	Higher	Similar	Similar	Similar	Higher @ Piloted Conditions	Lower If Process Works	Similar ?	Similar To Higher If Solvent Is Heat Stripped	Similar To Higher If Solvent Heat Stripped	Higher With Solvent Recovery	Higher
Demonstrated Recovery	Base	Similar	Similar	Higher	Less	Less Than Or Equal	???	Similar (Claimed)	Similar	Greater Than Or Equal (Good)	Claimed To Be High	Higher Lower Overall Vs. High Yield Upgrading
Tailings/Reclamation Impact	Base	Similar	Similar	Unknown	Claimed to Produce A Paste For Fines	Unknown	???	Similar	Dry Tails	???	???	Dry Tails
State of Development	Commercial Ready	Highest	Full System 100 tph Key Component 1000-4500 tph	2 Tonne Pilot	2 Tonne Pilot	20 tonnes Per Hour	Pre-Bench Scale	Small Pilot	Small Pilot	Pilot Scale	Many Unknown Processes Issues	5 Tonne/Hr Pilot
Rejects/Oil Loss Impact	Base	Similar	Similar To Base	Similar	Similar	???	???	≥	???	???	???	Potentially Higher
Environmental Factors	Base	Similar	Similar	Similar	Similar	Similar	—	Similar	Solvent In Tails	Chlorinated Solvent Residue In Tails If Air Emission	Solvent In Tailings Acid Leach Liquor	SO2 Recovery From ??? Gas
Cost of Tails Disposal	Base	Similar	Similar	Similar	Higher	Similar	Similar	Similar	Higher	Higher	Higher	Higher
Other Factors	—	—	Mine Planning Flexibility Conveyor Savings	—	Complex Water Recycle Process	Lower Froth Quality	Good Remote Mine Option	Applicable To Fine Tails Bitumen Recovery	Solvent Recovery Unresolved		Metals Recovery From Tails	Scale Up Of Very Specialized Complex Kiln Equipment

NOTE: Comments are made in reference to the Warm Slurry Extraction Process (i.e. similar means the alternative process is similar to the Warm Slurry Extraction Process).

3.5.6 Contingency Extraction Process

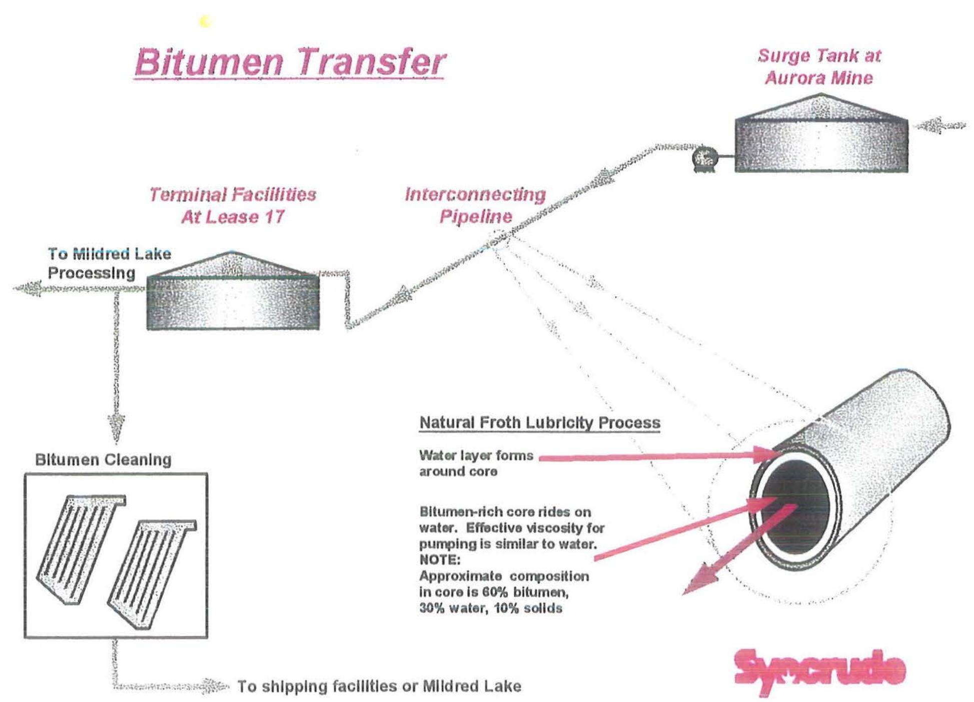
The Low Energy Extraction Process is still under development. In the event that the performance of the process falls seriously short of expectations, a variant of the Warm Slurry Extraction Process will be used as a contingency.

3.5.7 Bitumen Transfer Process

Bitumen is transported in a 610 mm diameter pipeline at a temperature of about 55^{o}C as a bitumen-rich slurry with an approximate composition of 60% by weight bitumen, 30% by weight water and 10% by weight fine solids. It is processed in the existing Froth Treatment and Upgrading complex at Mildred Lake. The approximate flow rate in the line is 6500 USGPM for Aurora Train 1 and 13000 USGPM for Trains 1 and 2 operating together. A second line is required for Trains 3 and 4.

The pipeline operates under the natural froth lubricity mode of transport in which some of the water in the product forms a layer around the bitumen in the pipeline and provides a low viscosity medium in which the high viscosity froth "rides". Figure 3.5-11 shows the principal features of the process.

Figure 3.5-11 - Key Features of Natural Froth Lubricity Process



Natural froth lubricity flow is a novel pipeline technology that has been operating over short distances in the oil sands for many years with little recognition for its potential in a regional context. This technology relies on the inherent nature of dispersed water droplets naturally present in the bitumen froth. Unlike Core-Annular flow, water reinjection is not required to re-establish flow conditions after a flow regime interruption. Flow can be re-established with the inherent low-shear characteristics of the bitumen froth.

The process is currently under further development by Syncrude for application to tranport over the 30-40 kilometre distances required for the Aurora Mine. The key advantage is that the technology allows the movement of bitumen in a pipeline at low pumping power using water as a transfer medium. This eliminates the use of hydrocarbon diluent at the Aurora site and the need for a diluent supply pipeline. It also eliminates sources of light hydrocarbon emission from diluent tanks and the potential for spillage of light hydrocarbon from pipelines.

A review of the selection process for the bitumen transfer technology can be found in Appendix A.

As noted in Section 1, a key element of the Aurora Mine plan is the movement of bitumen froth to a bitumen cleaning and shipping terminal adjacent to the Mildred Lake site (Figure 3.5-11). This facility will handle the increase in production from the new mine. Compared to current froth treatment technology, this bitumen cleaning technology will reduce both oil loss and air emissions, and has the potential to produce a bitumen with very low solids.

The new technology is being developed as a CONRAD (Canadian Oil Sands Network for Research and Development) project, in a partnership involving Syncrude, Suncor, Natural Resources Canada (NRCan), Bitmin Resources and Shell. The work is underway at NRCan's Western Research Centre. The rate of development of the bitumen cleaning technology, as well as the rate of growth of Aurora production, will determine the pace of its implementation.

3.5.8 Contingency Bitumen Transfer Process

The natural froth lubricity process is still under development. In the event that the process fails to meet expectations, the diluent-based process will be used as a contingency.

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3.6 UTILITIES AND OFFSITES

3.6.1 Overview

Syncrude has a goal to develop the Aurora Mine with efficient resource utilization, energy efficiency and project economics. To achieve this, the Aurora Mine will incorporate a combination of technological advances, mine and plant design techniques and equipment design parameters. This has resulted in an extraction design which, on a per unit of bitumen production basis, uses 60 % less energy than the extraction technology currently used in the industry. Some of the advances and design features employed that contribute to this improvement in efficiency are:

- Hydrotransport to move oil sand from the mine and deliver it to the extraction plant with ore conditioning completed;
- A new Low Energy Extraction Process;
- Natural froth lubricity for pumping bitumen froth product over moderate distances;
- Use of low level surplus waste heat energy from offsite;
- State-of-the-art equipment design — from heavy haulers to cogeneration facilities.

In addition to improving the level of energy efficiency, Aurora will use equipment design to reduce emissions where practical. One example of this is the use of low NOx burners on all fixed plant generating equipment.

3.6.2 Utilities Service Corridor and Site Access Road

The Aurora Mine requires a number of road, utility system and product connections to Mildred Lake and in turn to Alberta utility supply networks. This section provides a list of the required connections and a summary of the selection process used to choose the final routing. Table 3.6.1 provides the summary assessment. More detail is provided on the alternatives in Appendix A.

The required connections are:

- An access road to connect the Aurora Mine with the existing Highway 963.
- A high voltage electrical transmission line from Aurora North to Mildred Lake with a secondary power line to Aurora South.
- A natural gas pipeline to connect Aurora with supplies west of the Athabasca River. Individual laterals will connect with both Aurora plant sites.
- Two product pipelines to transport bitumen froth from the two Aurora plant sites to Mildred Lake.

- Two "hot" water pipelines to import heated water to the Aurora plant sites from Mildred Lake.
- A diesel product line from Mildred Lake with individual laterals to each Aurora plant site.

Utilities Service Corridor and Site Access Road Route Selection Process

The key objectives in the route selection process were to:
1. Identify alternative Athabasca River crossing locations and types of crossing.
2. Screen alternative river crossing locations against a set of "must" criteria. Alternatives that satisfied all of the "must" criteria were evaluated further.
3. Identify potential road alignments and screen against "must"criteria.
4. Identify alternative utility corridor routes which are compatible with the river crossing locations and road alignment options that remain after the initial screening.
5. Rank the river crossing locations, river crossing methods and corridor/road alignment combinations against a set of "want" criteria.

The "must" criteria used were:

- General
  1. Route must not encroach on the Fort McKay Settlement, Indian Reserve Lands, or the Beaver River Quarry Historical Resource Site.
  2. The route must satisfy all regulatory requirements.
  3. The route must have a minimum of 15 years useful life before re-positioning is necessary.

- Utilities Corridor/Pipeline Specific
  4. Connect Aurora to existing Mildred Lake facility.
  5. Must be operational on or before July 1, 2001.
  6. Must accommodate hydrocarbon, water and natural gas pipelines.
  7. Must not alter the thermal regime of any watercourse during operation (impacts trenching depth beneath river).

- Road Specific
  8. The location must be consistent with an all-weather road.

A list of criteria under the general headings of cost, engineering, environmental, historic resources and socio-economic factors were established. Each of these general subject headings were prioritized, further sub-divided and evaluated. The following steps were used in this evaluation:

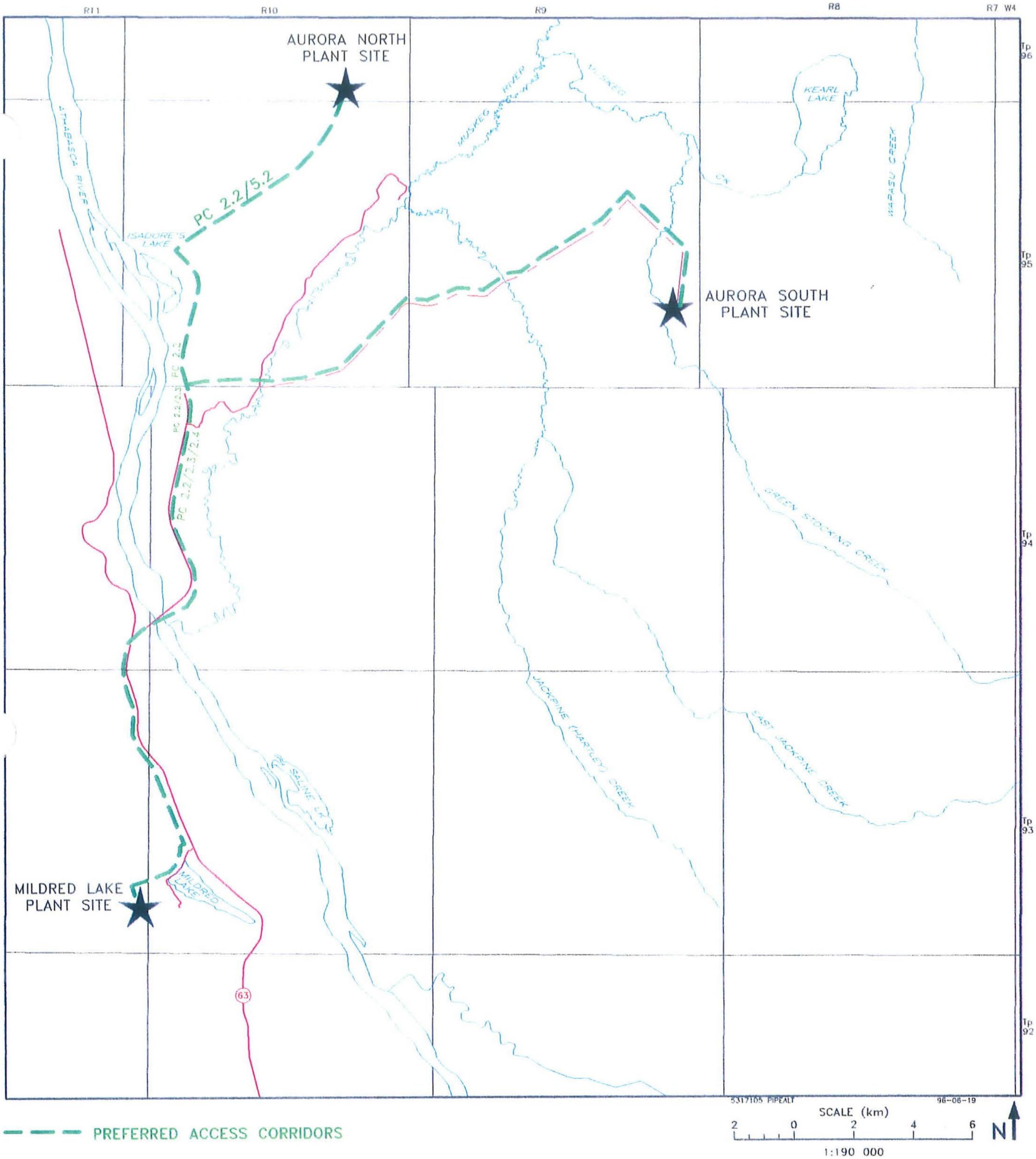
- River crossing analysis
- Roadway/pipeline corridor analysis
- Integration of river crossing and roadway/pipeline corridor analysis

Selected Utility Corridor and Access Road Route

The southern portion of the access road and utility corridor begins just east of the existing Mildred Lake settling basin and follows the routing of existing Highway 963, crosses to the east side of the Athabasca River on the existing Peter Lougheed Bridge. The routing continues up the east side of the Athabasca River an additional seven kilometres from the bridge. The road and utility corridor to Aurora South separate from the highway and proceed east at this point along the existing Canterra road. On this section of road an existing bridge over the Muskeg River will be replaced with a new single span bridge with increased underside clearance.

The selected route to Aurora North continues north along the highway for an additional 6.5 kilometres. There will be a junction with the highway at this point and the Aurora North road and access corridor will contnue northeast to the plant site. Both plant site access roads will be built to the appropriate Alberta Transportation and Utilities specification (RAU-210-110).

The utility corridor is located on the west side of Highway 963 for the section from the Mildred Lake site to the west end of the existing bridge. The pipelines cross the bridge in an existing pipeway underneath the bridge. The utility corridor is located east of Highway 963 for the section on the east side of Athabasca river. The utility corridor and access road route is shown in Figure 3.6-1.



BOVAR Environmental

Syncrude

Figure 3.6-1 Preferred Roadway/Pipeline/Utility Corridor for the Aurora Mine.

The rationale for this road/ utility corridor selection are;

- Favorable economics.
- Favorable geotechnical constructability and roadway geometry aspects.
- Lower environmental impacts in most of the areas evaluated including: fish habitat, wildlife habitat, forest resources, Aboriginal resource users, other resource users, existing and proposed private and public facilities, and disturbance to previously undisturbed areas. Impacts on historic areas are higher than some alternatives, and there are less construction requirements resulting in fewer construction related jobs and spin-off activities.

Table 3.6-1 Decision Analysis Summary Access Corridor and River Crossing

PROJECT COMPONENT	WEIGHT	ROAD 3 SCORE	ROUTE 1.3 RANK	ROAD 2 SCORE	ROUTE 2.2 RANK	ROAD 3 SCORE	ROUTE 2.3 RANK	ROAD 4 SCORE	ROUTE 2.4 RANK	ROAD 2 SCORE	ROUTE 5.2 RANK	ROAD 3 SCORE	ROUTE 6.3 RANK
COSTS													
Access Corridor	28	5.0	140	5.0	140	5.0	140	5.0	140	4.0	112	1.0	28
River Crossing	12	3.5	42	4.3	52	4.3	52	4.3	52	2.3	28	2.8	34
Sub-Total	**40**		**182**		**192**		**192**		**192**		**140**		**62**
ENGINEERING													
Access Corridor	7	2.3	16	5.0	35	3.0	21	2.7	19	2.9	20	1.6	11
River Crossing	3	3.1	9.	5.0	15	5.0	15	5.0	15	3.1	9	4.2	13
Sub-Total	**10**		**25**		**50**		**36**		**34**		**29**		**24**
ENVIRONMENTAL													
Access Corridor	35	3.2	112	3.9	137	3.9	137	3.7	130	3.1	108	2.2	77
River Crossing	15	3.7	56	4.6	69	4.6	69	4.6	69	3.5	52	5.0	75
Sub-Total	**50**		**168**		**206**		**206**		**199**		**160**		**152**
TOTAL	**100**		**375**		**448**		**434**		**425**		**329**		**238**

Water and Product Pipelines

Two hot water pipelines and two bitumen froth pipelines will transport material between Aurora and the Mildred Lake facility. The four lines will be carbon steel pipelines. The two hot water pipelines, one originating at each Aurora plant site, will be 760 millimetres in diameter and 34 kilometres in length. The two bitumen froth pipelines, one originating at each Aurora plant site, will be 610 millimetres in diameter and 34 kilometres in length.

With the exception of the Athabasca River crossing, the pipelines will be wrapped, cathodically protected and buried to a nominal depth of one meter. The pipelines will cross the Athabasca River on an existing pipeway under the deck of the Peter Lougheed bridge.

The pipelines transporting bitumen froth product may have an electrically-driven booster pump station located east of the bridge. Results from a 1996 field test program will be used to re-evaluate the need for this booster station.

Pipeline integrity with emphasis on the Athabasca River crossing is an issue that has been raised by several groups during the Aurora Mine consultation process. Syncrude will take the following actions to reduce the likelihood of a pipeline leak and mitigate the impacts of a leak in the unlikely event that one occurs.

General actions:

- Increase the design pipe corrosion allowance by three to six millimetres above normal practice.
- Establish a practice of regular visual inspections of the intersite corridor and booster pumphouse.
- Provide for periodic internal inspections using a device such as a "smart pig".

Actions for Athabasca River crossing:

- Double sleeve pipe (pipe within a pipe) the bitumen froth pipelines and equip with automatic pressure-activated motor-operated block valves on both sides of the Athabasca River.

Actions for other river crossings:

- Design and construct line with pressure-activated block valves on both sides of the river.

Natural Gas Pipeline

The natural gas pipeline supplying Aurora will also be installed in the utilities corridor. The main natural gas pipeline will cross the Athabasca River using the existing pipeway underneath the Peter Lougheed Bridge. Individual laterals will be built to each Aurora plant site. The specific source of natural gas is under review. The selection of a final supplier could result in minor changes west of the Athabasca River. The minimum required design supply pressure for Aurora is 4480 KPa (g). Seasonal variations of natural gas volume requirements are shown in Table 3.6-2 for one, two, three and four train operation.

Table 3.6-2 Seasonal variations of natural gas volume requirements

	Summer Normal x $10^3 Sm^3$/Hour	Winter Normal x $10^3 Sm^3$/Hour	Winter Peak x $10^3 Sm^3$/Hour
One Train Operation	23.6	42.4	70.7
Two Train Operation	54.8	81.3	110.7
Three Train Operation	78.4	123.7	181.4
Four Train Operation	109.6	162.6	221.4

* Stream day, Standard Cubic Meters/hour

Electrical Transmission Line

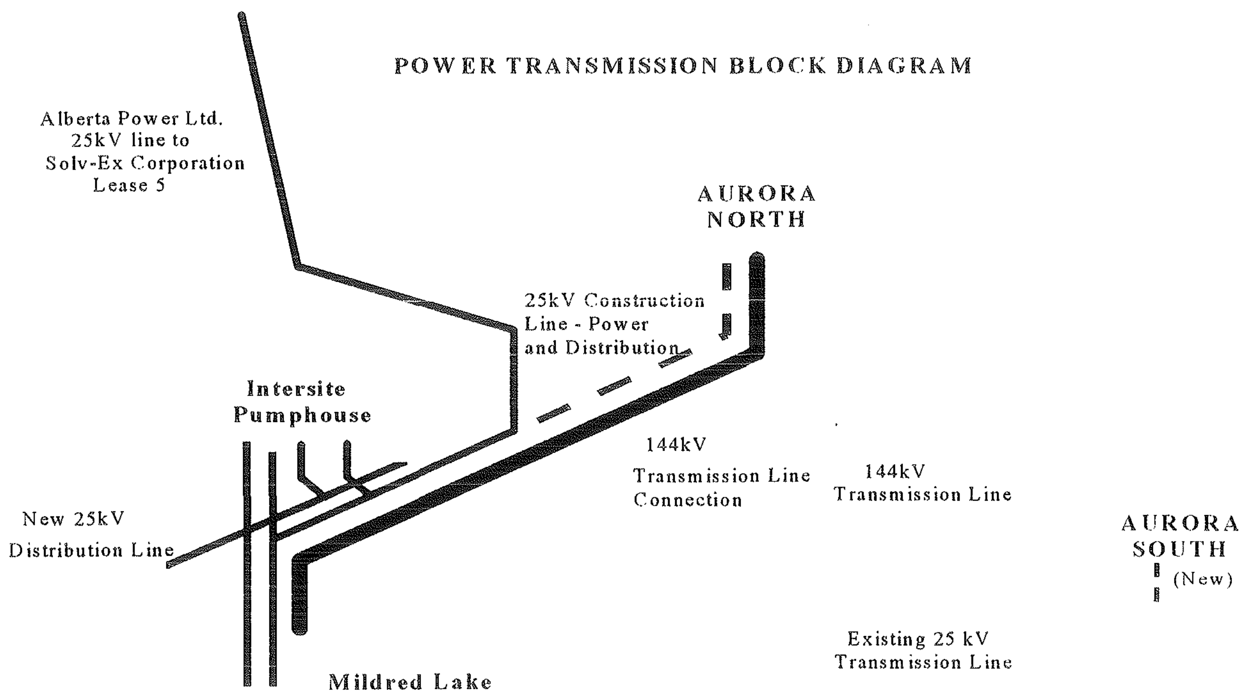
A high voltage electrical transmission line is required by Aurora for supplemental and back-up power as well as a means by which Aurora could supply surplus electrical power to Mildred Lake. At each mine site location, a new 144kV substation will be constructed and the voltage reduced to 72kV and 13.8 kV for on-site transmission and distribution. A sketch of this is shown in Figure 3.6-2.

The power line is indicated in this application as being a Syncrude facility. This will allow power generated at Aurora to be supplied to Mildred Lake and *vice versa* as the generation and load system at each site demands. Grid interchanges would take place at Mildred Lake, only. However, Syncrude is discussing this matter with Alberta Power Limited to see what other arrangements might be appropriate respecting the Alberta Interconnected System. As there are no clear precedents for this situation under the new legislation, it could take some time to resolve arrangements.

Intersite pumphouse electrical requirements will be provided from an existing 25kV distribution line (5L309). A new 25kV distribution line will provide a back-up power source for the product pipeline

An existing 25 kV line (5L309) will be extended to Aurora North to provide power during the construction period. No temporary power is required for Train 2 construction. An existing 25 kV power line located on the boundary between Oil Sands Leases 13 and 30 will be used to provide temporary power for construction of Train 3. No temporary power is required for Train 4 construction.

Figure 3.6-2 Power Transmission Block Diagram



3.6.3 Thermal-Electric Power Demand, Generation and Distribution

Aurora Energy Management

Overall Aurora energy balances and air emissions are shown in Tables 3.6-3 (single train operation), 3.6-4 (two train operation) and 3.6-5 (four train operation). Bitumen recovery from the mining of oil sands through the extraction operation is the dominant factor in overall energy efficiency. Further improvement in energy efficiency will come from improvements in bitumen recovery. Bitumen recovery will have priority in the engineering design phase and will be addressed by ongoing development programs.

The quantity of energy resources (natural gas, electrical power, and diesel) required by Aurora is dependent upon:

- Tonnage throughput. Tonnage throughput variability (especially peaking) normally results in higher energy use per tonne than a more stable operation at the same rate;
- Process temperature and fluctuations;
- Season (oil sand temperature, recycle pond water temperature).

Since purchased energy is 20 to 25 % of Aurora's total operating costs, there is a strong economic incentive for Aurora to reduce energy consumption.

The largest factor in improving energy efficiency at the Aurora Mine is the selection of the Low Energy Extraction Process for use in recovering bitumen. This process maintains the bitumen recovery level of existing commercially-used extraction processes while significantly reducing the operating temperature.

The mine design, which incorporates the shovel/truck/crusher/hydrotransport system, will also improve energy utilization. This reduces the direct energy used in the mining operation and eliminates oil sands loss points (losses at transfer points, conveyor losses). It also helps to reduce extraction energy usage and directionally increases bitumen recovery.

Another key element of Aurora's overall energy management strategy is the import of a large volume of surplus heat in the form of hot water from the Syncrude Mildred Lake facility. This hot water serves a dual purpose. It provides make-up water for the Aurora extraction process and provides a productive use for surplus heat from an existing operation.

Where practical, Aurora will use Variable Speed Drives (VSD) to increase the variable electrical demand component of the total plant load. In addition, Aurora's mining system will be primarily diesel- hydraulic rather than electric based.

Aurora's thermal/power generation strategy consists of:

- Co-generation (48 to 50 MW gas turbogenerator whose exhaust feeds directly into a once through steam generator)
- Import of surplus thermal energy (in the form of hot water)
- Import / Export of power from/to Mildred Lake

Air Emissions

The objective is to minimize the direct and indirect air emissions attributable to the Aurora operation. To achieve this objective, Syncrude will:

- Install dry low NO_x burners on all thermal - power generating equipment,
- Import surplus thermal energy rather than generating an equivalent amount of thermal energy,
- Install high efficiency (natural gas fired) cogeneration power and thermal generating equipment rather than import power fron the Alberta interconnected system. This allows for the inherent efficiency of co-generation and also avoids transmission line losses from transporting power over long distances.

Energy Balances/Air Emissions

Tables 3.6-3, 3.6- 4, and 3.6-5 summarize on a daily basis, the energy inputs, outputs, and related air emissions for a single train operation, two train operation and four train operation respectively.

As the tables indicate, bitumen in the oil sand accounts for 96.4% of the total site energy input while the remaining energy inputs consist of natural gas, heated water import, electrical power import, and various liquid fuels and process aids. Bitumen in the bitumen froth product accounts for 89.1% of the energy output. Bitumen losses to rejects and tailings account for an additional 7.7% of total energy output. Aurora energy consumption is expected to be about 5 GJ/m^3 (bitumen) produced.

Air emissions vary directly with tonnage throughput. Between 83 and 85% of all CO_2 emissions are directly attributable to the burning of natural gas for the purpose of thermal and/or electric power generation. Average calendar day emissions are expected to be 1,431 tonnes/day of CO_2 and 4.9 tonnes/day NOx for Aurora Train 1. This will increase to 2,797 tonnes/day of CO_2 and 10.1 tonnes/day NOx when both Aurora North trains are operating. Most of the NOx produced at Aurora can be attributed to diesel use by mobile equipment.

Thermal - Electrical Power Demand Profile

Tables 3.6-6 and 3.6-7 illustrate Aurora's thermal-electric power demand profile by season and major operating area for Train 1,Trains 1 and 2 and Trains 3 and 4. Most seasonal variations are related to differences in oil sand and process water temperatures.

Thermal - Electrical Power Design Bases

- **Aurora Train 1**

Provide sufficient thermal and electrical energy to support the processing of -10 °C oil sand at the rate of 8,000 (net) tph (conditioning line slurry density 1.55) and a hot water import rate of 1700 m^3/hour at 70 °C. Extraction process operating temperature is 25 °C and the bitumen froth shipping temperature is 65 °C.

- **Aurora Trains 1 and 2**

Provide sufficient thermal and electrical energy to support the processing of -10 °C oil sand at the rate of 16,000 (net) tph (conditioning line slurry density 1.55) and a hot water import rate of 3,300 m^3/hour at 73 °C. Extraction process operating temperature is 25 °C and the bitumen froth shipping temperature is 50 °C.

- **Aurora Trains 3 and 4**

Provide sufficient thermal and electrical energy to support the processing of -10 °C oil sand at the rate of 16,000 (net) tph (conditioning line slurry density 1.55) and a hot water import rate of 3,300 m^3/hour at 75 °C. Extraction process operating temperature is 25 °C and the bitumen froth shipping temperature is 50 °C.

Option Selection for Thermal- Electric Generation

The relative merits and costs associated with the various thermal-electrical power generating alternatives available to Aurora were evaluated within the context of six wide ranging generic options. These options and the selection rationale are delineated in Appendix A.

The "on lease" thermal-electric generating arrangement for Trains 1 and 2 is as shown on Figure 3.6-3. Major equipment is listed below. The thermal power generating arrangement for Aurora South will be the same as that of Aurora North.

- **Aurora Train 1:**

  One 48 - 50 MW (Nominal) gas turbo generator (GTG) base loaded at maximum

  Fuel: Natural gas
  Fuel Use: 15.3 KSm^3/hour at 45.8 MW (summer maximum)
  17.7 KSm^3/hour at 55.2 MW (winter maximum)
  Burners: Dry low NO_x type for reduced NO_X emissions
  Exhaust: Temperature 760°C (nominal), unit will exhaust directly to a Once Through Steam Generator (OTSG) (i.e. no stack)

  One OTSG nominally rated for 57 Kg/S at 2070 KPa(g) steam

  Temperature: 244°C (28°C superheat)
  Aux. Fired: Yes
  Fuel: Natural gas
  Fuel Use: 6.3 KSm^3/hour at 57 Kg/S (assumed maximum continuous rating)
  Normal fuel use varies with season and rate
  Typical winter 6.07 KSm^3/hour at 54.6 Kg/S
  Typical summer 5.23 KSm^3/hour at 46.5 Kg/S
  Aux Burners: Dry Low NO_X type for reduced NO_X emissions
  Blowdown: Zero
  Exhaust: 138°C
  Stack: 2.9 metres x 2.9 metres (inside dimensions)

  The overall energy efficiency of the GTG/OTSG co-generating arrangement is expected to be 83.9%.

  Two packaged boilers each (nominally) rated for 50 Kg/S at 2070 KPa(g) steam

  Temperature: 244°C (28°C Superheat)
  Fuel: Natural gas
  Fuel Use: 13.7 KSm^3/hour at maximum continuous rating (MCR)
  Normal fuel use varies with season and rate
  Typical winter (post 2004) 15.86 KSm^3/hour at 58 Kg/S(total)
  Typical summer 1.7 KSm^3/hour at 6.3 Kg/S (total, one boiler S/D)
  Burners: Dry low NO_X type for reduced NO_X emissions

Blowdown: 0.5 %
Exhaust: 188°C
Stack: 2.7 metres (inside diameter)
Efficiency: 82.8 %

One 2070 KPa(g)/310 KPa(g) letdown station
Capacity: 160 Kg/Sec
Water M/U: No

Most of the steam produced by the OTSG and packaged boilers will be used in shell and tube heat exchangers to heat process water.

- **Aurora Train 2: (Incremental to Aurora Train 1)**
  One 48 - 50 MW (Nominal) gas turbo generator base loaded at maximum
  Fuel: Natural gas
  Fuel use: 15.3 KSm^3/hour at 45.8 MW (summer maximum)
  17.7 KSm^3/hour at 55.2 MW (winter maximum)
  Burners: Dry low NO_X type for reduced NO_X emissions
  Exhaust: Temperature 760°C (nominal), unit will exhaust directly to an once through steam generator (OTSG) (i.e. no stack)

  One OTSG nominally rated for 57 Kg/S at 2070 KPa(g)
  Temperature: 244°C (28°C superheat)
  Aux. Fired: Yes
  Fuel: Natural gas
  Fuel Use: 6.3 KSm^3/hour at 57 Kg/S (assumed maximum continuous rating)
  Normal fuel use varies with season and rate
  Typical winter 6.07 KSm^3/hour at 54.6 Kg/S
  Typical summer 5.23 KSm^3/hour at 46.5 Kg/S
  Aux Burners: Dry low NO_X type for reduced NO_X emissions
  Blowdown: Zero
  Exhaust: 138°C
  Stack: 2.9 metres by 2.9 metres (inside dimensions)

  One 2070 KPa(g)/310 KPa(g) back pressure steam generator (BPSTG) under consideration
  Size: 50 MW (nominal)
  Flow: 180 Kg/S
  Efficiency: Isentropic Efficiency @ 89.5 %, generator efficiency 96 percent

Aurora Electrical Power Distribution

Electric power from the main plant substation will be reduced in voltage from 144kV to 72kV and 13.8kV. The distribution voltage of 13.8kV, a common industry standard, will be used to feed utilities, extraction and all other non-process loads within the main plant site. It will also be used to tie into the gas turbogenerator(s). The transmission voltage of 72kV will service the mine and tailings facilities.

Plant Site Distribution

13.8kV power will be supplied from the main plant substation to two distribution substations. One provides power to extraction and the second to utilities and any other non-process or miscellaneous plant site loads. In order to maximize accessibility and maintainability, power distribution and motor feeder cables will run overhead.

For Aurora Trains 1 and 3, the source of supply will be identical. The majority of the loads will be radial feeds (single supply), with the exception of critical process loads and distributed control systems which will have redundant supplies. With the start-up of the Aurora Trains 2 and 4, most of the systems initially designed as radial will be upgraded to full redundant, secondary selective systems.

Mine and Tailings Distribution

72kV overhead power transmission lines will be used to supply the mine and tailings. For Aurora Trains 1 and 3, the source of supply will be the same. A single circuit system will be installed from the main plant substation to each load centre where the power lines will be tapped to provide power to the individual equipment substations. When Aurora Trains 2 and 4 are brought on-line, the original single circuit system will be integrated into a double circuit looped system.

Refer to Figure 3.6-4 for the electrical power transmission distribution block diagram for Trains 1 and 2, and Figure 3.6-5 for Trains 3 and 4.

FIGURE 3.6-3
Aurora THERMAL-ELECTRIC Power Generation Schematic

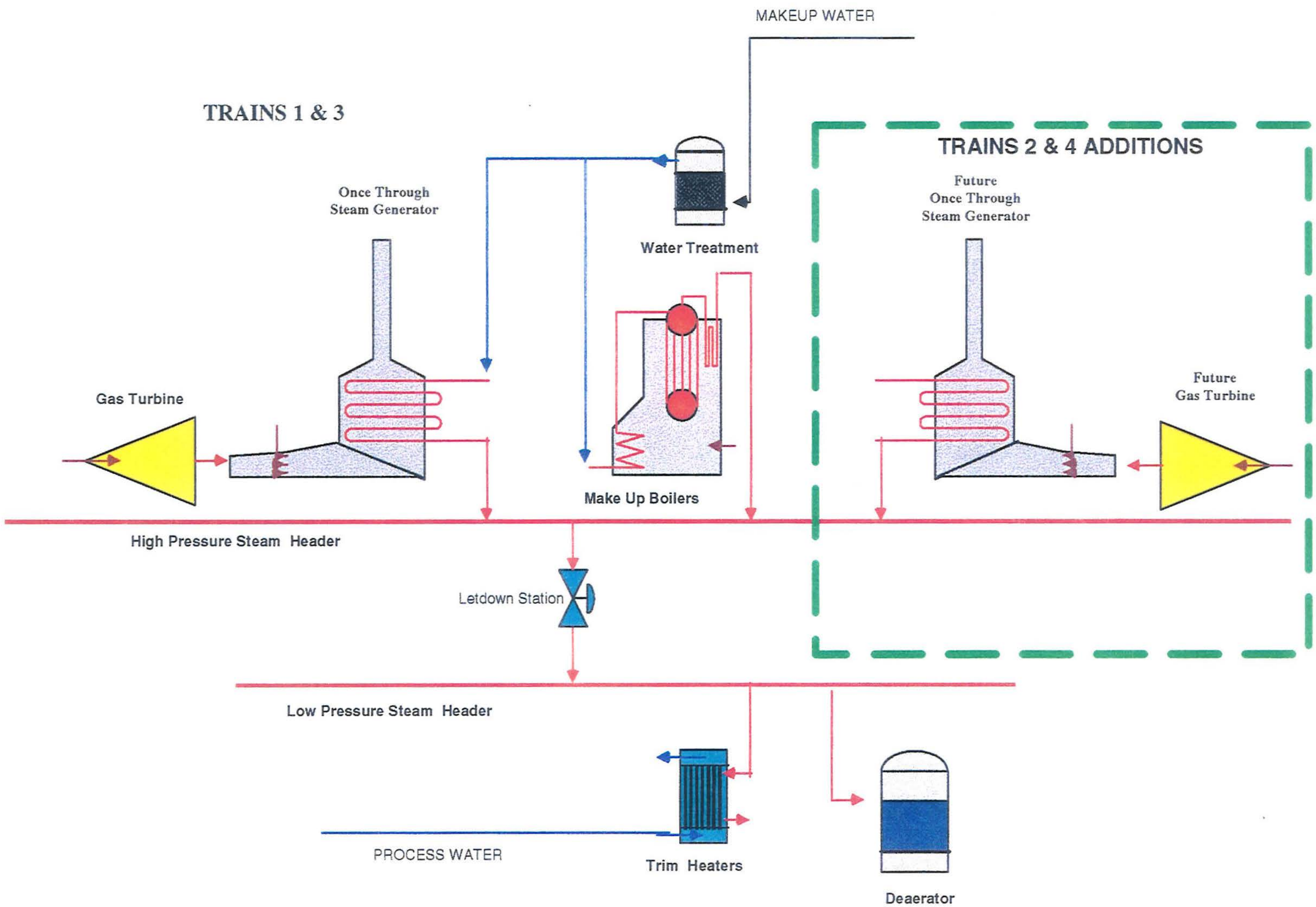


Figure 3.6-4 Power Transmission & Load Distribution Trains 1 & 2

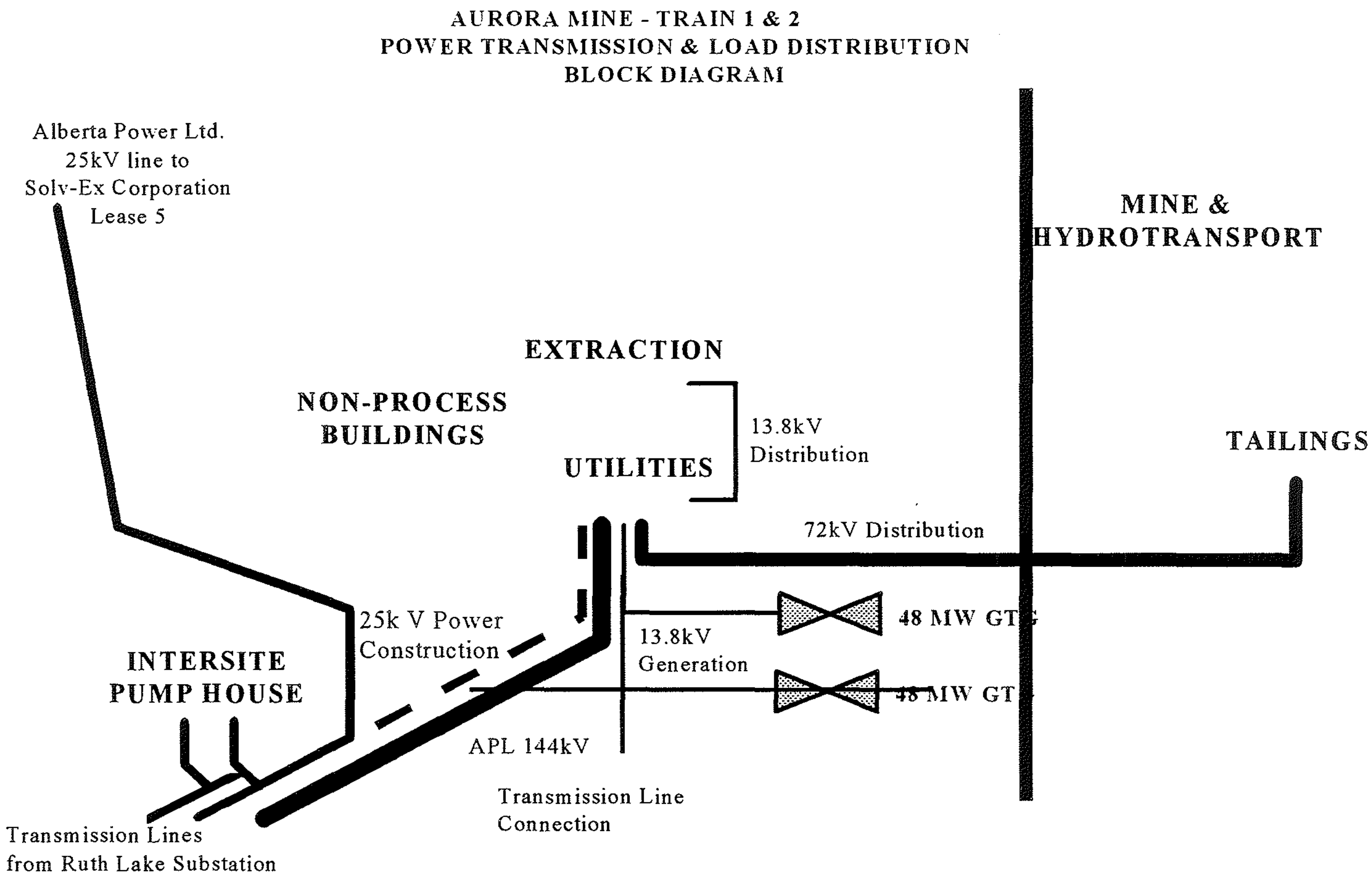


Figure 3.6-5

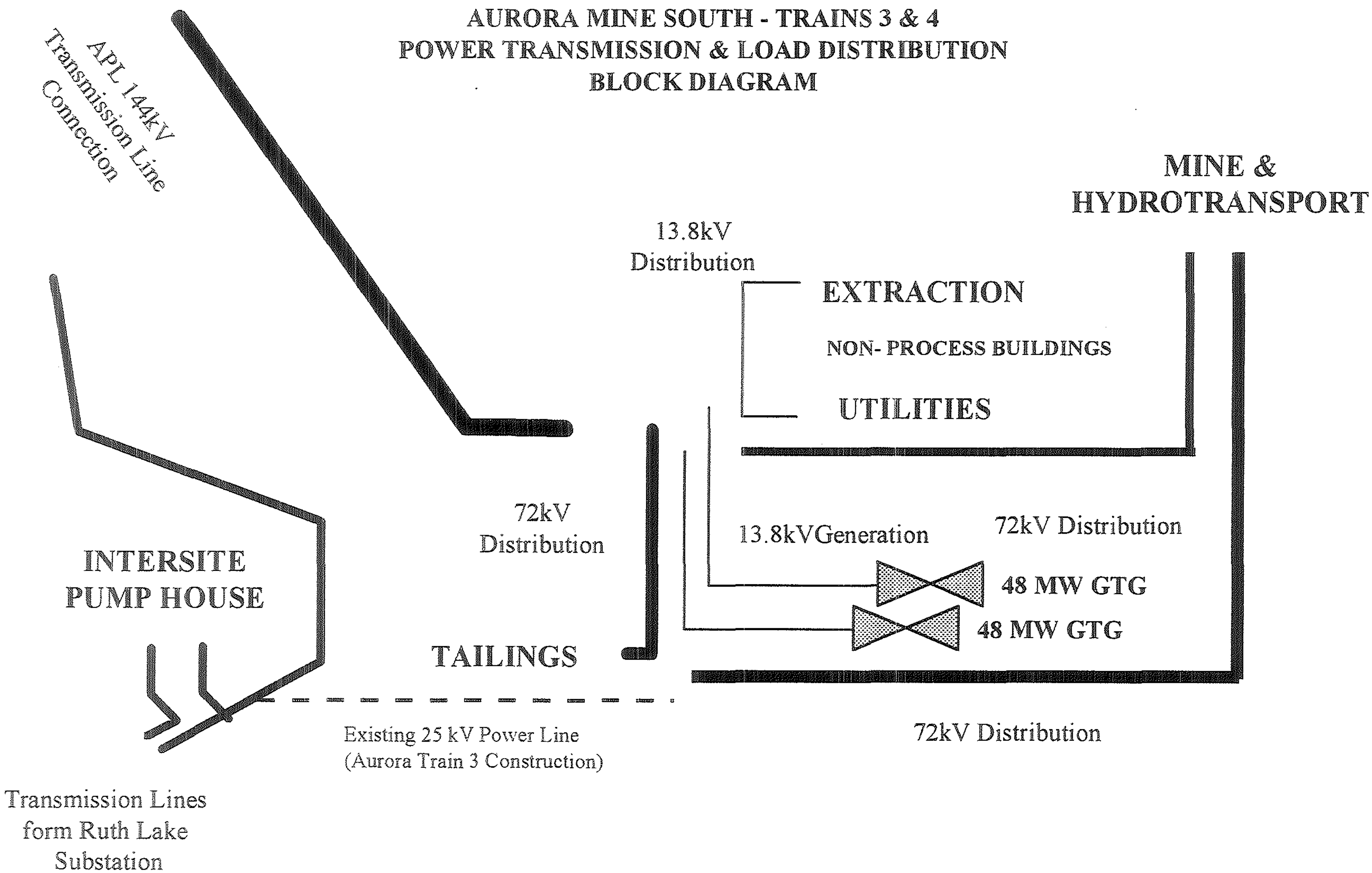

AURORA MINE SOUTH - TRAINS 3 & 4
POWER TRANSMISSION & LOAD DISTRIBUTION
BLOCK DIAGRAM
APL 144kV
Transmission Line
Connection
MINE &
HYDROTRANSPORT
13.8kV
Distribution
EXTRACTION
NON- PROCESS BUILDINGS
UTILITIES
72kV
Distribution
13.8kVGeneration
72kV Distribution
INTERSITE
PUMP HOUSE
48 MW GTG
48 MW GTG
TAILINGS
Existing 25 kV Power Line
(Aurora Train 3 Construction)
72kV Distribution
Transmission Lines
form Ruth Lake
Substation

Table 3.6-3 Bitumen Make/Year - 1 Train

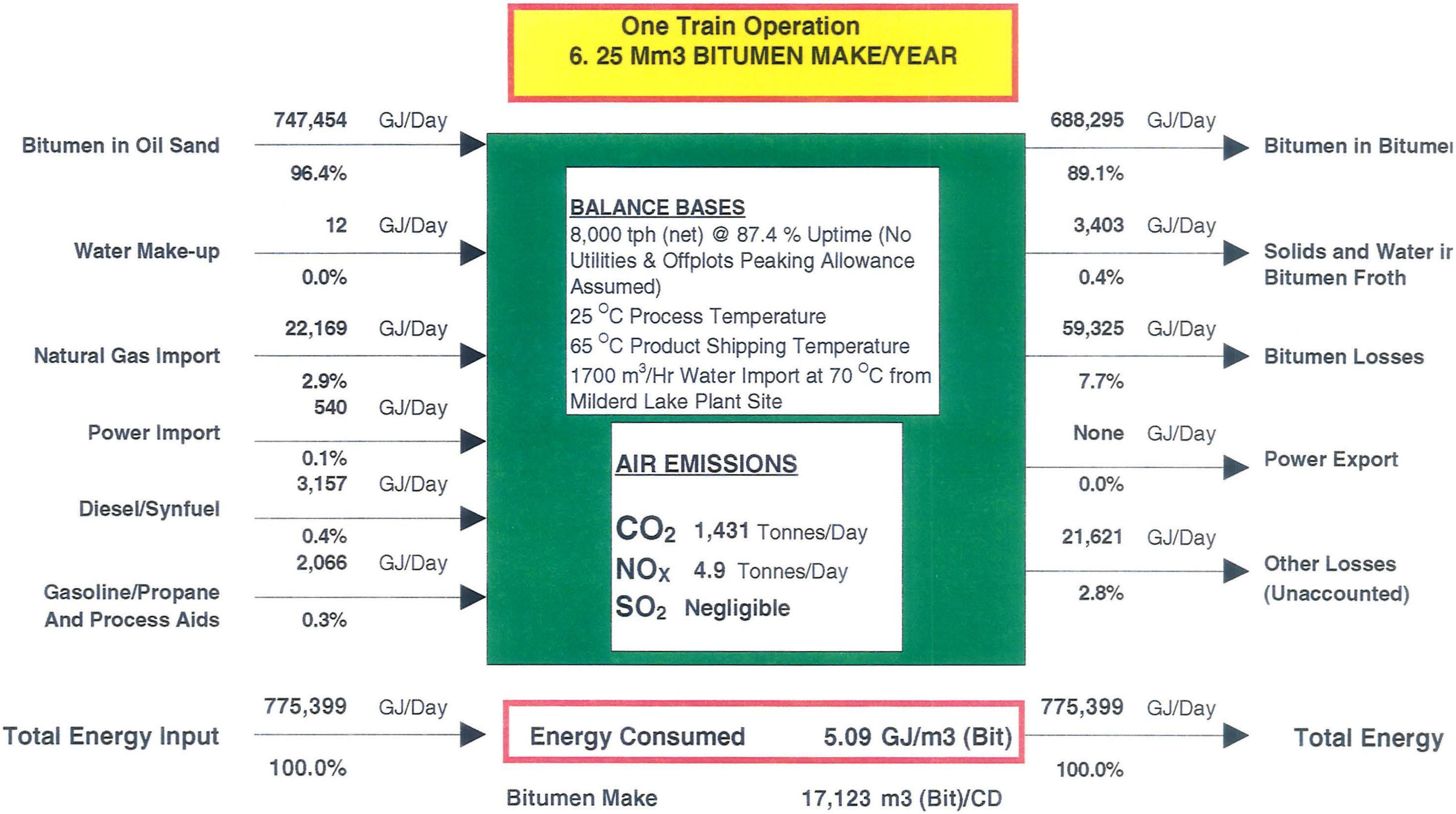


Table 3.6-4 Bitumen Make/Year - 2 train

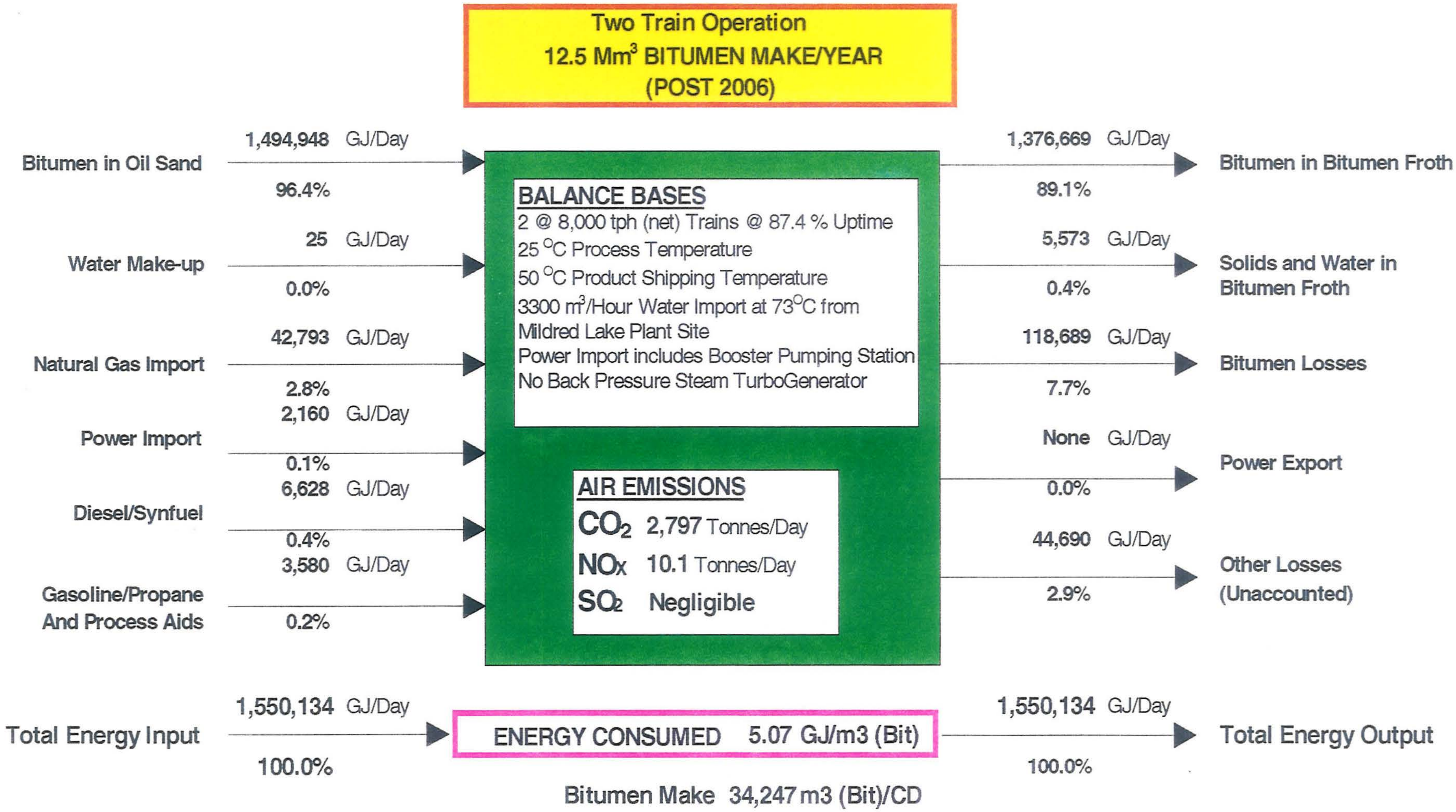


Table 3.6-5 Bitumen Make/Year - 4 Train

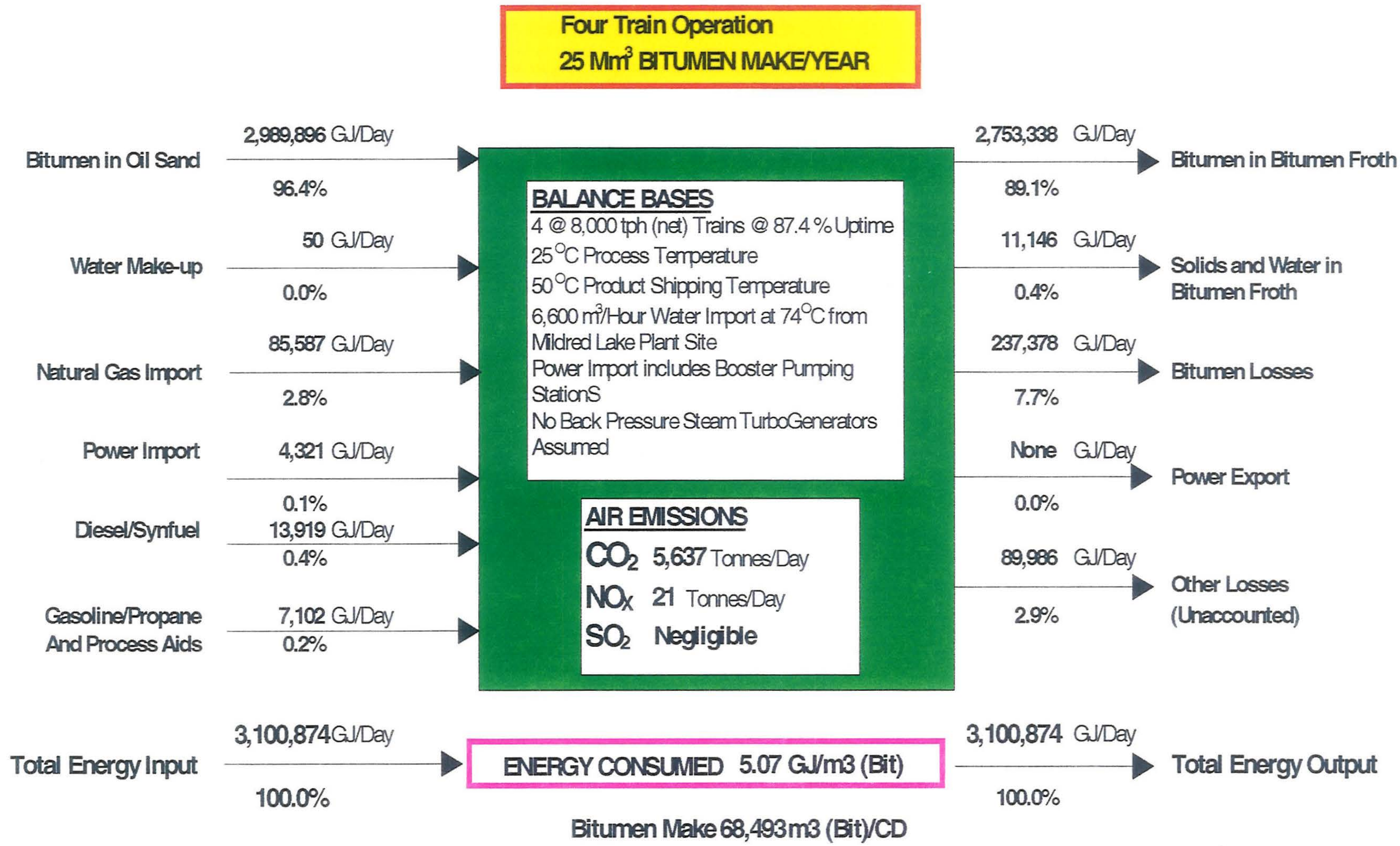


Table: 3.6-6 Thermal - Electric Power Demand Profile by season

TRAINS	SEASON	MAJOR AREA	THERMAL ENERGY DEMAND GJ/Hour	ELECTRICAL DEMAND (NORMAL) MW	ELECTRICAL DEMAND (PEAK) MW	COMMENTS
Aurora Train 1	Summer	Mining Oil Sand Processing Utilities & Offplots Intersite	105 1,174 539	10.7 34.7 7.4 3.2	12.9 42.4 8.6 3.4	Thermal: 8,000 tph (net O/S at 10°C, 100% Uptime, Slurry Density @ 1.6 25 °C Proc. Temp, Shpping Temp 65°C Elect. Normal Based upon 87.4% SF
	Winter	Mining Oil Sand Processing Utilities & Offplot Intersite	105 1,321 748	10.8 35.6 7.9 3.3	13.0 43.5 9.2 3.5	Thermal: 8,000 tph (net O/S at -10°C, 100% Uptime, Slurry Density @ 1.55 25 °C Proc. Temp, Shpping Temp 65°C Elect. Normal Based upon 87.4% SF

Table 3.6-7 Thermal - Electric Power Demand Profile by season & Operating Area

TRAINS	SEASON	MAJOR AREA	THERMAL ENERGY DEMAND GJ/Hour	ELECTRICAL DEMAND (NORMAL) MW	ELECTRICAL DEMAND (PEAK) MW	COMMENTS
Aurora Trains 1 & 2 [2006+]	Summer	Mining	221	33.2	41.3	Thermal: 16,000 tph (net) O/S at 10 oC,
		Oil Sand Processing	2,351	73.6	89.2	100 % Uptime, Slurry Density @ 1.6
		Utilities & Offplots	1,078	10.0	11.9	25 oC Proc. Temp, Shpping Temp 50 oC
		Intersite		6.3	6.7	Elect. Normal Based upon 87.4 % SF
	Winter	Mining	221	35.9	44.0	Thermal: 16,000 tph (net) O/S at -10 oC,
		Oil Sand Processing	2,645	75.2	91.2	100 % Uptime, Slurry Density @ 1.55
		Utilities & Offplots	1,495	10.6	12.6	25 oC Proc. Temp, Shpping Temp 50 oC
		Intersite		6.6	7.0	Elect. Normal Based upon 87.4 % SF
Aurora Trains 3 & 4	Summer	Mining	221	33.2	41.3	Thermal: 16,000 tph (net) O/S at 10 oC,
		Oil Sand Processing	2,351	73.6	89.2	100 % Uptime, Slurry Density @ 1.6
		Utilities & Offplots	1,078	9.4	10.5	25 oC Proc. Temp, Shpping Temp 50 oC
		Intersite		6.3	6.7	Elect. Normal Based upon 87.4 % SF
	Winter	Mining	221	35.9	44.0	Thermal: 16,000 tph (net) O/S at -10 oC,
		Oil Sand Processing	2,645	75.2	91.2	100 % Uptime, Slurry Density @ 1.55
		Utilities & Offplots	1,495	9.9	11.2	25 oC Proc. Temp, Shpping Temp 50 oC
		Intersite		6.6	7.0	Elect. Normal Based upon 87.4 % SF

3.6.4 Common Facilities

Natural Gas Letdown and Distribution

Both Aurora Mine plant sites will be equipped with natural gas pressure letdown systems, glycol heating systems (to prevent hydrate formation) and mercaptan injection facilities. All natural gas entering Aurora will be let down from 4,480 KPa (g) to a nominal 2,900 KPa (g) (minimum first stage letdown pressure determined by the gas turbogenerator). The natural gas letdown valve will be sized for a peak import rate of 120 Sm^3/hour. A back-up letdown valve of the same capacity will also be installed. A 4,480 to 2,900 KPa (g) power recovery turbine is being considered once the second train at each Aurora mine site has been installed (not assumed in the energy balances). Glycol heating will be installed immediately upstream of this letdown valve and mercaptan injected immediately downstream of it.

Natural gas import for other uses will be pressure reduced further These other uses include:

- Once Through Steam Generator (OTSG) duct bank burners,
- Packaged boilers,
- Fixed facility heating,
- Flare (sweep gas).

Storage Tanks

With the exception of water tanks all outdoor bulk storage tanks will be equipped with perimeter dykes in accordance with standard industry practice. Within the dyked areas, all drain connections to the plant site dirty water sewer will be valved (normally closed, valve stems will be external to the dyke). Vacuum trucks will be used to collect any spilled material which will either be recycled or disposed of in accordance with standard procedures.

At least one underground gasoline tank will be required at each Aurora plant site. These tanks will be installed in accordance with industry practice and all applicable regulations.

All plant site water tanks will be situated such thatwater that leaks or overflows will be directed into the dirty water sewer and eventually to the Recycle Water Pond where the water can be re-used in the extraction process.

Fire Suppression

Each Aurora plant site will have a fixed fire water system which consists of electrically-driven fire water pumps, with a 100% back-up, taking suction from the Basal Aquifer Pond. As an emergency back-up, a cross-over from the Process Water Circuit to the fire water distribution system will be provided.

The fire water distribution circuit (buried a minimum of three metres below grade) is a standard ring header (perimeter piping with fire hydrants surrounding a unit or building) design. It is capable of supplying all "fixed" Aurora plant site facilities (including all external tanks containing flammable materials). The non-process building will be equipped with a sprinkler system except in the operations control and computing centres where an inert fire extinguishing agent will be used.

Fire trucks located at both Aurora North and Aurora South will be used to fight fires occurring external to the fixed fire water system.

As is customary in the oil industry, in the event of a fire or other emergency, the first line of response will be provided by properly trained Aurora-based personnel. Emergency response agreements will be put in place to provide for the second line of response from Mildred Lake-based personnel and equipment, and the third line of response from Suncor and the municipality of Wood Buffalo.

Underground and Interconnecting Piping

In addition to the underground fixed fire water distribution system, both plant sites are equipped with a sanitary sewer as well as an underground dirty water sewer. The dirty water sewer is designed to:

- receive waste water from all plant site facilities (excluding extraction which uses the tailings lines to dispose of all waste water), nad
- act as a fire water and storm water sewer.

The dirty water sewer drains to the Recycle Water Pond so the water can be used in the extraction process.

The piping network interconnecting individual Aurora units consists of a primary, single tier pipe rack, with underlying large bore pipes mounted on grade. A secondary on grade pipeway will be perpendicular to the primary pipe rack. Tertiary single tier pipe racks will supply individual units.

3.6.5 Water Management - Process

Overview

The water management strategy for Aurora is in keeping with the commitment to minimize environmental impacts and maximize opportunities for efficiencies. The overall philosophy is to practise water conservation, reuse and recycle. Water conservation includes the reduction of water use or consumption. Water reuse is defined as the discharge of water from one system into another. Water recycle is the discharge of water from a system to an earlier stage of the water system such that water can pass through again.

Aurora's water requirements will be met by drawing water from the following sources:

- Import of water from the Mildred Lake facility,
- Mine depressurization water,
- Net run-off from precipitation on land areas and water bodies,
- Clean water wells,

- Other surface drainage.

Water Balance

The water balance at Aurora will be maintained by applying the following relationship:

Annual Inflows - Annual Outflows = Annual Accumulation

The inflows include:

- Make-up water from the Mildred Lake facility,
- Connate water (water in the oil sand ore),
- Basal aquifer depressurization water,
- Net runoff from precipitation on land areas and water bodies,
- Surficial aquifer de-watering.

The outflows include:

- Froth transport water (water contained in the bitumen product sent to the Mildred Lake Facility)
- Process atmospheric losses,
- Pond/lake evaporation,
- Ground water seepage.

The accumulated water is in:

- Reject pore water,
- The pore water in the coarse tailings deposits,
- The pore water in the fine tailings,
- The pore water in the composite tailings deposits,
- The free water in the tailings settling basin available for recycle into the extraction process,
- Recycle water pond and sumps.

Projected annual change in inflows, outflows and accumulation can be found in Tables 3.6-8 to 3.6-11. The figures illustrate water balance over a single train operation pre-composite tailings, a two train operation pre-composite tailings and 2009 post-composite tailings, and a four train operation.

As described below, Aurora's primary uses of water include heating, process use, potable water and fire water.

Heating water. Aurora will use a once through steam generator (OTSG) and package boilers to provide steam. The boiler feedwater for this service must be less than 0.25μs cation conductivity. To accomplish this, the Basal Aquifer water will be clarified, filtered and deionized using reverse osmosis followed by mixed bed ion exchange. All blowdown from the clarifier will be recycled to the extraction water makeup circuit. All filter backwash water will be recycled to the extraction water makeup circuit.

Process water. For process water, Aurora will use two sources: imported water from the Mildred Lake facility and free water inventory stored in the Aurora Mine settling basin.

Potable water. Potable water is required to satisfy the needs of approximately 150 persons. This will be drawn from a well on the site.

Fire water. The fire water, as well as water for such uses as gland seal water and miscellaneous washing, will be drawn from the basal aquifer storage.

Table 3.6-8 Water Balance Train 1

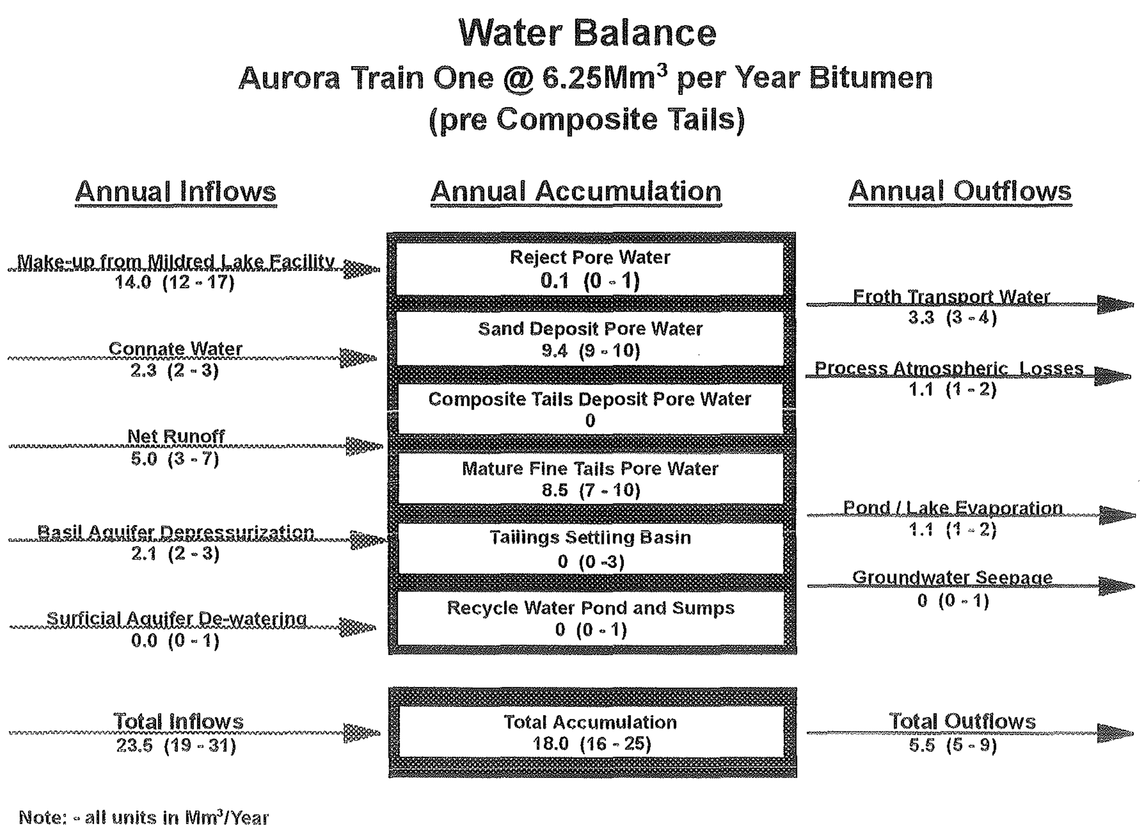
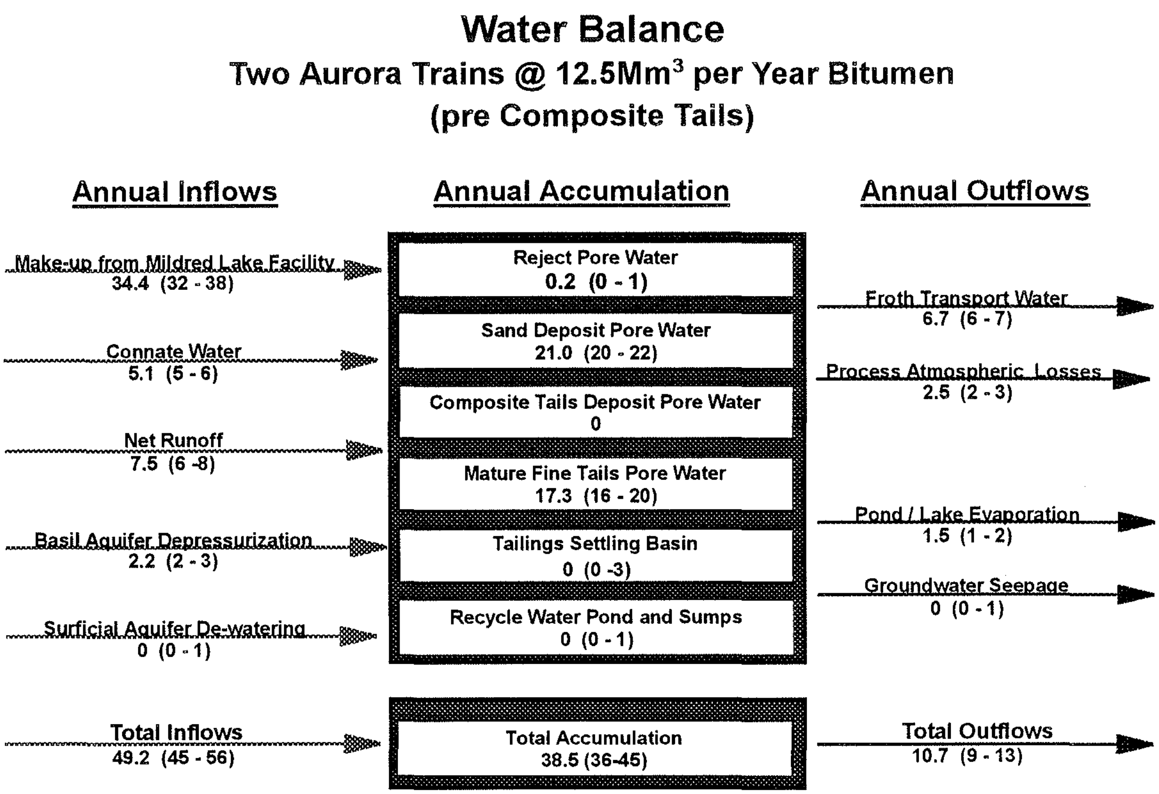


Table 3.6-9 Water Balance Train 2



Note: - all units in Mm^3/Year

Table 3.6-10 Water Balance 2 Trains

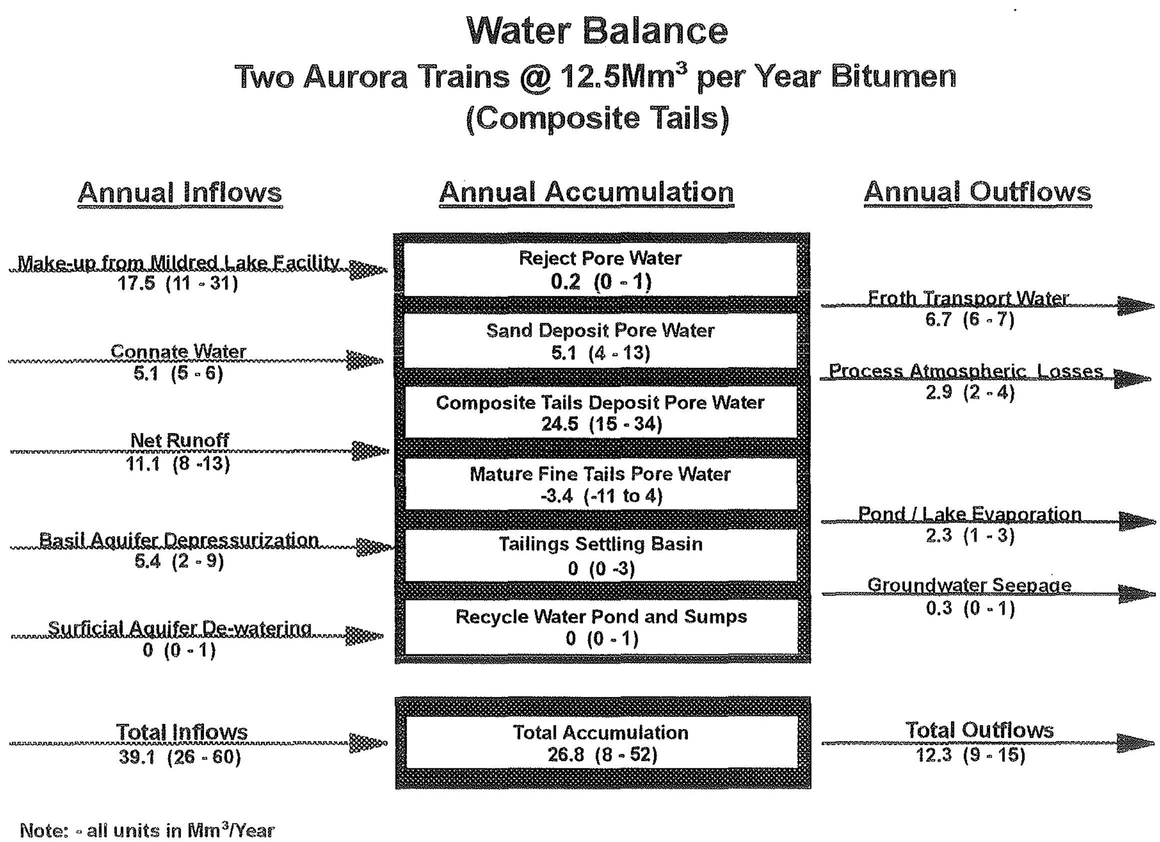
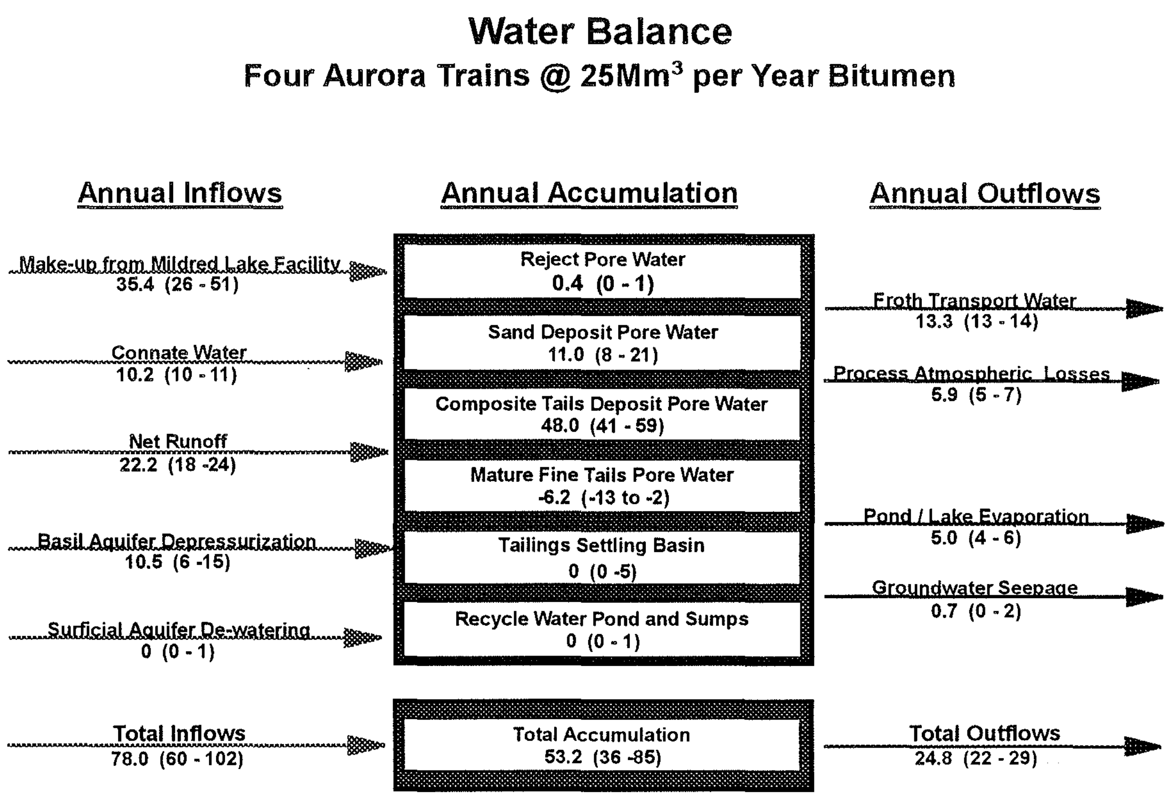


Table 3.6-11 Water Balance 4 Trains



Note: - all units in Mm^3/Year

Table 3.6-12 Quality of Make-up Water from the Mildred Lake Facility and Recycle Water

All values expressed in mg/L.

VARIABLE	RANGE	VARIABLE	RANGE
General		**Trace Metals (mg/L**	
pH(units)	7.7 - 8.0	Al	0.05 - 0.95
Conductivity (uS/cm)	120 - 7000	Sb	0.0005
Temperature ©*	18.5	As	0.0170
Suspended Solids (% by wt)	0.045 - 5	Ba	<0.1 - 0.12
Dissolved Solids (% by wt)	0.01 - 0.203	Be	0.011
Alkalinity (mg L^{-1})	135 - 765	B	2.60
Chem. Oxy.Demand (mgL^{-1})	340 - 361	Cd	0.003
Biol. Oxy.Demand (mgL^{-1})	1.0 - 5.2	Cr	<0.002
Dissolved Oxygen (mg L^{-1})	1.0 - 5.0	Cr+6	<0.03
Redox Potential (mV)	430	Co	<0.0003
Phenols (mg L^{-1})	0.006 - 0.017	Cu	0.010 - 0.05
Cyanide (mg L^{-1})	0 - 0.017	Fe	0.07 - 1.12
Sulphides (mg L^{-1})	0 - < 0.01	Pb	<0.02
Oil and Grease (mg L^{-1})	5 - 33	Li	0.106
Bitumen Content (% by wt)	0	Mn	0.052
Naphtha Content (% by wt)	0 - < 0.01	Hg	<0.00005
Dis. Organic Carbon (mgC/L)	11 - 60	Mo	0.164
Naphthenic Acid (mg/L)	0 - 101	Ni	<0.005
Tannin&Lignin (mg L^{-1})	1.0 - 7.0	Se	<0.004
Surfactants (MBAS) (mg L-1)	1.0 - 2.2	Ag	3.40 - 3.97
Hardness (as CaCO3)	33 - 250	Si	3.4
Acute Toxicity: Microtox Bioassay		Sr	0.306
IC50 (% by vol)	26	Ti	<0.003
IC20 (% by vol)	9	U	<0.5
Nutrients		V	0.005 - 0.027
o-Phosphate (mg P.L-1)	0.36	Zn	0.144 - 0.42
Total Phosphorous (mg P.L^{-1})	0.38		
Ammonia (mgNL^{-1})	0.06 - 7.2		
Nitrate + Nitrite (mgNL^{-1})	< 0.030 - 0.32		
Total Nitrogen (mgNL^{-1})	11.8		
Major Ions (mg.L^{-1})			
i) Cations			
Na^+	22 - 2000		
K^+	3 - 100		
Ca^{++}	6.0 - 40		
Mg^{++}	11 - 100		
ii) Anions			
F^-			
Cl^-	14 - 2000		
$SO_4^=$	33 - 3000		
HCO_3^-	167 - 855		
$CO_3^=$	1 - <5		

Imported Heat and Water Source

As stated in Section 3.6.3 and indicated in Tables 3.6-3 to 3.6-5, one element of the overall energy management strategy is the import of a surplus energy stream in the form of "hot water". from the Mildred Lake facility. This will serve two purposes. It will provide process make-up water to Aurora and, at the same time, will provide for the transfer of surplus heat from Mildred Lake. The rationale for exporting make-up water from Syncrude's Mildred Lake plant site to Aurora rather than importing water directly from the Athabasca River is explained in Appendix A.

Expected Mildred Lake facility hot water export volumes and temperatures are as follows:

- Aurora Two Train Operation: 1,700 m^3/hour at 75°C and increasing to 3,300 m^3/hour at 73°C after start-up of Aurora Train 2.
- Aurora Four Train Operation: 3,300 m^3/hour at 75°C.
- Aurora's external process water make-up requirements gradually drop over time resulting in changes in volume and temperature of the water exported from Syncrude's Mildred Lake facilities.

Mildred Lake facility export water source(s) will be from Mildred Lake itself, and/or from Mildred Lake plant recycle cooling water. This approach eliminates the need for an intake structure, two pumphouses and a settling pond on the east side of the Athabaska River. Use of recycle cooling water affects the accumulation of reclaimable inventory in the Mildred Lake settling basin. The quality of make-up water from the Mildred Lake facility is provided in Table 3.6-12

The water supply for the Mildred Lake facility is currently drawn from the Athabasca River through an intake structure located on the west bank of the river. Water withdrawal is authorized under Interim License No. 07921. The import of water to Aurora will be within the authorized volume in that license.

Process Water Supply, Heating, and Distribution

The process water supply, heating, and distribution circuits proposed for Aurora are shown in Figure 3.6-9. The process water supply and distribution systems are closed loop circuits. Sources of Aurora process water are:

- Tailings reclaim water
- Mildred Lake make-up water
- (Excess) treated basal aquifer water
- Plant site storm/dirty water sewer (very small volumes, intermittent flows).

A recycle water pond, located near the plant site, collects all excess treated basal aquifer water, Aurora plant site storm and dirty water sewer water, and tailings reclaim water. The recycle water pond will have a working volume of approximately 390,000 m^3 (providing volume for 1.5 days process requirements at 87.4 percent uptime for two trains, one metre for silt build-up, one metre for ice, one metre for freeboard).

The recycle water pond supplies two water distribution circuits:

- **Tailings Flush, Density Control and Extraction/Tailings Gland Water Circuit**
  The primary function of this circuit is to supply (on demand) tailings flush and density control water (not required under normal circumstances). A secondary purpose is to supply extraction and tailings with gland water. The circuit will be sized to supply 5,800 m^3/hour.
- **Process Water Circuit** (one per train)
  This pumping system is designed to supply 6,300 m^3/hour. Water from this circuit is mixed with make-up water and heated for use as slurry transport, froth wash and extraction clean-up water. An ambient temperature slip stream is also routed to the primary separator for separator density control reasons. Slurry and froth wash/clean-up water tanks with a one hour hold-up capacity have also been provided.

All waters supplied by the above two circuits eventually become a part of the tailings.

Potable Water Supply And Treatment

The potable water sizing basis is a daily consumption rate of 400 litres/person (this includes an allowance for miscellaneous industrial use). After start-up, the total population served will be approximately 135 for a one train operation. For two operating trains the site population is expected to increase to a maximum of 185. The potable water treatment plant will be sized for 150 people and will include a peak average demand design allowance of two.

Figure 3.6-7 (Potable Water Treatment Arrangement) illustrates the basic equipment and process aids required to upgrade Pleistocene channel well water to potable water standards. One potable water treatment plant will be required at Aurora North and a second at Aurora South. Water from two or three wells, which are located external to the active mining/plant area, will be piped to each packaged potable water plant. Potassium permanganate will be used to reduce total organic carbon. The water will be subsequently filtered using a manganese-coated green sand medium and then chlorinated prior to distribution.

The option of trucking potable water from the existing Mildred Lake facility to Aurora was investigated but rejected for reasons of higher life cycle cost.

It is expected that Pleistocene channel well waterwill also be used to supply a much smaller potable water treatment unit located at Aurora South.

Basal Aquifer Depressurization Water Treatment and Disposal

The basal aquifer underlying all Aurora leases contains dissolved hydrogen sulphide (H_2S) gas (at aquifer pressure). Characterization work done to date shows a variablity in H_2S concentations. This variablity is both by location and over time at individual locations.

To mitigate the potential detrimental environmental effects associated with the release of dissolved H_2S in basal aquifer water during mine depressurization, depressurization water will be pumped to two central treatment facilities one located at Aurora North and one located at Aurora South .

Since the concentrations of dissolved H_2S in depressured basal aquifer water is uncertain, Syncrude will:

- Monitor depressured basal aquifer water H_2S concentrations.
- If concentrations warrant it, remove the H_2S.

The basal aquifer water will be stored in a basal aquifer water pond (working volume 82,000 m^3) to provide an adequate supply of fire, utility, and boiler feed water treatment make-up water. Excess basal water will be pumped to the recycle water pond for use in the extraction process.

Boiler Feed Water

Inventoried basal aquifer water is the sole source of water for the boiler feed water treatment facility. Figure 3.6-8 (Boiler Feed Water Treatment Arrangement) indicates the basic boiler feed water treatment arrangement for Aurora. Treatment facility size is based upon:

- normal system losses (primarily process deaeration steam, utility deaerator vent losses, and miscellaneous steam users),
- the loss of condensate from the largest process water heat exchanger,
- treatment quality requirements, driven by the OTSG.

After the basal aquifer water is clarified using alum and chlorine in conjunction with an organic polymer, it is passed through a three stage filtering process (gravity, followed by carbon and cartridge filtration). The final treatment stages consist of reverse osmosis (RO), degassification, mixed bed ion exchange (polisher) and finally mechanical deaeration. The addition of an oxygen scavenger and organic amine will serve both as a chemical oxygen scavenger and pH adjuster. The mixed bed condensate polisher will be used to remove contaminants in the return condensate prior to reuse as boiler feed water.

Brine produced from the RO system as well as most process and packaged boiler blowdown losses will be returned to the recycle pond for re-use as process water.

Sanitary Sewer and Waste Treatment

All plant site sanitary waste will be collected in a sanitary sewer system and pumped to a central waste treatment facility. One of these facilites will be located at Aurora North and a second similar facility at Aurora South. Sanitary waste from mining areas and other remote locations will be collected and trucked to the same treatment facilities. The population served will be 185 during the day and approximately 116 on other shifts.

Figure 3.6-6 (Aurora Sanitary Sewage Treatment System) defines the different process steps associated with the proposed treatment facility. Effluent quality is expected to be 25 mg/*l* BOD (maximum) and about 25 mg/*l* suspended solids. Initially the sewage will be held in two anaerobic cells (two day detention time) and then transferred to a 60 day facultative cell. The treated sewage will be subsequently routed to a 22,000 m^3 waste stabilization pond for longer term storage. The treated effluent will be subsequently pumped (once per year) to the recycle water pond and used in the process. Consideration is also being given to the potential use of this treated effluent stream for green space irrigation.

The feasibility of trucking all sanitary waste to external waste treatment ponds as well as a mechanical treatment technologies such as rotating biological contactors as alternatives to local sanitary treatment lagoons were considered. Cost was the primary reason for rejecting these alternatives.

Chemical Supply and Storage

All chemicals used at Aurora will be trucked to site in either gaseous or liquid form. Those chemicals used in significant volumes in the utility plant are shown in Table 3.6-13.

Table 3.6-13 Annual Utility Chemical Consumption 4 trains

Chemical	Tonnes/Year	Application
Sulphuric Acid	600	Regeneration of ion exchange resins
Sodium Hydroxide (50%)	200	Regeneration of ion exchange resins
Aluminium Sulphate (Alum 48.5 %)	240	Water clarification, acts primarily as a coagulant
Sodium Aluminate	24	Water clarification, coagulation aid
Polymer	1.2	Water clarification, acts as a flocculant aid
Chlorine	40$^{\varphi}$	Disinfectant/Biocide $^{\varphi}$ Does not include potential use in secondary treatment stage for removal of dissolved H_2S from depressured basal aquifer water.
Amine Blend	24	Boiler feed water alkalinity control and O_2 scavenger
4102 Condensate Precoat Material	2	Condensate polisher

All one tonne chlorine cylinders and chlorination related equipment (excluding basal aquifer treatment facilities) will be located in the water treatment plant. Chlorine and chlorination equipment will be installed in a room physically isolated from other equipment in accordance with Syncrude specifications and the applicable governmental regulations. The chlorine room will be equipped with separate emergency ventilation and warning systems (visual, audible, with warning telemetry to the operations control centre). A similar arrangement will be made for the chlorination equipment installed in the basal aquifer treatment facilities.

All liquid chemicals will be stored in indoor tanks. Tank capacity will be a function of usage rate and truck delivery volumes. Perimeter dykes (concrete curbs) will be provided for all chemical storage tanks (either singularly or groups of tanks depending upon inventory) for the purpose of spill or leak control. Although all floor drains are linked to Aurora's sewer system, valved connections will be provided to prevent spilled chemicals from draining into the sewer system and ultimately into the recycle pond. Vacuum trucks will be used to collect any spilled chemicals. All spilled materials will either be recycled or disposed of according to standard procedures.

Industrial Waste Water Disposal

All liquid waste water streams will be discharged into the recycle pond and subsequently used as extraction process water.

Figure 3.6-6

Aurora Sanitary Sewage Treatment System

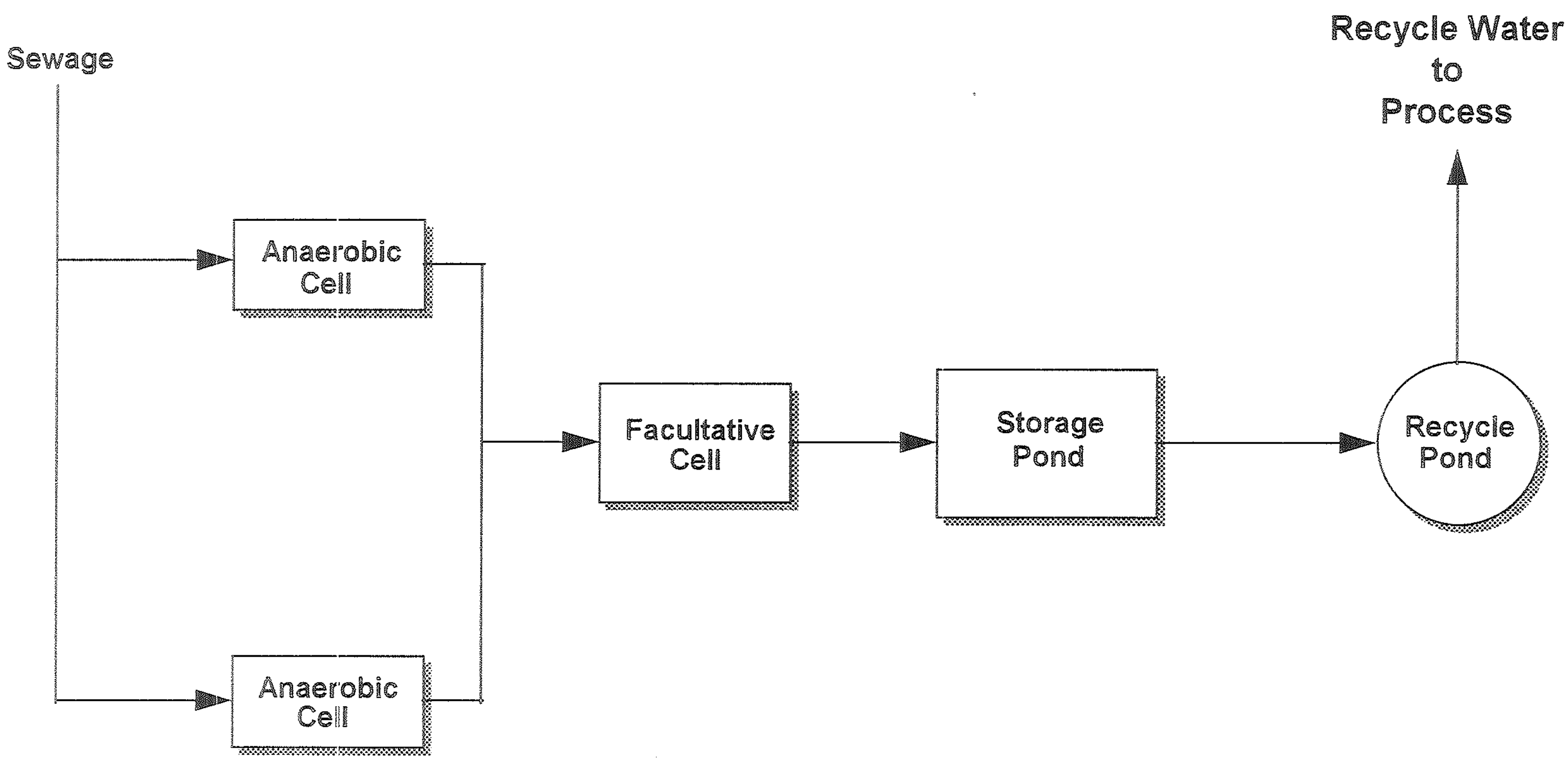


Figure 3.6-7

Potable Water Treatment Arrangement

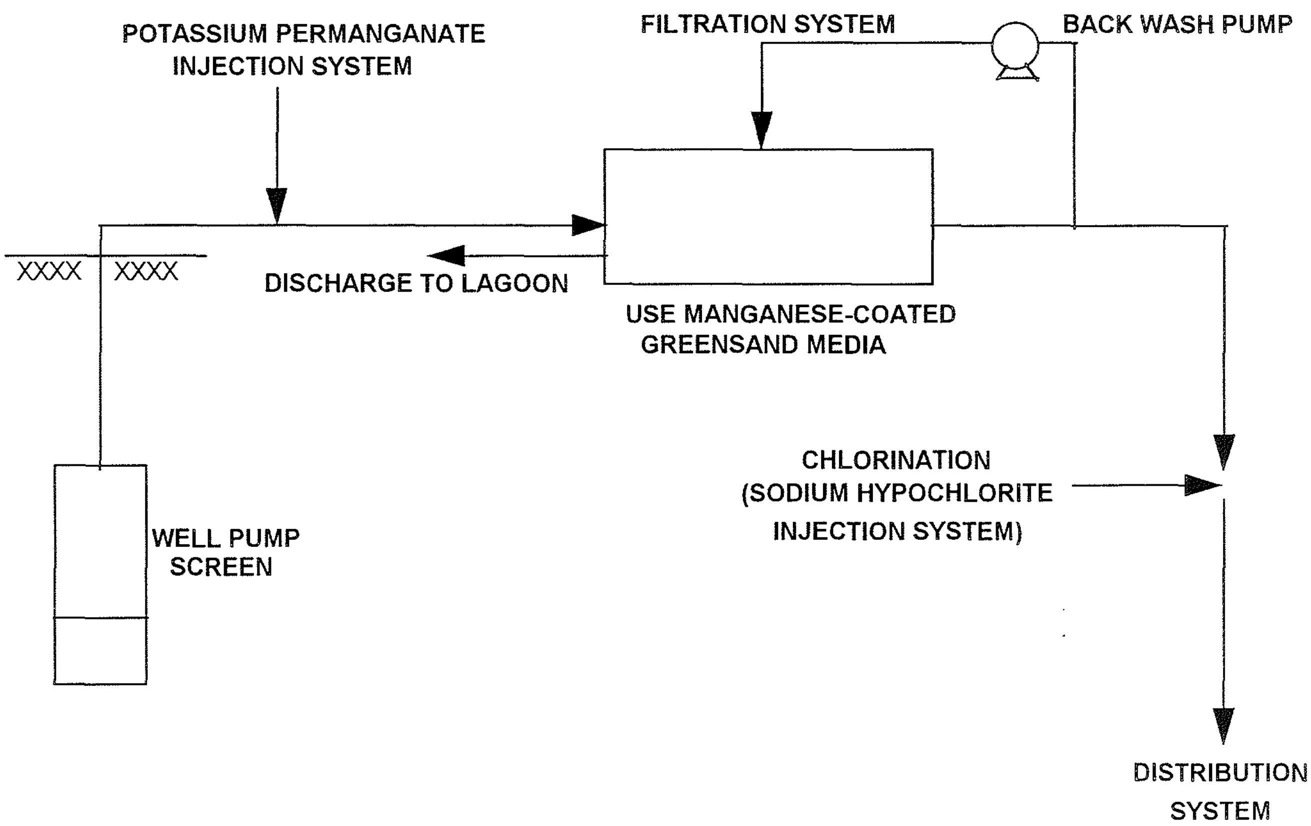


Figure 3.6-8

BOILER FEED WATER TREATMENT ARRANGEMENT

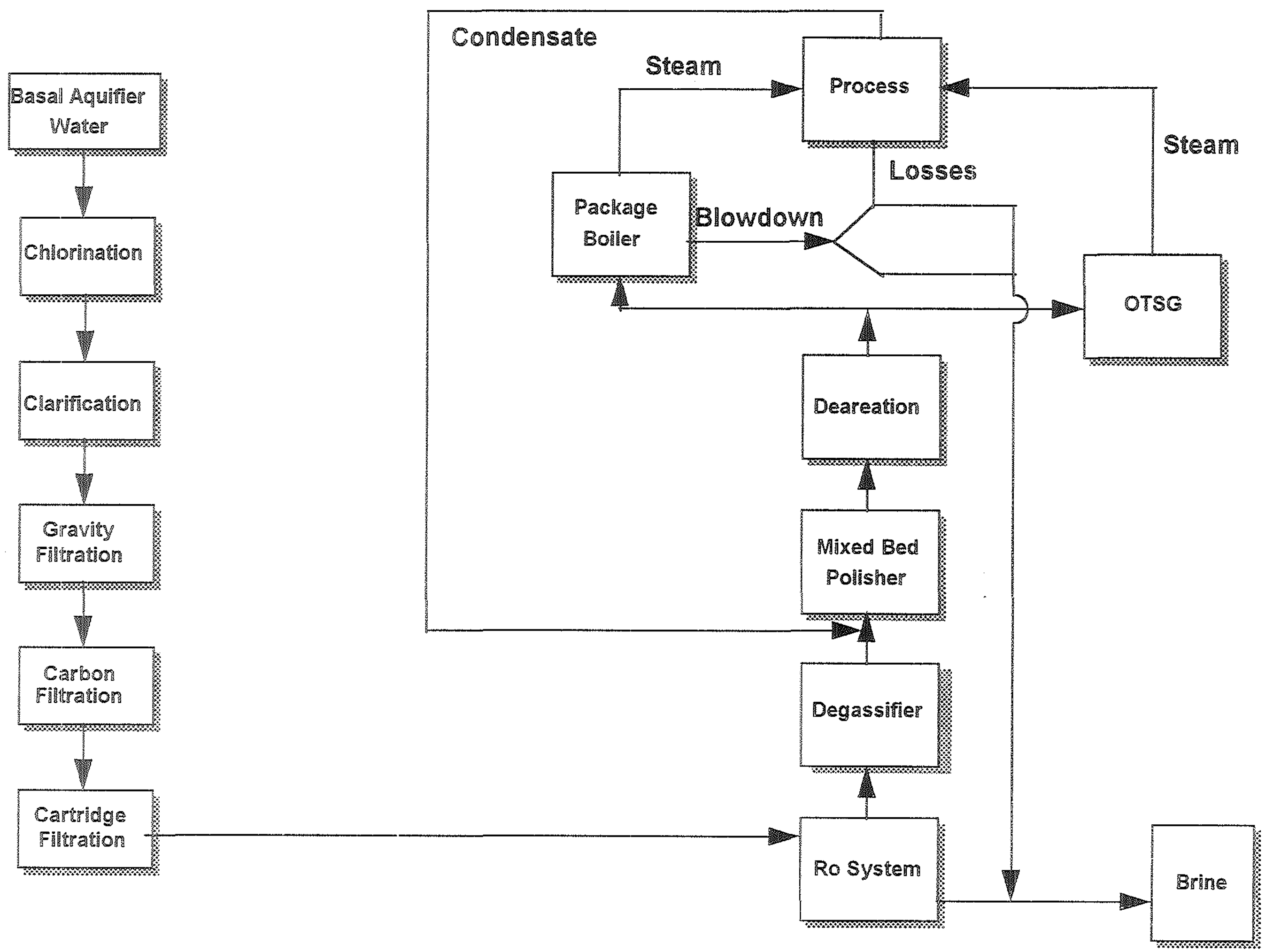
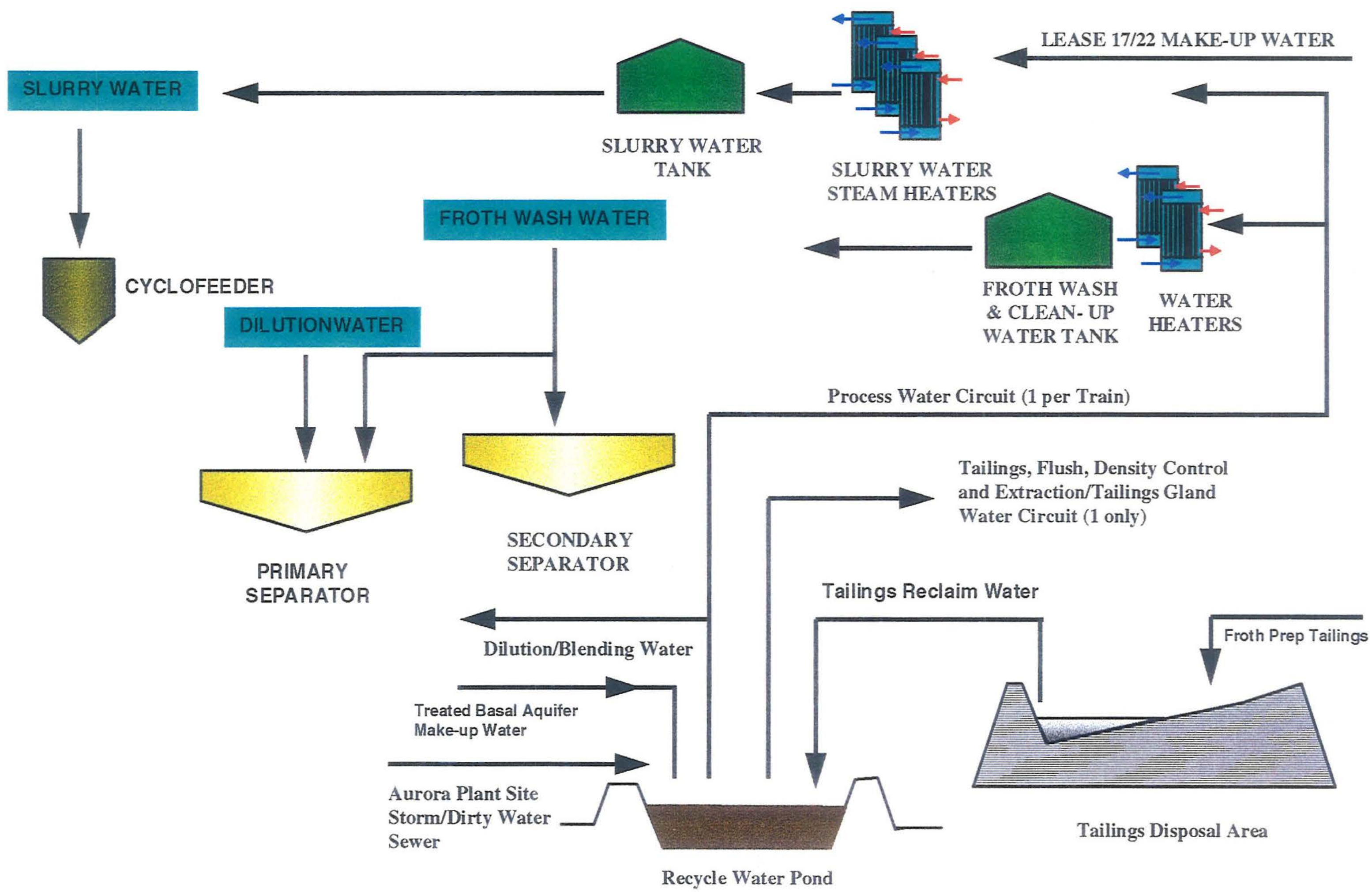


Figure 3.6-9

PROCESS WATER SUPPLY, HEATING & DISTRIBUTION



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3.7 Water Management

3.7.1 Introduction

This section covers water management plans for the Aurora Mine during development and operation. Water management plans for reclaimed areas are described in Section 11 of this Application.

Syncrude's principal goal in mine water management is to establish water management systems that will ensure minimum impact on the environment. The prime objectives are to protect clean surface waters from contamination and retain all potentially dirty waters on site for use in the extraction process.

3.7.2 Water Management Principles

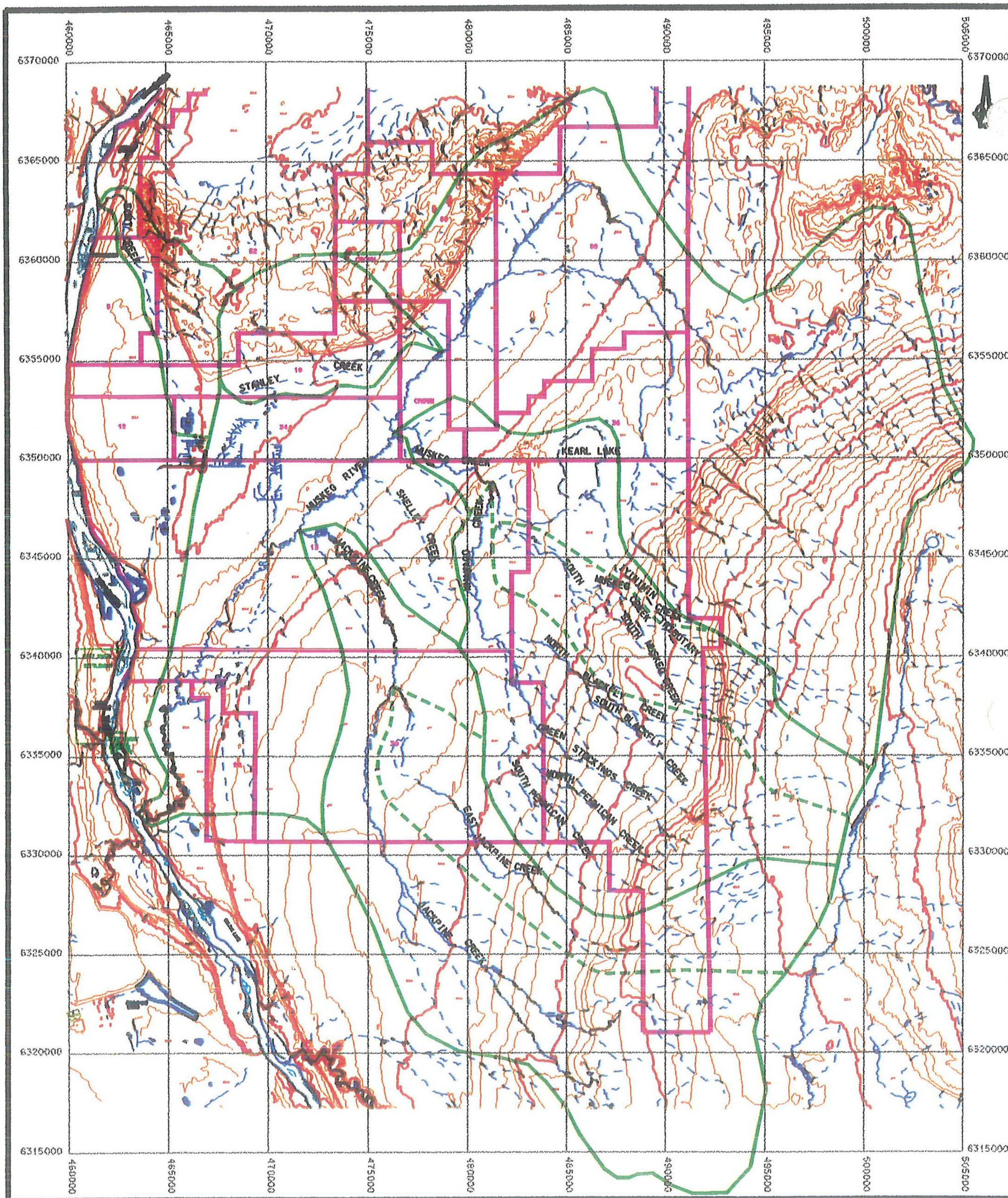
Clean Water

All surficial clean water will be intercepted and diverted around the disturbed operating area via interceptor ditches and creek diversion channels. The following guidelines apply to the design of these interceptor ditches and creek diversions channels:

- minimum impact on receiving streams,
- no net loss of fishery habitat,
- phased-in activities where appropriate,
- flexibility to accommodate changes in the mine plan,
- enhancement of fish and wildlife habitat where possible, and
- avoid impact on Kearl Lake.

Interceptor ditches and creek diversion channels will also be used to convey waters originating from the surficial aquifer. Creek diversion channels will be designed to accommodate the 100-year flood, subject to the outcome of risk assessments. Surficial dewatering will be staged to minimize disturbance to the land and prevent overloading of the Muskeg River. The discharge to the Muskeg River will be routed via existing wetlands and water polishing ponds. The existing system of drains installed by Alsands will be used where practical .

W:\mddwgs\aurora\other\eub_apea\ca Jun. 14, 1996 12:46:11



LEGEND

- Major Contour
- Minor Contour
- Stream
- Intermittent Stream
- Pond/Lake
- Lease Limit
- Drainage Area Boundaries

scale: 0 2000 4000 6000 8000 m

APPROXIMATE CREEK CATCHMENT AREAS (km²)	
Muskeg River	1414
Jackpine Creek	351
East Jackpine Creek	103
Muskeg Creek	310
Stanley Creek	56
Fort Creek	37

Syncrude AURORA MINE

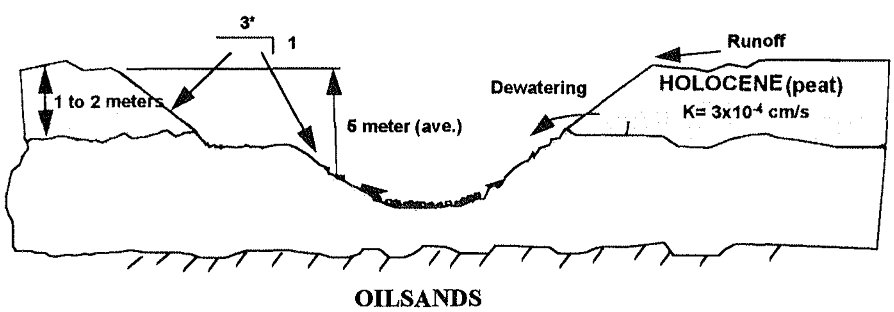
DRAWING TITLE: Creeks and Drainage Basins

DRAWING NUMBER: Figure 3.7-1 REV. 0

Sedimentation Control

Water velocities in unlined channels will be controlled. Channels releasing surface water into natural creeks will be designed to accommodate the 10-year flood without causing erosion. A typical ditch cross section is shown in figure 3.7-2. Channels with suspended sediment concentrations above the allowable limits will be routed through water polishing ponds.

Figure 3.7-2 - Typical Cross-Section of the Major Interceptor Ditches for Aurora North



*** Side slope angle is preliminary. It will be confirmed by field testing in 1997.**

1:10 year flow will be below Holocene

Some minor localized placement of coarser material will be required to reduce erosion

Dirty Water

Any water potentially coming in contact with oil sand, as well as process-affected water, will be contained using sumps and ditches and then routed to the recycle water pond via ditches and, if necessary, pipelines. It will then be recycled for re-use in the plant.

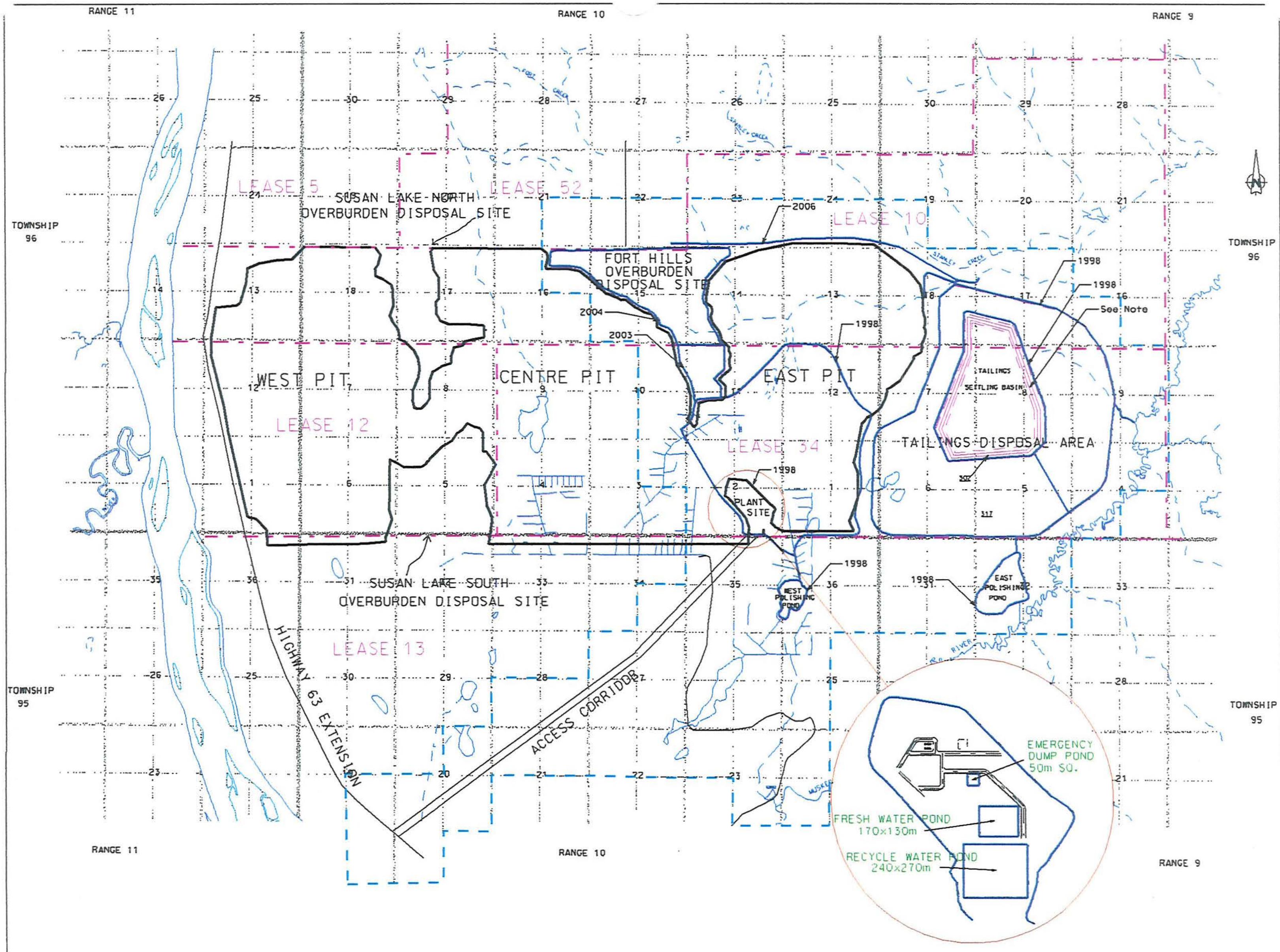
3.7.3 Predevelopment Drainage and Topography

The numerous creeks and drainage basins within the Aurora project area are shown on Figure 3.7.-1. The most significant drainage system in the Aurora Mine area is the Muskeg River, a major tributary of the Athabasca River. The major tributaries of the Muskeg are Jackpine Creek, Shelly Creek, and Muskeg Creek. All of the creeks, with the exception of Fort Creek, discharge into the Muskeg River.

The topography is classified as upland and lowland areas. The terrain is generally flat, except for the Fort Hills on the north edge of Lease 10 and Muskeg Mountain on the east side of Lease 31. Surface elevations range between 280 meters to 400 meters in lowland areas, and up to 510 metres on Muskeg Mountain. Ground slopes of less than 0.5% are typical of the poorly drained lowland areas. Slopes of 1 to 3% are encountered on the edge of Muskeg Mountain at elevations greater than 340 meters, and in the Fort Hills at elevations greater than 310 metres.

The dominant surface material in the lowlands is muskeg which is highly absorbent and generally poorly drained. It has a high water table at or near the surface immediately following snowmelt. Muskeg thickness ranges from 0.5 to 4.5 metres and in some places overlies a thick surficial aquifer.

The extensive lowland area introduces uncertainty in the delineation of drainage basin boundaries because the drainage paths across the muskeg will vary over time depending on the size of a flood and the activity of beavers. The stream channels are thus subject to extensive overbank flow during high flows.



LEGEND

Area of Influence Fence-line	– –	Dyke Crest	
Year of Construction	1998	Dyke Toe	
		Stream	
Diversion or Interceptor Ditch		Pond/Lake	
Ultimate Pit Limits		Existing Road	
Lease Limit	– · –	Elevation	

Note:

Shown here is the 2001 dyke, the year in which it begins retaining water.

For progression of dyke construction, see the status maps.

SCALE

0 2000 4000 m

Syncrude AURORA MINE NORTH

DRAWING TITLE:
WATER RESOURCES APPROVAL
AREA OF INFLUENCE MAP

DRAWING NUMBER: Figure 3.7-3 REV. 0

3.7.4 Approvals

The water management plans outlined in this section pertain to the maximum ten-year period of an approval under EPEA. As development of the Aurora Mine South is not expected during the EPEA approval period, water management approvals are applicable to the Aurora Mine North only.

As stated in Section 1.1, Syncrude is applying for a fenceline approval from the Water Resources Administration Division of Alberta Environmental Protection for the impoundment, use and diversion of surface waters in the area of Aurora Mine North. Under Section 11.1 of the *Water Resources Act*, each of these activities requires an application be made to Alberta Environmental Protection, and subsequent issuance of a licence, approval or permit. All of these activities are described in this Application. A fenceline approval would serve to streamline the approval requirements for work performed at Aurora. Syncrude would continue to be responsible for the time and manner in which water is released as well as any impacts that may result, as required under the Act.

Section 3.7.6 provides an outline of the Aurora North Water Management Major Milestones which, in conjunction with the mine status maps, included in Section 3.2, show the changes in surface water flows over the 10 years for which approval is being sought.

Figure 3.7-3 indicates the proposed area within which a fenceline approval would apply. The proposed approval area encompasses portions of lease 10, 12 and 34 as indicated in Section 1.0, Table 1-1. The delineated zone represents areas which will be influenced within the 10 year period of the approval being sought. These boundaries are not intended to establish the limit of Syncrude activities.

Activities within the proposed area would be covered by the fenceline approval while the established licensing and approval process would continue to be followed for activities taking place outside of the proposed area. Figure 3.7-4 provides a summary of the maximum anticipated water flows during the period 1996 to 2008 including clean water diversion and capture. The four main activities to be carried out under a fenceline approval include:

- Impoundment of surface and groundwater for process water use
- Surface aquifer and muskeg drainage
- Basal groundwater depressurization
- Surface drainage control

These activities are outlined in Section 3.7.5.

One other flow indicated in Tables 3.6-8 to 3.6-11 in Section 3.6 should be noted. This is a movement to the Aurora Mine of make-up water from the Mildred Lake Facility. Diversion of this water from the Athabasca River is already licensed under Water Resources Interim Approval 07921.

Also, Figure 3.7-4 provides estimates of the evaporative losses from the various clean water and process water ponds on the Aurora Mine north. These estimates are based on the maximum anticipated pond sizes during the period of 1997 to 2006.

3.7.5 Water Management Activities

Impoundment of Surface and Groundwater for Process Water Use

Activities include the formation of impoundments such as the Tailings Settling Basin (320 hectares), Emergency Dump Pond (0.3 hectares) and Recycle Water Pond (6.5 hectares). See Figure 3.7-4. Licensing from the Dam Safety Branch of Alberta Environmental Protection will be sought well in advance of construction of any fluid containment structures.

Surface Aquifer and Muskeg Drainage

The majority of surface and muskeg drainage water will be routed to the natural environment via the polishing ponds as indicated on the status maps in Section 3.2. The maximum release of this water, estimated at 12.6 Mm^3 , will occur in 1998 in preparation for site development activities. Though current plans call for the release of all surface aquifer and muskeg drainage waters to the natural environment, local variations in surface topography may make capture of this water more operationally efficient. Capture of surface aquifer and muskeg drainage could reach a maximum of 3.8 Mm^3/a.

The surficial aquifer (the water table in the overburden) and the muskeg will be ditched and drained about two years prior to overburden removal. The design of the drainage system is based on experience gained at the Mildred Lake Facility and a monitoring study conducted on Lease 31 in 1988 and 1989. These data have been extrapolated for the Aurora site. The water originating from the surficial aquifer will influence the muskeg dewatering scheme. Deep ditches, to the bottom of the Pleistocene deposits, are required. (Figure 3.2-3 is a map of muskeg thickness map.)

Table 3.7-2 provides the size of the dewatered area corresponding to status maps 3.2-17 to 3.2-30. Estimates of average annual flows are also tabulated for these time periods. The major drainage networks are illustrated on the annual status maps in 3.2-17 to 3.2-30. Tables 3.6-8 to 3.6-11 provide an average annual water balance for various stages of the Aurora Mine.

During the initial construction phase of Aurora North (1998 - 2001) the flow generated from dewatering the surficial aquifer is estimated to be approximately 0.282 m^3/s for the first two years. Once the initial volume has been depleted, a steady state will be reached during which the flow from the surficial aquifer will be approximately 0.02 m^3/s. The average muskeg dewatering discharge for this same time period could reach approximately 0.25 m^3/s, assuming an equivalent thickness of 0.67 metres of water being in a six- month period. Muskeg dewatering activities will be at a maximum during the initial site clearing and preparation; they will decrease during subsequent years. Muskeg drainage water on Aurora North will be collected and routed, when possible, through the existing Alsands drains and polishing or sediment ponds prior to it being discharged to the Muskeg River.

At Aurora South, a dyke and polishing pond will be constructed to control the outflow and allow any sediment load to settle out before being discharged into Muskeg Creek.

Basal Aquifer Depressurization

Basal aquifer depressurization involves the lowering of the level of the basal aquifer pressure head to allow safe mining within the pits. The maximum annual depressurization is anticipated to be approximately 16 Mm^3/a. All basal waters water will become part of the process water system.

The main aquifer consists of coarse-grained and pebbly sands of the Lower McMurray Formation, often the lower part of the fluvial sequence.The basal aquifer (water sands) is confined between the underlying Devonian formations and the basal clays and oilsand above. The elevation of the piezometric head is approximately 280 metres on Lease 34 and rises to the east. Less than a kilometre east of the Athabasca River there is a high on the Devonian surface, and west of this Devonian high the piezometric level is around 237 metres. Flow of groundwater in the basal aquifer is generally from east to west.

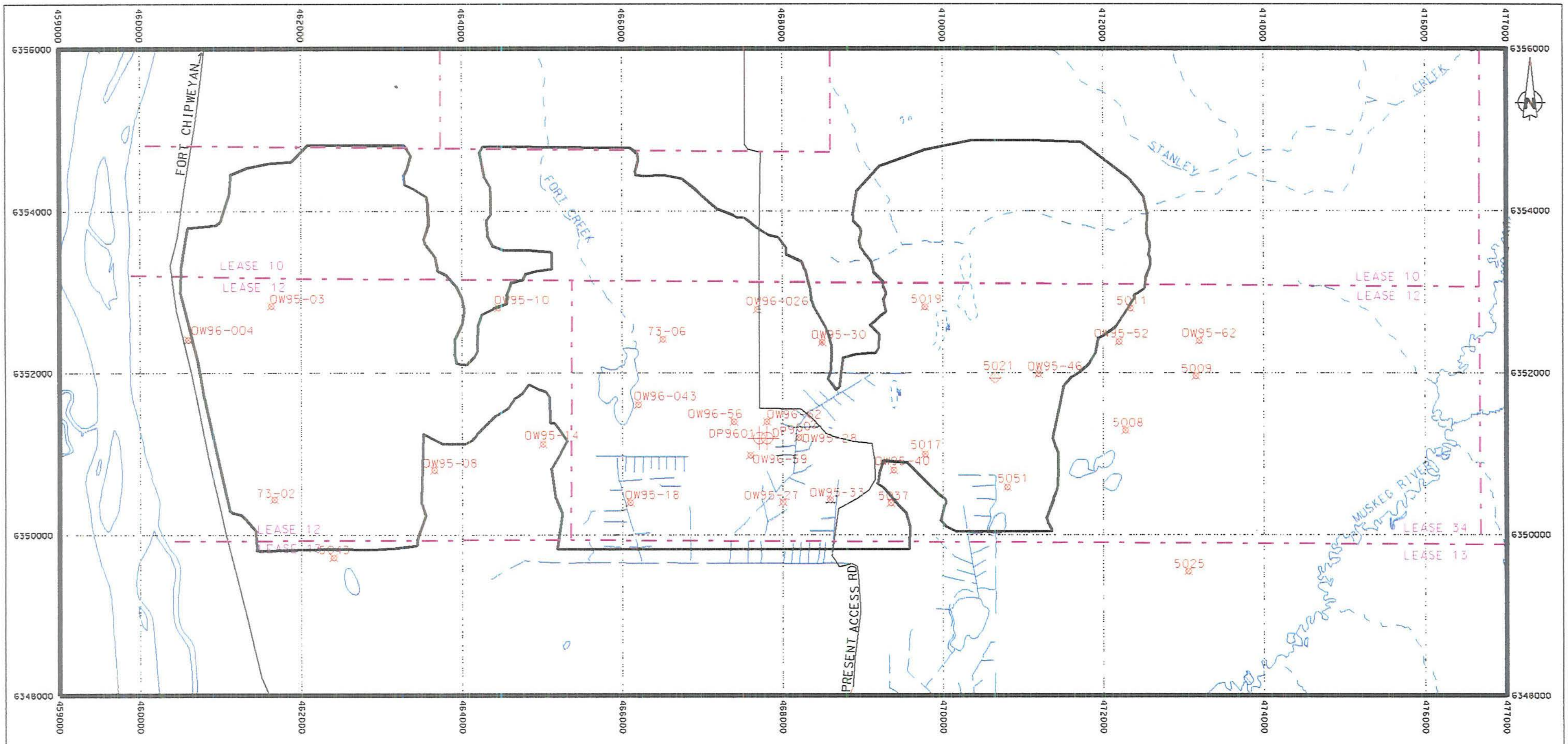
Initial hydrogeological investigations on Leases 12 and 34 were conducted by the Alberta Research Council for Petrofina Canada Ltd. in 1974 when two test wells (73-2 on Lease 12 and 73-6 on Lease 34) with corresponding observation wells were installed in the basal aquifer. At each of the wells pump tests were conducted to establish hydraulic parameters. During the winter of 1994/95 Syncrude installed 13 additional observation wells. All of these wells are shown on Figure 3.7-5.

Aquifer tests conducted on these wells indicate that the hydraulic conductivity (K) of the basal aquifer in this area ranges between 2.0×10^{-5} m/s and 6.0×10^{-5} m/s and the transmissivity (T) is in the order of 20 to 142 m^2/d. The Storativity Coefficient (S) is in the order of 0.006 to 0.009.

During the excavation of the Shell test pit on Lease 13 immediately south of Aurora North, aquifer tests were conducted. The aquifer parameters were $K= 1\times10^{-4}$ m/s, $T= 68\ m^2/d$ and S=0.0002.

Analysis of the pumping tests completed at Lease 31 approximately 15 kilometres southeast gave transmissivity values ranging from 43 to 200 m^2/d. Based on the average thickness over the area of influence of the pumping tests, hydraulic conductivities for the watersands were estimated to range from $2.2x10^{-5}$ m/s to $1.0x10^{-4}$ m/s. This is similar to the values obtained at the Alsands area where a regional transmissivity of 68 m^2/d was estimated for the Basal Aquifer.

These values are considered to be the estimates of the aquifer parameters for the watersands in the Aurora North Mine area. An isopach of the watersands in the Aurora North area is included earlier as Figure 3.2-9



LEGEND

Stream	Lease Limit
Pond/Lake	Existing Rd
Intermittent Pond	Obs. Well in Basal Aquifer
Intermittent Creek	Pumping Well
Existing Ditch	Obs. Well in Devonian
Design Pit Limit	

NO	DATE	REVISION	BY	CHK.	ENG.	APPD.
SCALE:	DRAWN BY: GJK	DATE: 22/05/96	CHECKED: LP	DATE: 7/6/96	ENGINEER:	APPROVED:

Syncrude AURORA MINE NORTH

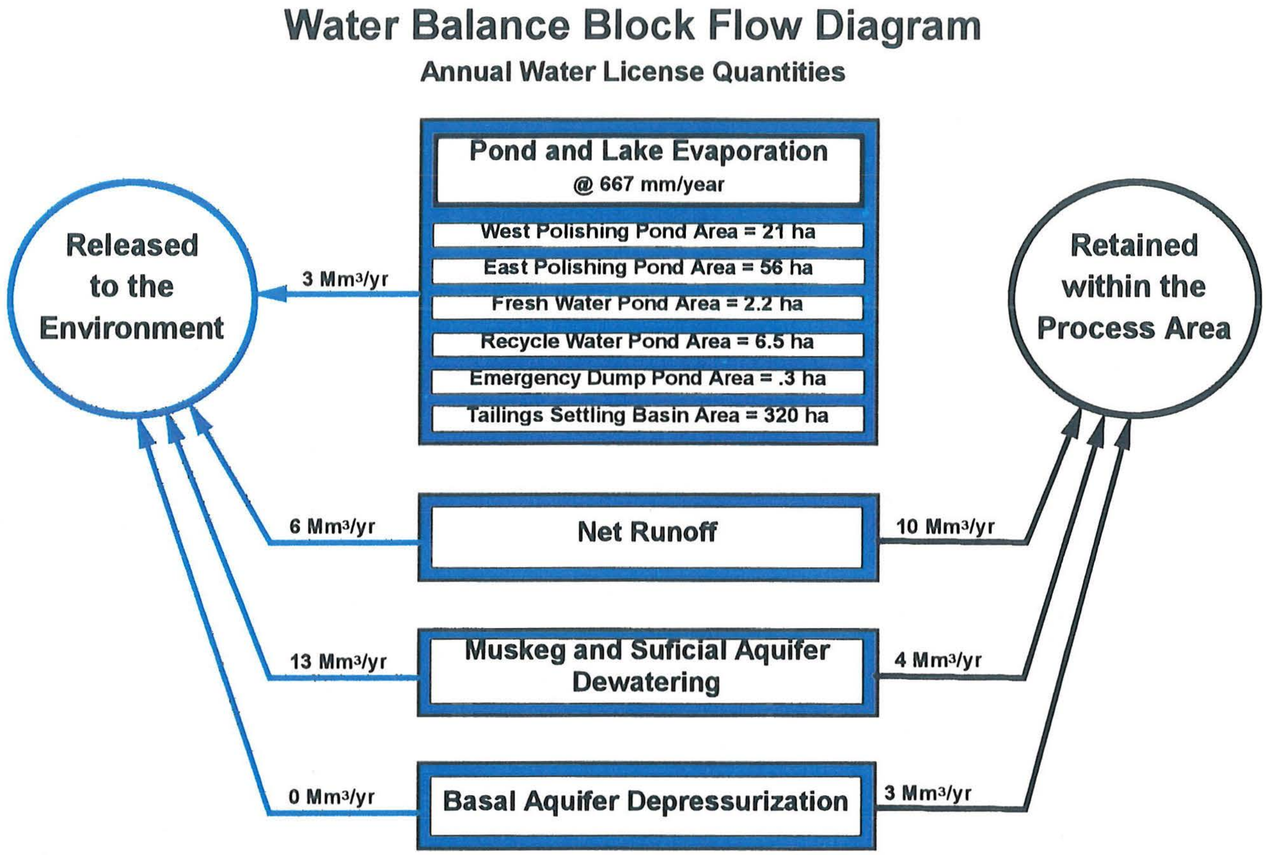
DRAWING TITLE:

OBSERVATION AND PUMPING WELL LOCATIONS

DRAWING NUMBER: Figure 3.7-5

REV. 0

Figure 3.7-4 - Water Balance Block Flow Diagram



Syncrude completed a 27 day pumping test in April, 1996. The data will be used to calibrate a 3-D numerical groundwater flow model that will be used to design the depressurization program for the Aurora North Mine.

Generally the basal aquifer water is brackish with total dissolved solids (TDS) typically less than 2000 mg/l. Table 3.7-1 shows the typical values for various water quality parameters.

Hydrogen sulphide (H_2S) gas has been observed during pumping tests at Aurora North and South. (Smaller quantitites of H_2S were detected at Aurora North and concentrations in both areas varied significantly over distance and time.) To the extent necessary, basal water containing H_2S will be treated prior to being sent to a process water pond to be used as plant process water.

Table 3.7-1 Water Quality Data for Basal Aquifer Water

PARAMETERS	UNITS	MINIMUM VALUE	MAXIMUM VALUE	AVERAGE VALUE
Calcium	mg/l	38.1	40	38.98
Magnesium	mg/l	18.1	21.2	19.79
Sodium	mg/l	660	740	701.88
Potassium	mg/l	14.1	16.4	15.19
Chloride	mg/l	304	347.1	328.09
Sulphate	mg/l	0.00001	1.3	0.74
PP Alkalinity	mg/l	0.00001	0.00001	0.00001
Total Alkalinity	mg/l	1318	1367	1340.25
pH	Units	7.2	7.74	7.43
Carbonate	mg/l	0.00001	0.00001	0.00001
Bicarbonate	mg/l	1606.642	1666.373	1633.76
T. Hardness	mg/l	170.4996	186.436	178.88
Hydroxide	mg/l	0.00001	0.00001	0.00001
Silicon	mg/l	2.54	2.75	2.63
S. Conductivity	umhos/cm	3134	3458	3295.00
C.O.D.	mg/l	63	84	69.88
Oil & Grease	mg/l	5.8	7.9	6.78
DO	mg/l	0.17	6.88	1.93
Phenols	mg/l	0.019	0.096	0.05
Sulphide	mg/l	0.1	4.26	1.22
TDS	mg/l	1861.321	1995.8865	1921.65
DIC	mg/l	323	349	336.00
TOC	mg/l	15.5	18.9	16.79
DOC	mg/l	14.7	16.9	16.01
T. Ammonia	mg/l	1.96	2.59	2.13
T.K.N.	mg/l	2.35	2.93	2.68
NO2 + NO3	mg/l	0.00001	0.218	0.03
T. Sulphur	mg/l	1.38	2.58	1.67
TSS	mg/l	0.00001	9	2.88
Aluminum	mg/l	0.00001	0.09	0.05
Barium	mg/l	0.29	0.32	0.30
Beryllium	mg/l	0.00001	0.001	0.0001338
Boron	mg/l	2.62	2.76	2.68
Cadmium	mg/l	0.00001	0.0005	0.000255
Chromium	mg/l	0.00001	0.018	0.01
Cobalt	mg/l	0.0004	0.0008	0.0005625
Copper	mg/l	0.00001	0.007	0.0025013
Iron	mg/l	0.00001	0.07	0.02
Lead	mg/l	0.00001	0.0017	0.0007388
Lithium	mg/l	0.234	0.276	0.252
Manganese	mg/l	0.038	0.042	0.04
Molybdenum	mg/l	0.00001	0.006	0.00213
Nickel	mg/l	0.0111	0.0175	0.01
Phos-T(ICP)	mg/l	0.1	0.27	0.19
Silver	mg/l	0.00001	0.0003	0.00007
Strontium	mg/l	1.04	1.12	1.06
Titanium	mg/l	0.00001	0.00001	0.00001
Uranium	mg/l	0.00001	0.0003	0.0000825
Vanadium	mg/l	0.00001	0.011	0.0018825
Zinc	mg/l	0.007	0.035	0.02
Ion Balance	mg/l	0.9	1.03	0.96

Table 3.7-1 is the average of 9 samples

The objectives of the depressurization and dewatering program are as follows:

- prevent slope failures due to excessive water pressure,
- reduce water at the pit floor, and
- minimize impact on the environment.

The piezometric pressure head in the basal aquifer will be lowered to a level near or below the proposed mine pit floor. The basal aquifer will be depressurized by wells screened in the watersands and installed around the perimeter and inside the pit. The wells will be pumped using submersible pumps. This method of aquifer depressurization and water control proved to be very effective on Lease 17, even though the watersands were thinner, lenticular and isolated in occurrence. This method was also shown to be viable at the test pit operation on Lease 13.

For future monitoring of groundwater, observation wells for monitoring water levels and groundwater quality will be installed. These wells will be located in various stratigraphic units downstream and upstream of the tailings settling area and the mining area. The exact locations of these wells and timing of installation will be determined at a later date. Further details are included in Section 8.

Surface Drainage Control

Surface drainage control during operations will involve diverting natural surface waters and runoff away from the Aurora operational areas and directing the water via surface ditching into the natural systems. The maximum volume of surface water that will be diverted — approximately 5.5 Mm^3/a — occurs in the year 2000. The status maps in Section 3.2 display the clean water ditching and polishing ponds utilized for clean water diversions.

During operations, all process-affected water and all run-off that comes into contact with oilsands, is routed to the recycle water pond. Interceptor ditches will divert and prevent any clean surface run-off water from entering the operating area. This water will be routed via ditches with low gradients around the operation and returned to the natural system as shown on the status maps. Dewatering activities will result in fairly constant volumes of water being discharged to the environment as indicated in Table 3.7-2. Around the year 2006, the opening of additional overburden disposal sites and the moving of clean water ditches ahead of mining operations will result in a brief increase in water release.

3.7.6 Aurora North Water Management Major Milestones

1998 - 2000. Construction activity begins in 1998. No stream diversions are required, only a perimeter ditch around the mining operations activity areas will be needed to intercept and divert surficial waters to a polishing pond before discharge to the Muskeg River. This perimeter ditch will be moved ahead of mining as mining progresses, as shown on the status plans. Sumps will be used when required to ensure a satisfactory gradient along the ditch.

Within the mining area, all water will be considered "dirty" and will be handled by ditches and sumps to a recycle pond. This dirty water system will also be used to control surface water within the pit.

A summary of areas being disturbed and areas from which water is diverted is presented in Table 3.7-2. The discharge route for all clean water, except clean water from the tailings area, is through the existing network of ditches and polishing ponds established by Alsands to the Muskeg River. A new polishing pond south of the tailings area will be constructed for the clean water coming from around the tailings site.

2001 to 2003. No additional major dewatering activities are needed. The discharge of surficial waters will continue through the existing drainage system.

2004 to 2005. The interceptor ditch to the north will be moved to accommodate the Fort Hills disposal site.

2006. The construction of the second stage collector ditch at the base of Fort Hills is required. It will discharge into Stanley Creek.

2010, 2015, 2020, and 2025. Dewatering of the surficial aquifer will continue as well as moving of the interceptor ditches to keep ahead of the mining and disposal site development.

2030. The initial implementation of closure drainage schemes begins. The east sand disposal site drains to Stanley Creek, as shown on the 2030 status map for the Aurora North site. The drainage from the reclaimed East pit will either be contained as shown on the status map for 2030 or temporarily discharged to Stanley Creek. This concept will be evaluated as to the logistics and environmental impact prior to the temporary discharge. The final closure plan is to route the surface run-off from the East pit westward eventually to the West pit lake.

Closure drainage. A final closure plan as outlined in Section 11 will be implemented following the completion of mining.

Table 3.7-2 Annual Volumes of Water Discharged to The Environment
AURORA NORTH

Annual precipitation (mm) =426

	Area in Km²					Discharge Volumes to the Environment			
	Undisturbed Km²	Cleared Km²	O/B Km²	Mine Km²	muskeg dewatering Km²	Ann. surf. aquifer vol. (M m³)	Average annual runoff (M m³)	Average* annual surf. dew. (M m³)	Approx. Total Discharge (M m³)
1998	5.01	18.00	-	-	5.46	8.91	2.3	12.6	15.0
1999	5.01	15.90	1.23	0.86	0.39	8.91	2.4	9.2	11.6
2000	5.01	14.08	1.23	-	0.97	0.62	2.1	1.3	3.4
2001	4.43	0.58	-	-	0.55	0.62	0.3	1.0	1.3
2002	3.32	1.70	-	-	1.12	0.62	0.4	1.4	1.8
2003	2.38	2.94	-	-	1.48	0.62	0.5	1.6	2.1
2004	3.93	5.83	-	-	3.30	0.62	1.0	2.8	3.8
2005	3.55	5.18	-	-	0.45	0.62	0.9	0.9	1.8
2006	2.04	1.48	-	-	0.55	10.04	0.3	10.4	10.7
2010	1.34	-	-	-	0.95	2.31	0.1	2.9	3.1
2015	3.51	7.16	-	-	4.76	3.12	1.0	6.3	7.3
2020	1.64	4.03	-	-	0.64	3.12	0.5	3.5	4.1
2025	-	3.11	-	-	0.00	3.12	0.3	3.1	3.5
2030	-	4.33	-	-	0.00	4.04	5.0	4.0	9.0

* Includes surficial aquifer and muskeg dewatering volumes.

Note: Discharge of runoff waters from approximately 12.3 km² of reclaimed consolidated tails, 4.7 km² of overburden and 12.3 km² of sand begins in 2030. The corresponding runoff rates were estimated as 93.4 mm, 115.1 mm and 21.3 mm respectively. Table 3.7-2 shows no distinct reclaimed section but the values are included in the total inflow to the environment.

3.7.7 Aurora South Major Milestones

2008. Mining activity begins at the Aurora Mine South. Several waterways require diversion in the vicinity of the mine, overburden and tailings area. Water management activities include creek interception and diversion as well as the collection of clean water runoff and surficial aquifer water volumes. The catchment area of the diversion east of the mine opening is approximately 100 square kilometres, while the diversion around the sand disposal area has a catchment area of approximately 165 square kilometres. Construction of a polishing pond west of Kearl Lake is required. The estimated volumes of water discharged into the environment are summarized in Table 3.7-3. The diversion ditch around the mine will be designed to be in use for about 12 to 15 years and is shown on the 2010 status map. All basal aquifer water required to be pumped will be contained on the Aurora South site for use in the process once the plant is running. This water will be stored within the tailings starter dyke until needed in the process.

Table 3.7-3 Annual Volumes of Water Discharged to The Environment
AURORA SOUTH

Annual precipitation (mm) =426

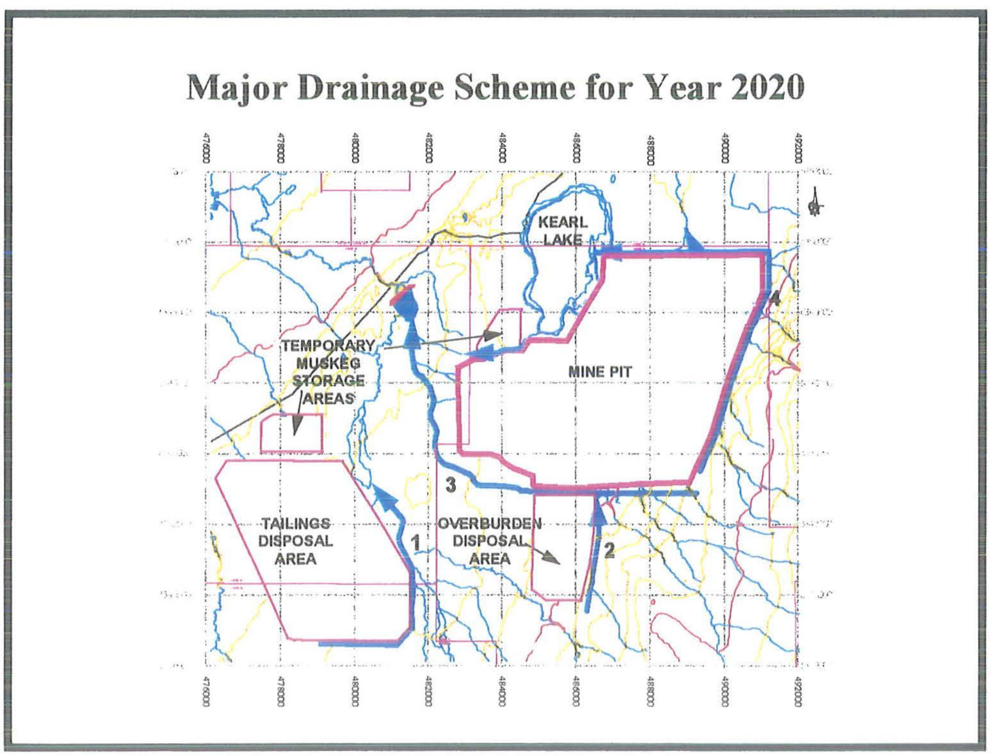
	Area in Km^2						Discharge Volumes to the Environment			
	Undisturbed Km^2	cleared Km^2	Open Water Kearl Lake Km^2	O/B Km^2	Mine Km^2	muskeg dewatering Km^2	Ann. surf. aquifer vol. $(M\ m^3)$	Average annual runoff $(M\ m^3)$	Average* annual surf. dew. $(M\ m^3)$	Approx. Total Discharge $(M\ m^3)$
2010	299.62	-	5.54	-	-	1.4	2.3	26.3	3.3	29.5

* Includes surficial aquifer and muskeg dewatering volumes.

2008 to 2019. Dewatering of the surficial waters from the muskeg will continue as well as moving of the interceptor ditches to keep ahead of the overburden removal.

2020. The construction of segments 2, 3, and 4 of the final diversion around the east side of the pit, shown on Figure 3.7-6. Segment 1 was constructed in 2008 and intercepts the flow from approximately 165 square kilometres. Segment 2 intercepts the flow from a drainage basin of approximately 22 square kilometres. Segment 3 intercepts the flow from approximately 65 square kilometres. Segment 4 intercepts the flow from an area of approximately 40 square kilometres.

Figure 3.7-6 - Major Drainge Scheme for 2020



Section 4.0 Environmental Impact Assessment Summary

An Environmental Impact Assessment (EIA) of the Aurora Mine is a requirement for approval under both the *Oil Sands Conservation Act* and the Alberta *Environmental Protection and Enhancement Act*. The Director, Environmental Assessment Division of Alberta Environmental Protection, issued terms of reference for the Aurora Mine EIA in June, 1995.

Syncrude contracted Bovar Environmental to prepare the EIA consistent with those terms of reference. Bovar has completed that task, and has issued an independent assessment of the Aurora Mine biophysical, social and economic impacts in the separate volume entitled "Environmental Impact Assessment for the Syncrude Canada Ltd. Aurora Mine". That volume has been submitted in support of this Application. For the convenience of the reader, Tables 4-1, 4-2 and 4-3 have been extracted from the Bovar EIA (Tables 1.5.1, 1.5.2 and 1.5.3 of the EIA). These tables present a summary of impacts of the Aurora Mine as assessed and documented by Bovar. They cover in some detail, the impacts of the Aurora Mine project. Further detail, and extensive discussion of the issues, appear in the EIA.

Syncrude understands this information as follows.

- Syncrude will be mining oil sand and extracting the bitumen from it. This land use will return substantial social and economic benefits to Albertans. Inevitably, when an area is mined, the land is disturbed and the existing land capabilities are displaced for a period of time.

- The bitumen extraction process washes out of the oil sands a range of compounds including salts and organic compounds. The process water, entrained in tailings, becomes part of the reclaimed landscape. One of the basic questions examined was whether that water, included in the reclaimed landscape as proposed in this application, would cause adverse effects to plants, animals or the health of people. The EIA concludes such effects should not occur. It indicates where further research and monitoring respecting the performance of the new composite tailings technology would instill greater confidence in this conclusion. Syncrude believes that the risk associated with undetermined health impacts from composite tailings is low because extensive work has been done on fine tailings and sand tailings - the two major constituents of composite tailings. However, for the sake of completeness, some of this work will be repeated on composite tailings.

- Reclamation of the areas disturbed at Aurora will result in a stable landscape with productive capabilities at least equal to the capability of what is there now. The capabilities after reclamation will be somewhat different, with more emphasis on aquatic habitat and forests and less on wetlands. Initially, the reclaimed landscape will favour early to mid-successional communities over late successional communities.

In Syncrude's view, the EIA demonstrates that plans for the Aurora Mine are based upon responsible development, including sound environmental practices. Mine planning and new technology have been utilized to minimize the area disturbed by mining activities and to return land to biological productivity as quickly as is practical. Syncrude fully agrees with the value of ongoing monitoring and research, particularly with respect to the role of process-affected water in the reclaimed landscape, and will continue its well-established commitment to quality work in this regard. Syncrude also recognizes the legitimate interest of local residents and others with an interest in the reclaimed landscape, and restates its desire and willingness to work with those stakeholders in tailoring reclamation programs to best suit long term objectives.

Section 4.0 - Table 4-1
(E.I.A. - Table 1.5.1 Summary of Undetermined Impacts of the Aurora Mine.

A. AIR QUALITY AND NOISE (Section 5.2, Hypotheses A-1 and A-2)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
1. Changes in Air Quality (Section 5.2, A-1)	• Mitigation measures to reduce the amount of visible emissions associated with vegetation clearing will include: reduction of burning and fuel usage through salvage clearing; burning when large fuel has a high moisture content and fine fuel has a low moisture content; and minimization of smoldering by keeping burn piles free of dirt and by immediately cleaning up piles following burn. • Design feature: Minimize area to be cleared. • Mitigation to reduce particulate emissions associated with overburden removal will include: selection of initial mine areas with shallow overburden which will reduce fuel usage and emissions from haul trucks and establishment of vegetation cover to stabilize surfaces of overburden piles. • Roadways will be watered continuously during warm, dry conditions to reduce particulate emissions. Water is not used during the winter for safety reasons. Occasionally a used-oil product is sprayed on the roads. • Syncrude will apply control measures such as revegetation of exterior surfaces of tailings settling basins and stabilization of sand surfaces by mixing sands with dredged Mature Fine Tails or peat to reduce particulate emissions. Deposition control systems such as snow fences, silt fences and berms will also be used to encourage wind-blown sand to deposit in a predicted location. • The pipelining technology to be used at the Aurora Mine eliminates the use of naphtha and thereby, substantially reduces the potential for fugitive hydrocarbon emissions. • Dry low NO_x burners will be installed on the stationary combustion sources at the Aurora Mine plant sites. This will substantially reduce NO_x emissions from these sources. • The basal aquifer depressurization water will be piped to central water treatment facilities, and if warranted, reduced sulphur compounds will be recovered by partial air stripping and combustion by a smokeless flare. This will minimize emissions of potentially odourous reduced sulphur compounds.	**Life of Operation:** • Fugitive particulate emissions can result from vegetation clearing, overburden removal, road construction and use, mining activities and tailings management. The impacts are considered to be Low (overburden removal and mining activities) to Moderate (vegetation clearing, roads and tailings management) in magnitude, Long-term, Local in scope (except for vegetation burning which is Regional) and Reversible (Impact Type B or C; Negative). • Total hydrocarbon and total reduced sulphur emissions can result from volatilization associated with the tailings settling basins, de-aerator vents within the extraction plant, and from fugitive sources, such as exposed oil sands faces. The impacts are considered to be Moderate (tailings settling basins and oil sands faces) and Low (deaerator vents) in magnitude, Long-term (tailings settling basins and oil sands faces) to intermittent (deaerator vents) in frequency, Local in scope and Reversible (Impact Type B or C; Negative). • Oxides of Nitrogen emissions can result from combustion sources that are either stationary (e.g., boilers) or mobile (e.g., mine fleet). The impacts are considered to be Moderate in magnitude, Long-term in duration, Regional in scope and Reversible (Impact Type B; Negative). • CO_2 emissions can result from combustion sources that are either stationary (e.g., boilers) or mobile (e.g., mine fleet). The impact of these emissions as an enhanced greenhouse gas are considered to be Moderate in magnitude, Long-term in duration, Global in scope and Irreversible (Impact Type B; Negative). **Post--Operation:** • No key residual impacts.

Section 4.0 - Table 4-1
(E.I.A. - Table 1.5.1 Summary of Undetermined Impacts of the Aurora Mine.

A. AIR QUALITY AND NOISE (Section 5.2, Hypotheses A-1 and A-2) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
1. **Changes in Air Quality (Section 5.2, A-1) (Continued)**	• The low energy extraction process will result in a significant reduction in the energy requirements at the extraction plant. Much of the heat, which would normally be lost as steam or exported with the tailings water, will be recovered and used to generate power on-site. This on-site generation will be natural gas fired and will therefore result in lower overall emissions than imported power which may be generated in coal fired facilities. • Design features of the Aurora Mine all of which contribute towards an energy efficient (low emissions) operation include: truck shovel mining which reduces the amount of overburden stripping; crusher/cyclofeeder/ hydrotransport which minimizes the ore truck haul distance; selection of a high grade/low overburden ore body which minimizes the amount of material handled. • Import of energy in hot water from Mildred Lake Plant. • Due to the low process temperature associated with the Aurora Mine facilities, no cooling tower is required. This will serve to reduce the potential for ice fog formation. • Fugitive emissions can be confirmed by flux chamber monitoring and ambient air monitoring. • Syncrude is a participant in RAQCC and will ensure their commitments for regional air quality and meteorology monitoring are met. • Syncrude is a sponsor and active participant of an environmental effects monitoring program which is currently under design. Syncrude is also a sponsor of the Alberta Oil Sands Community Exposure and Health Effects Assessment Program being led by Alberta Health.	

Section 4.0 - Table 4-1
(E.I.A. - Table 1.5.1 Summary of Undetermined Impacts of the Aurora Mine.

A. AIR QUALITY AND NOISE (Section 5.2, Hypotheses A-1 and A-2) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
2. Changes in Noise Levels (Section 5.2, A-2)	• The sound levels were predicted as line of sight, whereas the equipment will in reality be working on a mine bench 10 or 15 m below surface. The noise would be attenuated by the mine face, and by the indirect transmission path requirements.	**Life of Operation:** • No key residual impacts. **Post-Operation:** • No key residual impacts.

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B. WATER RESOURCES (Section 5.3, Hypotheses W-1, W-2 and W-3; Section 5.4, Hypotheses W-4 and W-5)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
1. **Changes in Flows (Section 5.3, W-1)**	• Surface water flows from undisturbed areas will be diverted around the mine closed circuit water system during mine operations by construction of diversion channels and perimeter interceptor ditches. • Aurora Mine North is located near a catchment divide at the headwaters of several small drainage basins. Consequently, stream diversions are not required at Aurora Mine North. The impact of drainage area taken out of circulation is minimized by locating the mine footprint in several basins. • Existing tributary streams entering the footprint of Aurora Mine South will be diverted in two stages to minimize impacts or receiving streams and to minimize the extent of the disturbed area during the early stages of development. • The second (final) diversion of the tributary streams at Aurora Mine South (built in year 2020) will be equipped with a bifurcation control structure to minimize changes in flow of Wapasu Creek during mine operations. • The diversion of the tributary streams at Aurora Mine South will be configured to minimize changes in drainage area of receiving streams. • The reclaimed landscape after mine closure will include a reclamation drainage system which will establish a suitable drainage network, with erosion and sedimentation characteristics equivalent to material analogues. • The end-pit lakes will be filled by pumping from the Athabasca River. This will occur after the Athabasca River water withdrawals for existing operations have been reduced. Athabasca River water withdrawals for filling the end-pit lakes will be temporary: two years for west end-pit lake; and five years for the south end-pit lake.	**Life of Operation:** • No key residual impacts. **Post-Operation:** • End-pit lake development will cause surface flows to be attenuated resulting in higher low flows and lower high lows. The net impact is Low in magnitude, Long-term in duration and Local in scope (Impact Type B; Positive). • End-pit lake development at the west pit will cause some drainage of the muskeg terrain surrounding the pit. This impact is Moderate in magnitude, Long- term, and Local in scope (Impact Type B; Neutral or Positive).

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B. WATER RESOURCES (Section 5.3, Hypotheses W-1, W-2 and W-3; Section 5.4, Hypotheses W-4 and W-5) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
2. Changes in Area and Character of Waterbodies (Section 5.3, W-2)	• Losses in the area of lakes, ponds and streams will occur mainly in the mine footprint and minimally at the perimeter of the mine as a result of surficial aquifer dewatering in areas adjacent to the mine pits. • Excessive seepage from Kearl Lake to Aurora Mine South will be prevented by construction of a cutoff or installation of dewatering wells which will replace water lost from Kearl Lake. • End-pit lakes will be developed in the west pit and the south pit as part of the mine closure landscape. The lakes will add a large lake area to the region far greater than the quantity of lake area lost by mine development with productive capability for a range of land uses. • The network of drainage courses in the post-closure landscape will double the surface area of streams lost as a result of mine development and far exceed an objective of no net loss of fish habitat.	**Life of Operation and Post-Operation:** • Development of end-pit lakes at the west and south pits will cause a significant increase in lake area far greater than the lake and watercourse area which was displaced by mine development. This impact is rated as High in magnitude, Long term in duration, and Local in scope (depending on the mine plans of potential nearby future oilsands mines) (Impact Type A; Positive).

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B. WATER RESOURCES (Section 5.3, Hypotheses W-1, W-2 and W-3; Section 5.4, Hypotheses W-4 and W-5) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
3. **Changes in Surface Water Quality (Section 5.3, W-3)**	• No disturbance to critical sport fish habitat (e.g., Arctic grayling) from instream activity, dewatering and diversions. • Mine development plan designed to minimize impacts to Jackpine Creek and Muskeg River. • Water from diverted streams, muskeg drainage and surface runoff will be diverted through polishing ponds and/or wetlands to remove sediment and organic matter prior to discharge into receiving waterbodies. • Mining activities will be set back several hundred metres from major water courses (Athabasca River, Muskeg River and Jackpine Creek) to reduce impacts of erosion and sedimentation. • Pipelines crossing the Athabasca River will be installed on existing pipe racks underneath the Peter Lougheed Bridge and directional drilling will be used for all other pipeline water crossings so that instream construction will not be required. • Erosion control measures will be used to prevent sedimentation from near shore construction. • Out-of-pit tailings settling basins is designed and operated to accepted Canadian standards for fluid retention structures and will be monitored extensively. • All Aurora Mine facilities are well above the Athabasca River 1 in 100 year flood level. • All water and bitumen froth pipelines will be thicker than normal and pipelines that cross the Athabasca River will be double walled. • In the event of spills (e.g., pipeline ruptures, traffic accidents) into waterbodies Syncrude follows Area Regional Spill Containment Standards and has a highly trained emergency response team. In addition, a mutual aid agreement is in place with the Fort McMurray Fire Department and Suncor Inc., Oil Sands Group to provide immediate additional backup, if necessary.	**Life of Operation:** • During the construction and operations phase, water quality of Kearl Lake, Muskeg River, Stanley, Jackpine, Shelley, and Muskeg Creeks and Alsands Drain are predicted to be affected to varying degrees by reclamation waters in the areas of Aurora Mine North and South. The impacts in these waterbodies can be characterized as Low to Moderate in magnitude, Long-term (i.e., > 10 years) in duration, Continuous in frequency, Local in scale and Reversible (Impact Type B or C; Negative). **Post-Operation:** • Water quality of Kearl Lake, the Muskeg River, Stanley, Jackpine, Shelley, and Muskeg Creeks and the Alsands Drain are also predicted to be affected by reclamation waters. The impacts in these waterbodies can be characterized as Low to Moderate in magnitude, Long-term in duration, and Local in scope (Impact Type B or C; Negative).

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B. WATER RESOURCES (Section 5.3, Hypotheses W-1, W-2 and W-3; Section 5.4, Hypotheses W-4 and W-5) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
3. **Changes in Surface Water Quality (Section 5.3, W-3) (Continued)**	• Syncrude will develop specific protocols to deal with spills at water crossings which will meet or exceed the standard procedures used by the Alberta petroleum industry. • Plant sites will have closed circuit water recycle systems to contain surface run-off and sediment and thus prevent surface water contamination. Hydrotransport and tailing pipelines will only occur between the mine site and the extraction facility. Hence, any hydrotransport spills would be contained within the closed circuit water recycle system. • At water crossings, pipelines will be equipped with isolation valves on each bank of the water course. • Pipeline corridors will be inspected weekly for signs of leaks, the booster pumphouse will be inspected once per shift and there will be periodic internal pipeline inspections. • Designed to maximize recycling of reclamation water.	

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B. WATER RESOURCES (Section 5.3, Hypotheses W-1, W-2 and W-3; Section 5.4, Hypotheses W-4 and W-5) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
4. **Changes in Flows and Levels of Groundwater (Section 5.4, W-4)**	• If required, a low permeability cut-off wall will be constructed between the South Pit and Kearl Lake to minimize ground flow inflow and impacts on Kearl Lake. • All basal aquifer depressurization water will be contained within the closed circuit operation of the mine and extraction plant. • Regular monitoring of water levels during Construction and Operation phase will be implemented.	**Life of Operation:** • Within approximately 500 m to 1500 m of the East Pit, Centre Pit, and West Pit mining areas, there will be a reduction in water levels in the surficial aquifers. At the South Pit, water levels in the Pleistocene sand and gravel channel aquifer may be lowered up to 3000 m from the edge of the South Pit. With the exception of the area around West End-Pit Lake, this impact will for the most part be reversible upon closure of the mine as water levels will return to, or near, their pre-mining levels. This impact is considered to be Moderate to High in magnitude, Long-term in duration, Continuous over the Construction and Operation phase, Regional in scope, and, in general, Reversible (Impact Type A or B; Neutral). • Hydraulic heads in the basal aquifer will be reduced during operation within a large area surrounding the Aurora Mine. Deep percolation rates in these areas will increase as a result of basal aquifer depressurization. Seepage from the Athabasca River into the depressurization wells is also expected to occur. This impact is considered to be High in magnitude, Long-term in duration, Continuous over the Construction and Operation phase, Regional in scope, and Reversible (Impact Type A; Neutral). **Post-Operation:** • West End-Pit Lake will permanently change groundwater levels and flow directions within the surficial aquifer along the western boundary of the Aurora Mine LSA. Water levels will be lowered within a 500 m to 1500 m distance from the former limit of the West Pit. West End-Pit Lake will receive groundwater discharge from both the surficial and basal aquifers, and it will recharge the basal aquifer along its westerly limit. This impact is considered to be Low to Moderate in magnitude, Long-term in duration, and Local in scope (Impact Type B or C; Neutral).

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B. WATER RESOURCES (Section 5.3, Hypotheses W-1, W-2 and W-3; Section 5.4, Hypotheses W-4 and W-5) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
4. **Changes in Flows and Levels of Groundwater (Section 5.4, W-4) (Continued)**		**Post-Operation (Continued):** • The tailings sand disposal areas will result in locally increased rates of infiltration. This may subsequently result in increased groundwater discharge rates to area watercourses including Stanley Creek, Muskeg River, Shelley Creek, Jackpine Creek and Muskeg Creek. This impact is considered to be Low to Moderate in magnitude, Neutral and Local in scope (Impact Type B or C; Neutral).
5. **Changes in Quality of Groundwater (Section 5.4, W-5)**	• Seepage from the tailings disposal areas will be collected in a toe ditch and recycled into the extraction process. • Potential seepage in sand and gravel aquifers beyond the toe ditch of the tailings sand disposal areas will be minimized by a lower permeability cut-off "key" beneath the perimeter road into the underlying clays or McMurray Formation Oil Sands. • CT will be placed primarily below existing grade within the lower permeability deposits of the Upper and Middle McMurray Formation Oil Sands. • Tank level controls, berms, sumps, and drainage ponds will be constructed in accordance with industry standards to control potential spills or leaks of process fluids. • Aurora Mine solid wastes will be placed in the Mildred Lake Class II industrial landfill (refer to EUB Application, Section 9.2.1). • Basal aquifer depressurization wells will continue to be operated following the placement of CT, to collect CT seepage to the basal aquifer during mine operations. • Regular monitoring of groundwater quality will be implemented.	**Post-Operation:** • Long-term seepage from the CT and tailings sand disposal areas will impact groundwater quality in the Aurora Mine area. Water in the basal aquifer is currently considered non-potable, however locally, the surficial aquifers and the water in the CT and tailings sand disposal areas may become potable. This impact is considered to be Moderate to High in magnitude, and Local in scope (Impact Type A, B, or C; Negative).

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C. AQUATIC RESOURCES (FISH AND WILDLIFE) (Section 5.8, Hypothesis AR-1; Section 5.7, Hypotheses AR-2 and AR-3)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
1. **Change in Abundance or Health of Fish Populations (Section 5.8, AR-1)**	• See features for Surface Water Quality, W-3. • All facility crossings of the Muskeg River will be located at one site. • There will be no instream works in the Muskeg River. • Water withdrawal from the Athabasca River will be minimized by maximizing use of recycled water, and withdrawals will be minimized during periods of low flow. • Aquatic habitat established in the reclaimed landscape will include an end-pit lake, a system of drainage channels and wetlands/ponds in depressional lows. Native fishes may be introduced to the end-pit lakes. • No disturbance to critical sports fish habitat, e.g., Arctic grayling, from instream activity. • Stream drainages and diversions are staged to reduce disturbance to forage fish habitat at any point in time.	**Life of Operation:** *Walleye, Goldeye, Arctic Grayling and Longnose Sucker* • No residual impacts on walleye, goldeye, or their habitat are anticipated during the life of the operation. *Forage Fish* • At Aurora Mine North approximately 2.2 ha of forage fish habitat will be lost, which represents less than 2% of the forage fish habitat (131 ha) in the LSA. This impact is considered Moderate in magnitude, Long-term in duration, Local in scope and Reversible (Impact Type B; Negative). • At Aurora Mine South approximately 28.7 ha of forage fish habitat will be lost, which represents 22% of the available forage fish habitat (131 ha) in the LSA. This impact is considered High in magnitude, Long-term in duration, Local in scope and Reversible (Impact A; Negative). **Post-Operation:** • Drainage restoration will restore approximately 60 ha of stream. These streams will provide forage fish habitat, which will replace more than double the amount of habitat lost during construction and operation. At Aurora North and South this will reverse the habitat loss incurred during construction and operation. Hence, this impact is considered High in magnitude, Long-term in duration and Local in scope (Impact Type A; Positive). • The impact of end-pit lake creation will be High in magnitude, Long-term in duration and Local in scale providing suitable fish habitat is created within the lakes. Approximately 2720 ha (27.2 km^2) of fish habitat will be created and could support species such as walleye, northern pike and lake trout (Impact Type A; Positive).

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C. AQUATIC RESOURCES (FISH AND WILDLIFE) (Section 5.8, Hypothesis AR-1; Section 5.7, Hypotheses AR-2 and AR-3) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
2. Changes in Abundance of Aquatic Wildlife Populations (Section 5.7, A-2 and A-3)	• The two tailings settling basins will have an oil recovery system and bird deterrents to minimize the potential for wildlife oiling. • As required, native trapper with a Wildlife Permit will be contracted to trap beaver at the periphery of the Aurora Mine development areas. • Aquatic habitat established in the reclaimed landscape will include two end-pit lakes with 10% littoral zone and a system of drainage wetlands/ponds in depressional lows and watercourses.	**Life of Operation:** *Beaver* • There may be a 54% decrease in the beaver (252 animals) in the Local Study Area due to stream dewatering (Hypothesis AR-2). This impact is High in magnitude, Continuous, Long-term in duration, Local in Scope, and Reversible (Impact Type A; Negative). *Dabbling Ducks* • Reduced availability of aquatic habitat may reduce dabbling duck populations within the LSA during the life of the operation. Other mechanical and human activity will disturb breeding ducks. The reversible loss of waterfowl populations in the LSA will likely be Low to Moderate in duration, Long-term in duration, Location in Scope and Reversible (Impact Type B and C; Negative). **Post-Operation:** • The creation of end-pit lakes, and new wetlands and streams will restore the habitat lost in the LSA; i.e., a small local gain of aquatic habitat for beaver in the LSA is expected. Habitat that supports beaver colonies will be re-established within the LSA. This impact is High in magnitude, Long-term in duration and Local in Scope (Impact Type A; Positive). • Expanded and restored water surfaces, both lakes and streams will enhance dabbling duck habitat within the LSA in a short time. Dabbling duck populations are expected to increase beyond original populations. This impact is Low to Moderate in magnitude, Long-term in duration and Local in Scope (Impact Type B or C; Positive).

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D. TERRESTRIAL RESOURCES (TERRAIN, SOILS, VEGETATION, WILDLIFE AND HISTORICAL RESOURCES (Section 5.5, Hypotheses TR-1 and TR-2; Section 5.6, Hypothesis TR-3; Section 5.7, Hypothesis TR-4; Section 7, Hypothesis TR-5)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
1. **Changes in Landforms (Section 5.5, TR-1)**	Landform disturbance and changes will be minimized by: • Selecting high quality ore body which maximizes the bitumen production per hectare, • Selecting initial mining locations at sharp boundaries between ore and waste, facilitating early progressive reclamation, • Utilizing composite tailings disposal reduces landform disturbance for out of pit disposal areas, and • Geotechnical design of the out of pit disposal areas ensures landform stability.	**Life of Operation:** • There will be a temporary disturbance of 9917 ha of landforms during the 30 year operating period of the Syncrude Aurora Mine. The temporary impacts during operation will be High in magnitude, Long-term in Duration, Continuous, Local and Reversible (Impact Type A; Negative). • There will be a permanent burial of 5254 ha of landforms during the operation of the Syncrude Aurora mine project. These impacts will be High in magnitude, Long-term, Once, Local and Irreversible (Impact Type A; Negative). **Post-Operation:** • There will be a re-establishment of 7827 ha of landforms (mine area, access roads, pipelines and plant sites that are similar to the pre-existing landforms). These impacts will be High in magnitude, Long-term, and Local in Scope (Impact Type A; Positive). • There will be 7323 ha of new landforms created due to the end-pit lakes and overburden and tailings disposal sites. These impacts will be High in magnitude, Long-term in duration, and Local in Scope (Impact Type A; Positive).

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D. TERRESTRIAL RESOURCES (TERRAIN, SOILS, VEGETATION, WILDLIFE AND HISTORICAL RESOURCES (Section 5.5, Hypotheses TR-1 and TR-2; Section 5.6, Hypothesis TR-3; Section 5.7, Hypothesis TR-4; Section 7, Hypothesis TR-5)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
2. **Changes in Soil Capability (Section 5.5, TR-2)**	Total land disturbances will be minimized by: • Selecting high quality ore body which maximizes the bitumen production per hectare, • Selecting initial mining locations at sharp boundaries between ore and waste, facilitating early progressive reclamation, • Utilizing composite tailings disposal reduces land disturbance for out of pit disposal areas, • Sequential mining facilitates early reclamation and minimizes net area disturbed, • Obtaining gravel from in the mining areas minimizes out of pit gravel excavation, and • Designing a road/utility corridor reduces the total disturbance required.	**Life of Operation:** • A total of 15 171 ha of soils, or 38% of the LSA, will be disturbed during the 30 year operational phase of the Aurora Mine. These residual impacts will be High in magnitude, Moderate to long-term in duration, Continuous, Local and Reversible (Impact Type A; Negative). *Bitumount Soils* The area of Bitumount soils will be decreased by 48% (1405 ha) in the LSA as a result of land disturbance. This is a High magnitude impact (Impact Type A; Negative). *Dover Soils* The area of Dover soils will be decreased by 38% (1126 ha) in the LSA as a result of land disturbance. This is a High magnitude impact (Impact Type A; Negative). *Firebag Soils* The area of Firebag soils will be decreased by 26% (633 ha) in the LSA as a result of land disturbance. This is a High magnitude impact (Impact Type A; Negative). *Mclelland Soils* The area of Mclelland soils will be decreased by 44% (2859 ha) in the LSA as a result of land disturbance. This is a High magnitude impact (Impact Type A; Negative). • Land capabilities may be decreased temporarily through soil mixing and burial, soil compaction and soil erosion. These residual impacts will be Low to Moderate in magnitude, Moderate to Long-term in duration, Continuous, Local and Reversible (Impact Type B or C; Negative).

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D. TERRESTRIAL RESOURCES (TERRAIN, SOILS, VEGETATION, WILDLIFE AND HISTORICAL RESOURCES (Section 5.5, Hypotheses TR-1 and TR-2; Section 5.6, Hypothesis TR-3; Section 5.7, Hypothesis TR-4; Section 7, Hypothesis TR-5) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
2. **Changes in Soil Capability (Section 5.5, TR-2) (Continued)**	A reduction of soil capability due to soil erosion during the construction and operation phase will be minimized by: • The overburden and tailings disposal areas will be designed to maximize the geotechnical stability of the structures as described in Section 5.5.1.2., • Working surfaces and slopes will be graded to minimize runoff erosion, • Progressive reclamation during operations will minimize slope erosion, and • Establishing a barley nurse crop the following spring after reclamation material replacement will protect the soil from erosion. A reduction in soil capability through land based oil and chemical spills will be prevented by: • Proper pipeline design, • Regular monitoring of the pipelines, and • Spills will be immediately cleaned-up using field tested methods of the Area "Y" Oil Spill Co-operative.	**Life of Operation (Continued):** • Drainage of soils prior to site development will be required for the Organic and Gleysolic soils, and will improve land capability along with land restoration. These residual impacts will be High in magnitude, Moderate to Long-term in duration, Continuous, Local and Reversible (Impact Type A; Positive). **Post-Operation:** • Reclamation will restore soil capability on 12 171 ha of the disturbed areas, although about 2111 ha of soils will be permanently lost due to access road construction and development of end-pit lakes. This residual impact of soil capability replacement will be High in magnitude, Long-term and Local in Scope (Impact Type A; Positive).

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D. TERRESTRIAL RESOURCES (TERRAIN, SOILS, VEGETATION, WILDLIFE AND HISTORICAL RESOURCES (Section 5.5, Hypotheses TR-1 and TR-2; Section 5.6, Hypothesis TR-3; Section 5.7, Hypothesis TR-4; Section 7, Hypothesis TR-5) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
2. **Changes in Soil Capability (Section 5.5, TR-2) (Continued)**	Soil capability will be restored by: • Salvaging suitable reclamation material over the life of the project, • Replacing 50 cm of suitable reclamation material over all disturbed areas. The reclamation material will consist of 20 cm of suitable upper lift reclamation material with an organic matter content of at least 20% (volume/volume), and 30 cm of suitable mineral material for the lower lift, and • Capping the CT deposits with 100 cm of conventional tailings sand and an additional 50 cm of suitable reclamation material as described above. The potential impact of CT release water on soil capability will be mitigated by: • Capping the CT deposits with 100 cm of conventional tailings followed by 50 cm of suitable reclamation material, and • Regularly monitoring the quality of the reclamation material on all reclaimed areas. • Creating sand ridges on the CT deposits, to provide an optimum soil moisture regime and minimize accumulation of salts in the soil.	

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D. TERRESTRIAL RESOURCES (TERRAIN, SOILS, VEGETATION, WILDLIFE AND HISTORICAL RESOURCES (Section 5.5, Hypotheses TR-1 and TR-2; Section 5.6, Hypothesis TR-3; Section 5.7, Hypothesis TR-4; Section 7, Hypothesis TR-5) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
3. **Changes in the Structure and Diversity of Plant Communities** (Section 5.6, TR-3)	• Minimum overburden removal in initial stage of pit development minimizes out of pit placement of overburden and land disturbance of out of pit disposal areas. • Clearing within tight pit limits and dewatering of the smallest practical area throughout the life of the operation to reduce land disturbance. • Minimum land disturbance for out of pit tailings disposal and utility corridor. • Phased clearing and early, progressive reclamation to minimize the period during which vegetation productivity is interrupted. • Successful reclamation, limiting erosion and establishment of streambeds. • Reclamation to vegetation communities native to the region, including those dominated by the following plant species: jack pine; aspen-jack pine; aspen; aspen-white spruce; white spruce; willow; and grasses.	**Life of Operation:** • There will be a loss of 15 171 ha (38%) of the vegetation communities within the Local Study Area as a result of site clearing. The removal of vegetation is considered to be High in magnitude, Long-term in duration, Local in spatial extent, Continuous and Irreversible during the life of this project (Impact Type A; Negative). *Aspen-White Spruce Communities* There will be a 14% (5423 ha) decrease in the area of aspen-white spruce communities in the Local Study Area as a result of site clearing. This is High magnitude impact (Impact Type A; Negative). • There will be a loss of 8353 ha (21%) of wetland communities within the Local Study Area of which 5424 ha (36%) are fens. Of the fens, 516 ha (10%) are patterned fens. There will also be an undetermined disturbance of wetlands outside of the Local Study Area extending to a maximum distance of 2000 m from the mine areas. The disturbance of wetlands is High in magnitude, Long-term in duration, Regional, Continuous and Irreversible (Impact Type A; Negative). *Riparian Shrub Communities* There will be a 50% (316 ha) decrease in the area of riparian shrub communities in the Local Study Area as a result of site clearing (Impact Type A; Negative).

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D. TERRESTRIAL RESOURCES (TERRAIN, SOILS, VEGETATION, WILDLIFE AND HISTORICAL RESOURCES (Section 5.5, Hypotheses TR-1 and TR-2; Section 5.6, Hypothesis TR-3; Section 5.7, Hypothesis TR-4; Section 7, Hypothesis TR-5) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
3. Changes in the Structure and Diversity of Plant Communities (Section 5.6, TR-3) (Continued)		**Post-Operation:** • Of the 15 171 ha of the plant communities within the Local Study Area lost as a result of site clearing approximately 12 171 ha (80% of the Aurora Mine) will be replaced with similar terrestrial vegetation communities following reclamation. (does not include linear corridors for roads which are permanent structures or pipelines and powerlines that will be reclaimed immediately following construction). The impacts will be High in magnitude, Long-term in duration and Local in spatial extent (other impact terms not applicable) (Impact Type A; Positive). *Old Growth Forests* Under proper forest management and timber harvest planning the area of old growth forest within the Local Study Area could increase from its possible maximum area of 4% to an area of 1254 ha (8% of LSA) (Impact Type A; Positive). *Aspen-White Spruce Communities* There will be a 12% (5423 ha) increase in the area of aspen-white spruce communities in the Local Study Area as a result of reclamation. This will increase the total area to 6156 ha (Impact Type A; Positive). *Riparian Shrub Communities* There will be a 213% increase in the area of riparian shrub communities within the Local Study Area with the replacement of 1354 ha to willow/sedge shrublands (Impact Type A; Positive).

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D. TERRESTRIAL RESOURCES (TERRAIN, SOILS, VEGETATION, WILDLIFE AND HISTORICAL RESOURCES (Section 5.5, Hypotheses TR-1 and TR-2; Section 5.6, Hypothesis TR-3; Section 5.7, Hypothesis TR-4; Section 7, Hypothesis TR-5) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
4. **Changes in Abundance of Terrestrial Wildlife Populations (Section 5.7, TR-4)**	• Clearing and reclamation of the mine site will be phased to reduce the size of the area of habitat disturbed at any one point in time. • The disturbed areas will be reclaimed to a mosaic of landforms and early to moderate successional habitat types that will evolve to white spruce, aspen-white spruce, aspen, jack pine-aspen, jack pine, willow and graminiod fen. • Activities adjacent to the Athabasca and Muskeg rivers and their tributaries will be constructed outside the critical winter period, consistent with Fish and Wildlife guidelines and over as short a period as practicable. • Syncrude personnel will be educated on wildlidfe and how to minimize disturbances.	**Life of Operation:** *Moose* • There will be about a 35% decrease in habitat available (195.2 km^2 or 7914 Habitat Units [HUs]) over the Long-term to moose in the LSA due primarily to the removal of aspen communities and to disturbance (habitat avoidance). The increase in browse in areas of improved drainage will partially offset this negative effect. Not all moose displaced will suffer mortality, as populations in the area are thought to be below carrying capacity (Impact Type A; Negative). *Black Bear* • There will be about a 35% decrease in habitat available (148 km^2 or 6346 HUs) to bear in the LSA over the Long-term due primarily to the removal of jack pine and aspen communities. Therefore, there may be a 35% decrease in bear in the LSA. Increased vehicle-wildlife collisions and mortality could result due to increased traffic levels north of the Peter Lougheed Bridge (Impact Type A; Negative). *Snowshoe Hare* • There will be up to a 36% decrease in habitat available (159 km^2 or 9105 HUs) to hare in the LSA over the Long-term due primarily to the removal of aspen, white spruce and black spruce communities and to disturbance (habitat avoidance). All hare displaced may not suffer mortality, depending on cyclic population levels, there may be a 0 to 36% decrease in hare in the LSA (Impact Type A to C; Negative).

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D. TERRESTRIAL RESOURCES (TERRAIN, SOILS, VEGETATION, WILDLIFE AND HISTORICAL RESOURCES (Section 5.5, Hypotheses TR-1 and TR-2; Section 5.6, Hypothesis TR-3; Section 5.7, Hypothesis TR-4; Section 7, Hypothesis TR-5) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
4. Changes in Abundance of Terrestrial Wildlife Populations (Section 5.7, TR-4) (Continued)		**Life of Operation (Continued):** *Fisher* • There will be up to a 36% decrease in habitat available (5974 HUs) to fisher in the LSA over the Long-term due primarily to the removal of jack pine/aspen, white spruce/ jack pine and aspen communities and habitat for prey species, and this may result in a 36% decrease in the fisher population (Impact Type A; Negative). *Red-back Vole* • There will be up to a 36% decrease in habitat available (7343 HUs) to red-backed vole in the LSA over the Long-term due primarily to the removal of aspen and white spruce communities (Impact Type A, Negative). *Great Gray Owl* • There will be up to a 39% decrease in habitat available (3188 HUs) to great gray owl in the LSA over the Long-term due primarily to the removal of graminoid fen and white spruce communities for nesting and for hunting of prey species (Impact Type A; Negative). *Ruffed Grouse* • There will be up to an 8% decrease in habitat available (3332 HUs) to ruffed grouse in the LSA over the Long-term due primarily to the removal of aspen communities with buffaloberry, saskatoon and balsam fir. Populations of ruffed grouse may be 8% lower than they otherwise would be during the 9-10 year cycle within the LSA (Impact Type B; Negative).

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D. TERRESTRIAL RESOURCES (TERRAIN, SOILS, VEGETATION, WILDLIFE AND HISTORICAL RESOURCES (Section 5.5, Hypotheses TR-1 and TR-2; Section 5.6, Hypothesis TR-3; Section 5.7, Hypothesis TR-4; Section 7, Hypothesis TR-5) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
4. **Changes in Abundance of Terrestrial Wildlife Populations (Section 5.7, TR-4) (Continued)**		**Life of Operation (Continued):** *Cape May Warbler* • There will be up to a 12% decrease in habitat available (4612 HUs) to Cape May warbler in the LSA over the Long-term due primarily to the removal of mature white spruce, black spruce and larch communities (Impact Type A; Negative). **Post-Operation:** *Moose* • Over time, site reclamation will replace most of the quality and capabilities of habitat (6230 HUs reclaimed and no longer avoided) that will be lost due to clearing of the Aurora Mine. Reclaimed habitat will not provide higher capability after the end of the operation, and numbers of moose will remain depressed in the LSA unless habitat management and moose management strategies are implemented to enhance moose populations. After several years, the successional vegetation will provide about 78% of the habitat capability lost through clearing and avoidance. As a second growth species, moose should re-occupy the Aurora Mine site very quickly after reclamation. The replacement of habitat is High in magnitude, Long-term in duration, Phased over time and Local in Scope (Impact Type A; Positive). *Black Bear* • Reclaimed habitat will not provide capability equivalent to pre-disturbance levels for several years after the end of the operation, and numbers of bear will remain depressed in the Local Study Area (Impact Type B; Negative). After several years, mid-successional vegetation will provide higher capability habitat for bear (up to 13% higher value) than existed prior to disturbance. The replacement of habitat is High in magnitude, Long-term in duration, Phased over time and Local in Scope (Impact Type A; Positive).

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D. TERRESTRIAL RESOURCES (TERRAIN, SOILS, VEGETATION, WILDLIFE AND HISTORICAL RESOURCES (Section 5.5, Hypotheses TR-1 and TR-2; Section 5.6, Hypothesis TR-3; Section 5.7, Hypothesis TR-4; Section 7, Hypothesis TR-5) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
4. **Changes in Abundance of Terrestrial Wildlife Populations (Section 5.7, TR-4) (Continued)**		**Post-Operation (Continued):** *Snowshoe Hare* • Reclaimed habitat will provide 66% of the capability (6190 HUs reclaimed and no longer avoided) for hare that was provided by the pre-disturbance landscape. The replacement of habitat is High in magnitude, Long-term in duration, Phased over time and Local in Scope (Impact Type A; Positive). *Fisher* • Reclaimed habitat will not provide as much capability for fisher for 40 to 60 years after the end of the operation, and numbers of fisher will remain low in the Local Study Area (Impact Type B; Negative). After 40 to 60 years, late successional vegetation will restore up to 85% of the original capability habitat for fisher for the Long-term. The replacement of habitat is High in magnitude, Long-term in duration, Phased over time and Local in Scope (Impact Type A; Positive). *Red-back Vole* • Reclaimed habitat will replace 85% of the capability (6263 HUs) for red-back vole that was provided in the pre-disturbance landscape. This replacement of habitat is High in magnitude, Long-term in duration, Phased over time and Local in Scope (Impact Type A; Positive). *Great Gray Owl* • Reclaimed habitat will provide habitat capability (5677 new HUs) in excess of pre-disturbance habitat in the LSA. After 80 years, climax vegetation will provide higher capability habitat for owls (up to 178% higher value) than existed prior to disturbance in the LSA (Impact Type A; Positive) and >1% increase in the RSA. This replacement of habitat is High in magnitude, Long-term in duration, Phased over time and Local in Scope (Impact B; Positive).

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D. TERRESTRIAL RESOURCES (TERRAIN, SOILS, VEGETATION, WILDLIFE AND HISTORICAL RESOURCES (Section 5.5, Hypotheses TR-1 and TR-2; Section 5.6, Hypothesis TR-3; Section 5.7, Hypothesis TR-4; Section 7, Hypothesis TR-5) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
4. **Changes in Abundance of Terrestrial Wildlife Populations (Section 5.7, TR-4) (Continued)**		**Post-Operation (Continued):** *Ruffed Grouse* • Reclaimed habitat will provide capability (4929 HUs) in excess of pre-disturbance levels for several years after the end of the operation, and numbers of grouse may increase in the LSA. After several years, mid-successional vegetation will provide higher capability habitat for grouse (up to 148% higher value) than existed prior to disturbance in the LSA. This replacement of habitat is High in magnitude, Long-term in duration, Phased over time and Local in Scope (Impact Type B; Positive) (Impact Type A; Positive). *Cape May Warbler* • Reclaimed habitat will provide 45% of the capability (2054 HUs) provided to Cape May warblers in the pre-disturbance landscape. Although this capability will not be replaced for up to 80 years when spruce forest achieves sufficient maturity, the replacement of habitat is High in magnitude, Long-term in duration and Local in Scope (Impact Type A; Positive).

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D. TERRESTRIAL RESOURCES (TERRAIN, SOILS, VEGETATION, WILDLIFE AND HISTORICAL RESOURCES (Section 5.5, Hypotheses TR-1 and TR-2; Section 5.6, Hypothesis TR-3; Section 5.7, Hypothesis TR-4; Section 7, Hypothesis TR-5) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
5. **Changes in the Number and Integrity of Historical Resource Sites (Section 7, TR-5)**	• A Historical Resources Management Plan (HRMP) will be developed and implemented. • The HRMP will include Historical Resource Impact Assessment and Historical Resource Mitigative studies designed to meet government regulatory requirements.	**Life of Operations:** • Collectively, the magnitude of primary impacts on the Precontact Native archaeological resources due to surface disturbances is anticipated to be Moderate to High, of Long-term duration, occurring Intermittently during the mine's lifetime, Provincial in scope and Irreversible (Impact Type A or B; Negative). • The magnitude of primary impacts on Precontact Native archaeological resources at the site-specific level due to surface disturbances is anticipated to be Low to Moderate, of Long-term duration, occurring Intermittently during the mine's lifetime, Regional to Provincial in scope and Irreversible (Impact Type B or C; Negative). • The magnitude of primary impacts on Postcontact Native historical resources due to surface disturbances is anticipated to be Moderate to High in magnitude, of Long-term duration, occurring continuously during the mine's lifetime, Local in scope and Irreversible (Impact Type A or B; Negative). • The magnitude of primary impacts on Palaeontological resources due to below-surface disturbances is anticipated to be Low to Moderate, Long-term in duration, occurring Intermittently during the mine's lifetime, Regional to Provincial in scope and Irreversible (Impacct Type B or C, Negative). • The HRMP will contribute to mitigating the impacts which will occur during the operation of the Aurora Mine (Impact Type A; Positive). • Secondary impacts to Historical Resource sites on vacant or occupied Crown Lands within the LSA outside of the fenced Aurora Mine sites may result from increased regional recreationist use and other regional developments as an economic consequence of the Aurora Mine. This Moderate to High magnitude, Long-term impact, Intermittent in frequency, Local to Provincial in scope and Irreversible (Impact Type A or B; Negative). **Post-Operations:** • No key residual impact.

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(E.I.A. - Table 1.5.1 Summary of Undetermined Impacts of the Aurora Mine.

E. RESOURCE USE (Section 5.9, Hypotheses RU-1, RU-2, RU-3, RU-4 and RU-5)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
1. **Changes in Tree Productivity and Timber Harvest Potential (Section 5.9, RU-1)**	• Minimum land disturbance for overburden removal, out of pit tailings disposal and utility corridor. • Merchantable timber will be salvaged. • Phased clearing and early, progressive reclamation to minimize the period during which vegetation productivity is interrupted. • Successful reclamation, limiting erosion and establishment of streambeds. • Reclamation will return the land capability for forest production to greater than that of the pre-disturbance landscape. • Continued research into reclamation to improve forest productivity	**Life of Operation:** • No key residual impacts. **Post-Operation:** • There will be an increase in timber production as a result of an increase in the land capability for forest productivity and the re-establishment of 9480 ha of forests that will support commercial trees (250% increase). This increase in timber production is High in magnitude, Long-term in duration and Local in Scope (Impact Type A; Positive).
2. **Changes in Fishing Opportunities (Section 5.9, RU-2)**	• Existing sportfish fisheries will not be disturbed. • Two end-pit lakes will be designed to support sportfish and will be stocked. • Improved access to east side of the Athabasca River to Aurora North Mine.	**Life of Operation:** • No key residual impacts. **Post-Operation:** • There should be an increase in fishing opportunities in the Local Study Area after closure over the long-term, primarily due to creation of the West and South pit lakes and improved access. The effect will be Moderate in magnitude, Long-term in duration and Local in Scope (Impact Type B; Positive).

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(E.I.A. - Table 1.5.1 Summary of Undetermined Impacts of the Aurora Mine.

E. RESOURCE USE (Section 5.9, Hypotheses RU-1, RU-2, RU-3, RU-4 and RU-5)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
3. **Changes in Hunting and Trapping Opportunities (Section 5.9, RU-3)**	• Reclamation to vegetation habitat that will support game and fur bearing species. • Improved access to east side of the Athabasca River to Aurora North Mine.	**Life of Operation:** • There will be a decrease in hunting and trapping opportunities in the Local Study Area during construction and operation of the Aurora Mine due to reduced abundance of terrestrial and aquatic wildlife populations and restricted access to the development area. The magnitude of this effect is Moderate, Long-term, Local and Reversible (Impact Type B; Negative). **Post-Operation:** • There will be an increase in hunting and trapping opportunities for some game species and a decrease for other species available over the long-term (20 years), as some terrestrial and aquatic species populations will increase and others will decrease in the reclaimed landscape. Access will be improved within Leases 10, 12 13, 31 and 34, and new roads will provide access to the end-pit lakes. The increase in hunting and trapping opportunities is Moderate in magnitude, Long-term and Local in Scope (Impact Type B; Positive and Negative).
4. **Changes in Food Gathering Opportunities (Section 5.9, RU-4)**	• Re-establishment of harvestable plants including berry producers, trees, shrubs, herbaceous plants and mosses to provide for a variety of traditional and non-traditional uses. • Improved access to east side of the Athabasca River.	**Life of Operation:** • There will be a decrease in food and medicinal/spiritual plant gathering opportunities during construction and operation in the Local Study Area due to a decrease in abundance of harvestable plants and restricted access to existing plant harvest sites. The magnitude will be High, Moderate in duration and Local to Regional in scope. Frequency will be intermittent coinciding with clearing operations (Impact Type A; Negative). **Post-Operation:** • There will be a general increase in the harvestable plants within the development area after closure of the Aurora Mine. The decline in food and medicinal/spiritual plant gathering opportunities for some plant species in the Local Study Area will continue in the short-term after reclamation. Over the long-term, this will improve as native plants establish on reclaimed sites. Access to harvestable plants will be increased through the upgrading of existing roads and the construction of new roads. The magnitude will be High, Long-term in duration, and the scope of impact is Local to Regional (Impact Type A; Positive).

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E. RESOURCE USE (Section 5.9, Hypotheses RU-1, RU-2, RU-3, RU-4 and RU-5) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
5. **Changes in Non-Consumptive Resource Use (Section 5.9, RU-5)**	• No water intake within the Athabasca River valley. • Minimum land disturbance for overburden removal, out of pit tailings disposal and utility corridor to limit aesthetic impact. • No impact to historical sites or First Nations Reserve Lands. • Improved access to east side of the Athabasca River to Aurora North Mine. • Enhanced diversity of aquatic and terrestrial recreation activities through the creation of end-pit lakes, hills and a mosaic of vegetation communities.	**Life of Operation:** • No key residual impacts. **Post-Operation:** • No key residual impacts.

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(E.I.A. - Table 1.5.1 Summary of Undetermined Impacts of the Aurora Mine.

F. HUMAN HEALTH AND PUBLIC SAFETY (Section 5.10, Hypothesis H-1; Section 5.11, Hypothesis H-2)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
1. **Changes in Human Health (Section 5.10, H-1)**	• See features for Air Quality, A-1. • See features for Surface Water Quality, W-3. • Capping layer added on reclamation deposits to reduce or eliminate direct exposure to subsoil materials. • Aurora Health Hazard Assessments and Surveillance Program in place to monitor occupational health and safety.	**Life of Operation:** • No key residual impacts. **Post-Operation:** • No key residual impacts.
2. **Change in Public Safety (Section 5.11, H-2)**	• Tailings settling basin dyke walls have instrumentation to monitor for slippage and leakage and design approach based on extensive experience. • Majority of pipeline route is in remote area with low potential for exposure to public. • Increased corrosion allowance, and periodic internal inspections to reduce chance at an accidental release. • Athabasca River crossing on Peter Lougheed Bridge will be double sleeved. • River crossings will be equipped with isolation values to minimize potential release volume and duration. • Emergency Response Plans being developed for slope failures and pipelines breaks. • Highway 963 north of Peter Lougheed Bridge to be upgraded to primary highway standards to safely handle increased traffic. • Syncrude employees trained in defensive driving to avoid accidents. • Loss management program to identify potential problems and implement follow-up actions.	**Life of Operation:** • The increased risk to public safety due to traffic accidents is considered to be Low to Moderate in magnitude, Long-term in duration, Continuous through the life of the project, Local in scope and Irreversible (Impact Type B or C; Negative). **Post-Operation:** • No key residual impacts.

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(E.I.A. - Table 1.5.1 Summary of Undetermined Impacts of the Aurora Mine.

G. SOCIO-ECONOMICS (Section 8)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
1. **Temporary increase in housing demand during construction phase**	• Use of construction camp to accommodate most of the Aurora Mine construction work force.	**Life of Operation:** • Minor upward pressure on the housing market in the urban service area of Fort McMurray. **Post-Operation:** • No key residual impact.
2. **Temporary increase in demands for recreational, health and safety services during the construction phase.**	• Use of construction camp, including on site recreational facilities, to accommodate most of the Aurora Mine construction work force.	**Life of Operation:** • Minor and time-limited increase in demand for recreational and social services in the urban service area of Fort McMurray. **Post-Operation:** • No key residual impact.
3. **Increased usage of Highway 963**	• Use of construction camp to minimize commuting construction workers and provision of bus transportation for operation phase workers.	**Life of Operation:** • Minor increase in highway usage. **Post-Operation:** • No key residual impact.
4. **Reduced opportunities for traditional and non-traditional land uses**	• Ongoing consultation with the affected Native communities, especially Fort McKay; completed compensation agreements with affected trappers, staged on-site tree removal at project inception and reclamation of the mine site at project completion.	**Life of Operation:** • Reduced traditional and non-traditional land uses during the life of the mine. **Post-Operation:** • No key residual impact.

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(E.I.A. - Table 1.5.1 Summary of Undetermined Impacts of the Aurora Mine.

G. SOCIO-ECONOMICS (Section 8) (Continued)

Environmental Issue	Design Features/Mitigation/Monitoring	Residual Impact
5. **Long-term increase in property tax base for the Municipality of Wood Buffalo**		**Life of Operation and Post-Operation:** • Lower municipal taxes or higher level of services than would be the case in the absence of the project.
6 **Long-term increase in household and business income in the region**	• Ongoing efforts of Syncrude to work with local area and especially Native-owned businesses for the provision of goods and services.	**Life of Operation and Post-Operation:** • Increased level of economic activity, household, and business income.

Section 4.0 - Table 4-2
(E.I.A. - Table 1.5.2 Cumulative Effects Summary

Environmental Issue	Residual Impact
1. **Changes in Air Quality (Section 5.2, A-1)**	**Post-Operation:** • Beyond the life of the Aurora Mine, potential sources for emissions include the release of hydrocarbon vapours from the reclaimed landscape (e.g., emissions from dry land reclamation of composite tailings (CT) and mine areas) and from the lakes associated with the tailings settling basins. This impact is considered to be Unknown in magnitude, Negative in direction, Long-term in frequency, Local in scope and Unknown in degree of reversibility. The direction and reversibility have been categorized as unknown, since the nature of the reclaimed surface has not been determined (Impact Type Undetermined).
2. **Change in Soil Capability (Section 5.5, TR-2)**	**Post-Operation:** • Seepage from the CT deposits may temporarily contaminate soils. Further monitoring will be required to define the magnitude and extent of any impacts. These residual impacts will be Unknown in magnitude, Moderate to Long-term, Continuous, Local to Regional and Reversible. This potential impact was identified due to lack of data and the subsequent protective conservative assumptions incorporated into this analysis (Impact Type Undetermined; Negative).
3. **Changes in the Structure and Diversity of Plant Communities (Section 5.6, TR-3)**	**Post-Operation:** *Patterned Fens* • There will be a decrease in the area of wetland communities in the Local Study Area as a result of site clearing. Wetland communities will develop through successional changes to the seasonal wetlands created during reclamation, however, patterned fens are not anticipated to re-establish for a very long time (Impact Type Undetermined).
4. **Changes in Terrestrial Wildlife Populations (Section 5.7, TR-4)**	**Post-Operation:** • The residual impacts on terrestrial wildlife from inhalation of air emissions from CT deposits, is Undetermined due to lack of data.
5. **Changes in Human Health (Section 5.10, H-1)**	**Post-Operation:** • The residual impacts on human health associated with use of the reclaimed Aurora Mine pertain to potential impacts from inhalation of air emissions from CT deposits. This potential impact was identified due to lack of data (Impact Type Undetermined). • The residual impacts on human health associated with use of the reclaimed Aurora Mine pertain to potential impacts from ingestion of plant foods grown on these deposits. This potential impact was identified due to lack of data and the subsequent protective conservative assumptions incorporated into this analysis (Impact Type Undetermined).

Section 4.0 - Table 4-2
(E.I.A. - Table 1.5.2 Cumulative Effects Summary

Part A: Biophysical Environmental Issues	Existing Impacts (including other proposed/expected projects)	Incremental Effects (Aurora Mine)	Cumulative Effects (existing + incremental)
Significant Natural Features (Westworth 1990): Terrain, Vegetation and Wildlife	Where effects occur, they are mainly due to linear corridors (roads, utilities, exploration) and recreational use. Timber harvesting by Al-Pac/Northlands has not impacted existing features. Future harvesting will be approved by AEP to ensure protection.	The Aurora Mine will disturb a small portion of the Fort Hills (terrain feature of regional significance)	Cumulative effects include existing disturbances plus the disturbance of a small portion of the Fort Hills.
		It will disturb 438 ha of patterned fens (1% total RSA fen area) that are within a protective buffer (CNT (96007100) for the Fort Hills significant landform.	Cumulative effects include existing disturbances plus the disturbance of 1% RSA of patterned fens at McClelland Lake.
		Some dewatering of watercourses, such as East Jackpine Creek (designated regionally significant, contains river otter habitat) may occur; this will be small scale, limited effect and reversible through reclamation and establishment of new watercourses.	Cumulative effects include existing disturbances plus minor flow changes in East Jackpine Creek.
Air: NO_x emissions	Regional NO_x emissions are estimated to be 93.4 t/d. Maximum hourly NO_x concentrations at the Aurora Mine due to existing sources are expected to be 25 to 30 $\mu g/m^3$.	NO_x emissions are expected to be 5.6 t/d from 1 Train to 22.8 t/d from 2 Trains in 2001.	NO_x contributions due to the Aurora Mine stationary sources is expected to increase the NO_x concentrations at the Aurora Mine due to existing sources from 25-30 $\mu g/m^3$ to 50-60 $\mu g/m^3$ range. These values are much less than the NO_2 guideline of 400 $\mu g/m^3$.
Air: CO_2 emissions	CO_2 emissions in 1995 were 35 065 t/d and in the future will be about 47 103 t/d.	CO_2 emissions (Aurora Mine-Train 1) are expected to be 2130 t/d.	CO_2 emissions (Aurora Mine-Train 1) are about 5% of the regional CO_2 emissions, in the future.
Surface Water Quantity: changes to Athabasca River flow due to effects of water withdrawal, mine water releases, and changes in surface water yield from catchment runoff	Changes to flow due to existing disturbance range from -0.315 m^3/s currently, to -0.531 m^3/s in the future due to mining, to + 0.019 m^3/s after reclamation.	Incremental changes to flow due to the Aurora Mine ranges from -0.261 m^3/s in the future due to mining, to -0.149 m^3/s after reclamation.	Cumulative changes in flow range from -0.315 m^3/s currently, to -0.792 m^3/s in the future due to mining, to -0.130 m^3/s after reclamation.
Surface Water Quality: Reclamation Water Releases	Projected (modelled) releases by Suncor-Steepbank and Syncrude-Mildred Lake predict an area of elevated CT water (> 1%) along the west bank of the Athabasca River.	Under worst-case conditions, an incremental area of >1% CT water concentration is predicted along the east bank as a result of drainage from the reclaimed Aurora Mine landscape.	Cumulative effects on water quality due to reclamation water releases are not expected to adversely affect human health or aquatic biota.
Surface Water Quality: Acidifying Emissions	The ³ 0.3 kmol H^+/ha/a contour (approximate critical loading value for sensitive lakes) is restricted to a small area immediately around the existing oil sands facilities. No nearby sensitive lakes.	SO_2 and NO_x emissions from the Aurora Mine are low, only 1 t/d of SO_2 and 6 t/d of NO_x (Train 1). These emissions account for < 0.4 and 6% of regional SO_2 and NO_x (Train 1) emissions.	AEP is reviewing critical loading values for lakes, and is updating their database of sensitive lakes in north-eastern Alberta. Once complete, a more rigid analysis of potential impact will be possible.

Section 4.0 - Table 4-3

(E.I.A. - Table 1.5.3 Summary of Undetermined Impacts of the Aurora Mine.

Part A: Biophysical Environmental Issues	**Existing Impacts (including other proposed/expected projects)**	**Incremental Effects (Aurora Mine)**	**Cumulative Effects (existing + incremental)**
Soils Disturbance	Existing disturbances to soils in the RSA, total 104 795 ha, or 10% of RSA.	Incremental disturbances in the RSA from the Aurora Mine will total of 15 171 ha (1.5% of RSA) of which only 21 ha will be permanent disturbances (<1% of RSA).	Cumulative disturbances in the RSA total 119 966 ha (12% of RSA), of which 3489 ha (<1% of RSA) are permanent disturbances and 116 477 (11% of RSA) are temporary disturbances.
Vegetation	Total existing and proposed vegetation disturbances in the RSA, up to the closure date of the Aurora Mine (2042), total 104 795 ha, or 10% of RSA.	The development of the Aurora Mine will increase the disturbance area by 15 171 ha (1.5% of RSA). Only 21 ha (<1% of RSA) will be permanent.	Cumulative disturbances in the RSA total 119 966 ha (12% of RSA), of which 3489 ha (<1% of RSA) are permanent disturbances and 116 477 (11% of RSA) are temporary disturbances.
Wetlands	Total existing and proposed wetland effects in the RSA amount to 7797 ha.	Aurora Mine will have an incremental increase on wetlands of 8353 ha (1.5% of the wetlands in the RSA).	The cumulative effect of wetlands in the RSA is 16 150 ha (3% of wetlands in the RSA).
Wildlife Habitat based on Habitat Units (HU) for Key Indicator Species (KIR)	Existing disturbances account for a 6.5% loss of habitat for wildlife. The most substantial permanent disturbance for wildlife in the RSA is residential development at Fort McMurray (2109 ha).	Incremental loss of HUs due to vegetation clearing range from 2.3% of RSA for snowshoe hare to 1.4% of RSA for great gray owl.	Cumulative effects to wildlife habitat range from 7.5 to 9.1% of the RSA, of which Aurora Mine effects to KIR species habitat are a small part.
Fish Health: Athabasca River	Background toxicity from effluent releases from the existing Syncrude and existing and proposed Suncor operations	The zone of elevated CT was largely comprised of only 1 to 2% CT water which is equal to the NOEC for fish health endpoints or slightly greater, but five to ten times lower than the LOEC.	Adverse effects on fish health in the Athabasca River are unlikely as a result of the cumulative levels from existing and proposed water releases.
Fish Habitat	Proposed and existing oil sand mines have impacted Ruth Lake, Mildred Lake, Poplar Creek, Beaver River, Leggett Creek, Wood Creek and the unnamed creek that drains into Shipyard Lake Wetlands. Habitat loss associated with Syncrude's Mildred Lake Facility and the Steepbank Mine will be reversed by reclamation.	Incremental fish habitat loss due to the proposed Aurora Mine was assessed as an approximate loss of 30.9 ha of forage fish habitat in Muskeg and Athabasca River tributaries and no loss of sport fish habitat. At Aurora Mine, the total increase in lakes and ponds created during reclamation is 2 720 ha plus 60 ha of watercourses. The net result is a significant improvement in habitat quality and a gain in habitat quantity.	Although there will be some fish habitat loss during the operations of the oil sand facilities, the establishment of lakes and watercourses during reclamation will more than replace the lost habitat.

Section 4.0 - Table 4-3
(E.I.A. - Table 1.5.3 Summary of Undetermined Impacts of the Aurora Mine.

Part A: Biophysical Environmental Issues	Existing Impacts (including other proposed/expected projects)	Incremental Effects (Aurora Mine)	Cumulative Effects (existing + incremental)
Resource Use: Fishing	There will be some reduced opportunities for fishing during the construction and operations of existing or proposed oil sand plants, until watercourses and lakes have been established through reclamation.	No effect to sport fish or fishing opportunities. Reclamation will enhanced fish habitat with the creation of 2720 ha of lakes and ponds and approximately 60 ha of drainages, and thus enhance fishing opportunities.	Although there could be some cumulative reduction in fishing opportunities during construction and reclamation, reclamation will result in improved opportunities.
Resource Use: Forestry	The greatest effect to the area of merchantable forest in the RSA will be from timber harvesting by Alberta Pacific Forest Industries and Northland Forest Products (99% of total effect). The total area harvested by Alberta Pacific Forest Industries and Northland Forest Products in the 30 year period prior to the year 2042 will be 71 057 ha (14% of RSA). Other activities will also result in loss of merchantable forests.	The annual salvage of timber from the Aurora Mine will be less than 1% of the FMA and quota Annual Allowable Cut. The area to be harvested from the Aurora Mine is 3830 ha (<1% of RSA).	The combined total AAC volume is 3 301 200 m^3/yr. Combining forest harvesting by Alberta Pacific Forest Industries and Northland Forest Products and by Syncrude for the Aurora Mine, 15% of the RSA will be affected.
Resource Use: Hunting and Trapping	Developments result in 6.5% loss of habitat and wildlife populations, and thus hunting and trapping opportunities.	The Aurora Mine will further reduce habitat for snowshoe hare and moose by 2% and for black bear, fisher and ruffed grouse by 1%.	The cumulative effect will result in a maximum decrease of 7 to 8% in the hunting and trapping opportunities over the moderate to long-term.
Resource Use: Harvestable Plants	Existing disturbances within the RSA have disturbed 104 795 ha of vegetation or 10% of the RSA. Of this area, 3468 ha (<1% of the RSA) is permanent loss; and could result in a decrease in traditional and non-traditional use of vegetation for medicinal, dietary, ritual, utensil and dyes.	Only 21 ha of Aurora disturbance will be permanent. Drawdown of the surficial aquifer will increase the productivity of 3836 ha of land that produces harvestable plants.	Cumulative existing and proposed disturbances to the year 2042, are 119 966 ha or 11% of the RSA, of which 3489 is permanent.
Increased Access	There are roughly 300 km of major roadways within the RSA. As well, there are numerous smaller access routes related to seasonal roads, trails and exploration linear disturbances and utility right-of-ways.	Roads to Aurora Mine represent a 7 km (2.3%) incremental increase in permanent roads in the RSA. Aurora Mine roads would represent far less than a 2.3% incremental increase if all other existing access roads, trails and pathways were considered.	The cumulative effect is approximately 307 km of major roadways, plus other existing smaller access roads, trails and pathways.
Human Health: Noise Effects	Sources of noise that may contribute to cumulative effects include those related to Syncrude and Suncor's existing projects, the proposed Steepbank and Aurora Mines, Solv-Ex, AOSTRA, Northlands Forest Products, and various mine sources.	Given the distance of the Aurora Mine from the other developments, it is not expected that activities at the Aurora Mine contribute to incremental increases of noise at other sites in the RSA.	Cumulative effects are not significantly increased by the Aurora Mine.

Section 4.0 - Table 4-3
(E.I.A. - Table 1.5.3 Summary of Undetermined Impacts of the Aurora Mine.

Part B: Socio Economic Environmental Issues	**Mitigative Measures**	**Residual Cumulative**	
Increase in housing demand during construction and operations phases of Solv-Ex, Suncor, and Syncrude projects.	Use of construction camps to accommodate most of the construction work forces.	Some upward pressure on the housing market in the urban service area of Fort McMurray	
Limited increase in demands for recreational, health and safety during the construction and operational phases of various projects.	Use of construction camps, including on site recreational facilities, to accommodate most of the construction work forces.	Minor increase in demand for recreational and social services in the urban service area of Fort McMurray.	
Increased usage of Highway 963.	Use of construction camps to minimize commuting construction workers and provision of bus transportation for operation phase workers associated with various projects.	Minor increase in highway usage, but remaining well within the rated capacity of the road.	
Reduced opportunities for traditional and non-traditional land uses.	Ongoing consultation with the affected Native communities, especially Fort McKay; reclamation of project mine sites at project completion.	Reduced traditional and non-traditional land uses during the life of the mine.	
Long term increase in property tax base for the Municipality of Wood Buffalo.		Lower municipal taxes or higher level of services than would be the case in the absence of the projects.	
Long term increase in household and business income in the region.	Ongoing efforts of project proponents to work with local area and especially Native-owned businesses for the provision of goods and services.	Increased level of economic activity, household, and business income.	
Minor increase in long term population of the urban service area of Fort McMurray.	Increase take-up of municipal infrastructure already in place.	Increased population in the urban service area of Fort McMurray.	

5.0 EXISTING APPROVALS

The Aurora Mine is on a greenfield site and, as such, has only those approvals necessary for resource evaluation and environmental assessment. The following is a summary of the drilling and water monitoring approvals and authorizations obtained by Syncrude to date.

Approval OSE 940004 and amendments issued by the Land Reclamation Division of Alberta Environmental Protection, authorizes Syncrude to conduct an oil sands exploration program in Township 96, Range 9, 10, and 11, all west of the Fourth Meridian. The Approval expires on December 20th, 1998.

On January 18, 1996, pursuant to Section 19, Subsection (1) of the Public Lands Act, a Letter Of Authority was issued, by the Land Administration Division, to enter upon the above specified public lands for the purpose of conducting further oil sands exploration program.

On February 8, 1996 a Letter of Authority was received from the Water Resources Administration Division for the diversion of up to 3,930 cubic metres/day from dewatering wells in NE 3-96-10-W for aquifer evaluation purposes. Diversion activities are to be completed by June 30, 1996.

Water Resources Administration Division Permit No. 1922 dated April 27, 1995, authorizes the installation of four stream-flow monitoring stations east of the Athabasca River. Two of these stations are within the boundaries of Lease 31:

- Station S3: NE Quarter, Section 14, Township 95, Range 8, West of the Fourth Meridian
- Station S4: NW Quarter, Section 32, Township 94, Range 8, West of the Fourth Meridian
- Two monitoring stations situated on Leases 13 and 89.

A Licence of Occupation from Alberta Environmental Protection exists for each of the monitoring stations on Syncrude Lease 31:

- Station S3 LOC 950763
- Station S4 LOC 950763

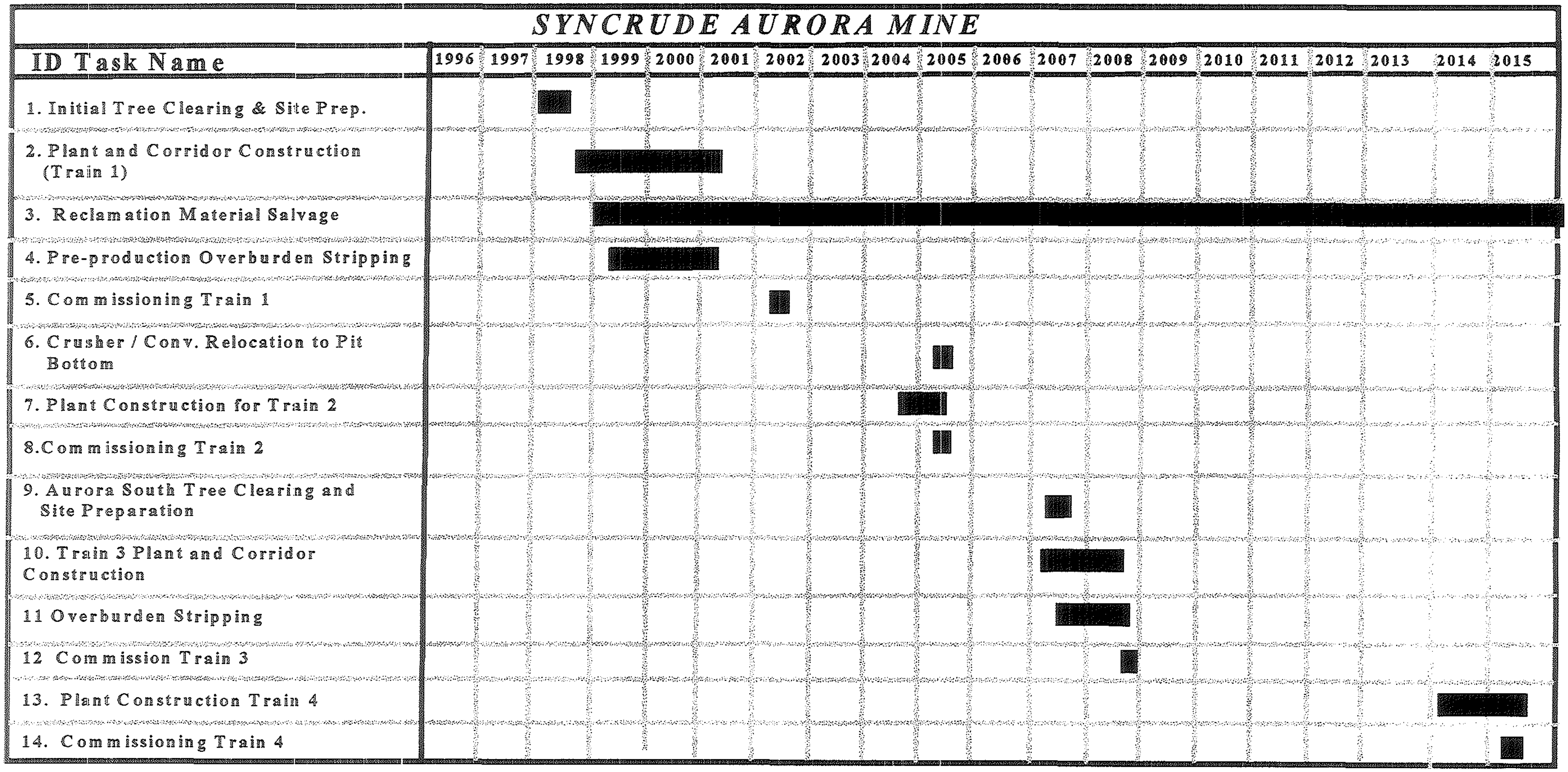
6.0 Project Schedule

The Aurora Mine is planned for development in a series of stages. Figure 6-1 covers the construction and commissioning schedules while more detailed schedules for mining, tailings management and reclamation activities can be found in Sections 3.2, 3.3 and 11, respectively.

As described in Section 1.0, there is considerable flexibility in the timing of stages two, three and four. At present, it is expected that Train 1 will start up in 2001 and Train 2 in 2005. These dates could be shifted in either direction, by up to one year in the case of Train 1 and by two or three years in the case of Train 2. The schedule also shows Trains 3 and 4 being commissioned in 2008 and 2015 respectively. These dates could advance under the right economic and market conditions. Any change in a train start-up date would shift the activities associated with that train accordingly.

Although on the current schedule, site preparation and mining activities on Trains 3 and 4 (Aurora Mine South) do not commence until 2005, approval of the Board for the development of Aurora South is very important to Syncrude. Aurora South will allow Syncrude to respond to market needs and develop synergies among the stages of Aurora Mine development.

Figure 6-1 Schedule



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7.0 Releases to the Environment

7.1 Introduction

The Aurora Mine will produce bitumen through mining and oil sand processing. Upgrading and refining of bitumen will not be conducted on the Aurora site, consequently substance releases will typically be limited to those associated with surface disturbance activities.

This section summarizes the anticipated releases to the air and water as a result of Aurora Mine operations. Additional information on air and water emissions can be found in the EIA.

7.2 Air Emissions

Syncrude's objective is to minimize the direct and indirect air emissions attributable to the Aurora operation. To achieve this objective Syncrude plans to:

- install dry low-NOx burners on all thermal-electric generating equipment;
- import heat by pipelining hot water from the Mildred Lake Facility, rather than generating an equivalent amount of thermal energy at Aurora;
- install on-lease gas turbine co-generation rather than rely on power from the interconnected grid. On-site generation is energy efficient because waste heat from co-generation will be used in the extraction process. It will also eliminate the transmission line losses associated with importing power from remote distant sources.

7.2.1 Emissions of Nitrogen Oxides and Carbon Dioxide

Emissions of carbon dioxide (CO_2) and nitrogen oxides (NOx) will vary directly with tonnage throughput. Between 83-85% of all CO_2 emissions at the Aurora Mine will be directly attributable to the burning of natural gas for the purpose of thermal energy and electric power generation. The balance of the CO_2 emissions are attributable to the mobile equipment in the mine which also account for the majority of the NOx emissions from the Aurora site.

Average calendar day CO_2 emissions are expected to be 1,431 tonnes per day, and the NOx emissions 4.9 tonnes per day, for Aurora Train 1. This will increase to 2,797 tonnes per day of CO_2 and 10.1 tonnes per day of NOx when both Aurora North trains are operating. The two trains at Aurora South will repeat this pattern.

Plant Site Facilities

The thermal-electric generating arrangement for Aurora North is described in Section 3.6 and shown on Figure 3.5.2-1. Train 1 will consist of a Gas Turbo Generator (GTG). Exhaust will be directed to a Once Through Steam Generator (OSTG). Exhaust from both the GTG and the OSTG will be routed to an exhaust stack located on the OSTG. The overall energy efficiency of the GTG/OSTG co-generating arrangement is expected to be approximately 84%.

There will also be two boilers to provide additional steam generation for the plant in response to fluctuating demands. Exhaust from these units will be routed to a common stack. Exhaust temperature is anticipated to be approximately 188 ^{o}C.

The GTG, OSTG and boilers will all be fitted with dry low-NOx burners to reduce NOx emissions.

The locations of these utilities and co-generation facilities are indicated on the Plant Site Plan in Figure 3.4-2. Table 7-1 provides the stack and emissions parameters for normal operating conditions for a single operating train at Aurora Mine North.

Table 7-1 Stack and Emissions Parameters for Normal Operating Conditions for Each Operating Train

	Summer		Winter		
Parameter	**OSTG 1[(a)]**	**Boiler 1**	**OSTG 1[(a)]**	**Boiler 1**	**Boiler 2**
Stack Height (m)	25	25	25	25	25
Exit Diameter (m)	3.27	2.74	3.27	2.74	2.74
Building Height (m)	10	10	10	10	10
Building Length (m)	60	60	60	60	60
Building Width(m)	30	30	30	30	30
Total Flow Rate (m^3/s)[(b)]	155.3	57.0	176.0	98.2	98.2
Exit Velocity (m/s)	29.6	15.2	33.5	26.3	26.3
Exit Temperature (^{o}C)	186.7	182.2	186.7	182.2	182.2
NOx Emission Rate (g/s)	6.9	2.7	7.6	4.6	4.6
(t/d)	0.60	0.23	0.66	0.40	0.40

(a) Includes emissions from GTG1 and duct firing from OSTG1.
(b) At 15^{o}C and 101.3 kPa.

Commencing with the winter of 2006, the normal emissions associated with the winter operation of Trains 1 and 2 will result from:

- two boilers operating in conjunction with the full-load operation of two gas turbines (GTG1 and GTG2), and
- duct firing from the Trains 1 and 2 once-through steam generators (OSTG1 and OSTG2).

Stack and emission parameters associated with summer and winter operations of two trains are presented in Table 7-2.

Table 7-2 Stack and Emission Parameters - Two Train Operation

	Summer			Winter			
Parameter	OSTG 1(a)	OSTG2(b)	Boiler 1	OSTG 1(a)	OSTG2(b)	Boiler 1	Boiler 2
Stack Height (m)	25	25	25	25	25	25	25
Exit Diameter (m)	3.27	3.27	2.74	3.27	3.27	2.74	2.74
Building Height (m)	10	10	10	10	10	10	10
Building Length (m)	60	60	60	60	60	60	60
Building Width(m)	30	30	30	30	30	30	30
Total Flow Rate (m^3/s)(c)	155.3	155.3	21.3	178.0	178.0	141.1	141.1
Exit Velocity (m/s)	29.6	29.6	5.7	33.9	33.9	37.7	37.7
Exit Temperature (°C)	186.7	186.7	182.2	186.7	186.7	182.2	182.2
NOx Emission Rate (g/s)	6.9	6.9	0.9	7.2	7.2	6.6	6.6
(t/d)	0.60	0.60	0.8	0.62	0.62	0.57	0.57

(a) Includes emissions from GTG1 an duct firing from OSTG1.
(b) Includes emissions from GTG2 and duct firing from OSTG2.
(c) At 15°C and 101.3 kPa.

Mobile Fleet Emissions

Mobile fleet emissions were estimated by Syncrude on the basis of expected fuel consumption and the application of appropriate emission factors for diesel and gasoline fueled vehicles. Table 7-3 presents the estimated NOx emissions associated with the anticipated development of the Aurora Mine.

Table 7-3 Projected NOx Emissions

	NOx Emission Rate (t/d)		
Year	Diesel Fuel	Gasoline/Propane	Total
2002	4.0	0.04	4.1
2006	8.5	0.05	8.6
2016	17.9	0.07	18.0

The years 2002 and 2006 are the first years when Train 1 and both Trains 1 and 2, respectively, are scheduled to be in full operation. Similarly, 2016 is expected first year of the full four train operation.

7.2.2 Hydrogen Sulphide Emissions

The water in the basal aquifer underlying all Aurora leases contains dissolved hydrogen sulphide (H_2S) gas at aquifer pressure. Based upon extensive basal aquifer water characterization testing conducted by OSLO Alberta Ltd. on Lease 31 (in the area of the Aurora south pit) and initial work by Syncrude on the Aurora Mine North area, it is apparent H_2S concentrations vary greatly throughout the aquifer, with recorded values from zero to 30 mg/l. In some cases, individual well H_2S concentrations appear to vary over time.

To mitigate the potential release of dissolved H_2S from basal aquifer water during mine depressurization, depressurization water will be hard piped and pumped to central treatment facilities located at both Aurora North and South plant sites.

Since the concentrations of dissolved H_2S in depressured basal aquifer water is very uncertain, Syncrude plans to monitor depressured basal aquifer water H_2S concentrations. H_2S will be removed by partial air stripping, if concentrations warrant. All vapours will be routed to a smokeless flare for incineration. Energy balances assume a nominal natural gas sweep rate of 0.06 MSm^3/day per flare.

After treatment, the basal aquifer water will be held in a basal aquifer water pond (working volume 82,000 m^3) to provide a sufficient inventory to ensure an adequate supply of fire, utility, and boiler feed water treatment make-up water. Excess basal water will be pumped to the recycle water pond for use in the extraction process.

7.2.3 Fugitive Emissions

Hydrocarbon and Reduced Sulphur Compounds

Tailings Settling Basins

Surveys of fugitive emissions have been conducted on existing oil sands tailings settling basins. Data from these surveys have been pro-rated to account for the anticipated size of the Aurora Settling Basins (3 square kilometres for Aurora North and 2 square kilometres for Aurora South) and for the differences in effluent characteristics (no naphtha diluent will be used at Aurora). The anticipated emission rates for hydrocarbon and reduced sulphur compounds are presented in Table 7-4. Since these values are based upon existing basins that contain naphtha discharges, they represent the upper bound of anticipated emission rates.

Table 7-4 Total Hydrocarbon and Total Reduced Sulphur Emissions from Settling Basins

Location	Hydrocarbons C1 to C10 ($\mu g/m^2/s$)	Hydrocarbons C5 to C10 ($\mu g/m^2/s$)	Reduced Sulphur Compounds ($\mu g/m^2/s$)
Aurora North	0.44	0.26	0.008
Aurora South	0.29	0.17	0.005
Combined	0.73	0.43	0.01

Exposed Oil sands Faces

Flux monitoring surveys have been conducted on existing oil sand mine areas. Fugitive emissions from the proposed Aurora Mine were estimated from these data assuming the fugitive emissions from the mine areas are proportional to the bitumen production. Table 7-5 presents the values for the various stages of the Aurora Mine stages

Table 7-5 Fugitive Hydrocarbon and Reduced Sulphur Compound Emissions from Mining Areas

Location	Bitumen Production (10^6 m^3/a)	C_1 to C_{10} (t/d)	C_5 to C_{10} (t/d)	Reduced Sulphur Compounds (t/d)
Aurora (one train)	6.25	2.2	0.8	0.02
Aurora (two trains)	12.5	4.4	1.6	0.04
Aurora (four trains)	25	8.8	3.2	0.08

7.2.4 Wind Blown Sand

Syncrude will use two primary methods for the control of wind blown sand.

1) Eliminating sources of wind blown sand. This will be achieved by capping the source areas with material types other than sand. Reclamation material will be placed on completed slopes and benches as part of the yearly reclamation program, as early as practicable. This prevents the underlying sand from becoming airborne. Another available type of capping material — extraction plant rejects — has also been successful.

2) Control sand deposition locations. Methods to achieve this are being tested on the existing oil sands tailings facilities. Deposition control systems such as snow fences, silt fences and berms all encourage the wind-blown sand to deposit in a predicted location on the lee-side of the structures. Although these systems do not completely prevent wind-blown sand, they help control the problem and prevent the sand from covering reclaimed areas.

7.2.5 Dust

Normally, water is sprayed on the mine haul roads for dust suppression. In warm, dry conditions this is often a continuous process. (Water is not used during the winter for safety reasons. Dust is also less of a problem during winter.) Periodically, a used-oil product is sprayed on the roads. This method lasts longer as the oil binds the road material whereas the sprayed water simply evaporates over time.

Current plans include the shipment of gypsum from off-site suppliers for use in the formation of Composite Tails. The gypsum will most likely be trucked, partially wet, along Highway 963 to Aurora. It will be transported in covered trucks suitable for transportation of loose materials along a public highway.

7.3 Water Emissions

7.3.1 Pre-Startup Water Releases

Draining of muskeg and the surficial aquifer (the water in the overburden material) will be required in advance of construction and mining at Aurora. The surficial aquifer and muskeg will be ditched and drained about two years prior to overburden removal. The design of the drainage system is based on experience gained at the Mildred Lake Facility and a monitoring study conducted on Lease 31 in 1988 and 1989. These data have been extrapolated for the Aurora North site.

During the construction phase of Aurora North (1998 - 2001) the flow generated from dewatering of the surficial aquifer is estimated to be approximately 0.3 m^3/s for the first two years. After the initial volume of the aquifer has been depleted, a steady state will be reached at a rate of approximately 0.02m^3/s. The average muskeg dewatering discharge for the same period could reach approximately 0.25 m^3/s assuming an equivalent thickness of 0.67 m of water being removed in a six-month period. Muskeg dewatering activity will be at a maximum during the initial site clearing; and will decrease during subsequent years.

Muskeg drainage water from the Aurora Mine North will be collected and routed, when possible, through the existing Alsands drains and polishing or sediment ponds prior to discharge to the Muskeg River. As the water being discharged originates from the muskeg and surficial aquifer, its quality is the same as other surface waters in the region.

Major drainage works are illustrated on the annual Mine Status Maps in Section 3.2 and water management activities are described in Section 3.7.5 Table 3.7-2 quantifies the area being dewatered during the time periods corresponding to the status maps. Estimates of average annual flows are also tabulated for the time periods.

7.3.2 Water Releases During Operation

During operations all process-affected water, and all run-off that could come into contact with oil sands, is routed to the recycle water pond. Interceptor ditches will divert and prevent any clean surface run-off water from entering the operating area. This water will be routed via natural ditches with low gradients around the operation and returned to the natural system as shown on the status maps. Dewatering activities (described in Section 3.7.5) will result in fairly constant volumes of water being discharged to the environment as indicated in Table 3.7-2 of Section 3.7. The opening of overburden disposal sites and the moving of clean water ditches ahead of mining around 2006 will result in a brief increase in water releases.

7.4 Chemical Consumption

A list of process aids and chemicals used in significant volumes in the extraction plant are included in Section 3.5.1. Kerosene will be become part of the hydrocarbon stream and will be exported with the bitumen froth. Methyl-isobutly-carbinol will become part of the process water stream which goes into the tailings settling basin. Other extraction chemicals will either be contained for off-site disposal or routed to the process water stream.

The other major chemical usage at Aurora will occur in the utilities and off-sites area. A list of those chemicals used in significant volumes by utilities and off-plots is provided in Table 3.6-2. All major chemicals consumed in the utilities water processing will be routed to the process water stream and ultimately to the tailings settling basin.

7.5 Release Controls

Syncrude will employ three forms of emission control at the Aurora Mine:

- corporate environmental management systems including standards, practices and procedures,
- plant processes selected on the basis of pollution prevention, and
- plant equipment installed expressly to control emissions.

Syncrude's environmental management system involves the full integration of environmental management activities into the corporate loss management program. This program encompasses losses to people, property, production and the environment. As such, environmental management is not a stand-alone program under the responsibility of a staff group. Environmental considerations are taken into account in the development and execution of everything the company does, including policy and management leadership, training, task analysis and task observation, risk analysis and communication. It is the responsibility of every employee to ensure that the elements of the loss management program are incorporated into every task performed.

All Syncrude practices and procedures are developed in accordance with the requirements of the corporate loss management program. Each critical procedure and task is subject to careful analysis. If it is a routine procedure, a structured task analysis is conducted, a procedure written, and regular task observations carried out to ensure the procedure is adequate and maintained current. For non-routine tasks, a specific safe work plan is prepared. If the complexity of the task warrants, a formal risk assessment is conducted, and a risk management plan prepared. In all cases, the methodology and requirements of these activities ensure that environmental considerations are explicitly recognized and explored, and consequently are integral to getting the job done well. The result is a very effective contribution to emission control.

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8.0 Research and Monitoring

8.1 Land Reclamation Research and Monitoring

8.1.1 Land Reclamation Monitoring

Syncrude has an ongoing and well-developed program of land reclamation monitoring for the Mildred Lake facility. Monitoring of Aurora Mine reclamation will be based on this program. It is aimed at documenting changes and trends in soil and vegetation parameters, in order to assess land reclamation effectiveness and identify potential improvements.

There are currently four monitoring programs: capping program effectiveness, soil fertility assessment, woody seedling assessment, revegetation species and biomass assessment. An overview of these programs is provided in Table 8-1.

Capping Program Effectiveness and Soil Fertility Assessment

Capping of overburden and tailings materials with suitable reclamation material is conducted under contract to a local operator. Longer term contracts are now the desired way of doing business in order to build expertise, commitment, and consistency in an operator.

During program operation, certain Syncrude employees act as contractor monitors to ensure that the terms of the contract are followed and that quality criteria are being met. In the stripping of *in-situ* material such monitoring includes maintaining design depths within source plots and ensuring that contaminants in the source plots (rocks, frozen lumps, large amounts of clay, and snow) do not compromise the quality of the material to be placed. At the placement site, the monitors ensure that contractors follow specifications regarding material placement including maintaining material placement depths within the placement areas, ensuring that large frozen lumps of material are pushed to the boundaries of the placement areas (to be broken up in summer), ensuring that snow is removed from the placement area prior to material placement, and ensuring that placed material is not compacted by haulage equipment.

Each spring, following a winter capping program, the areas that were treated are assessed with respect to the adequacy of treatment. Sampling units are defined according to differences in treatment or physical characteristics and usually no larger than 10 hectares For each unit, composite surface (0-15 centimetres), subsurface (15 - 30 centimetres or below the topdress layer if deeper than 30 centimetres), and deep (to total depth of capping) samples are taken and sent for lab analyses. Usually five to eight sub-samples, evenly distributed, are combined to make one composite sample. Observations are also made at each sub-sample location, using a Dutch auger, which describe the depths of reclamation materials and the conditions encountered.

The following analyses are performed and reported for surface samples (0-15 centimetres):

- Reaction (pH units)
- Organic Matter (OM) content by loss on ignition (although a large number of samples have been analyzed for organic carbon content as well, in order to correlate the indices)
- Particle Size Distribution (PSD) and Texture (unless very highly organic)
- Plant Nutrients (NH_4 - N, NO_3 - N, P, K, & SO_4 - S)
- Where necessary EC, SAR, and % Oil may also be obtained (usually only if not highly organic)

The following analyses are performed and reported for subsurface samples(15-30 centimetres):

- Reaction (pH units)
- Electrical Conductivity (EC - dS/m)
- Sodium Adsorption Ratio (SAR) and associated soluble salts
- Particle Size Distribution (PSD) and Texture
- Saturation
- Oil content (if failing the sniff test) and OM content (for deep organic placement), where necessary

Observations noted at sub-sample locations include:

- Depth of topdressing (organic layer)
- Depth of capping
- Texture (determined manually)
- Compaction
- Stoniness (presence), stated as a function of difficulty in obtaining a sample or presence in the auger
- Odour (particularly if hydrocarbon)
- Colour
- Inclusions (e.g. organic lumps within mineral material, carbonates, oil sand)

All pertinent information is recorded. Using the observations and analytical data, an assessment is made of the quality of the capping program, whether any areas require re-treatment, and opportunities for improving the conduct of future programs.

A number of research projects dealing with the adequacy of capping quality parameters are underway or have been completed. The projects, particularly the soil reconstruction and capping depth studies, form the basis of a review of those quality parameters.

Woody Seedling Assessment Program and Revegetation Species and Biomass Assessment

Seedling planting programs are generally assessed at contract completion, the following year, the fifth year, and at five year intervals thereafter. Permanent sample plots are currently used for this assessment, although regeneration surveys, using the stocked quadrant method, have been employed on larger, older areas. Each permanent sample plot is 20 metres on a side and is located randomly to represent an area of between five and ten hectares. Within each plot, for each of the planted seedlings, a determination is made of survival, and height. As well, the plot is assessed with respect to native species reinvasion (both woody and herbaceous) and for percent cover of herbaceous competition for the woody species.

8.1.2 Land Reclamation Research

Syncrude conducts a comprehensive land reclamation research program. The objective is to further develop cost-effective land reclamation strategies and techniques for achieving acceptable reclamation on all lands disturbed by Syncrude's operations.

The program consists of 13 active in-house projects and one government/industry joint project. These projects are in three main categories: soil reconstruction, woody plant establishment, and ecosystem redevelopment and land-use. Table 8-2 highlights current land reclamation research projects.

Syncrude is also participated in a joint industry and governmental initiative to develop a Land Capability classification for forest ecosystems in the oil sands region. The salvage and replacement of soils are critical steps in ensuring the success of oil sands reclamation. They can also be the most expensive steps in the process. Thus, it is important for the operators and the regulators to make soil salvage and replacement decisions that are environmentally effective and cost-efficient. To achieve this, a joint industry and government working group has developed the Land Capability Classification System for Forest Ecosystems in the Oil Sands Region.

Table 8-1 Status of Land Reclamation Monitoring Projects (Syncrude)

	ACTIVITY IN		
PROJECT	**1995**	**1996**	
Revegetation species and biomass monitoring	No	No	- 38 plots being maintained for periodic assessment
Soil fertility assessment	No	No	- 38 plots being maintained for periodic assessment
Woody seedling plantation survival	Yes	Yes	- 1, 5, 10 and 15 year survival/height of plantations being assessed
Capping Program effectiveness	Yes	Yes	- Ongoing sampling of winter capping programs program; plans are to switch to sampling after 1 years' settlement; initial depths of placement to be determined by surveyed volume/area. Initially will provide consecutive years measurements
Database development	Yes	Yes	- Program will be initiated to consolidate historical reclamation data for archive and spatial query using Geographic Information System.

Table 8-2 Status of Land Reclamation Research (Syncrude)

PROJECT	ACTIVITY IN 1995	ACTIVITY IN 1996	STATUS
Ecosystem Redevelopment			
Wood Bison Research	Yes	Yes	-Research continuing as put forward in 5-year plan presented to Alta. Env. in 1992. Presently 101 bison on 260 ha. on MLSB toeberm and S. in-pit disposal.
Soil Reconstruction			
Mine waste reclamation amendment criteria	Yes	Yes	Initiated in 1995, a new system to evaluate reclaimed mine soils against pre-existing *in-situ* soils was developed and will be field tested in 1996.
Capping depth study	No	Yes	- Seedling assessments done in 1993; Progress report written by consultant; Seedling assessment planned for 1996.
Woody Plant Establishment			
Plants established on solidified fine tailings	Yes	Yes	- Project established in 1992; Tree seedlings planted in 1993; Assessment ongoing
Hybrid poplars for reforestation	Yes	Yes	- Stoolbed development initiated in 1992; Interplant seedlings in 1993 to increase density; Additional clones planted in 1995
Use of brush blanket to enhance tree growth	Yes	Yes	- Research plot established in 1992; Assessment ongoing
Suitability of reconstructed soil for tree establishment.	Yes	Yes	- Test plots constructed in 1993; Assessment ongoing.
Siberian larch field performance	Yes	Yes	- Project established in 1993; Assessment ongoing
Evaluation of selected native grass for land reclamation	Yes	Yes	- Project established in 1993; Joint research project with ARC; Assessment ongoing
Evaluation of selected native legumes for land reclamation	Yes	Yes	- Project established in 1994; Joint research project with ARC; Assessment ongoing

	ACTIVITY IN		
PROJECT	**1995**	**1996**	**STATUS**
Plant growth on fine and composite tailings	Yes	Yes	- Initiated in 1995; Joint research project with the Alberta Environmental Centre; Artificially created soil aggregates using fine tailings and composite tailings; Currently evaluating plant growth on these aggregates.
Phytotoxicity of fine tailings and composite tailings.	Yes	Yes	- Initiated in 1995; Joint research with UofA to examine uptake by woody plants of organic compounds from fine tailings and composite tailings; Research ongoing.
Evaluation of sand dune plant species for tailings sand reclamation.	Yes	Yes	- Initiated in 1995; Joint research with Wild Rose Consulting, Inc; Plant specimen and seeds collected from Athabasca sand dunes; Seed germination tests in progress.

8.2 Air Quality Research and Monitoring

Air quality monitoring associated with the Aurora Mine will be designed and executed consistent with the work of the Regional Air Quality Coordinating Committee (RAQCC).

RAQCC was established in 1986 as a mechanism for interested parties in the Fort McMurray/Fort McKay region to jointly address air quality issues and coordinate monitoring and research activities. RAQCC is currently very active in this respect, with working groups making rapid progress on the redesign of the air quality monitoring system, augmentation of the environmental effects monitoring programs, and development of a management system for those two areas of activities addressing control, funding, and communications.

All of these development activities are taking place in the context of the Clean Air Strategic Alliance (CASA) concepts for air quality management in the province of Alberta, particularly the concept of Zonal Air Quality Management. It is probable RAQCC will, in the near future, become responsible for the CASA zone for northeastern Alberta. RAQCC membership has expanded to include Alberta Environmental Protection, the Energy and Utilities Board, Syncrude, Suncor, Solvex, Northland Forest Products Ltd., the community of Fort McKay, Wood Buffalo Regional Municipality, the Northern Lights Regional Health Centre, and the Fort McMurray Environmental Association.

The RAQCC Air Monitoring Working Group is in the process of reassessing and redesigning the air quality monitoring system in the region. The current system includes 12 monitoring stations (as well as a station required by the Solvex approval and mobile monitoring stations operated by Syncrude and Suncor), all of which are heavily biased towards the compliance aspects of air quality. The Working Group is proposing a move towards a system better balanced among compliance, ambient air quality measurement, and background air quality measurement, plus a component of support for environmental effects monitoring (discussed below). A system recommendation will be presented to RAQCC for acceptance as early as June, 1996.

The most important air quality issues in the region, as defined by RAQCC consensus, are human health, odours, and acid deposition. Next in importance are ozone and effects on vegetation. A concern of general application to all issues is data quality and data integrity. The redesigned monitoring system will provide information relevant to all these issues, through a combination of continuous reading instrumentation, passive monitors, and intermittent monitoring.

Air emissions from the Aurora Mine will constitute a minor component of total regional emissions. The redesign of the regional monitoring system will take these emissions into account, in the selection of monitoring locations and monitoring equipment.

Syncrude is an active participant in the Air Monitoring Working Group, and is fully committed to providing a fair share of the resources required to redesign, reestablish and operate the regional air monitoring network.

8.3 Terrestrial Ecosystem Research and Monitoring

Syncrude has maintained a substantive environmental baseline and environmental effects monitoring program since the early 1970s. During the 1992-94 review of Syncrude Mildred Lake plans by the EUB, Syncrude committed to a continuing comprehensive monitoring program, augmented as appropriate.

Syncrude is fulfilling that commitment through leadership of a RAQCC Environmental Effects Monitoring (EEM) Working Group. This group has been making good progress towards a comprehensive, integrated monitoring program with connections to the air quality monitoring system. It will include both terrestrial and aquatic components (the aquatic components are included in the discussion of aquatic monitoring below).

Progress to date has included a multi-stakeholder workshop in February 1994, a report and recommendation from the Alberta Research Council, program development and costing by Bovar Environmental, substantial program evolution as the result of review by a scientific advisory panel, collaboration with the CASA-EEM working group and the Canadian Forest Service, and three days of discussions in March 1996. The current proposal includes:

- Terrestrial acidification monitoring via a network of ecologically analogous plots, half in high and half in low deposition zones (in jack pine forest communities, and in one additional community to be selected later), with monitoring programs in cooperation and coordination with the Canadian Forest Service.
- Aerial infra-red vegetation stress surveys at roughly five year intervals.
- Monitoring of trace metals in soil, vegetation, and small mammals, along transects to a distance 70 km south of the bitumen upgraders, at intervals of roughly five years.

The intent is to achieve RAQCC (multi-stakeholder) consensus on the final design of a 1996 pilot program by June, 1996, and then finalize the overall program design by January, 1997.

The EEM program as proposed is consistent with the Aurora Mine air emission types and rates. It will include, geographically, the Aurora Mine area. Therefore, Syncrude considers the RAQCC regional program provides appropriate monitoring of terrestrial environmental effects associated with the Aurora Mine.

8.4 Aquatic Ecosystems Research and Monitoring

8.4.1 CONRAD Environmental Aquatic Technical Advisory Group (CEATAG)

The CONRAD Environmental Aquatic Technical Advisory Group (CEATAG) was formed by the aquatic issues group within the Environmental Technical Planning Group (TPG) of the Canadian Oil sands Network for Research and Development (CONRAD). Since its inception in the November, 1995, membership has grown to 30 members representing government research, universities and environmental consulting firms.

CEATAG functions as a focus for the aquatic component of oil sands environmental research. It acts as a vehicle to get scientifically-based knowledge to corporate management and government decision makers in an effective manner. CEATAG has five specific objectives designed to meet the needs identified within the oil sands aquatic research field;

- Facilitate, coordinate and integrate the activities of numerous groups and individuals conducting research related to oil sands environmental aquatic issues.
- Communicate research results to stakeholders such as the corporate management of Syncrude and Suncor, local, provincial and federal governments, environmental and native NGOs, the scientific community, and the public at large.
- Provide peer review of new projects.
- Document, review, assess and archive research results.
- Provide an Aquatic Technical Advisory Group to support the activities of the Environmental Technical Planning Group of CONRAD.

Table 8-3 provides a summary of the projects active during 1996.

Table 8-3 List of 1996 Projects (CEATAG)

#	TITLE	CONTACT
96-01	CEATAG organizational + administrative activities	Syncrude
96-02	Chemical + toxicological evaluation of waters released from MFT	Syncrude
96-03	Development of plankton community in ponds influenced by MFT	Syncrude
96-04	Effect of MFT-affected waters on perch	Univ. Waterloo
96-05	Development of a littoral zone model for the Base Mine Lake	Syncrude
96-06	Effect of MFT-affected waters on fat head minnows	Univ. Alberta
96-07	Effect of MFT-affected waters on the bioenergetics of the leech Nephelopsis obscura.	Univ. Calgary
96-08	Development + role of the detrital zone in water-capped MFT + CT	Hydroqual
96-09	Characterization of microbial populations in process-influenced waters, with special emphasis on the role of sulphate reducing bacteria in CT and MFT deposits.	Microbial Technologies Vancouver
96-10	Monitoring of physical, chemical and biological changes in four ponds filled with CT water .	Syncrude
96-11	Effect of oil sands dyke seepage water on the wetland and pond ecosystems	Syncrude
96-12	Aquatic assessment protocols for oil sands operations	Nat. Water Res. Inst.
96-13	Environmental dynamics of base/neutral compounds from oil sands fine tailings	Nat. Water Res. Inst.
96-14	Acute and chronic toxicology of naphthenic acids in tar sands fine tailings.	Alberta Environmental Centre
96-15	Physico-chemical properties of naphthenic acids	Alberta Environmental Centre
96-16	Review of the effect of salinity on aquatic organisms, with emphasis on the water releases from composite tailings	Syncrude
96-17	Assessment of biodegradation rates of radio-labelled naphthenic acid components under different environmental conditions (CONRAD AQ-7)	Alberta Energy
96-18	Natural biological tailings and seepage water decontamination (CONRAD AQ-8)	Suncor
96-19	Bioaccumulation within biota on amended/modified fine tailings (CONRAD AQ-9)	Alberta Energy

#	TITLE	CONTACT
96-20	Oil sands reclamation landscape model (CONRAD AQ-11)	Suncor
96-21	Natural and managed biological treatment of waters released from the Consolidated Process (CONRAD AQ-16)	Suncor
96-22	Biological treatment options for Consolidated Tailings Release Water (CONRAD AQ-17)	Suncor
96-23	Baseline aquatic monitoring of Lease 86/17 area (CONRAD AQ-18)	Suncor
96-24	Determining the ecological viability of constructed wetlands (CONRAD AQ-21)	Suncor
96-25	Laboratory study on trophic level effects and fish health effects of Suncor Tar Island Dyke Wastewater (CONRAD AQ-19)	Suncor
96-26	Rainbow trout fish taint analysis study (CONRAD AQ-20)	Suncor
96-27	Syncrude and Suncor Environmental Impact Assessment- Aquatic Baseline Report for the Athabasca, Steepbank and Muskeg Rivers in the vicinity of the proposed Steepbank and Aurora mines	Syncrude / Suncor
96-28	Syncrude and Suncor Environmental Impact Assessment- Hydrology and Hydrogeology Program	Syncrude / Suncor
96-29	Optimization of macrophyte growth in constructed lakes	Syncrude
96-30	Lower Athabasca River Basin Technical Advisory Group	Syncrude
96-31	Suncor Environmental Impact Assessment- Environmental and Human Health Risk Assessment	Suncor
96-32	Laboratory study on trophic level effects and fish health effects of Suncor' Wastewater Treatment System Discharge	Suncor

NOTE - Most projects being carried out by universities or outside contractors are funded in whole or in part by Syncrude.

8.4.2 Water Monitoring

During pre-startup activities, dewatering of the surface aquifer at Aurora North will take place. This water will be routed through a series of ditches and polishing ponds and subsequently discharged to the Muskeg River. In order to properly monitor the potential effects of this discharge water on the receiving streams, Syncrude will institute a program of surface water monitoring on and around the Aurora North site — including the Muskeg River at locations upstream of the development and below the last drainage outfall on the Muskeg River. Samples will also be taken of any drainage waters that are discharged to the Muskeg River and, where applicable, from any seepage control ponds used for the containment of process affected water around the Sand Storage Area. Where appropriate, additional water sampling points will be added to the list as the plant disturbance area increases, or additional surface drainage outfalls are installed. The parameters to be monitored at each of these locations will be comparable to the surface water quality parameters currently monitored at the Mildred Lake facility.

Five stream flow monitoring stations were installed at various locations near the new lease areas. Monitoring was conducted beginning in 1995 and current plans call for ongoing flow monitoring in these locations.

8.4.3 Fisheries Monitoring

Athabasca River, Main Stem

Fisheries surveys to determine use of the area, accompanied by benthic invertebrate collections, are currently planned. The area to be sampled would be that included in the Environmental Impact Assessment of 1996, covering the section from Saline Lake to at least the Barge Landing.

Muskeg River and Tributaries

Regular surveys of Jackpine Creek and other high potential spawning areas will be performed. Population dynamics of non-sport species will be monitored concurrently. After an initial period of collections a formal review of results will be conducted with stakeholders, and program content revised.

8.4.4 Benthic Monitoring

Benthic organisms integrate the effects of various components of water character. Studying the reaction of benthic invertebrates to variations in stream inputs can be a valuable tool in monitoring the effects of the Aurora Mine on local streams. Syncrude will conduct a series of benthic invertebrate surveys during the term of the approval.

8.4.5 Groundwater monitoring

For future monitoring of groundwater, observation wells for monitoring both water level changes and groundwater quality will be installed. These wells will be installed in various stratigraphic units both downstream and upstream of the tailings settling area and the mining area. The exact locations of these wells and timing of installation will be determined at a later date.

8.4.6 Environmental Impacts of Froth Transport

Despite the technological safeguards that will be incorporated into the pipeline design, there is a very small residual risk of a leak or breakage of the froth transport pipeline. Due to the uniqueness of the proposed froth slurry and its transfer system, there is limited literature information available on the short-term acute effects of aqueous froth slurries and their components. A research program will be undertaken to better understand the potential effects of the froth on the environment. Studies will be conducted to characterize the major components and their properties. This will include the identification of toxic and priority constituents as well as the pathway of their delivery resulting from a spill into the Athabasca River Basin.

8.5 Fine Tailings Management Research

8.5.1 Introduction

Syncrude is collaborating with many parties on tailings management issues. All information on tailings is openly shared with Suncor. Other consortia include:

- The Fine Tailings Fundamentals Consortium.
- CONRAD (Canadian Oil Sands Network for Research and Development).
- CEATAG (CONRAD Environmental Aquatic Technical Advisory Group).
- Research partnerships such as those with Alcan, University of Alberta, Alberta Environmental Centre.
- CANLEX (Canadian Liquefaction Experiment) — a consortium of mining and consulting companies researching liquefaction of tailings — primarily at the Syncrude site.
- Research fellowships — inviting academics to take a sabbatical at Syncrude.

8.5.2 Fine Tailings Fundamentals Consortium

The Fine Tailings Fundamentals Consortium brought researchers together from several research agencies to study the fundamentals of fine tailings. The consortium pioneered cooperative research over a five year period and explored all aspects of tailings in a massive assault on the subject. The work culminated in a conference held in June 1995. Results are documented in "Advances in Oil Sands Tailings Research". It is the most comprehensive documentation on oil sand tailings available.

Many of the ongoing programs described in this section build on the results of the Consortium studies.

<u>Fine tailings measurement techniques</u>

Characterization of fine tailings has been a challenge for many years. The traditional methods used to describe the grain size ignored the finest particles that are the active components of fine tailings. Shortcomings with the traditional methods are now recognized and the methods currently in use take into account the fine grained component and /or measure surface activity.

<u>Materials balance and prediction</u>

The development of options to reduce the creation of fine tailings has been hampered by inadequate procedures to characterize fine tailings. Improvement in fundamental knowledge and in methods of characterizing fine grained components have allowed progress in this area.

A detailed computer model to simulate the mass balance and to predict the amount of fine tailings created in the tailings settling basin has been developed. Its predictive capability has been improved by the introduction of improved information on fine grained components. This model has been applied in Aurora Mine tailings design.

These improvements in material balance and forecasting fine tailings are prerequisites to reducing the volume of fine tailings through changes in operations.

8.5.4 Alternative Fine Tailings Disposal Techniques

Considerable effort is being expended to improve our understanding and confidence in the suite of available disposal techniques for fine tailings. Much of this work is through cooperative programs with others, especially Suncor.

Water-capping

Water capping is one viable technology for long term tailings management. Observations will continue at the seven research pits, the large demonstration pond, and a research wetlands.

Full-scale implementation in the Mildred Lake base mine is underway. About 150 million cubic metres of fine tailings will be placed in the mined-out pit and capped with water, creating a lake. The lake is scheduled to be in place by 2010, as per the Base Mine Lake agreement.

Composite Tailings

Previous work investigated the optimum chemical levels needed to create Composite Tails (CT) and explored the boundary between segregating and non segregating mixes. Further scientific understanding of composite tailings will assist in the full-scale implementation this technology. Laboratory research continues to explore the effect of chemical treatment and sand/fines ratio on the volume and chemistry of released water, and the physical properties (consolidation, permeability, strength) of the material.

Field demonstration tests are being used to gain operating experience in order to verify predictions from laboratory tests and provide material (water and solids) for laboratory programs. In the summer of 1995 Syncrude undertook a 60,000 cubic metre CT demonstration test. Analysis is still underway but the results are positive such that one tailings line will be operated in the CT mode for a period of time in 1997.

Freeze Thaw

Freezing extracts water from fine tailings. Upon thawing, a considerable volume of clean water is released and the solid component is denser and appears to behave as a normal consolidating soil. Freeze thaw research is taking place in the lab (primarily at the University of Alberta) and in the field.

Evaporation

Drying can be used to dewater and to solidify fine tailings. Syncrude conducted a field experiment to evaluate the drying option in 1993. Follow-up work is continuing with the Alberta Environmental Centre.

Filters

The potential to dewater fine tailings using wick drains is being examined. Artificial wicks shorten the drainage path and accelerate the release of water. A laboratory study is underway to appraise the effectiveness of wicks in dewatering fine tailings. The economics of using wicks is also being studied.

Deep thickeners

Densifying fine tailings by using flocculants and deep thickeners has been studied for some time. Syncrude recently formed an alliance with Alcan to investigate this approach. Alcan has successfully densified its fine tailings with flocculants and thickeners.

Risk assessment and screening

Tailings options were subjected to a detailed risk assessment, using the Mildred Lake operation as the test case. Areas of concern were identified and subjected to a detailed geotechnical risk assessment to identify ways of reducing the potential risk associated with the various designs.

8.6 Human Health Research and Monitoring

8.6.1 Regional Health Study

Northeastern Alberta is seen as a major industrial area and a focus for environmental and human health concerns. During Syncrude's 1992 application before the ERCB, air quality as related to human health concerns was an issue raised by intervenors from Alberta Health, Fort McKay and environmental groups. The Board acknowledged these concerns and Syncrude committed to support and participate in a regional health study.

The study is now known as the Alberta Oil Sands Community Exposure and Health Effects Assessment Program. Its overall purpose is to investigate, understand and characterize the links between environmental exposure to chemicals related to the oil sands industry and other activities, and human health in the Fort McMurray region.

The specific goals of the study are:

- Produce accurate data and information on the exposure of individuals and communities in the area to substances released into the air by the oil sands industry and other activities;
- Produce accurate data and information on the incidence and prevalence of disease in the population and biological markers of exposure and effect; and
- Investigate and analyze possible associations among measures of health status, health outcomes and measures of exposure to substances in the air.

Other goals of the program include:

- Interpret and communicate the findings to the oil sands industry participants, Regional Health Authority, Alberta Health, the public and the other stakeholders;
- Ensure that the public is invited and encouraged to participate in and provide input to the program;
- Ensure that the work of the program is carried out in an open and accountable manner and in cooperation with the communities in the area;
- Ensure open and effective communications and information sharing; and
- Provide periodic progress reports and a final report to the Management Committee, made up of representatives from Syncrude, Suncor, Alberta Health, the Regional Health Authority, Aboriginal representatives, environmental associations, and the public.

The Study has the approval of all stakeholders who are all members of the Management Committee noted above, and is being conducted in three phases.

Phase One — consists of the pilot study which is intended to test the procedures and equipment to be used during the main study. The pilot study is underway and will be completed in the fall of 1996.

Phase Two — is the main study which will run from the fall of 1996 until the fall of 1997. This study is essentially a receptor study in that it will place monitors on human hosts and measure the uptake of VOCs, gasses, and particulates. There will also be stationary monitors located indoors and outdoors throughout the region. Along with the exposure data collected during the main study, data from Alberta Health, cancer statistics and information from physicians will also be assessed to identify possible linkages between the health of area residents and the emissions sources in the area.

Phase Three — Once the main study period has ended there will continue to be ongoing surveillance and monitoring under the auspices of the Regional Health Authority, with participation by the stakeholders.

Copies of the program are available through Alberta Health or the Regional Health Authority.

8.6.2 Aurora Health Hazard Assessments And Surveillance Program

This program is the core of the occupational health program, requiring compliance with all relevant laws and regulations. It endeavors to ensure a safe and healthy workplace for all employees. The program is a systematic examination of the workplace to identify and evaluate the potential exposure to health hazards associated with the work environment and work practices.

The hazard assessment consists of three phases:

Phase One — Identification of all potential hazards for all work operations.
Phase Two — Detailed monitoring for the evaluation of identified health hazards in all operations.
Phase Three — Ongoing monitoring of significant health hazards to assess the effectiveness of control measures.

This hazard assessment has been conducted for all current Syncrude operating areas, and an assessment for the Aurora Mine project is underway. .

Aurora Mine will be an open-pit mine that uses the truck and shovel method to mine the oil sand, and crusher/hydrotransport technology to transport it to an on-site bitumen extraction plant. Most of these processes have been employed at Mildred Lake. The associated health hazards at the new mine will be similar. To predict the health risk at the Aurora Mine, Syncrude will conduct a Health Hazard Assessment at the Mildred Lake facility in the summer of 1996. Information obtained from this assessment will be used to anticipate the situation at the Aurora Mine.

8.7 Process Monitoring

The entire plant will be operated from a central control room located in the Operations Control Centre, allowing for efficient monitoring of all process streams.

Suitable flow monitors will be installed on incoming streams for efficient process monitoring and operation.Major inputs will include make-up water from the Mildred Lake facility and natural gas.

Monitoring of inputs will be necessary to ensure proper process control. The methods used for monitoring the inputs to the Aurora Mine will vary according the nature of the input and mode of delivery. Suitable industry standards have been established for monitoring and testing process streams associated with oil sands extraction facilities. The appropriate technology for monitoring of these streams will be selected during the detailed engineering phase of the project. Appropriate sampling and laboratory analysis of process and output streams will be performed to ensure efficient process operations.

Solid waste streams from Aurora will be monitored as to volume and type of waste. Details are discussed in Section 9.

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9.0 Waste Management

9.1 Introduction

The ability to manage — and reduce — waste is not only a matter of economics but also an important part of responsible environmental management. In this section, Syncrude's current practices for waste management at Mildred Lake will be described. Many of these will be applicable to the Aurora Mine. Others, associated with Upgrading or materials no longer used, will not apply.

Syncrude has adopted the "Four Rs" of reduce, reuse, recycle and recover. All employees are encouraged to cut down on waste, reuse material for other purposes, recycle to extend the life of all resources used, and recover resources from waste materials before disposal.

Through this philosophy Syncrude has realized a number of opportunities for waste reduction during the 18 years of operating experience at Mildred Lake. This experience will be used at the Aurora Mine, where comprehensive programs to manage and reduce wastes will be implemented.

9.2 Current Waste Management Programs

Syncrude has prepared a manual of guidelines for waste management providing information on proper disposal procedures, storage and transportation procedures, and safe handling and response procedures for industrial waste, sanitary wastes and special or hazardous wastes. The company also employs a Waste Management Specialist. This individual is responsible for advising user groups on approved methods and locations for waste management, arranging off-site disposal of wastes, and reviewing waste disposal permits and audit systems.

In every facet of the Syncrude operation, employee initiative is resulting in a new life for materials once considered waste. For example, up to 1,500 steam traps, blocked with a build-up of copper oxides, were routinely discarded every year. Now through a discovery by an Upgrading employee, the traps are cleaned with a solution of water, hydrogen peroxide and glacial acetic acid. After sitting in the solution for 24 hours, the traps become unplugged and can be reused. The result: less waste to dispose of and tens of thousands of dollars in annual savings.

In 1994, Syncrude adopted chlorofluorocarbon (CFC) management guidelines. Reflecting national and international efforts to ban CFCs as ozone depleting substances, Syncrude developed an integrated management program to address the problem of CFCs. A reclamation unit has been established with all refrigeration mechanics trained in CFC handling procedures. New refrigeration units are ordered with ozone-friendly refrigerant.

In 1995, Syncrude removed all portable fire extinguishers containing Halon 1211, a CFC. The extinguishers, which were in storage, went to a Winnipeg-based company, one of only two companies in Canada recognized as Class I by Underwriters Laboratories — capable of all facets of Halon management. About 2700 kg of Halon 1211 were removed from the Syncrude site.

Other materials recycled in 1995 included:
- over 1,000,000 litres of used lubricating oil (from the auto shop and Mining)
- 283 bins of paper shipped to Edmonton for recycling
- 213 plastic bags of popcans and bottles sent to a recycler located in Fort McMurray
- 19640 feet of discarded conveyor belting sold for use in the livestock and trucking industry
- 1554 photocopier toner cartridges shipped to Edmonton for recycling
- 41 plastic bags of styrofoam packaging "popcorn" sent to a recycler in Edmonton
- 58 Tons of wet electrolyte lead-acid batteries sent off-site to a metal recycler
- 85 heavy hauler tires sold to a feedlot operator for livestock fencing
- process catalyst sent to reprocessing facilities for recovery of valuable metals

9.3 Aurora Mine Waste Management Programs

The design of many of the facilities associated with the Aurora Mine project are consistent with conservation of materials, reduction of emissions, and thereby the reduction of wastes. Examples include:

- Implementation of hydrotransport technology substantially reduces requirements for belting, rollers and idlers in lengthy conveyors.
- The Low Energy Extraction Process significantly reduces the energy requirements of the extraction plant. Much of the heat imported into the extraction facility is either lost as steam or exported with the tailings water to the tailings settling basin. With the low energy process, considerably less heat energy is required and wasted.
- As discussed elsewhere in the Application, an efficient energy cycle has been designed in the Aurora Mine.

The following are among the waste management practices at Mildred Lake that are transferrable to the Aurora Mine:

- Collection and reprocessing of waste lube oil to recover liquid hydrocarbon product.
- Collection, filtering and reuse of waste ethylene glycol from building heating systems and from car/truck usage.
- Collection of reusable scrap metal from pipes, electrical cables, vessels and tanks and shipment to various recycling facilities throughout Alberta. Metal drums are washed, flattened and taken off-site to a scrap dealer.

9.4 Aurora Mine Waste Handling Procedures

Syncrude will transport the majority of the solid waste from the Aurora Mine to the Mildred Lake Facility for disposal in the approved Industrial Landfill Site. This takes advantage of sorting and recycling activities (e.g. metals recycling), security and control over material, and use of existing equipment and infrastructure.

Predictions of the volumes of industrial and sanitary waste at Aurora are projected from the volume of waste generated at Mildred Lake. Table 9-1 presents the volumes of various waste types generated at the Mildred Lake Facility during 1995, the estimated proportions contributed by the Mine, Extraction, and Utilities areas, and predictions for Aurora based upon one- and two-train operations.

By these estimates Syncrude expects the volume of waste from Aurora Train 1 to be approximately 12% of the volumes of waste generated on the Mildred Lake Site, and approximately 25% for a two-train operation. As the Aurora production system will use less materials than current mining practices, this estimating method likely overstates total waste volumes.

Table 9-1 Aurora Waste Volume Predictions

Waste Type	1995 Full Plant	1995 Partial Plant	Aurora 1 Train	Aurora 2 Train
Industrial	10817	5354	1339	2677
Sanitary	1121	555	139	278
Scrap Metal	1983	982	246	491
Sand	2943	1457	364	729
Barrels	754	373	93	187
Debris	494	245	61	123
Rubber	916	453	113	226
Total	**18273**	**9045**	**2261**	**4522**

The current estimated life of the Mildred Lake Landfill is approximately eight years. Start-up of Aurora Train 1 and Train 2 is not expected to impact the life expectancy of the landfill because the Aurora Mine will be replacing the trains in the Mildred Lake West Mine. The exception to this would be if construction debris from Aurora was transported to the Landfill. Construction debris is anticipated to be approximately 3 - 4 truckloads per day — an increase of approximately 1000 trucks per year, or 15% over the current level of use. This would decrease the life expectancy of the landfill by about six months. Sanitary waste from the construction camp will require disposal. The contractor operating the camp will be responsible for waste handling and disposal.

Table 9-2 provides details of storage and disposal methods for various wastes generated at the Aurora Mine.

Table 9-2 Waste Minimization Strategies at Aurora Mine

WASTE	STORAGE METHOD AND LOCATION	PRECISE DISPOSAL METHOD AND LOCATION
LIQUID		
Surface Runoff Water	No Storage Planned	Surface runoff ditches will convey clean surface runoff into the natural surface drainage systems. See Section
Boiler Blowdown Water	Process Water Pond via Dirty Water Sewer	Pumped to Settling Basin to become part of the process water system.
Cooling Water Blowdown	NE	NE
Steam Condensate	NE	NE
Water Treatment Wastewater	Process Water Pond via Dirty Water Sewer	Pumped to Settling Basin to become part of the process water system.
Vessel Drains	Process Water Pond via Dirty Water Sewer	Pumped to Settling Basin to become part of the process water system.
Produced Water (Basal Aquifer)	Process Water Pond	Pumped to Settling Basin to become part of the process water system
Floor Drains	Process Water Pond via Dirty Water Sewer	Pumped to Settling Basin to become part of the process water system.
Equipment Wash	Process Water Pond via Dirty Water Sewer	Pumped to Settling Basin to become part of the process water system.
Vent/Flare Liquids	NE	NE
Filter Backwash (potable & boiler)	Process Water Pond via Dirty Water Sewer	Pumped to Settling Basin to become part of the process water system.
Sanitary Sewage	Sewage Treatment Lagoons via the Sanitary Sewer	All Sanitary sewage generated at the Aurora Mine will be treated in facultative cells and stored for 12 months prior to routing to process water pond.
Engine Oil	Storage tank	Recycled through heavy slops system at Mildred Lake Facility
Lube Oil	Storage tank	Recycled through heavy slops system at Mildred Lake Facility
Laboratory Waste	Storage tank	Trucked to Mildred Lake Facility for disposal in Effluent pond.
Amine	NE	NE
Glycol	Storage Tank	Trucked to Mildred Lake Facility for Disposal/Reuse
Methanol	NE	NE
Other Sweeteners	NE	NE
Utilities Process Chemicals	Process Water Pond via Dirty Water Sewer	Pumped to Settling Basin to become part of the process water system.
Heat Medium (oils)	Storage Tanks	Recycled through heavy slops system at Mildred Lake Facility
Other Turnaround Wastes	As Applicable	
Alum (Water Treatment)	Process Water Pond via Dirty Water Sewer	Pumped to Settling Basin to become part of the process water system.
Other (tailings)	Sand disposal area	Material pumped to tailings disposal site.

Table 9-2 - Waste Minimization Stategies (cont.)

SLUDGES		
Tank Bottoms	Tailings disposal site	Material removed from tanks will be trucked to the tailings disposal site for disposal.
Reclaimer Bottoms	NE	NE
Pond Bottoms	Tailings disposal site	Material dredged from pond bottoms will be piped to the tailings disposal site via the extraction tailings lines.
Septic Tank	NE	All sanitary sewage will be collected via the sanitary sewer and routed to the treatment ponds.
Cooling Towers	NE	NE
API Separator Sludge	NE	NE
Diatomaceous Earth (water Treatment)	Vessels	Material removed by vacuum truck and disposed of in the tailings disposal site.
SOLIDS		
Domestic Garbage	Containers	All domestic garbage will be transported to the approved landfill site at the Mildred Lake Facility.
Carbon Filters	Dumpster	Approved Landfill.
Sock Filters	NE	NE
Cartridge Filters	Dumpster	Approved Landfill.
Construction Material	Dumpsters	Approved Landfill.
Catalyst	NE	Bitumen froth is produced at the Aurora Mine and shipped to the Syncrude Mildred Lake Facility for upgrading.
Desiccant	NE	NE
Iron Sponge or Other	NE	NE
Spill Debris	Drums, In-pit, or sumps	Depending on nature of spilled material it may be reused in the process, disposed of in the mined out pit or shipped to an approved waste treatment facility
Drums (>20L)	Stockpiled at landfill facility	Returned to manufacturer, placed in AEP approved on site landfill or shipped off site for recycling.
Capacitors	NE	NE
Ion Exchange Resin	Vessels	Tailing Settling Basin
Asbestos	NE	NE
Incinerator Ash	NE	Bitumen froth will be produced at the Aurora Mine and shipped to the Syncrude Mildred Lake Facility for upgrading.
Baghouse Dusts	NE	NE

Table 9-2 - Waste Minimization Stategies (cont.)

OTHER		
Off Site Waste	NE	Corporate policy does not allow for non-Syncrude waste to be disposed of on site.
Drum Wash		Mildred Lake Effluent Pond
Pond Skim	NE	NE
Pigging Waste	Tailings Disposal Site	Tailings Disposal Site
Dirty Sulphur	NE	NE
Sulphur Contaminated Soil	NE	NE
Sulphur Remelt Waste	NE	NE
Transformer Oil	Storage Tanks	Recycled through heavy slops system at Mildred Lake Facility

NE - Indicates Not Encountered.

9.4.1 Other Waste Streams

Heavy Hauler Tires

Heavy hauler tires, 12' in diameter and 3½' wide, will be stockpiled at the Aurora site until a contractor is hired to remove the tires for burial at an approved landfill site. Removal of the tires will take place yearly. The estimated volume is about 300 tires per year. There is currently no economic method for recycling or disposal of most of these large tires other than landfilling them. Once the mine is in full operation and there is a location available in the mined out pit, approval may be sought for a Licensed Industrial Landfill on the Aurora site. This landfill would be for tires only.

Hazardous Wastes

Wastes deemed hazardous, if any, will be transported to the Special Waste Interim Storage Area (SWISA) at the Mildred Lake Site, where they will be stored until they can be shipped to an approved facility for treatment and/or disposal.

9.4.2 Movement of Wastes along Highway

Industrial and sanitary wastes will be transported from the Aurora mine to the Mildred Lake Facility for disposal. The Aurora Mine will be located approximately 35 kilometres north east of the current Mildred Lake Plant. The roadway will be constructed to primary highway design standards.

Table 9-3 provides estimates of the number of trucks per year and per day that can be expected from Aurora based upon the 1995 Syncrude Landfill Summary.

Table 9-3: 1995 Landfill Summary, Number of Loads of Solid Waste

Carrier	Base Plant	Selected Plants	Aurora 1 Train loads/yr	Aurora 1 Train loads/day	Aurora 2 Trains loads/yr	Aurora 2 Trains loads/day
Contractor	5234	2591	648	2.6	1295	5.2
Syncrude	905	448	112	0.4	224	0.9
Other	675	334	84	0.3	167	0.7
Total	6814	3373	843	3.4	1687	6.7

Loads per day estimates are based upon a 5-day week or 250 days per year.

If construction debris from the Aurora Mine is transported to the Base Mine Landfill, an increase of about 1000 loads (3-4 loads/day) is predicted.

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10.1 Introduction

The Aurora Mine will develop a comprehensive Loss Management Program to standards equivalent to those now in use at Mildred Lake. This program focuses on the prevention of, preparedness for, and response to all types of incidents in order to eliminate or reduce the impact of an emergency on people, the environment, production or equipment. The Aurora Emergency Plan will be modeled on the CAN / CSA-Z731 Standard (Emergency Planning for Industry) and will be developed to guide all actions in the event of an emergency.

Emergency Planning for the Aurora Mine will be coordinated with the present Syncrude Emergency Plan and will be covered by Mutual Aid arrangements in place in the Wood Buffalo region.

10.2 Emergency Plan

10.2.1 Roles and Responsibilities

The Emergency Plan will be designed to assist all individuals at the Aurora site with specific responsibilities to be exercised during an emergency.

The Plan will develop responses to:

- Fires and explosions
- Medical emergencies
- Rescue situations (confined space, vehicle extrication, high angle)
- Dangerous goods responses

10.2.2 Resources

Aurora will have 24-hour, 7-days-a-week emergency response capabilities. The Emergency Plan will specify the size of the emergency response organization, describe specific response requirements and specify training requirements for assigned employees.

10.2.3 Mutual Aid Agreement

A Mutual Aid Agreement is presently in place between Syncrude, Suncor and the Municipality of Wood Buffalo. Syncrude's Aurora project will be covered by this agreement. Under this agreement each party has agreed to provide assistance, to the extent they are able to do so, to any of signatories of the agreement. In addition, the participants have agreed to the development of compatible Emergency Response Procedures. These procedures are reviewed by each party at least once per year.

10.2.4 Area Y Co-op

An organization specializing in oil spill response (the Area Y Co-Op) presently exists in the Wood Buffalo region. Syncrude's Aurora activities will be included in this cooperative. In the event of a spill, a participant may at any time request additional resources from members of the Co-op.

The Area Y Co-op maintains a 40-foot oil spill equipment trailer and stages an annual exercise to test oil spill response capabilities.

10.2.5 Establishing, Updating and Auditing the Plan

The Emergency Plan will be prepared prior to the start of initial construction. It will be developed based on the CAN / CSA-Z731 standard for Industrial Facilities. The development of the Aurora Plan will involve a multi-user assessment to identify all potential hazards resulting from the new facilities. A risk assessment of each of these hazards will be carried out and used to prioritize the development of specific emergency plans.

One specific area requiring development is emergency response procedures to address potential spills to the environment from pipeline operations, particularly at pipeline river crossings. These procedures will be developed to meet or exceed the standard emergency response procedures used by the petroleum pipeline industry in Alberta.

Roles and responsibilities will be developed for all key people identified in the Emergency Plan. A survey of resources and a training needs analysis will be carried out to identify any short falls and eliminate them. A survey of resources and a training needs analysis will be done to identify any shortfalls and correct them.

The Plan will also include various levels of simulation to test the level of preparedness. As the development of the Aurora facility progresses through the initial construction, start-up and operational phases, the Plan will be updated to reflect changing requirements. The testing, auditing and updating components will be done in accordance with industry practice.

Periodic audits of the Emergency Plan will be conducted by internal and external auditors. These audits typically involve documentation checks and personal interviews to assess knowledge and the workings of the plan.

10.2.6 Filing of Emergency Response Plans

Under the provisions of the *Water Resources Act*, Dam and Canal Safety Regulations, and the Emergency Response Plan for Dam Breach, Aurora may be required to assess the hazard potential for the tailings dyke and submit Emergency Preparedness Plans to the Dam Safety Branch of Alberta Environmental Protection. If required, hazards will be assessed and an Emergency Preparedness Plan will be submitted in accordance with the regulations.

10.2.7 Fire Suppression

A fire suppression system will be installed at each Aurora plant area. It will include a water supply pond, fire water pumps, water distribution system and appropriate fire monitor coverage. Each site will also have a first response team appropriately trained for dealing with fires and other emergencies. More description is included in Section 3.6.4 (Common Facilities).

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11.0 Reclamation and Closure Plan

11.1 Introduction

Surface mining results in disturbance of the land for the period of active mining. The objective of minesite reclamation is to restore land productive capability once mining of the resources has been completed. In Alberta, the minimum standard for reclamation of areas disturbed by mining is that they be returned to a state where the average productive capability is at least equal to that of the landscape prior to mining.

In the case of oil sands mining, the productivity of the natural forest lands is foregone during the period from disturbance until the reclamation is re-established. During that period, the productivity of the land is value added by oil sands mining. Oil sands mining is a very productive use of land compared with other economic activities. One measure is the dollar value of production in relation to land disturbance in hectare years. For the Aurora Mine, the value of the oil produced from each hectare disturbed will be about 7 million dollars. Assuming a 50 year period during which other productive uses are disrupted, this represents $140,000 per hectare per year of value added by oil sand mining. This clearly exceeds the value added by any other set of land uses.

The oil sands mining industry has accumulated 30 years of experience in land reclamation through research and practical field implementation of reclamation practices. In particular, Syncrude has reclaimed over 2,000 hectares of land at its Mildred Lake site. The oil sands industry continues to add to its knowledge base on oil sands mining reclamation.

Syncrude's vision for the reclaimed landscape at the Aurora Mine is a mix of forest, parkland, wetlands and lakes, compatible with the existing landscape. The reclaimed landscape will be stable, biologically self-sustaining and have a productive capability at least equal to the pre-disturbed state.

One of the key advances in the Aurora Mine design is that it includes a suite of new technologies and knowledge that together allow progressive reclamation. Progressive reclamation means that land uses associated with the reclaimed landscape are re-established sooner,
Syncrude believes the reclaimed landscape at the Aurora Mine will support a range of land uses greater than that sustained by the undisturbed landscape. Insofar as the vegetation communities in the reclaimed landscape drive the land uses that are possible, the vegetation communities prescribed in this plan were selected to meet a number of land use objectives. For example, in the reclaimed landscape the replacement of terrestrial and aquatic ecosystems will support forestry, wildlife habitat, and recreation/traditional land use (fishing, berry picking, hunting, camping and picnicking). Topography also influences land use. However, in planning the mining of Syncrude's leases and the associated material disposal, there is limited opportunity to influence topography. Consequently, most of the flexibility in land uses comes from the flexibility in selection of vegetation communities.

Syncrude recognizes the importance attached to land capability by a number of communities and groups. The proposed reclamation plan attempts to balance the respective interests of a variety of existing land users and stakeholders. In particular, this plan takes into account the principles implicit in the objectives and guidelines being put forward in the Draft Fort McMurray-Athabasca Oil Sands Subregional Integrated Resource Plan (1995). The incorporation of these principles is reflected in the proposed vegetation communities of the conceptual ecosystems in the closure landscape.

In refining ultimate plans, Syncrude is willing to consider land use preferences provided by a regional multi-stakeholder forum, should one be formed. Syncrude has in the past been a proponent and strong supporter of multi-stakeholder groups and would be an active participant in a group formed to address reclamation and land use in our region. Syncrude has made particular efforts to understand the preferences of the community of Fort McKay, and will continue to do so.

In general, disturbed areas will be reclaimed to conform to the surrounding topography. Vegetation communities will be re-established primarily through the use of species native to the region.

Mined out pits, back-filled with overburden and tailings, and out-of-pit disposal areas will be graded for water management and erosion control. The surfaces of these upland areas, prior to amendment, will be non-saline and non-sodic — either through selective placement of overburden materials or through burial of unsuitable materials by tailings sand disposal. Surfaces will be amended with suitable surface soils and geologic materials from the areas mined.

The final topography and drainage of this landscape are depicted by Figures 3.2-31 and 3.2-40 (both found at the back of Section 3.2) for Aurora Mine North and Aurora Mine South, respectively. About 14% of the disturbed area will be reconstructed as lakes. Syncrude considers these lakes to be desirable landscape components. The perimeter of the end pit lakes will be constructed such that approximately 10% of the lake area is littoral zone. A complete description of the closure drainage design including lakes, littoral zones and wetlands is in Section 11.6.

Justas the original landscape was not comprised solely of productive forest, not all of the area will be reclaimed as productive forest.. Those areas not reclaimed as productive forest will yield capabilities only poorly represented in the original landscape. For example, there will be the potential for grazing animals (such as the re-introduction of wood bison to the region) and improved habitat for migratory waterfowl.

The following sections contain a detailed description of the reclamation philosophy, concepts, and practices which Syncrude is applying to the Aurora Mine. Reclamation activity at the Aurora Mine will commence towards the end of the ten year approval period provided for by the Environmental Protection and Enhancement Act. Syncrude will be preparing short term, detailed mine plans on an annual basis, including specific detailed plans for reclamation field activities which form an important component of mine planning. Plans describing field programs will be prepared annually, and submitted for review well in advance of execution of the activities described therein.

11.2 Predevelopment Site Analysis

A description of the Aurora Mine site prior to development is provided in Section 4.0 of the Environmental Impact Assessment. It includes a discussion of existing terrain, soils, water resources, vegetation, wildlife and fisheries (please note that although the baseline soils and vegetation mapping was plotted at 1:20,000 scale, the interpretation was performed using 1:10,000 scale photography).

11.3 Schedule for Reclamation

In this plan 120 hectares of reclamation has been identified to occur in the period 1997 to 2006. That reclamation activity occurs in the last years of that period. It is presented on the Mine status maps for the Aurora Mine North Figures 3.2-17 to 3.2-30 in Section 3.2. The Aurora Mine South status map for 2010 does not show any reclamation since mining activity does not commence until 2008, and no areas are available for reclamation by 2010.

11.4 Landform Design

There are three principal types of uplands landforms planned for the Aurora Mine: composite tailings (CT) disposal sites, out of pit sand disposal sites, and overburden disposal sites. A description of each of these follows.

11.4.1 Composite Tailings Disposal Sites

The disposal sites for composite tailings will be located in the east, centre, and south pits. These mine pits will be filled with CT resulting in surface elevations near original ground level, as shown in Table 11-1. The south pit will be filled with CT except for the northeast corner which will be occupied by a lake.

Table 11-1 Ground Levels at CT Disposal sites.

Pit	Existing Ground Levels (m)	Final CT Surface After Consolidation (m)
East Pit	296 - 310	305 - 321
Centre Pit	292 - 300	285 - 310
South Pit	325 - 340	334 - 340

The overall slope of the CT surfaces will be about 0.5%. The CT material will consolidate rapidly over the initial period of several years following deposition, during which excess CT porewater will rise to the surface. The CT surface will be covered with sand. The sand cap will be provided to:

- allow access for reclamation,
- reduce surface runoff during extreme rainfall conditions, and
- enable leaching of salts resulting from upward flux of CT porewater.

In addition to the sand cap over CT, a series of sand ridges will be built on the CT surfaces by hydraulic placement. These ridges will provide a mechanism for ongoing leaching of salts that could otherwise accumulate from an upward flux of porewater. They will also enable early planting of upland vegetation on the CT area which may otherwise behave as a large wetland for a number of years as a result of the upward flux of CT porewater. These ridges will result in the creation of a network of secondary drainage channels on the CT deposits.

The surface of the sand cap and sand ridges will be covered with a 0.5 metre layer of topsoil composed of a mixture of organic soil and mineral soil.

The CT areas located at the periphery and above original ground will be relatively dry because there will be a net outward seepage at those locations. These periphery areas are expected to support dry upland vegetation. There is also a large area of CT in the east pit where CT is placed on natural ground composed of overburden material. This area is also expected to be relatively dry because of unimpeded vertical seepage to the more pervious overburden soils underlying the CT material. Surface runoff at these drier CT areas will be relatively small except during snowmelt when melting governs water yield.

Areas not built up by sand ridges will be very wet. Overwet soil moisture conditions are expected to characterize the lowland areas of the centre of each CT disposal site as well as those periphery areas which are situated below ground level. These areas will exhibit conditions typical of muskeg terrain, including high evapotranspiration, low surface water yield, and potentially high flood volumes depending on antecedent moisture conditions.

11.4.2 Out of pit Sand Disposal Sites

The out of pit sand disposal sites will be built above original ground level with 6H:1V overall side slopes and a relatively flat top surface which drains to a large seasonal wetland at the centre. The structure will be built mainly of sand with some remnant layers of fine tailings in the area used for fine tailings settling and consolidation during mine operation. The top surface and side slopes of these sand structures will be 0.5 metres of reclamation material composed of a mixture of organic soil and mineral soil over free draining sand expected to be similar in grain size, gradation and permeability to the sand in Suncor's existing sand structures (coarser than the sand at Syncrude's existing Mildred Lake Facility). As a result, the surface of the sand structures will be characterized by rapid infiltration and relatively low potential for gullying after the establishment of mature vegetation.

As a result of the free draining sand subsoils at the out of pit sand disposal sites, this area is expected to be characterized by relatively dry soil conditions capable of supporting upland vegetation.

11.4.3 Overburden Disposal Sites

Overburden disposal sites will be built above original ground level at out of pit locations during the initial years of pit development. Side slopes will be 3H:1V intermediate and 4H:1V overall. The top surface will be crowned to encourage drainage to the edges. These structures will also be reclaimed with a 0.5 metre thick layer of reclamation material. Reclaimed overburden areas will be subject to relatively low surface water yield in summer due to the high porosity of the reclamation material and the well drained conditions of the relatively steep topography. The relatively impervious subsoils and high soil moisture storage capacity of surficial soils are expected to result in conditions favourable for upland forest production.

11.5 Reclamation Material Management

Syncrude's approach to reclamation material salvage and placement for the Aurora Mine will be the same as that used at the Mildred Lake mine. This approach includes the following key strategies:

- Salvage suitable quality reclamation material from within areas to be mined. The primary benefit of this is an economic one in that this material has to be moved in advance of mining.

- Consider as contingency the volume of suitable quality reclamation material in areas planned for out of pit disposal of overburden and tailings.

- Salvage reclamation material and haul it directly to areas actively undergoing reclamation wherever possible. This maximizes the natural re-establishment of native species, and minimizes stockpiling.

- Minimize stockpiling, whenever possible, but recognize that it cannot be eliminated entirely. Stockpiling is known to have an adverse effect on reclamation material quality with time. Stockpiling also increases the cost of reclamation since the material is handled twice.

- Reclaim disturbed areas as soon as practicable. This restores the land sooner, limiting the time the land is not available to existing uses, including traditional land uses, recreational uses, and forestry operations. Reclaiming mine disposal areas as quickly as practical limits the opportunity for wind and water erosion. Progressive reclamation also allows for maximizing the financing of reclamation costs during operation of the mine, thus minimizing expenditures required after cessation of mining.

11.5.1 Definition of Suitability

Syncrude has completed soil surveys for all of the areas to be disturbed by mining and associated activities (Landcare Research and Consulting *et al.* 1996). As well, Syncrude systematically samples and analyzes the surface Holocene and Pleistocene materials, ahead of mining, to a depth of 5 metres to determine the suitability of the overburden units for use as reclamation material. In general, sample sites are densely located within the five year mine area and more sparsely located in areas that will be mined beyond five years. This system of reclamation material identification has proven successful at Mildred Lake. For Aurora Mine North, a total of 106 hole locations have been auger drilled to date for the purpose of taking samples to analyze for reclamation suitability. These locations are indicated on Figure 11.1.

For Aurora Mine South, prior work by OSLO determined that, in general, the surface 2 metres of the area to be mined provided sufficient suitable quality reclamation material to reclaim all disturbed areas. This information, combined with the soil survey performed by Syncrude for Aurora South (Landcare Research and Consulting *et al.* 1996) indicates that there is sufficient suitable quality reclamation material within the area to be disturbed by mining to reclaim that same area. However, the information available on the suitability of overburden for reclamation is not yet in the same format as that for Aurora Mine North. Mining activities are not scheduled to start at Aurora Mine South until 2008. Therefore a detailed reclamation materials balance for Aurora Mine South has not yet been prepared. Syncrude will be incorporating information collected by others with new auger drilling results as they become available to produce a detailed balance. This detailed balance will be available for an EPEA approval of Aurora Mine South when required.

The Holocene samples (almost always muskeg), when analysed, do not always meet the criteria for "suitable". However, organic material, if used in correct proportion, will always produce suitable results. In developing a reclamation materials balance, it is also assumed that the surface 0.5 metres everywhere will produce "suitable" reclamation material as this is the most biologically active layer and the one that supports current growth. Figure 3.2-3 in Section 3.2 indicates the locations and depths of Holocene organic material. Using this database and the geologic model, Syncrude is able to characterize, generally, the suitability of the various lithological facies for use as reclamation material as well as specifically for the locations sampled. Table 11-2 indicates the quality criteria for suitable reclamation material. Figure 11.1 (isopach of suitable reclamation material for Aurora North) indicates the locations and depths of material which has been determined to be suitable for reclamation purposes.

Table 11-2 Criteria for Suitability as Reclamation Material

PARAMETER	VALUE
In-situ Depth (metres)	<3.0
Organic Matter, Placed top 20 cm (v/v%)	20 - 50
pH	4.0 - 8.0
Electrical Conductivity (dS/m)	<4.0
Sodium Adsorption Ratio	<8.0
Oil (%)	<1.0
Texture	L, SiL, SL, SiCL, SCL, CL, Si
Inclusion of Acceptable, Poorer Quality Material (%)	<30.0
Depth of *in-situ* surface material deemed always suitable (cm)	50.0

11.5.2 Standard Salvage and Replacement Practices

Surfaces which are non-saline and non-sodic (including both tailings sand and overburden surfaces) will be covered with 50 centimetres of reclamation material. Overburden placement will be scheduled such that all disposal areas constructed in the future will have surfaces composed of non-saline/non-sodic material. Any saline/sodic or otherwise poor quality substrate will be buried with at least one metre of material suitable for plant growth, of which at least 50 centimetres will be suitable surface material. In areas to be reclaimed as wetland or littoral zone, deeper organic layers may be placed.

Composite tailings deposits will be finished off with a cap of 1 metre of conventional tailings sand to insulate the reclamation material from any adverse properties of the CT material. This sand cap will also improve the trafficability of these areas for the placement of reclamation material.

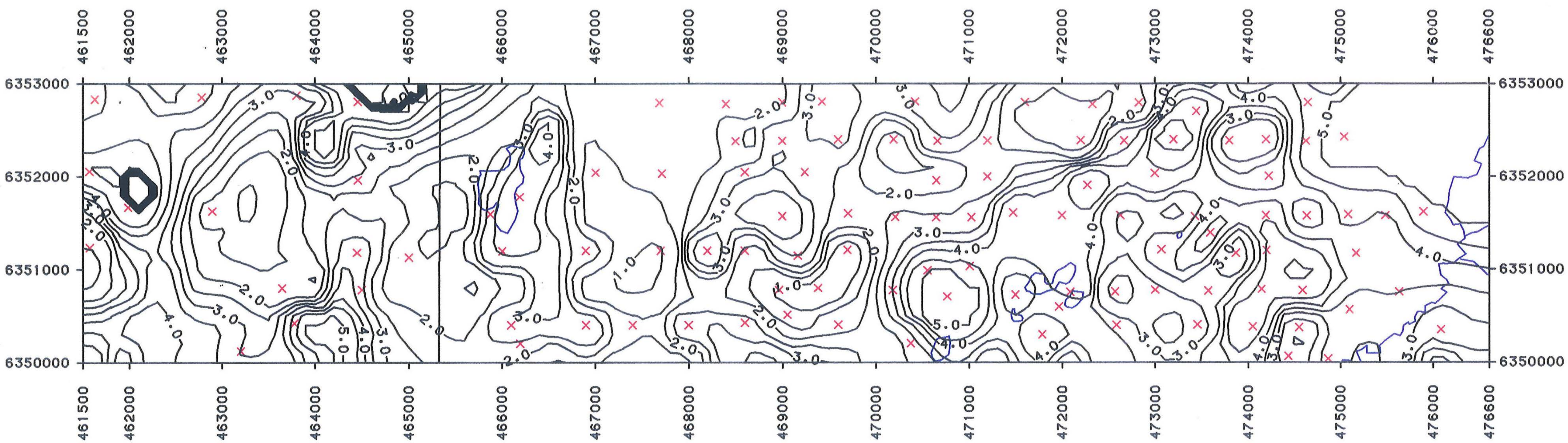
Generally, the reclamation material will be salvaged during the winter prior to overburden removal in a given area and hauled directly to the areas to be reclaimed. The planning basis is that only material in the overburden strip will be salvaged. A swell and mining loss factor of 1.05 was used to calculate placement volume.

Reclaimed surfaces will have the following properties:

pH (relative acidity)	<8
EC (electrical conductivity)	<4(dS/m)
SAR (sodium adsorption ratio)	<8
Texture	Loamy (<40% clay size)
O.M. (Organic Matter) in the surface 20cm	20%>OM<50% (v/v)
Inclusion of poor material	<30%

Excavation is done, generally, using a back-hoe sitting upon the frozen surface. The material is loaded into mine haulage trucks and transported to the reclamation site where it is dumped and spread immediately using a tracked dozer. To the extent that large frozen lumps are remaining after spreading, a final spreading must be done in the spring.

There are several advantages to operating a winter program. These include trafficability, lack of compaction in the final product (because of the frozen conditions of the pore-water), and the entrapment of moisture in the reclamation layer (due to the inclusion and mixing of snow). Improved moisture conditions, because of this entrapment, have been observed to persist for at least one growing season and assist in the establishment of vegetation.



SCALE IN METERS

LEASE 12

LEASE 34

SYNCRUDE AURORA MINE

SUITABLE RECLAMATION MATERIAL

X denotes Auger Hole locations

DRAWN BY: G.K.	DATE	SCALE: 1:50000	EXHIBIT #
APPVD. BY:		DATE: 6-MAY-96	
DESIGN BY: G.K.	DATE	DWG.NO.:	
APPVD. BY:			

FIGURE 11 - 1

11.5.3 Reclamation Materials Balance for Aurora Mine North

In developing a reclamation materials balance, for reasons noted previously, it is assumed that all of the Holocene material will produce adequate reclamation material. It is not necessary to salvage all of the muskeg available. Syncrude will salvage sufficient reclamation material from areas to be disturbed for mining to reclaim all lands scheduled for reclamation to the end of the life of the project (including post-mining closure activities), on a schedule appropriate to that reclamation. Reclamation material will be stockpiled to address an identified period of shortfall.

Table 11-3 indicates the relative percentages of reclamation material types by year.

Table 11-3 Percentages of Reclamation Material Types by Year

Material Type	1999	2000	2001	2002	2003	2004	2005	2006	2007-2010	2011-2015	2016-2020	2021-2025	2026-2030	2031-2035	Total
Holocene	30	10	0	0	16	75	51	42	72	21	39	31	9	45	34
Sand & Gravel	58	87	0	0	83	25	40	39	21	70	36	36	37	11	36
Pg Tills	6	4	0	0	0	0	8	19	7	3	10	5	32	35	16
Pl Clays	5	0	0	0	0	0	1	1	1	7	16	28	23	9	14

Table 11-4 indicates the volumes of muskeg peat which are part of these reclamation material volumes.

Table 11-4 Muskeg as a proportion of total suitable reclamation material

Time Period	Reclamation Material Reserves (Mbcm)	Muskeg Volume (Mbcm)	% Muskeg By Volume
1999-2000	3.3	0.78	23.6
2001-2005	5.4	2.61	48.3
2006-2010	11.7	7.99	68.3
2011-2015	8.0	1.64	20.5
2016-2020	9.5	3.68	38.7
2021-2025	13.1	4.06	31.0
2026-2030	18.0	1.69	9.4
2030+	11.3	5.08	45.0
TOTAL	**80.3**	**27.53**	**34.2**

The foregoing assumes no swell factor during salvage and placement nor any mining losses. These two factors approximately balance one another. For actual program planning, it is assumed that swell accounts for 5% additional volume after spreading. Mining losses are known at the time of actual program planning. Table 11-5 provides the reclamation material requirements for Aurora North.

The reclamation material balance for Aurora Mine North is presented in Table 11-6. Material from out of pit disposal areas for both overburden and tailings is not included in this table, as the material required constitutes only 45% of the available material within the mining area alone.

Table 11-5 Reclamation Materials Requirement for Aurora North

Time Period	Fort Hills Dump		Susan Lake North Dump		Susan Lake South Dump		Settling Basin		East Pit CT Disposal Area		Centre Pit CT Disposal Area		West Pit Beach		TOTAL	
	(ha)	(Mbcm)	(ha)	(Mbcm)	(ha)	(Mbcm)	(ha)	(Mbcm)	(ha)	(Mbcm)	(ha)	(Mbcm)	(ha)	(Mbcm)	**(ha)**	**(Mbcm)**
1999-2000	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	**0**	**0.0**
2001-2005	0	0.0	0	0.0	0	0.0	120	0.8	0	0.0	0	0.0	0	0.0	**120**	**0.8**
2006-2010	745	3.7	0	0.0	0	0.0	150	1.1	0	0.0	0	0.0	0	0.0	**895**	**4.8**
2011-2015	31	0.1	0	0.0	0	0.0	555	3.9	0	0.0	0	0.0	0	0.0	**586**	**4.0**
2016-2020	0	0.0	392	2.0	759	3.8	0	0.0	195	1.0	0	0.0	0	0.0	**1,346**	**6.8**
2021-2025	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	**0**	**0.0**
2026-2030	0	0.0	0	0.0	0	0.0	379	2.6	1,500	10.5	0	0.0	0	0.0	**1,879**	**13.1**
2030+	0	0.0	0	0.0	0	0.0	0	0.0	*41	0.2	1,800	12.6	307	2.2	**2,148**	**15.0**
TOTAL	776	3.8	392	2.0	759	3.8	**1,204**	**8.4**	**1,736**	**11.7**	**1,800**	**12.6**	307	2.2	6,974	**44.5**

Table 11-6 Reclamation Materials Balance for Aurora North

Time Period	**Area** (Ha)	**Material Required** (Mbcm)		**Material Available** (Mbcm)		**Surplus / (Deficit)** (Mbcm)		**Planned Stockpile** (Mbcm)	
		Periodic	**Cum.**	**Periodic**	**Cum.**	**Periodic**	**Cum.**	**Periodic**	**Cum.**
1999 - 2000	0	0.0	0.0	3.3	3.3	3.3	3.3	0.0	0.0
2001 - 2005	120	0.8	0.8	5.4	8.7	4.6	7.9	0.0	0.0
2006 - 2010	895	4.8	5.6	11.7	20.4	6.9	14.8	4.1	4.1
2011 - 2015	586	4.0	9.6	8.0	28.4	4.0	18.8	1.1	5.2
2016 - 2020	1,346	6.8	16.4	9.5	37.9	2.7	21.5	2.7	7.9
2021 - 2025	0	0.0	16.4	13.1	51.0	13.1	34.6	10.6	18.5
2026 - 2030	1,879	13.1	29.5	18.0	69.0	4.9	39.5	0.0	18.5
2030+	2,148	15.0	44.5	11.3	80.3	(3.7)	35.8	5.6	24.1
TOTAL	**6,974**	**44.5**	**44.5**	**80.3**	**80.3**	**35.8**	**35.8**	**24.1**	**24.1**

11.6 Closure Drainage Plans

11.6.1 Design Philosophy and Objectives

A drainage and water management plan for the reclaimed landscape has been prepared to support the development of a feasible surface water drainage scheme and to provide a basis for assessing any environmental impacts associated with the post mine closure drainage scheme. The principal mine water management objective is to provide sustainable drainage facilities that minimize adverse impacts and maximize the productivity of the post-closure landscape.

Sustainable facilities are needed to avoid adverse environmental impacts associated with deteriorating drainage systems, increased sediment yield and decreased productivity of the land and water resources. The drainage systems described herein are intended to require no regular maintenance after a period of monitoring following mine closure. They are expected to function without intervention and to accommodate extreme hydrologic events, minor geotechnical slope failures, climate change and changes in vegetative cover, as does the natural environment.

Sustainable reclamation drainage systems can be developed by replicating natural analogues, which are dynamic and subject to gradual evolution. Such systems avoid rigid facilities and structures composed of man-made materials. Instead, they incorporate flexible erosion control methods that are capable of adjusting to change. Sustainable water handling systems are characterized as follows:

- Channels built to suit the hydrologic regime relationships exhibited by natural streams. (Regime relationships include cross section shapes, channel depth, channel slope and meander characteristics in terms of discharge, bed material and valley gradient.)

- Robust, self-healing capability of all drainage systems.

- Floodplains that provide conveyance capacity and flood storage to accommodate extreme events such as the 100-year flood and even the probable maximum flood without excessive erosion or sediment yield.

- Avoidance of dams and reservoirs.

- Wetlands and shallow ponds to attenuate floods, minimize flow velocities and channel erosion, and provide bioremediation of surface runoff originating from reclaimed CT and tailings sand areas.

- Conveyance of surface runoff in deep swales (valleys) to prevent short circuiting into neighbouring watersheds.

- Avoidance of cross slope channels.
- Minimum change in discharge and drainage area of natural channels.

11.6.2 Design Features

The proposed conceptual closure drainage schemes are shown on the closure status maps in Section 3.2 (Figures 3.2-31 and 3.2-40). The arrangement of the drainage network will be refined to include changes in tailings technology and updates in the mine plans. The experience gained in water management from the Mildred Lake site will be applied in refining the closure plans for the Aurora Mine.

Primary Drainage Channels

The general approach for designing sustainable drainage channels is to develop regime channels that are characterized by sediment equilibrium and hydraulic conditions which mimic natural systems and are subject to gradual evolution over geomorphic time. Some of the steeper channels excavated in natural ground cannot be designed in accordance with natural regime conditions because of their steep slope. These non-regime diversions will be similar to the existing streams draining the slopes of Muskeg Mountain on the east side of the Aurora Mine. These streams are presently in a downcutting mode; however, they have inherent longevity because they are excavated into erosion resistant materials which will supply natural granular armouring and non-erodible barriers in the event of downcutting. The reclamation drainage channels will be designed in regime as much as possible to avoid or minimize the need for rigid riprap armouring.

The slopes of main channels through the reclaimed CT areas will have a minimum slope of 0.001 to ensure positive drainage and to minimize channel erosion.

Regime channels are designed to minimize channel erosion. They will be subject to infrequent scour and should never be subject to deep scour. For mine closure, the recommended design criteria for stable channel design of unlined regime channels are no erosion during the 10 year flood event, little erosion during the 100-year flood, and moderate erosion during the Probable Maximum Flood (PMF) event. Table 11-7 presents the maximum allowable flow velocities adopted for design of the regime channels.

Table 11-7 Maximum Allowable Flow Velocities in Regime Channels

Flood Event	Maximum Flow Velocity (m/s)	
	Sand/CT Material	Overburden or Natural Ground (clay/silt/gravel)
2 Year Flood	0.5	1.0
10 Year Flood	1.0	1.5
100 Year Flood	1.5	2.0
PMF	2.0	3.0

Channel conveyance capacity and flow velocities were calculated based on Manning's n values of 0.03 for sand/CT materials and 0.035 for overburden and natural ground.

Like natural fluvial systems, channels are designed to meander in large swales or valleys to reduce the channel bed slopes. The main channel conveys low flows and small, normal flood events whereas floodplains convey high flows and large flood events.

Secondary Drainage

Whereas the primary drainage channels provide surface water outlets from each tailings disposal area, secondary drainage systems will provide drainage within those areas.

The proposed secondary drainage system will be developed by controlled placement of sand infill to develop a network of sand ridges. This would force drainage to occur in swales between the ridges. The ridges would be constructed in such a manner as to develop a "natural-like" dendritic drainage system. As indicated above, the advantage of this construction procedure is that it would enable access for reclamation, leaching of the soils and earlier planting of upland vegetation on the ridges. The ridges are approximately 5 metres high with 50 metre top widths and side slopes of about 15H:1V. They will be composed of tailings sand. Typical spacings of the ridges vary from 200 to 400 metres. Drainage channels between the ridges are expected to develop naturally by erosion during the initial period of high flux rates immediately after construction. This natural evolution will facilitate the development of a regime channel pattern and cross sectional shape. The resulting secondary drainage system is expected to be stable over the long term, following reduction of upward flux of CT pore water.

Shallow Pond Wetlands

Shallow pond wetlands will be built into the drainage system at each CT and sand disposal site. The wetlands provide significant hydrological and environmental benefits for the reclamation system. They are needed to attenuate flood discharges and provide sustained flow releases. This will reduce downstream flow velocities and thereby reduce the rate of erosion, sediment yield and the rate of channel evolution. By providing sustained flood releases and long residence times, the wetlands will also serve to improve drainage water quality through biological action.

Permanent wetlands are sized with an area of about 10% of the local contributing drainage area. The depth of wetlands will range from 0 to 1 metre with an average depth of 0.5 metres.

The wetlands form part of a stable landscape and do not entail risks associated with dams and reservoirs. There is no mechanism for catastrophic spillage and dewatering. They are less than 2.5 metres in depth and therefore would not be classified as dams/reservoirs according to the Canadian Dam Safety criteria.

Hydrological characteristics of the proposed wetlands are given below in Table 11-8.

Table 11-8 Hydrologic Characteristics of Proposed Wetlands

	Aurora Mine Wetlands				
	North Sand Disposal Site	East Pit	Centre Pit	South Sand Disposal Site	South Pit
Drainage Basin (km^2)	7.2	15.8	31.4	11.3	24.6
Wetland Area (km^2)	0.84	1.81	1.12	1.24	1.50
Maximum Depth (m)	1	1	1	1	1
Volume (dam^3)	560	1200	750	830	1000
Residence Time* (months)	45	10	3	42	15

* Calculated by wetland water volume divided by mean annual flow from local drainage area.

End-Pit Lakes

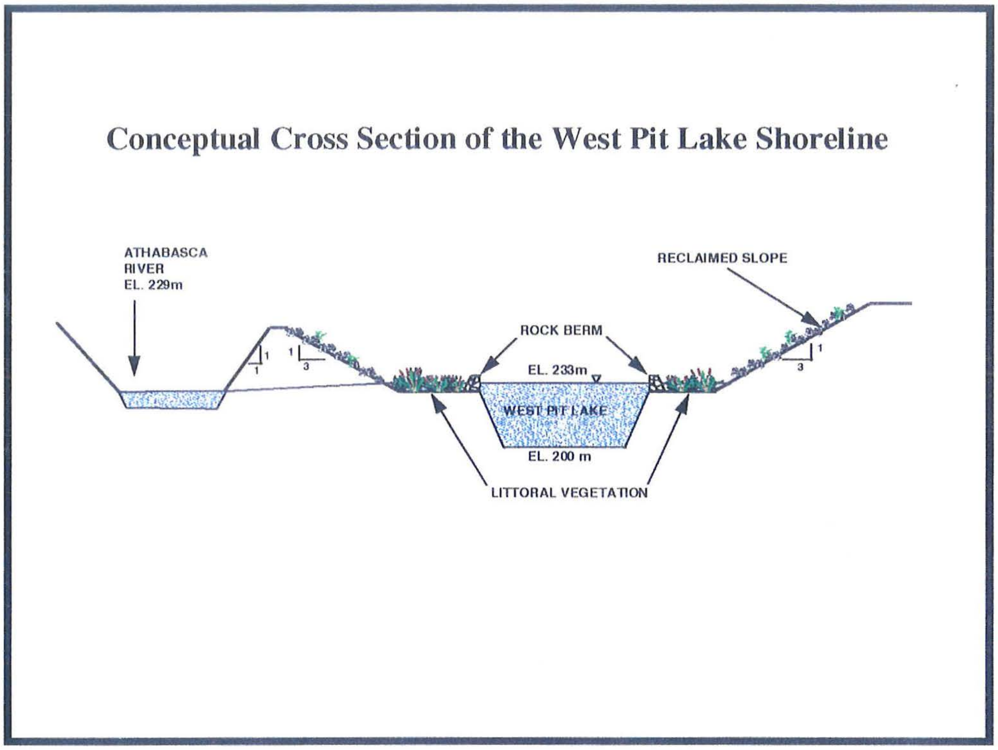
The reclamation drainage system will include two end pit lakes. These lakes will be designed to minimize the risk of wave erosion and to achieve satisfactory biological productivity. The shores of the lake will be protected against wave erosion. One method of accomplishing this is to build a rock riprap erosion protection system along the shoreline. Another approach is to cap the perimeter berms with overburden material containing cobbles and boulders, providing a self-armouring system in which wave erosion would expose armour material that would eventually create a stabilized equilibrium condition. A littoral zone covering 10% of the lake area is needed for biological productivity.

Littoral zone area can be achieved in a number of ways. One method involves managing the placement of overburden in the mined out pit such that specific areas of the lake perimeter have a 60-100 metre wide berm constructed on the pit wall to provide a 0.5 metre depth of water. This material will be configured to serve as a wide beach. The berm and littoral zone would need to be protected against wave erosion because of the high waves expected on this large deep lake. The beach will be protected by rock spur dykes or rock berms using the same concept illustrated on Figure 11-2. This method is well suited to the west pit lake as shown on Figure 11-3.

A second method involves the development of a littoral zone in conjunction with a wetland on a CT disposal area. This second method is particularly well suited for the south pit lake as shown on Figure 11-4. Here, a large littoral area can be developed conveniently on the CT area which is at about the same level as the end-pit lake. Like the west end-pit lake, the littoral zone will need to be protected with discontinuous rock berms as illustrated on Figure 11-2.

The proposed conceptual closure drainage schemes are shown on the closure status maps in Section 3.2 (Figures 3.2-31 and 3.2-40). The arrangement of the drainage network will be refined to include changes in tailings technology and updates in the mine plans. Experience gained in water management from the Mildred Lake site will be applied in modifying the closure plans for the Aurora sites as required.

Figure 11-2 Cross Section of West Pit Lake



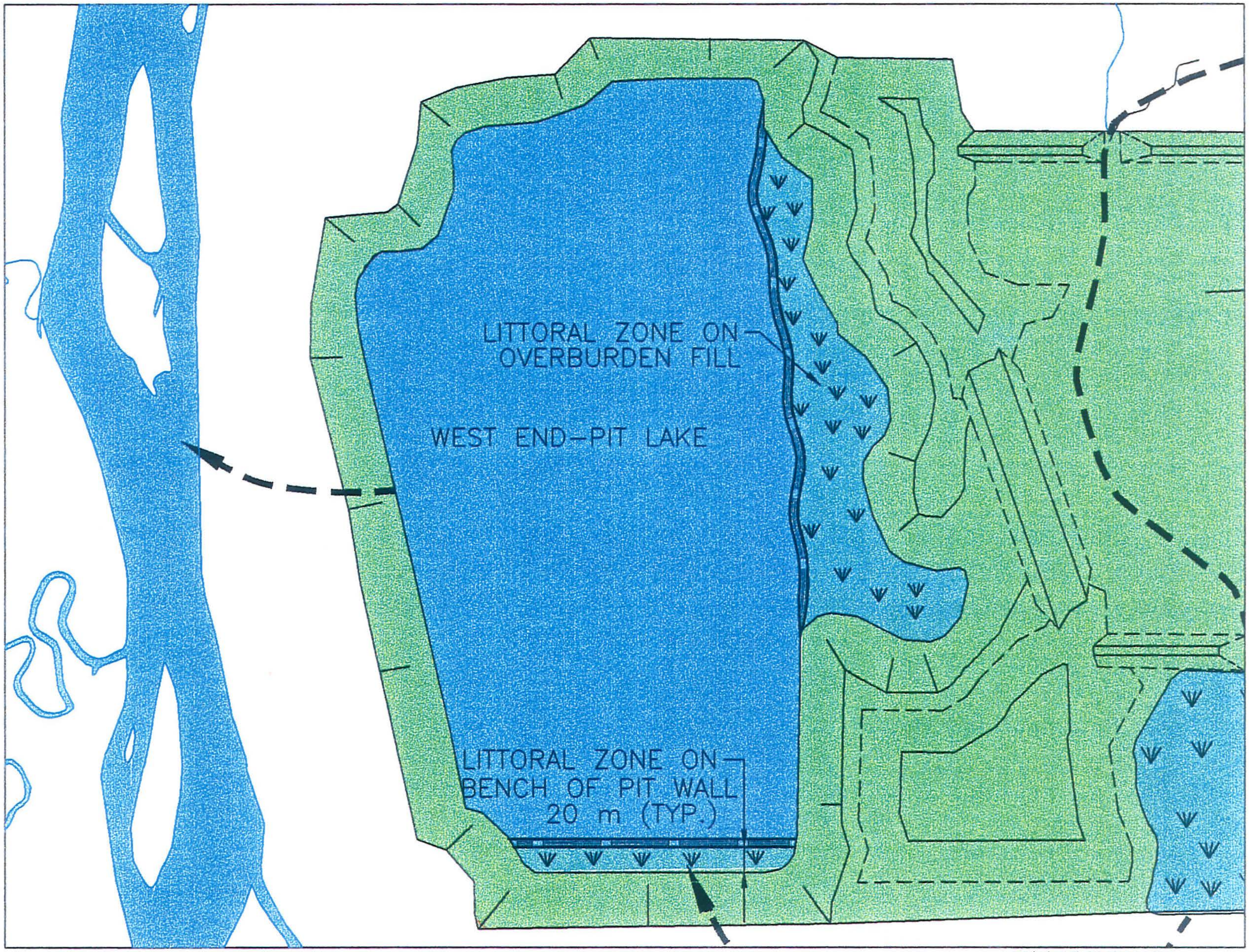


FIGURE 11 - 3

WEST END-PIT LAKE

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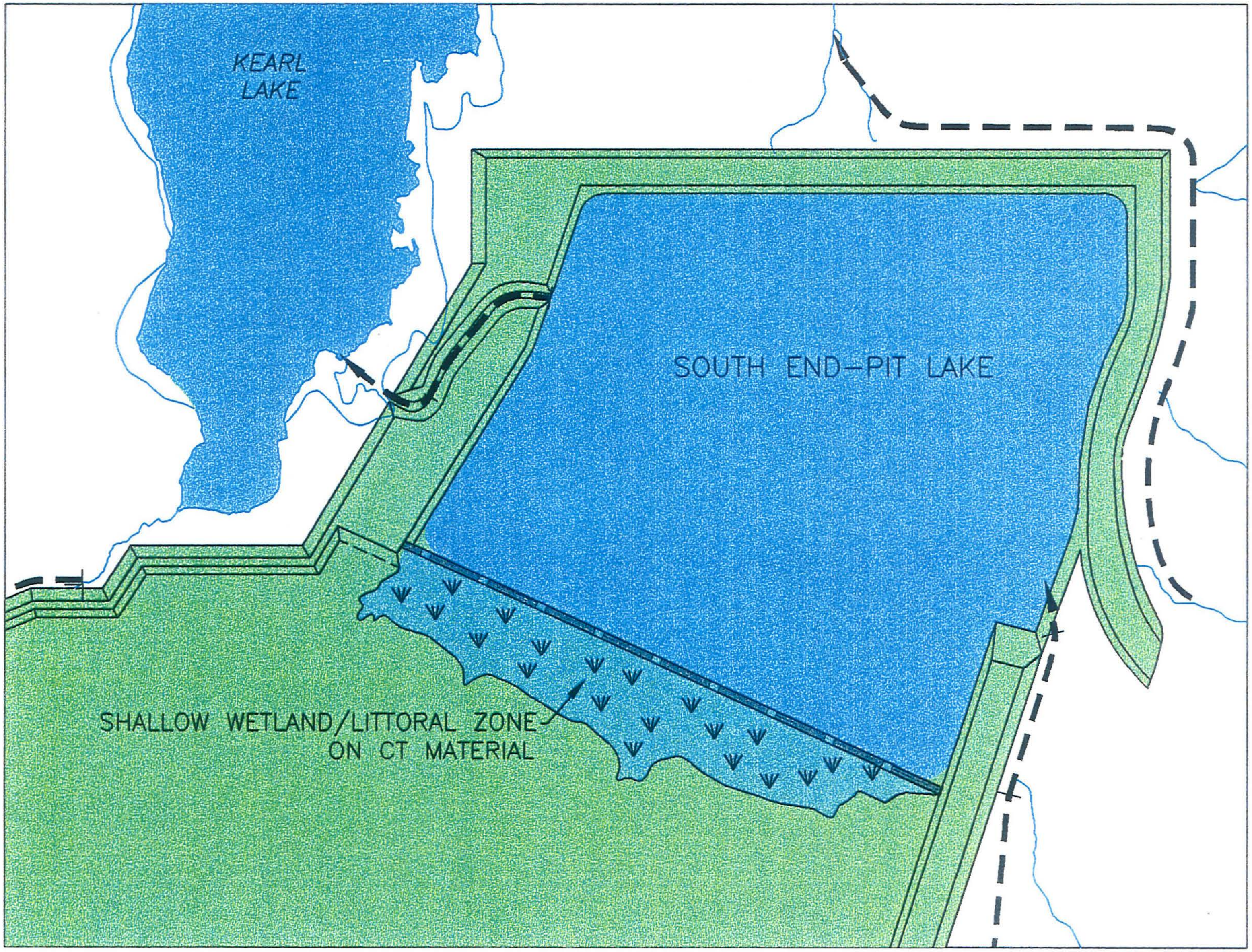

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FIGURE 11 - 4

SOUTH END-PIT LAKE

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CT Storage Areas

The CT disposal areas are described in Section 11.4.1. They will be located in the east and centre pits of the Aurora Mine North and the south , east and centre areas of the Aurora Mine South.

Shallow pond wetlands will be built into the drainage system at each CT disposal area. The wetlands will provide significant hydrological and environmental benefit for the reclamation system. They will form part of a stable landscape and will not be subject to risks associated with dams or reservoirs, since there is no mechanism for catastrophic spillage and dewatering.

Out-of-Pit Sand Disposal Areas

The out of pit sand disposal areas are described in Section 11.4.2.

Overburden Storage Areas

Overburden disposal areas are described in Section 11.4.3.

11.6.3 Aurora Mine North Design Features

The layout of the major and secondary drainage courses at the north and south mines is shown on the closure maps in Section 3.2 The proposed reclamation drainage system at the north mine is composed of four sub-basins including three mine pit areas and an out-of-pit sand disposal area. The out of pit sand disposal area is located at the east end of the north mine area and drains to the Muskeg River via Stanley Creek. The east and centre pits drain westward to an end-pit lake in the west pit. The west pit lake is 10 square kilometres which drains directly to the Athabasca River. The Aurora Mine North drainage scheme requires no major diversion of natural streams because it is located at a catchment divide.

Tailings Storage Area

The out of pit sand disposal area, located on the east end of Lease 34, will have a 355 metre crest elevation which is about 75 meters above the level of southeast toe. The top surface area of this structure is about 8 square kilometres and will be relatively flat with 6H:1V overall side slopes. Drainage from this plateau will be through a long channel of relatively shallow slope as shown on the closure plan for the Aurora North in Section 3.2 (Figure 3.2-31).

The chosen plan incorporates a 5 kilometre long channel conveying the surface runoff from a seasonal wetland at the 340 metre elevation, down to Stanley Creek at the 300 metre elevation. The maximum slope of this channel is designed at 1.0 percent where the channel reach flows across overburden material. Using non erosive overburden material will limit erosion while supporting the growth of in channel vegetation. The seasonal wetland on the plateau of the sand storage area is an essential feature of the chosen plan. Water accumulating in the wetland will attenuate outflow rates in the channel.

Composite Tailings Disposal In Pit

It is proposed to fill the east pit and centre pit with CT. This engineered landform will be designed to have a gentle slope to facilitate drainage. The east pit will be filled to the 320 to 325 metres elevation, which is 20 to 25 meters above the natural ground elevation. The CT will settle to approximately the 316 metres elevation at the south end and drain north to a pond at elevation 305 .The centre pit will be filled with CT to approximately 300 to 305 metres, and is expected to settle to approximately the 285 metre elevation in the southwest. A relatively shallow wetland is planned in the centre pit. The higher elevation in the east pit will permit drainage and avoid a permanent lake forming over the mined out area.

The outlet channel will be routed west toward the west pit lake as shown on the closure plan Figure 3.2-31 in Section 3.2. The channels outlets located in the CT material are expected to be managed outlets during the initial consolidation of the CT material. These structures will require lowering in the future in accordance with the rate of CT consolidation. The channel from the centre pit to the west pit lake is planned to be about 3 kilometres long with a 1.3% slope in undisturbed soil. This conforms to the design criteria governing channel erosion. It will discharge into the west pit lake.

West Pit Lake

At the end of operations at Aurora Mine North, the west pit will be mined out leaving a 10 square kilometre pit excavated to a base elevation of about 200 metres which is about 28.5 metres below the mean flow level of the Athabasca River Figure 11-2. The pit will be filled to a depth of about 33 metres by pumping/siphoning water from the Athabasca River during the four high flow months from June to September. The lake will be filled over a period of two years or more, to minimize impacts on the river. For a two year filling period, the required rate of river diversion is 16 m^3/s which is about 1.3% of the mean Athabasca River flow of 1200 m^3/s during the summer high flow period. Syncrude will make the necessary application for approval to withdraw this water from the river on a timely basis.

The west pit will be filled to a level of 233 metres which is at the 100 year flood level of the Athabasca River immediately west of the west pit. This will provide positive drainage to the river and will minimize the risk of lake level fluctuations associated with normal river flooding. Lake level fluctuations are not desirable because that would increase the exposure of the shoreline to wave erosion and would limit the effectiveness of littoral zones around the lake.

Pertinent levels of the Athabasca river near the west pit are as follows:

Mean flow level	228.5 metres
2 year flood level	231.1 metres
100 year flood level	233.1 metres

The west pit lake will be separated from the Athabasca River by a ridge of land about 1 km wide (at river level) which will preserve the appearance and environmental quality of the Athabasca River valley. This ridge between the lake and the river is wide enough to accommodate the small drop in level between lake and river so that the lake will not present the risks associated with a constructed dam and reservoir.

An outlet channel is required to connect the lake with the Athabasca River. The outlet channel will maintain a constant lake level of 233 metre elevation and will ensure outflow by a surface water outlet. Lake discharge rates will be relatively small as indicated by the following data.

Mean annual discharge	0.162 m^3/s
10 year flood discharge	0.83 m^3/s

The lake level is close to the piezometric levels of the basal aquifer which are 230 metres on the west side and 240 metres on the east side. The small 7 metre difference between the basal aquifer level on the east side and the lake level will result in a net basal aquifer seepage to the lake of 0.006 m^3/s. The lake outflow by basal aquifer seepage to the Athabasca River is expected to be about 0.017 m^3/s. This is much less than the total outflow of 0.162 m^3/s and therefore the lake level will be controlled by the surface water outlet channel, except during occasional seasonal low flows or drought years. A lake water balance simulation, which was conducted based on a 42 year climate record, shows that the lake will have an outflow during 35 of the 42 years simulated.

The lake outlet channel shown on Figure 11-3 is a long term abandonment outlet system. During mine operations, the outlet will probably consist of a culvert or outlet pipe installed by directional drilling. This form of outlet could be maintained indefinitely if Alberta Transportation takes over responsibility of the outlet as part of their jurisdiction of maintaining Highway 963, which presently runs along the proposed ridge.

11.6.4 Aurora Mine South Design Features

The layout of the primary and secondary drainage courses at Aurora Mine South is shown on the closure map 3.2-40 in Section 3.2. The proposed reclamation drainage scheme of the south mine is composed of four features: diversion of headwater streams, out-of-pit sand and overburden disposal areas, CT storage in pit, and an end pit lake. The CT disposal area drains to an end pit lake at the northeast corner of the pit and to a channel which connects the end pit lake with Kearl Lake. The out of pit sand disposal area drains directly to Muskeg Creek.

Diversion of Headwater Streams

Aurora South operations will require several diversions during operation and abandonment. The diversion system along the south side of the mine pit and overburden dump involves the same routing as that used during the operational phase (Figure 3.7-6). The reclamation drainage scheme includes replication of the natural drainage features with provision of robust self-healing systems to ensure longevity.

The upstream end of the east side diversion follows a similar route as the east side diversion implemented in the second stage of mine operations. While suitable for use during mine operations, this scheme is not sustainable for the long term. Beaver dam flooding could cause short circuiting by spillage and channel avulsion if the channel were left unattended and unmaintained after mine closure. Therefore, a 15 to 20 meter high barrier fill will be constructed above the east side of the mine pit. Part of the east side diversion will flow into an end pit lake at the northeast corner of the mine area while the other part will flow to Wapasu Creek which would have lost approximately 60% of its catchment area. This routing through the south pit lake will supply nutrients from the upstream drainage area and provide sufficient through-flow to avoid salinization of the lake.

Sand and Overburden Disposal Areas

The operational drainage plan implemented in approximately 2020, and shown in Figure 3.7-6, will be modified for closure as shown in the closure drawing for the Aurora South Mine in Figure 3.2-40 in Section 3.2. A permanent open channel will be constructed to replace the culverts utilized during operations. The permanent open channel will be built to be compatible with the natural drainage system.

The surface of the sand storage area will drain all surface flow to a large central seasonal wetland. The wetland will provide water storage and will release excess water to infiltration and to surface outflow via the outlet channel. The outlet channel will be cut into a sloping berm to convey flow from an elevation of 365 to ground level at 330 meters. The slope length of the channel will be about 4000 meters and this will provide for a valley slope of about 1.0 percent and a channel slope (with meandering channel) of 0.5 percent. The channel will need to be cut into cohesive overburden material to prevent rapid deterioration by erosion.

CT Disposal In Pit

The surface of the CT disposal area in the mine pit will slope at about 0.5 percent northeast to the south pit lake. The CT material will consolidate rapidly over a period of several years during which excess CT porewater will rise to the surface. A managed channel will be required during the period of rapid consolidation. The CT disposal area will be designed so that the CT surface level near the south pit lake is equal to the level of the lake (approximately 334 meters) after CT consolidation.

South Pit Lake

The south pit lake, shown on Figure 11-4, is also a necessary component of the post-closure landscape. At the end of mining, there will be a deep pit at the northeast corner of the south pit. Upon mine closure, the pit will be filled with water pumped from the Athabasca River or diverted from nearby streams to form an 81 metre deep lake. Pumping from the Athabasca River would be conducted over about a 5 year period and would be restricted to the peak flow periods to minimize impacts to the river. Like the west pit lake, the filling rate could be limited to 16 m^3/s during the four maximum flow months of each year. This would reduce mean flows in the Athabasca River by about 1.3%. If appropriate, filling could be spread over a longer period. Collecting surface flow from nearby tributary streams and headwaters of Wapasu Creek would require a much longer period of time (i.e., more than 100 years).

Surface runoff from the reclaimed CT disposal site and the runoff from adjacent natural drainage areas will provide a through-flow of 0.205 m^3/s. The proposed outlet channel will convey excess water to Kearl Lake.

The south pit lake will be filled to a level close to original ground level so that the lake can drain by a shallow open channel to a natural receiving water body. A lake level of 334 metres elevation is planned. This will provide a positive gradient to Kearl Lake, which is 2 metres lower at an elevation of 332 metres. The lake will drain to Kearl Lake via an open channel as shown on Figure 11-4. The lake level of 334 metres ensures that the lake is below natural ground at the west, north and east sides. The south side of the lake will be contained by an overburden dyke and CT disposal which rises to a level of 354 metres at the southwest corner of the pit.

Although the lake level of 334 metres elevation avoids the risk of spillage into adjacent areas, a barrier fill is required on the west, north and east perimeter to ensure runoff from other basins remains in the natural outlets of those basins. The height of barrier fill above existing ground varies from 10 metres on the east side to 5 metres at the northeast corner, the north side and the west side. The higher fill at the east side is required to prevent overflow of the east side diversions as a result of sediment accumulations, icing and debris blockage.

11.6.5 Performance and Evolution of Reclamation Drainage Systems

As discussed earlier, the drainage facilities are designed to evolve gradually over geomorphic time at rates similar to natural schemes. The results of such change are not expected to cause unacceptable events such as catastrophic dewatering of lakes and wetlands. Examples of tolerable change which could take place over long periods (i.e., centuries or thousands of years) are:

- Outlet channels could erode downwards resulting in exposure of underlying cobbles and gravel which would re-armour the channel.

- Channel erosion at the west pit lake outlet or the centre pit (CT deposit) outlet could cause exposure of oil sand, which is expected to become hardened to an erosion resistant material before exposure by channel degradation.

- Wave erosion of the west pit lake shoreline by some extreme event in the far future could expose hardened, erosion-resistant oil sand material.

11.6.6 Performance Criteria and Monitoring

Performance criteria and a program of performance monitoring provides a basis for regulatory agencies to determine if the reclaimed facility will achieve the requirement of long-term sustainability. Successful performance of the facility is required to enable the regulatory agency to allow final closure of the reclaimed mine. The following performance criteria and performance monitoring programs would provide regulatory agencies with the information required to assess the sustainability of the drainage systems and lake shoreline protection systems.

- Erosion of drainage channels and total sediment yield should not exceed rates that have been predicted using the techniques described in this report, taking into account climate variability. Total sediment yield should be measured by constructing small sediment traps (pools) along major drainage channels and by annually surveying the remaining storage volume of each sediment trap. Channel erosion should be measured by surveying reference cross sections annually.

- After construction of the long-term shore protection systems, successful performance will be known by comparing the stability of the riprap material with predictions. The proposed shore protection will be deemed to be successful if the rate of rock movement and erosion is less than or equal to the predicted rate.

It is expected that erosion performance will improve rapidly immediately after full reclamation and will improve gradually thereafter. The expected improvement is due to establishment and growth of a good vegetation cover and root mass, and gradual maturing of the topography.

11.7 Re-establishment of Vegetation Communities

11.7.1 Surface Preparation and Fertilization

Following winter soil replacement, some additional site preparation in the form of dozer work is required in the spring to eliminate rough areas and large pieces of previously frozen soil. The contouring of the newly placed reclamation material assists in further developing appropriate drainage.

Reconstructed soils are generally deficient in nitrogen (N), phosphorus (P), and potassium (K) and therefore require fertilization. A number of factors may influence the type, blend, and application rate of fertilizer applied, including crop to be grown, soil texture, and soil drainage. Slow release fertilizer is preferred.

In 1993, Syncrude began using a bulk fertilizer system which allows for the purchase of bulk blended fertilizer. Based on past experience, a 10-30-15-3 blend works best. By applying this fertilizer blend at a rate of 500 kg/ha, the major nutrients -- N, P_2O_5, K_2O and S -- are supplied at respective rates of 40, 150, 70, and 15 kg/ha. This fertilizer is typically broadcast using either wheeled spreaders or a helicopter.

11.7.2 Erosion Control

Preventing erosion of reclaimed slopes while at the same time striving to establish trees is a familiar challenge. Agronomic grasses have been used successfully in controlling erosion on slopes, but they tend to outcompete tree seedlings. Syncrude began testing the use of a barley nurse crop on reclaimed slopes for the purpose of controlling erosion in 1990 (the seeding of a barley nurse crop not only helps to control erosion, but also allows the establishment of planted trees and naturally occurring native species.) Results to date are positive, and while monitoring is continuing to further refine the application rates for various soils, Syncrude will continue to employ this method at the Aurora Mine. The barley application rates were reduced to 20-25 kg/ha in 1995 from 50 kg/ha in 1990 and 30 kg/ha in 1993.

11.7.3 Tree and Shrub Planting

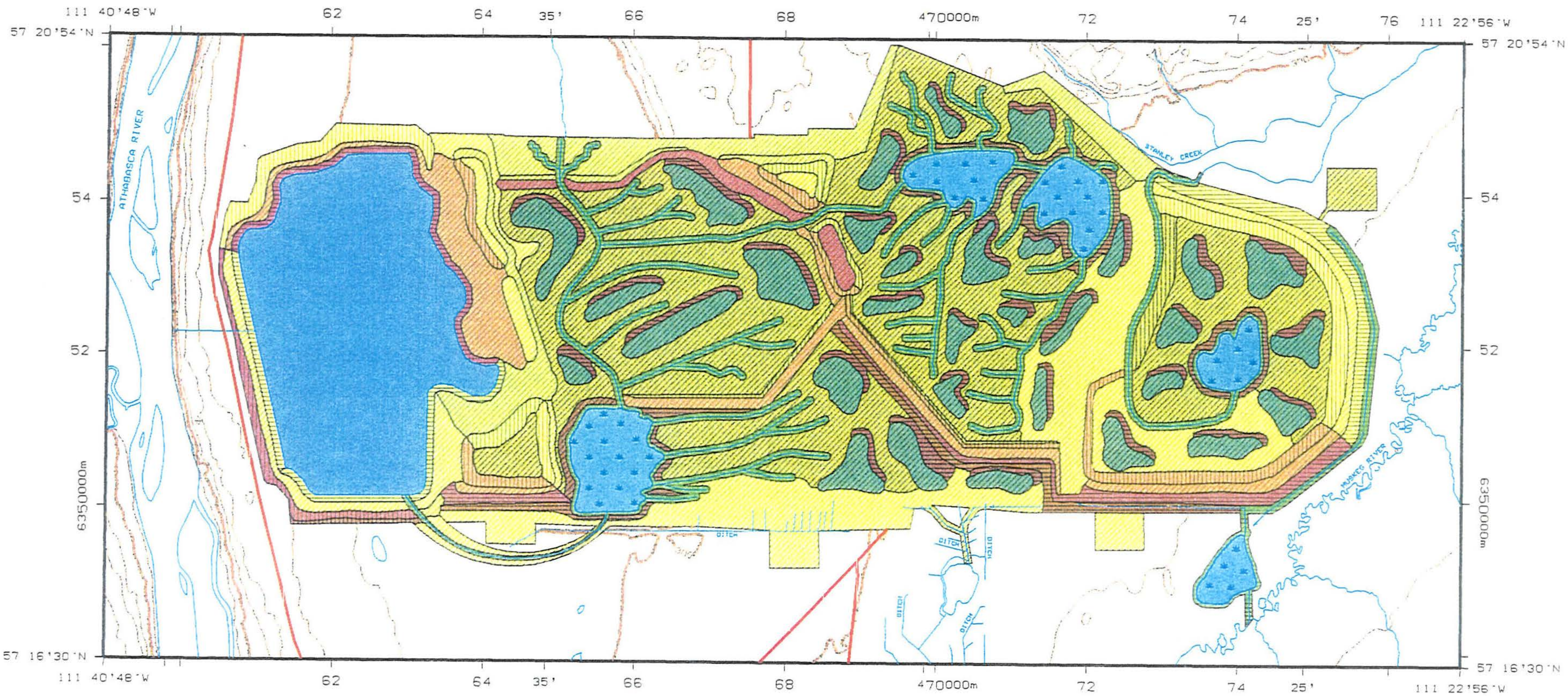
In general, trees will be planted on slopes and parkland areas will be established on flat or gently sloping areas. Tree and shrub seedlings, grown from seed collected from the local area, are planted at a stocking density of 2000 stems per hectare. The strategy for planting to achieve the vegetation community designations is provided in Table 11-9. The distribution of these communities in the closure landscape is provided in Table 11-10 and is shown on Figures 11-5 and 11-6 for the Aurora Mine North and South respectively.

Table 11-9 Revegetation plan to achieve vegetation communities

Vegetation Community Designation	Site Location	Species Planted to Achieve Vegetation Community
Jack pine/blueberry/lichen	Upper and middle slope positions of south and west-facing slopes	Jackpine
Jack pine-aspen/blueberry-bearberry	Lower slope portions of south and west-facing slopes	Jackpine, aspen
Aspen/saskatoon-pincherry	Toe of south and west facing slopes	Aspen, saskatoon, pincherry
Aspen/low bush cranberry	Southern exposures along grassland fringes	Aspen, lowbush cranberry
Aspen-white spruce/ buffaloberry	Level surfaces away from excessive moisture	Aspen, white spruce, buffaloberry
Aspen-white spruce/rose	Gently sloping sites	Aspen, white spruce, rose
White spruce/dogwood/fern	North-facing slopes	White spruce, dogwood
Cattail marsh	Wetland drainage sites	
Willow/calamagrostis	Areas adjacent to wetland drainage sites or ephemeral streams	Willow
Graminoid fen	Grassland openings on level surfaces	Grass species will be define at a later date.

Table 11-10 Distribution of Aurora Mine reclamation vegetation communities

Vegetation Community	Area in North Mine		Area in South Mine		Total Area
	ha	%	ha	%	ha
Jack Pine/Blueberry/Lichen	504	6.6	329	4.6	833
Jack Pine-Aspen/Blueberry-Bearberry	298	3.9	265	3.7	563
Aspen/Saskatoon-Pincherry	258	3.4	151	2.1	409
Aspen/Low-bush Cranberry	230	3.0	35	0.5	265
Aspen-White Spruce/Buffaloberry	1761	22.9	2392	33.7	4153
Aspen-White Spruce/Rose	1320	17.2	683	9.6	2003
White Spruce/Dogwood/Fern	488	6.4	766	10.8	1254
Willow/Calamagrostis	694	9.0	660	9.3	1354
Graminoid Fen	717	9.3	620	8.7	1337
Wetland	391	5.1	128	1.8	519
End-pit Lakes	1015	13.2	1075	15.1	2090
Permanent Linear Corridors					391
Total	7676		7104		15171



LEGEND

VEGETATION TYPE (BECKINGHAM'S CLASSIFICATION)

- A1.2 - Jack Pine, Bearberry, Lichen
- B1.1 - Jack Pine, Aspen, Blueberry, Bearberry
- D1.2 - Aspen, Saskatoon-Pincherry
- D1.5 - Aspen, Low Bush Cranberry
- D2.1 - Aspen, White Spruce, Buffalo Berry
- D2.5 - Aspen, White Spruce, Rose
- E3.1 - White Spruce, Dogwood, Fern
- K2 - Willow, Calamagrostis
- K3 - Graminoid Fen
- Open Water
- Wetlands

RELATIVE SLOPE POSITION

- Upper
- Middle
- Lower

CONVENTIONAL SYMBOLS

- Rivers
- Roads
- Contours (20m Interval)

N

SCALE 1 : 55,000

METRES 0 500 1000 2000 3000 4000 5000 6000 METRES

Projection: Universal Transverse Mercator (UTM) Ellipsoid: NAD27 Zone: 12

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Figure 11-5
Aurora Mine North conceptual ecosystem in the closure landscape.

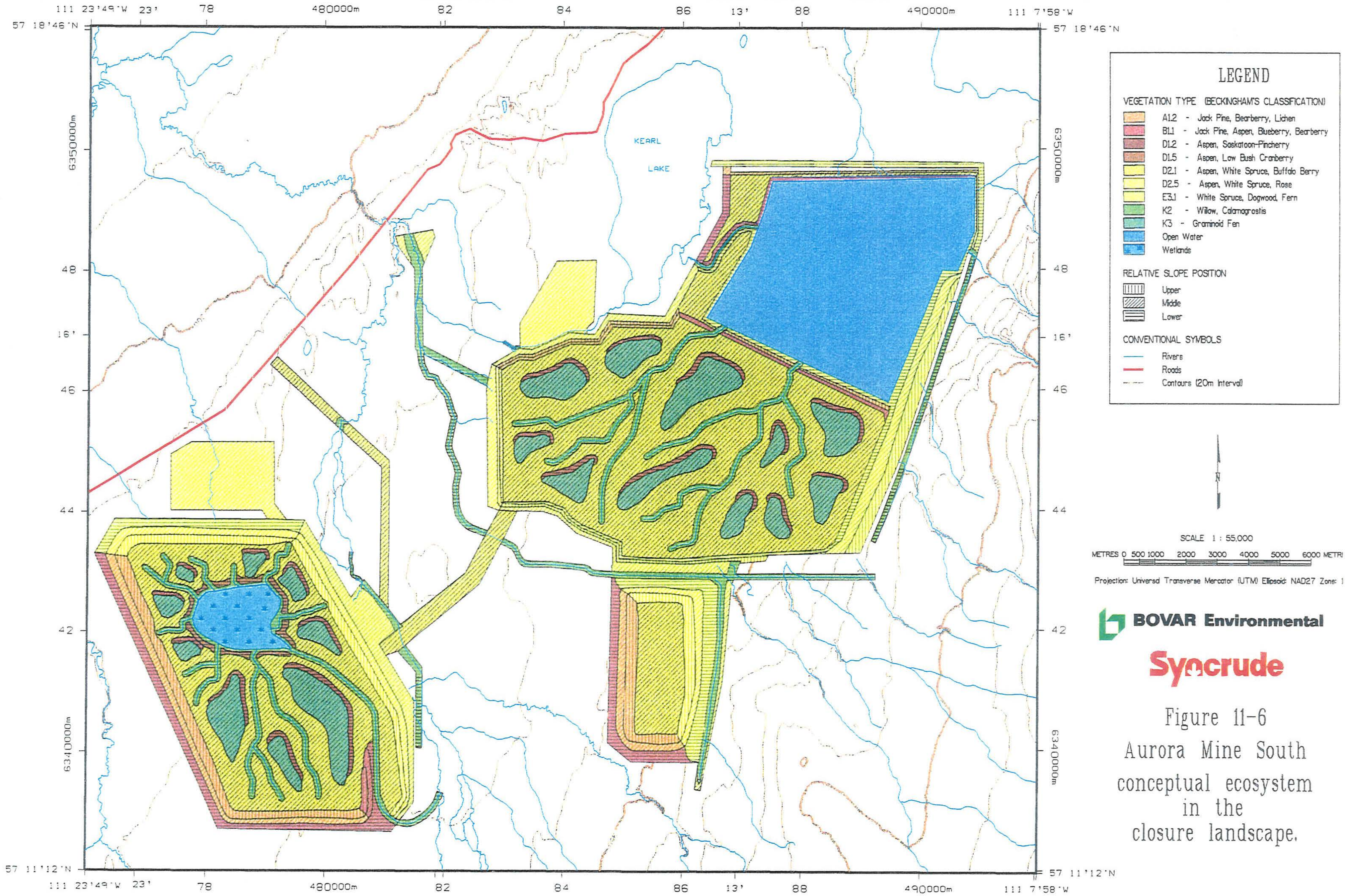

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Figure 11-6
Aurora Mine South
conceptual ecosystem
in the
closure landscape.

Parkland areas will be stabilized by establishment of a thrifty grass sod, intermingled with clumps of aspen.

Grass will be seeded using one or more of several agronomic grass species currently being tested and evaluated for ease of establishment, productivity, and palatability. Testing of the performance of alternate native grass species is in progress. Maintenance fertilization of grassland areas during at least the first two to three years of establishment is expected. Fertility requirements and the schedule, timing, blend analysis, application rate of maintenance fertilizations for grassland areas are being evaluated.

11.7.4 Wildlife Habitat

The objective of the reclamation plan is to re-establish some of the same terrestrial habitat types that were removed through clearing, but in different proportions than in the original landscape. Because the establishment of mid- to late-successional habitat takes many years after a site has been reclaimed, wildlife communities immediately following oil sand mining will be inherently different from the communities occurring on the site preceding development. There will be a shift from species that inhabit late successional and mature habitats (e.g. squirrel, fisher) to those that occupy early and mid-successional habitats (e.g., hare, moose, black bear). Therefore, the habitat capabilities associated with the reclaimed landscape will initially be lower for some terrestrial wildlife species and higher for others.

Terrestrial wildlife habitat will be re-established by recontouring the landscape, establishing new drainage systems, and designing and establishing mosaics of the vegetation communities.

For wildlife the development of an undulating terrain is recommended. This terrain should have a high diversity of slopes, aspects, elevations and moisture-holding capacities, to provide topographic relief, shelter, and a diversity of micro-habitats. This can be achieved by:

- Placing and shaping overburden to provide a variety of landforms and aspects — for example, crescent-shaped mounds or dumping of excess overburden in an irregular fashion to create knobs 2 to 3 metres high.

- Regrading slopes to maximize irregularity.

11.7.5 Vegetation Succession

A mosaic of nine primary vegetation communities will be established (Figures 11.5 and 11.6). These communities, as listed in Table 11-10, will re-establish native vegetation communities common to the Northern Boreal Mixedwood Region and known to occur within the development area. There will be a decrease in the number of plant communities in comparison to those that existed prior to the development of the Aurora Mine. These re-established communities will be suited to the landform, drainage, aspect, slope, soils and elevation of the reclaimed sites. This will enhance the ability of these communities to restore sustainable and compatible ecosystem function to the reclaimed areas. The reclamation vegetation communities will initiate the establishment of a variety of successional stages as outlined below (successional status is approximate).

- Early Successional
  - Willow/ Calamagrostis
  - Graminoid/Fen

- Mid Successional
  - Jack Pine/Blueberry/Lichen
  - Jack Pine-Aspen/Blueberry-Bearberry
  - Aspen/Saskatoon-Pincherry
  - Aspen/Low-bush Cranberry

- Late Successional
  - Aspen-White Spruce/Buffaloberry
  - Aspen-White Spruce/Rose
  - White Spruce/Dogwood/Fern

As vegetation communities develop, the successional status will vary and change with natural ecosystem processes. The following mechanisms will promote this development:

- Direct haul and placement of reclamation materials will promote the germination and establishment of native seeds and roots held within the soil material.

- Reclamation seeding and planting will be completed primarily with native vegetation species.

- Fertilization and seeding rates will be maintained at levels that will promote the invasion of native vegetation from surrounding sources.

- Monitoring of reclamation will be conducted to ensure successful re-establishment of the desired terrestrial communities.

- Wetland communities will be promoted within seasonal wetlands and along drainage channels created within the reclamation landscape.

11.8 Reclamation Issues

11.8.1 Land Use

As discussed above, Syncrude considers the selection of reclamation land capability and land use objectives to be a very important issue. It is Syncrude's intention to participate with all of our stakeholders in defining land use options for these reclaimed lands. At the present time Syncrude has proposed a landscape which would be, for the most part, well drained with designated lakes and wetlands. The well drained uplands would be devoted to forest growth and parkland for grazing/browsing. Lakes and streams would be suitable for fisheries and recreational use. Wetlands, as well as the lakes, would provide water in the landscape for wildlife and groundwater recharge and habitat for nesting and migratory waterfowl, and for recreational opportunities.

For wood bison — a key wildlife species — Syncrude, with advice from regional stakeholders, has chosen to conduct research on reclamation tailored to facilitate reintroduction of this subspecies to the region. Talks and research are currently underway to further evaluate the feasibility of this initiative.

Discussions are continuing with the Forest Management Agreement holder in the area to define an optimum forest management scenario. It is expected that these talks will indicate a value for fast growing hybrid poplars for fibre production.

The majority of reforested land will be planted to meet a mixed wood re-establishment standard, using species that have proven most effective in past reclamation experience and which are, or will be, identified by stakeholders as desirable for the intended uses.

11.8.2 Restoration of Capability

The productive capability of the reclaimed landscape will be at least equivalent to that of the pre-disturbed landscape. Generally, the reclaimed landscape should support higher land capability for forest production, and higher capability wetlands and lakes for fish and wildlife than the pre-disturbance landscape. A complete analysis of reclamation capability is included in the Environmental Impact Assessment.

Discussions and research are taking place on the major landscape allocations to forests, grazing land, wildlife, and recreation. Syncrude is confident that, with appropriate allocation of resources and expenditures, previously existing capabilities (as documented in the Environmental Impact Assessment) will be re-established and important additional capabilities created.

11.8.3 Fine Tailings Handling

Syncrude has conducted extensive research, development and mine planning in support of this application. We concluded that the most cost-effective and satisfactory means of dealing with the greater proportion of fine tailings in respect of the Aurora Mine is using the CT technology for tailings disposal.

Syncrude will continue an active fine tails management research and development program as described in Section 8.5.

11.8.4 Composite Tailings Release Water

Syncrude has carried out significant research to develop the composite tailings technology. Results to date indicate that water draining from CT presents similar issues as those that arise with drainage from Mature Fine Tails (MFT). However, there is limited field experience with CT. An extensive research and development program is under way, as described in Section 8.5. A detailed assessment of CT water issues is included in the EIA.

11.8.5 Wind Blown Sand

Minimizing wind blown sand blowing from tailings disposal areas at oil sands mines has been worked on for a number of years. The solution to the problem is stabilization once the construction of the disposal area is complete. At Mildred Lake, Syncrude has employed several techniques to control the wind erosion of fine and coarse particles onto reclaimed areas. These include

- Reclamation of the crest and beach by amending with muskeg and establishing a vegetative cover. This has been effective in controlling the burial of reclaimed areas by sand. However, employing this technique over large areas of beach is not efficient.
- During the fall of 1993, Syncrude dredged Mature Fine Tails onto an area of beach and mixed it with the surface sand using a variety of methods. We are continuing to evaluate the effectiveness of this technique through further trials.
- Syncrude has also experimented with seeding tailings beaches with grass. Syncrude continues to evaluate the effectiveness of this method.

These approaches are applicable to the Aurora Mine. However, the major emphasis at the Aurora Mine will be early progressive reclamation, particularly in out of pit sand disposal areas, which will use the partitioned pond concept to maximize early availability of land for reclamation..

11.8.6 Public Consultation

Syncrude is a strong supporter of public participation in project review, monitoring and evaluation processes.

Following is a description of the reclamation related public consultation activities Syncrude has pursued to date.

- Syncrude took a lead role in advocating and establishing the Regional Land Use/Reclamation Subcommittee of the Fort McKay Interface Committee, which was followed by an active role in the work of that group and support of the recommendations it produced. Syncrude would welcome a continuing mandate for a regional multi-stakeholder group tracking reclamation issues.

- Syncrude funded a survey of post-reclamation land use preferences within the community of Fort McKay.

- The community of Fort McKay has been collaborating with Syncrude on the design and operation of the grazing research program established at Mildred Lake. That research is part of the broader Syncrude initiative to develop the knowledge and ability to reclaim land to a broad range of capabilities, meeting the needs of the people who will be living in the region beyond the lifetime of the oil sands mining industry. Participation by local residents is essential to the success of this initiative.

- Syncrude arranged a tour of reclamation activities at mine sites across Alberta for elders and leaders of the community of Fort McKay, to increase the knowledge base on reclamation issues amongst this key stakeholder group.

- Tours of the oil sands facilities are offered to the general public at low cost by the local tourist bureau. Syncrude supports these tours and has been working to increase the reclamation content of the tours as the reclamation program on our site matures.

- Syncrude endorses public and interest group participation in the annual fine tailings workshops organized by the Land Conservation Department of Alberta Environmental Protection, in fulfillment of a condition of our current D&R approval.

- Syncrude funded a study of existing and potential recreation opportunities, taking advantage of ongoing reclamation activities. This study included a survey of interested organizations in the region including the Naturalist Association and the Fish and Game Association.

- Syncrude has promoted public access to the increasing understanding of fine tailings management issues through the open, inclusive operation of the Fine Tailings Fundamentals Consortium and through frequent presentations at scientific and technical forums.

- Syncrude has established a reclamation interpretive facility at the south west corner of the Mildred Lake S-4 Overburden disposal area. This facility will aid public understanding of Syncrude reclamation programs and performance.

- Syncrude has assembled a panel of recognized external experts (SLRTAP - Syncrude Land Reclamation Technical Advisory Committee) to provide, among other things, external peer review and a public voice in the development of Syncrude's reclamation and closure plans.

11.8.7 Mildred Lake Reclamation

The Aurora Mine as proposed in this application has no effect on Mildred Lake reclamation practices or schedule, except for a possible later date for completion of mining and reclamation in the Mildred lake North Mine. This possibility is dependent on a range of factors, but if it occurred would be considered beneficial to an orderly closure of the Mildred Lake mine.

11.9 Research and Monitoring

Please refer to Section 8.6 for a description of these activities.

References

Alberta Environmental Protection 1995. Draft Fort McMurray-Athabasca Oil Sands Sub-regional Integrated Resource Plan.

Landcare Research and Consulting *et al.* 1996. Baseline Soil Survey, Terrain Analysis and Soil Interpretations for the Aurora Mine EIA.

Leskiw 1996. Land Capability Classification for Forest Ecosystems in the Oilsands Region.

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12.0 Public Consultation Process

Syncrude has established an ongoing commitment to various forms of consultation for ongoing operations and future activities. The commitments that have been established are:

- Proactively interact with interested parties in the Regional Municipality of Wood Buffalo area.
- Provide an extra level of consultation with Fort McKay in recognition of its proximity to both existing and future facilities.
- Maintain open communication with other native communities in the Wood Buffalo region on topics of interest to them.
- Provide information to interested parties regionally, provincially or nationally, responding to issues and requests for information in an effective and timely manner.
- Maintain active and open communication with appropriate government agencies (regional, provincial and federal).

Syncrude has conducted extensive public consultation activities since the Aurora Mine was formally announced to the public on June 12, 1995. Public notice of the Terms of Reference, as required under the *Alberta Environmental Protection and Enhancement Act*, was published in the following newspapers:

- Fort McMurray Today, Edmonton Journal and Calgary Herald on Friday June 30, 1995
- Windspeaker July 31, 1995

12.1 Summary of the Public Consultation Activity

Copies of the Syncrude Aurora Mine, Preliminary Disclosure Document have been provided to approximately 200 individuals, corporations and regulators.

Syncrude provided copies of the Environmental Impact Assessment Terms of Reference as issued by the Director of Environmental Assessment Division, Alberta Environmental Protection on November 17, 1995,to approximately 50 parties. Following this distribution, Syncrude received a number of oral comments and two written responses. The two written responses were from the Fort McKay First Nation and the Fort McMurray Environmental Association

Syncrude has offered and is willing to discuss issues associated with the Aurora Mine with any interested party. Particular attention has been given to ensuring that regional stakeholders are well-informed. While there have been some requests for information, other than regional parties there have been no requests of Syncrude to discuss issues associated with development of the Aurora Mine. A summary of consultation with regional stakeholders follows.

Fort McKay

- Five meetings were held with the Fort McKay Chief between April of 1995 and March of 1996 providing information on Aurora field (winter drilling) and regulatory activities. A meeting was held with the Fort McKay Metis leader providing similar information.

- An information video on the Aurora Mine regulatory process was translated into Cree. This video was shown to the Fort McKay elders on November 21, 1995, and a copy was provided to Fort McKay for their use.
- Nine meetings were held with small groups of Fort McKay elders and Aurora representatives in the first quarter of 1996. A translator was provided at each of these sessions. These sessions provided the elders with basic information on the Aurora Mine and an opportunity to provide information and raise issues. The elders also provided some guidance on the information presented at the March 14, 1996 community meeting.
- A general community meeting was held in Fort McKay on March 14, 1996. Twenty-eight residents attended the meeting.
- Individual meetings which led to the establishment of compensation agreements with four trappers whose traplines are impacted by Aurora.

Fort Chipewyan

- A meeting was held with various Chiefs and Councillors on April 3, 1996, in Fort Chipewyan. The Mikesew Cree, the Fort Chipewyan First Nation and the Fort Chipewyan Metis participated in the discussions. An agreement was put in place to hold a single community meeting for the three groups May 24, 1996. The community meeting was held on the evening of May 24, 1996, with about 250 attendees.

Fort McMurray First Nation, Janvier First Nation

- Syncrude, the Athabasca Tribal Corporation (ATC) and ATC member groups met September 13, 1995. Syncrude committed to consult on the Aurora Mine directly with Fort McKay and Fort Chipewyan. Syncrude also agreed to continue to discuss potential native contract and community development opportunities through currently established Syncrude channels with the Fort McMurray First Nation and the Janvier First Nation. These discussions are continuing.
- Syncrude continues to discuss potential contract opportunities with Metis groups in the Fort McMurray region. This also uses currently established channels.

Wood Buffalo

- A meeting was held with the Wood Buffalo Regional Council on July 5, 1995, to provide them a basic information package on the Aurora Mine..
- Meetings with the Standing Committee on Oil Sands Development were held on February 5, 1996, and April 24, 1996.
- Open houses were held at the Interpretive Centre in Fort McMurray on November 23, 1995, and April 22, 1996. Invitations were sent to all groups that had requested Preliminary Disclosure or Terms of Reference Information and all of the First Nation Chiefs and Metis Leaders. Combined attendance at the two sessions was about 365 people.

- A discussion was held with the Wood Buffalo Regional Planning group and Alberta Transportation and Utilities on May 27, 1996. Topics discussed were the Utility Corridor and road specifications and junction with highway 14-963.
- Syncrude has also discussed the Aurora Mine with the Fort McMurray Construction Association (March 6, 1996) and Northern Alberta Building Trades (March 23, 1996).

In addition to these specific activities, Syncrude has distributed two information bulletins to the mailing list established for the preliminary disclosure document and has provided a telephone hot-line number (790-8118) for inquiries or comments.

Future Consultation Plans

- A list of individuals, groups, communities and companies interested in receiving the Aurora Mine Application has been compiled. The Application will be forwarded to them shortly.
- Dialogue the communities of Fort McKay, Fort Chipewyan and Fort McMurray on a combination of socio-economic and environmental issues will be ongoing.
- Additional dialogue will also occur with individuals, groups or companies as the need arises.

12.2 Summary of Issues Raised

A summary of the comments and questions resulting from these consultation activities follows.

- What are the impacts of the project on vehicle traffic?
  - Highway 63 through Fort McMurray to Mildred Lake.
  - Mildred Lake to Fort McKay turn-off.
  - Fort McKay turn-off to Aurora junction with winter road.
- The road through Aurora North is presently used for access to areas farther north for hunters, trappers and forestry activities. Will this access remain available through the Aurora Mine construction and operation?
- How will Syncrude prevent hydrocarbon spills into the Athabasca River from the product line that crosses the river?
- What actions is/will Syncrude take to ensure an appropriate level of participation of native people both as employees and contractors during the construction phase of the Aurora Mine? And during the operation of the Aurora Mine?
- Presently employment at Syncrude requires completion of grade 12. Is Syncrude prepared to waive this?
- What actions will Syncrude take to ensure local businesses will have a fair chance to participate in this activity?
- Will mine drainage activities at Aurora have an impact on McClelland Lake?
- What impact will land disturbance and mine drainage activities have on fen and bog south of McClelland Lake?
- What rivers and streams are being relocated and what impacts will this have on fishing and fish spawning?

- What can Syncrude do to reduce the length of time between land disturbance and reclamation?
- Will Aurora Mine activities cause any additional impacts on Athabasca River water quality?
- Will Syncrude activities interfere with the operation of the Susan Lake Gravel Pit? Will Syncrude require granular resources from Susan Lake during construction and operation?

12.3 Impacts on the Project from Public Consultation

In addition to the above comments and questions, specific issues have been raised in the following areas:

- Additional emphasis was placed on the development of reclamation strategies that would reduce the average length of time land was in a disturbed state over the life of the mine.
- A tailings siting alternative, which did not require stream relocation, was included for the initial mine opening. This alternative was selected and is included as the final planning base.
- A pipe sleeve (pipe within a pipe) has been added as a risk reduction measure at the Athabasca River crossing of the bitumen froth lines.

Table 12.3-1 - Meeting Dates

PUBLIC CONSULTATION FOR AURORA MINE PROJECT		
Event Date	**Community**	**Activities**
15 May 1995	Suncor	Meeting with Suncor to discuss common application items.
6 June 1995	Fort McKay Environmental Services	Meeting - lobbying for fisheries/wildlife / traditional use contract work
12 June 1995	Fort McKay, Chief Grandjamb	Meeting
19 June 1995	Fort McKay First Nation	Meeting - Explain Aurora Project and Terms of Reference
26 June 1995	Fort McKay First Nation	Baseline Contracts
29 June 1995	200 Mailing List	Sent copy of Preliminary Disclosure Document
4 July 1995	Wood Buffalo Regional Council	Information sharing
6 July 1995	P. Ladouceur	Meeting - Environmental Video
14 July 1995	Fort McKay First Nation	Meeting TOR and Contracts
18 July 1995	Fort McKay First Nation	Meeting - Contracts
19 July 1995	Suncor	Meeting with Suncor to discuss common application items.
21 July 1995	Fort McKay First Nation	Meeting
6 September 1995	Bonnie Evans	Meeting - Baseline Contracts
12 September 1995	Bonnie Evans	Meeting - Baseline Contracts
13 September 1995	ATC-T Mercredi + Chiefs	Update on Aurora.
14 September 1995	Tony Mercredi, ATC	Update Meeting
15 September 1995	Fort McKay Environmental	Meeting - Baseline Contracts
18 September 1995	Fort McKay First Nation	Judy Smith presented impact hypotheses
18 September 1995	P. Ladouceur	Review draft impact hypotheses
19 September 1995	P. Ladouceur & Harriet Boucher	Tailings Tour and information session
21 September 1995	P. Ladouceur	Review Baseline Reports
4 October 1995	Bonnie Evans	Baseline Contracts

PUBLIC CONSULTATION FOR AURORA MINE PROJECT		
18 October 1995	P. Ladouceur	Review Baseline Reports
21 November 1995	Elders Visit	G.Pool update to Elders
24 November 1995	Fort McMurray Community	Newsletter enclosed in the Today newspaper
27 November 1995	Fort McMurray Public 180 Attendees	Open House-Regulatory Process Video and Information Sharing
8 January 1996	P. Ladouceur & S. Sinclair	Meeting - Elders Visits
17 January 1996	Municipality of Wood Buffalo - City Manager + Economic Development Steering Committee	Meeting
25 January 1996	Northland Forest Products	Impact of the Aurora Mine on Northland Operation
25 January 1996	Brown & Root - Edmonton	Update Meeting
25 January 1996	Industra Services - Edmonton	Update Meeting
25 January 1996	Camron - Edmonton	Update Meeting
25 January 1996	Chemco Electrical - Edmonton	Update Meeting
3 February 1996	Fort McKay Metis Local - R. Faichney	Meeting with D. Kershaw update on Aurora
5 February 1996	Standing Committee on Oilsands Development	Update Meeting
6 February 1996	Elder Willie Grandjambe P. Ladouceur	Meeting
6 February 1996	Elder Arthur Boucher	Meeting
7 February 1996	Elder Ernie Lacorde, Emma Lacorde	Meeting
12 February 1996	Employees	Aurora Project information available on Netscape
13 February 1996	Veronica Rolland, Roy Rolland, Edward Rolland, Dophus Ahayason	Meeting
14 February 1996	Fred McDonald, Flora Grandjambe	Meeting

PUBLIC CONSULTATION FOR AURORA MINE PROJECT		
16 February 1996	Emma Faichney, Zachary Powter	Meeting
20 February 1996	Alice Boucher	Meeting
20 February 1996	Fluor Daniel Wright -	Update Meeting
20 February 1996	SNC Lavalin	Update Meeting
21 February 1996	Bantrel Calgary	Update Meeting
21 February 1996	Simons Group	Update Meeting
21 February 1996	Optima Engineering	Update Meeting
23 Ferbuary 1996	Bonnie Evans	Baseline Contracts
23 February 1996	Mary Tourangeau	Meeting
6 March 1996	Fort McMurray Construction Association	Update Meeting
14 March 1996	Fort McKay Community 28 attendees	Community Meeting
18 March	Alice Boucher	Meeting
19 March 1996	Northern Alberta Aboriginal Business	Update Meeting
23 March 1996	Northern Alberta Building Trades - General Membership (500 people)	Update Meeting
27 March 1996	Northern Alberta Building Trades Leaders	Update Meeting
29 March 1996	Stanley & Associates	Update Meeting
29 March 1996	UMA Group	Update Meeting
29 March 1996	Bonnie Evans	Baseline Contracts
3 April 1996	Fort Chipewyan Elders	Initial Meeting
17 April 1996	On the Threshold	Conference on Local and Native Contracting
18 April 1996	On the Threshold	Conference on Local and Native Contracting
19 April 1996	Fort McMurray Community	Newsletter distributed with Today newspaper
22 April 1996	Fort McMurray Public - Meeting - 185 attendees	Open house
23 April 1996	CIM Branch	Aurora Update
24 April 1996	Wood Buffalo Standing Committee on Oilsands Development	Aurora update including a discussion of issues raised at previous meeting.
24 April 1996	Ken Dutchak	Meeting

PUBLIC CONSULTATION FOR AURORA MINE PROJECT		
14 May 1996	Fred Hnytha	Aurora Update
21 May 1996	Bonnie Evans	Baseline Contract
21 May 1996	Peter Ladouceur	Draft Application Review Meeting
22 May 1996	Wood Buffalo Regional Planners	Update on cumulative Socio-Economic Impacts
27 May 1996	Municipality of Wood Buffalo & A. T. & U.	Peter Lougheed Bridge issues/ Highway 14-963 issues
27 May 1996	Fort Chipewyan Community	Community Meeting
3 June 1966	T Punko-Band Manager Fort Chipewyan First Nation	Fort Chipewyan First nation issues

13.0 INFORMATION UNDER OTHER REGULATIONS

1.0 Potable Water Regulations

Under Potable Water Regulations 123/93 approval is required for the potable water treatment and distribution system to be installed at Aurora. The Potable water system is discussed in Section 3.6.4. Design, construction and operation of the facility will be consistent with all Provincial regulations and requirements.

Further information on the Potable Water Treatment Arrangement will be provided at the detailed engineering stage of the project.

2.0 Waste Water and Storm Drainage.

Under the Wastewater and Storm Drainage Regulation 119/93, and approval is required for the wastewater and storm drainage system to be constructed on the Aurora Plant Site is included in Section 3.6.4. Design construction and operation of the facility will be consistent with all provincial regulations and requirements.

Further information on the Wastewater and Storm Drainage arrangement will be provided at the detailed engineering stage of the project.

14.0 Application Format

The following five tables provide a "road-map" of where various information requirements are addressed in the application.

14.1 Energy and Utilities Board Application Guide G-23

ROAD-MAP OF APPROVALS APPLICATION WITH RESPECT TO REQUIREMENTS UNDER EUB APPLICATION GUIDELINE G-23

Section	Requirements	Addressed in: Application Section	Addressed in: EIA
1.5.1	Identification of the Act and Sections thereof under which the application is made;	1.1	Application
1.5.2	The name(s) and address of the applicant and any partners involved in the scheme and the details of company incorporation;	1.0	1.1
1.5.3	A statement of the need and timing for the project;	1.0	Application
1.5.4	An overall description of the proposed scheme, including the location, size and scope, the schedule of preconstruction, construction, start-up activities, duration of operations, and a discussion of the reasons for selecting the proposed schedule;	2.0 3.0 6.0	Application
1.5.5	A description of the regional setting of the development and reference to existing and proposed land use;	2.1, 2.3	4.0
1.5.6(a) 1.5.6(b)	A map indicating the freehold, leasehold, mineral and surface rights of the proposed scheme and surrounding area, and maps with legal description showing the location of landowners and their dwellings in relation to the proposed oil sands site;	2.1 EIA	1.0 Figure 1.4 Figure 1.12
1.5.7	A map showing important topographical features, existing areas of habitation, industry, the proposed site, and any development in the project area;	2.1 EIA Figure 3.7-1	1.0
1.5.8	An aerial photo mosaic of the development area at an appropriate scale to illustrate locations of the project components;	EIA	1.0 Figure 1.4
1.5.9	A general description of storage and transportation facilities of the final hydrocarbon product, including detail of size and ownership of any pipeline which may be utilized;	3.5.1 3.5.4 3.6.1	Application
1.5.10	The proposed rate of production of the hydrocarbon product over the term of years for which approval of the operation is requested;	1.1	Application
1.5.11	a description of the subject oil sands owned by or leased to the applicant;	2.1.1	Application
1.5.12	A description of the status of negotiations held or to be held with the freehold, leasehold, mineral surface rights owners;	2.3, 12.0	Application

1.5.13	A description of the proposed energy source(s), with a comparison to possible alternative sources, the anticipated rates of resource, utilization and a general description of sources and supply;	3.1.1 3.6.3 3.6.5	Application
1.5.14	A description of results of the public information programs planned or initiated for the project;	12.0	8.4.2
1.5.15	The term of the approval sought, including the expected starting and completion dates of the scheme;	1.0 6.0	Application
1.5.16	Name of person who is responsible for the application and to whom correspondence should be addressed	1.0	1.1
2.1.1(a) to (k)	A geological description of the zone or zones of interest within the project area supported by	3.2.1	Application
	(a) a description and illustration of the log and core evaluation techniques, geophysical surveys, quality control measures used, and any correlation's made,	AUR	
	(b) maps showing the locations of all evaluation wells and indicating those that have been cored and those that have been logged, and their purpose,	Figure 3.7-5 Figure 11.2	
	(c) maps showing the location of other evaluation methods such as seismic or electromagnetic surveys,	AUR	
	(d) a description of oil sands depositional environments, facies distinction, character, fines and their effects upon resource recovery, lateral and vertical continuity and subsurface features such as sinkholes, faults or joint sets, supported by representative cross-sections, isopach and contour maps,	3.2.1 Table 3.2-2	
	(e) a description of the techniques used to model geological data,	3.2.2	
	(f) a description and interpretation of dip measurement programs completed within the project area supported by appropriate maps,	AUR	
	(g) a description of the overburden geology identifying facie's characteristics, buried channels, and construction materials with supporting maps and cross sections,	3.2.1	4.2
	(h) identification of geotechnically sensitive materials with maps showing their vertical and lateral distribution,	AUR	

2.1.1(a) to (k) Cont'd	(i) a description of the regional hydrological conditions including flow regimes, aquifer thickness maps and aquifer quality, (j) specific hydrological and geological details, maps and cross sections within proposed locations for the plant site, tailings, discard and storage sites, and other surface facilities, and (k) a description of future evaluation work to be carried out and supported by a plan;	Figure 3.2-9 Table 3.7-1 3.2.1 3.2.1, 3.2.5 3.7.4 3.2.1	Application
2.1.2(a) to (g)	An evaluation of the reserves within the project area, the mine site, plant site, tailings site, discard site and other surface facilities which include: (a) a description of the cutoff grade and thickness criteria used to establish the in-place resources potential of the project area supported by reserve trends and appropriate maps, (b) a description of the cutoff grade, thickness and dilution criteria used to define potentially mineable oil sands including results derived from ore criteria studies used in conjunction with geology, project economics and mine planning, c) the relationship between ore quality and bitumen extraction recovery and its basis, (d) maps showing the quality of the oil sands zone or zones, (e) a tabulation of the in-place and potentially recoverable crude bitumen volumes for the zone or zones of interest supported by maps and representative cross sections, (f) maps showing the overburden thickness, centre reject thickness, ore thickness, waste to ore ratio and bitumen saturation after applying the mineable oil sands criteria, and (g)a description and illustration of the methods used to estimate ore, waste, grade and reserve volumes;	3.2.2 3.2.2 AUR 3.5.3 3.2.1, 3.2.5 3.2.1, 3.2.5 3.2.1, 3.2.5 3.2.2	Application

2.1.3(a) to (c)	A description of the project layout and mining equipment selected supported by (a) maps showing the land surface topography and project layout, (b) separate plans and description of the proposed plant site, tailings disposal sites, discard sites and storage sites showing the alternative locations examined, cost breakdowns comparing the proposed sites to alternative locations, construction, land acquisition or other considerations, and the recovery costs associated with mining any potential ore under the proposed sites, (c) a description and illustration of the mining equipment selection method and proposed mining method including comparisons to alternate methods and reasons for selection;	3.2.4 Status Maps Figure 3.7-1 Appendix A 3.2.4	Application
2.1.4(a) to(d)	A description of the mine development plans supported by (a) a description of the analysis completed to determine the location of the opening cut having consideration for annual production requirements, in-pit storage optimization and out-of-pit storage restrictions, (b) tabulation of overburden, ore centre reject, grade, fines and crude bitumen volumes for each of the first six years and in subsequent three year mining blocks thereafter, over the life of the mine supported by two plans referencing the mining and overburden removal blocks respectively, (c) tabulation of discard storage and tailings stream volumes itemized by storage site, (d) a description and illustration of specific criteria that may apply to the recovery of oil sands at the base of feed, pit limits or to specific periods in the mine life, supported by contour maps of the mine area showing the final pit floor and the base of potentially mineable oil sand elevations;	3.2 Appendix A 3.2 Table 3.3-2 Table 3.3-3 Table 3.2-6 3.2.0, 3.2.2 Status Maps	Application

2.1.5(a) to (e)	A description of the design, stability analysis, construction method and schedule of pit slopes and discard, including tailings, supported by (a) plan view maps and cross sections, (b) a description of strengths and test results completed on each material type or assumed pore pressure and factor of safety results, (c) a description of the dip trends and zones of weak materials existing in the mine area and their impact upon bench orientation, mine plans and stability as mining progresses, (d) a description and illustration of blasting patterns, test results and the effect upon bench stability, (e) a description and illustration of the depressurization program including aquifer characteristics and variability and pump test results;	3.2.4, 3.2.8 3.3 3.2.1, 3.2.5, 3.3 AUR AUR AUR 3.2.1 3.7.5	Application
2.4.1(a) to (d)	a separate description of the bitumen extraction and utilities facilities, including (a) a discussion of the process, (b) process flow diagrams indicating major equipment, stream rates and composition, and the proposed production measurement devices, characteristics and locations, (c) chemical and physical characteristics and properties of feeds and product materials, including, for tailings, the following: clear liquid, turbid liquid (percentage solids), size analysis, mineralogical characteristics, settling characteristics and solids (percentage moisture), (d) the relationship between ore quality, processing, and sludge generation and storage.	3.5 3.6 3.5, 3.6 3.1.1 Figure 3.1-1 Figure 3.5-3 to 3.5-8 Table 3.6-3 to 3.6-8 3.2.2, 3.3 3.2.1, 3.3 3.5.1 3.5.3	Application
2.4.2	Overall material and energy balances, including information with respect to hydrocarbon and sulphur recoveries, water use and energy efficiency;	3.5.2 3.6.3, 3.6.5 Table 3.6-3 to 3.6-5 Table 3.6-8 to 3.6-11	Application
2.4.3	The quantity of products, by products and discard generated and a general description of their disposition;	3.5.4, 3.6.5 7.0 9.0	Application
2.4.4	The manner in which surface drainage within the areas of the processing plant, product storage and discard disposal would be treated and disposed;	3.7	Application

2.4.5	A comparison of the proposed process with alternative processes considered on the basis of overall recovery, energy efficiency, cost, commercial availability and environmental considerations and the reasons for selecting the proposed process;	Appendix A	Application
2.4.7	A sample set of production accounting reports for the processing facility with each entry explained using flows from the identified measurement points and calculated flows based on sound engineering techniques.	N/A	N/A
2.5.1	A description of any facilities to be provided for the generation of electricity to be used by the project;	3.6.3	Application
2.5.2	Identification of the source, quantity, and quality of any fuels, electricity or steam to be obtained from sources beyond the project site;	3.6.3	Application
2.5.3	Where energy resources from outside the project boundaries are to be supplied to the project, a detailed appraisal of the options available to eliminate the need for such resources, with consideration for overall recovery, energy balance, costs, technical limitations and environmental implications.	3.6	Application
2.6.1	A description of air and water pollution control and monitoring facilities, as well as a liquid spill contingency plan;	3.6 3.7 10.0	Application
2.6.2(a) to (d)	A description of the water management program, including: (a) the proposed water source and expected withdrawal, (b) The source-water quality control, (c) the waste-water disposal program, (d) a water balance for the proposed scheme,	3.6.5 3.7	Application
2.6.3	The manner in which surface water drainage within the project area would be collected, treated and disposed;	3.7	Application
2.6.4	A description of the air and water pollution control and monitoring facilities.	3.6, 3.7, 7.0 Note 1	Application
2.6.5(a) to (d)	a description of the emission control system including: (a) stack design criteria and process data, (b) any additions of residue gas or natural gas to the flare system to ensure combustion of hydrogen sulphide, (c) methods proposed for the control of all air pollutants from all potential or actual sources at the operation during normal, emergency and maximum operating conditions, (d) the monitoring program for hydrogen sulphide, sulphur dioxide, total sulphation, hydrogen sulphide, soil pH, nitrogen oxides and hydrocarbons in the surrounding area;	 Note 1 3.6.5 Note 1 8.0	Application

3.1.1(a) to (g)	An appraisal and projections, on an annual basis of: (a) revenues by product, (b) itemized capital and operating costs, including a breakdown of furl costs and non-fuel operating costs, (c) some discussion of the project financing, (d) royalties and taxes, (e) net cash flow, (f) marketing arrangements, and (g) supply arrangements for fuel requirements and electric power;	EIA	Note 2
3.1.2(a), (c) and (d)	A description of project costs which include capital and operating costs and: (a) for a mining application: a breakdown for each component of the project including site preparation, overburden stripping, oil sands mining, extraction upgrading, tailings, utilities and off-sites, operating costs, (c) for processing applications: a breakdown for each component of the project including site preparation, production/injection distribution system; upgrading, utilities and off-sites, (d) for pollution abatement and monitoring: a breakdown of capital and operating costs related to overall project costs.	EIA	Note 2
3.2.1	A summary of quantifiable public benefits and costs incurred during the construction and operation of the project as they pertain to the Province of Alberta and Canada;	EIA	8.4, 8.5
3.2.2	A summary of non-quantifiable public benefits and costs incurred each year during construction and operation of the project as they pertain to Alberta and Canada;	EIA	8.4, 8.5
3.3.1	An appraisal of the economic impact of the project on the region, province and country;	EIA	8.5.6
3.3.2	A discussion of any initiatives undertaken in conjunction with the project to accommodate regional economic priorities and interests;	12.0	8.0

3.3.3 (a) to (d)	An assessment of direct and indirect employment opportunities for all groups associated with the project including: (a) A projection of maximum and minimum workforce demand by skill categories in the construction (quarterly) and operating (annual) phases, and an analysis of how these demands will be met. Identify the perceived shortages. (b) an analysis of the indirect and induced employment generated by the project due to employment multiplier effects, (c) a discussion of the employment and training arrangements that would be provided by the applicant to enable residents of the region to participate in meeting the workforce demands, an to what extent these arrangements, might alleviate any perceived labour shortages, and (d) a discussion of any arrangements with, the applicant's recommendations to various government agencies (vocational training institutes, advanced educational; programs etc.) to facilitate the utilization of the local, regional and provincial workforce in the project.	EIA	 8.4.4 8.4.4 8.5.3 8.5
4.0	An Environmental Impact Assessment as outlined in the Terms of Reference.	EIA	EIA
5.0	A Biophysical Impact Assessment		5.0
6.0	A social impact assessment presenting the effects of the scheme on the population base in the impacted area and its consequence on the need for infrastructure.	3.1.3	8.4
7.0	An environmental protection plan addressing both biophysical and social impacts including mitigation measures, environmental monitoring, and environmental research.	EIA 4.0	Table 1.5.1
8.0	A conceptual Development and Reclamation Plan	11.0	Application
9.0	A Solid Waste Management Plan describing the solid wastes to be generated, their disposal methods and location.	9.0	Application

Note 1 - Information pertaining to these requirements will be provided at the detailed engineering stage.

Note 2 - Overall economic benefits of the project are provided in the Socio-Economic section of the EIA. Other detailed economic information has not been provided.

AUR - Information Available Upon Request

14.2 AEPEA Approvals Regulation 113/93, Section 3.1 (a - s)

ROAD-MAP OF APPROVALS APPLICATION WITH RESPECT TO REQUIREMENTS UNDER AEPEA APPROVALS PROCEDURE REGULATION 113/93

Clause	Requirement	Addressed in: Application Section	Addressed in: EIA
3(1)a	The name and address of the applicant;	1.0	1.1
3(1)b	The location, capacity and size of the activity to which the application relates.	1.0, 2.0, 3.4	1.0
3(1)c	The nature of the activity, the change to the activity or the amendment, addition or deletion, as the case may be;	3.1 - 3.7	1.0
3(1)d	Where the applicant requires an approval from the Energy Resources Conservation Board or the Natural Resources Conservation Board in relation to the activity, the date of the written decision in respect of the application;	1.0 1.1	Application
3(1)e	An indication of whether an environmental impact assessment report has been required	4.0	
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;	5.0	Application
3(1)g	The proposed or actual dates for construction commencement, construction completion and commencement of operation;	6.0	Application
3(1)h	A list of substances, the sources of the substances and the amount of each substance that will be released 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, the method by which the substances will be released and the steps taken to reduce the amount of the substances released;	3.6 3.7 7.0	Application
3(1)i	A summary of the environmental monitoring information gathered during the previous approval period;	EIA	4.0
3(1)j	A summary of the performance of substance release control systems used for the activity during the previous approval period;	N/A	N/A
3(1)k	The 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;	7.0	5.0

3(1)l	The measures that will be implemented to minimize the amount of waste produced, including a list of the wastes that will or may be produced, the quantities and the method of final disposition of them;	3.5.4 3.6.5 7.0, 9.0	Application
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;	2.0 3.2.4 3.3.2 4.0	Table 1.5.1 5.0
3(1)n	confirmation that any emergency response plans that are required to be filed with the local authority of the municipality in which the activity is or is to be carried on or with Alberta Public Safety Services have been so filed;	10.0	Application
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;	10.0	Application
3(1)p	the conservation and reclamation plan for the activity;	11.0	Application
3(1)q	A description of the public consultation undertaken or proposed by the applicant;	12.0	Applcation
3(1)r	Information required under any other regulation under the Act to be submitted as part of or in support of the application;	N/A	N/A
3(1)s	Any other information required by the Director, including information that is addressed in a standard or guideline in respect on the activity that is published or adopted by the Department.	N/A	N/A

14.3 Applications Guide for Development and Reclamation of Oil Sands Mining Operations.

ROAD-MAP OF APPROVALS APPLICATION WITH RESPECT TO THE REQUIREMENTS UNDER SECTION 8 OF THE GUIDE TO THE PREPARATION OF APPLICATIONS AND REPORTS FOR COAL AND OIL SANDS OPERATIONS

Section	Requirements	Addressed in: Application Section	Addressed in: EIA
2.0	**Conceptual Development and Reclamation Plan**		
2.1	Overview of the Development	3.1	1.0
2.2	Life-of-Mine Development Plan	3.1, 6.0	Application
2.2.1	Mining	3.2.4, 3.2.8 11.0	Application
2.2.2	Infrastructure	Figure 1.0-2 3.2.4, 6.0	Application
2.2.3	Water Mangement	3.2.1, 3.2.4 3.2.5, 3.6.5 3.7	Application
2.2.4	Plant Site andAssociated Facilities	3.2, 3.5.1, 3.5.4, 3.6.5, 11.5	Application
2.3	**Life-of-Mine Reclamation Plan**		
2.3.1	Conceptual Plan	3.2.4, 11.0	Application
2.3.2	Restoration of Capacity	11.7	4.3, 4.3
2.4	**Development and Reclamation Plan**		
2.4.1	Biophysical and Mining Issues	EIA	4.3, 4.54
2.4.2	Public Participation	11.9, 12.0	3.0
3.0	**Pre-Development Site Analysis**		
3.1	Biphysical Inventory		4.0
3.1.1	Climate		4.1
3.1.2	Topography and Erosion Potential		4.2.1
3.1.3	Soils and Overburden		4.3
3.1.3.1	Soils		4.3
3.1.3.2	Overburden (Surficial and Bedrock Geology)		4.2.2, 4.2.3
3.1.4	Water Resources		4.4, 4.5
3.1.4.1	Surface Water		4.4
3.1.4.2	Hydrogeology		4.5
3.1.5	Vegetation and Forest Resources		4.6
3.1.6	Fisheries and Wildlife (Habitat and Resources)		4.7, 4.8
3.1.6.1	Wildlife		4.7
3.1.6.2	Fisheries		4.8

3.1.7	Special or Unique Land Uses on Features		4.9
3.1.8	Pre-Development Land Use		4.9
3.2	Pre-Development Land Capability		4.9
3.2.1	Capability for Agriculture		4.6, 4.9.6
3.2.2	Cabability for Forestry		4.6, 4.9.6
3.2.3	Capability for Wildlife and Fisheries		4.7, 4.8
3.2.3.1	Wildlife		4.7
3.2.3.2	Fisheries		4.8
3.2.4	Capability for Recreation		4.9
4.0	**Detailed Development and Reclamation Plan**		
4.1	Background	11.1	
4.1.1	Upgraded Pre-Development Site Analysis	11.2	4.0
4.1.2	Upgraded Conceptual Development and Reclamation Plan	3.2.4 11.0	
4.2	**Development Plan**		
4.2.1	Mining	3.2, 11.0	
4.2.2	Infrastructure	Figure 1.0-2 3.2 6.0	
4.2.3	Water Mangement	3.2.1, 3.2.4 3.2.5, 3.6.5 3.7	
4.2.3.1	Drainage Control	3.2.4, 3.2.5 3.7	
4.2.3.2	Groundwater Diversion Plan	3.2.1, 3.7.5	
4.2.4	Plant Site and Associated Facilities	1.0, 1.1, 3.4	
4.2.5	Timber Salvage Plan	3.2, 3.2.4	
4.2.6	Soil Salvage Plan	3.2, 3.2.4 11.6	
4.2.7	Land Ownership	2.1 2.3	
4.3	**Reclamation Plan**		
4.3.1	General	11.0	
4.3.2	Topography	11.0	
4.3.3	Soil Replacement Plan	11.5	
4.3.4	Revegetation Plan	11.8	
4.3.5	Wildlife Habitat Plan		5.7
4.3.6	Re-Establishment of Surface Water Resources	11.7	
5.0	**Research and Monitoring**	8.1	

14.4 EIA Terms of Reference Pursuant to AEPEA

SYNCRUDE AURORA MINE FINAL TERMS OF REFERENCE FOR EIA CROSS-REFERENCED WITH THE SYNCRUDE APPLICATION

Terms of Reference Point	Environmental Assessment Topic or Issue	Addressed in: Application Section	Addressed in: EIA
1.0	**Introduction**		
1.2	**Public Consultation**		
1.2	inform the public	12.0	3.1
1.2	document consultation measures	12.0	3.2
1.2	record suggestions and concerns	12.0	3.3
1.2	demonstrate how concerns addressed	12.0	3.1
1.2	document contact with aboriginal peoples	12.0	3.0
1.3	**Proponent's Submission**		
1.3	a glossary of terms		1.0
2.0	**Project Overview**		
2.1	describe Syncrude and key developers/operators	1.0, 2.0	1.1
2.2	**Proposed Development and EIA Study Area**		
2.2	legal description and boundaries mine pits, material disposal locations dewatering and water control facilities	Figure 1.0-2 2.1 Status Maps in Section 3.2	Figures 1.2.1 and 1.2.2 1.3.2
2.2	Infrastructure: roads, powerlines, pipelines, building complex, sewage treatment	3.6	1.3.1 Application
2.2	Study Area rationale for selection for each study component, air quality, aquatics, socio-economics	EIA	1.7 8.4.1.1
2.2	landscape characteristics considered: Athabasca River Valley wetlands characteristics	3.2.1, 3.2.5	1.7
2.3	**Project Components and Development Schedule**		

2.3	stages of development description for construction, operation, and abandonment of mine areas, oil sand extraction facilities, transportation facilities, buildings, local infrastructure	3.0 6.0 11.4	1.3.1
2.3	Development schedule for components with expected duration of each component Schedule of reclamation for first decade conceptual plans for decommissioning/reclamation/abandonment for activities completed within 20 years	6.0 11.0	1.3.2 2.2.7
2.4	**Project Need and Alternatives**		
2.4	Project Need	1.0	1.4.1 Application
2.4	project alternatives, environmental implications	Appendix A	1.4.1 Application
2.4	rationale for selected alternative	Appendix A	1.4.1 Application
2.4	component selection: technical, geotechnical, economic, environmental criteria: rationale for selection of components and rationale for location of components	Appendix A	1.4.1 Application
2.4	alternative technologies and methods: substance release	7.0, 8.0	1.4.1 Application
2.4	studies to improve operations, reclamation	8.0	2.5.2 Application
2.4	linkages to other facilities and approval changes	3.1.2, 2.2	Application
2.5	**EIA Summary**	4.0	1.5
2.5	summary of results (address i. to v.)	4.0	Table 1.5.1
2.5	regional, temporal and cumulative effects	4.0	Table 1.5.2
2.5	impact significance- magnitude, extent, duration, frequency, reversibility- quantitative predictions where possible	4.0	Tables 1.5.1 & 1.5.2
2.5	participation in monitoring activities	8.0 4.0	Table 1.5.1 Application
2.6	**History, Regulatory Approval**		
2.6	activities in the area, map and discussion	EIA	1.6
2.6	legislation, policies, approvals: provincial, municipal, federal	1.0, 2.0 5.0	Application
3.0	**Project Description**		
3.1	Site Development	3.1	
3.1	preferred location of mine, plant site, oil sand processing and orebody	Appendix A	1.4.1 Application

3.1	development sequence	6.0	1.3.2
3.1	illustrate site development plan, lease development location of mining, mine area, plant site, tailings, overburden storage, chemical storage locations	Status maps in Section 3.2 1.0, 2.1, 3.4 9.0	1.3 Figures 1.2.1 & 1.2.2
3.1	stages of development activities and their environmental effects	Status maps in Section 3.2 1.0, 2.1, 3.4 9.0	1.3 Figures 1.2.1 & 1.2.2
3.1	location map for existing and proposed facilities and their components utility/transportation corridors roads and bridges pipelines (production, water)	1.0 Status Maps in Section 3.2	Figures 1.2.1 & 1.2.2, 1.6 Application
3.1	Surface disturbance extent land clearing disturbances in the river valley disturbances of waterbodies and wetlands duration and magnitude of disturbances	Status Maps in Section 3.2	1.3.1 Tables 1.3.1, 5.3.1, 5.5 & 5.6
3.2	**Process Description**		
3.2	technology advances and environmental effects	3.3, 3.5, 3.6, 3.7, 7.0	Application
3.2	mine: material balances, energy balances, flow diagrams	3.2, 3.2.4	Application
3.2	processing oil sands: material/energy balances, flow diagrams	3.2, 3.3, 3.5, 3.6,	Application
3.2	short and long term mining plans	3.2	Application
3.2	hydrotransport operations	3.5	Application
3.2	future development and design efforts	8.0	Application
3.2	reducing tailings (quantity and storage time) reducing discharge of contaminants to air, land, water re-use, recycle, recover useful products from waste stream evidence of optimal environmental performance	3.3 3.5 3.6 9.0	Application
3.2	chemical inputs: quantities and regulatory class	3.5, 3.6.5	Application
3.3	**Mine Plan**		Application
3.3	open-pit mine location drawings mine sequence	3.2 Status maps	Application

3.3	timber salvage and clearing, muskeg drainage, mine depressurization, water management, soil salvage, overburden removal, aggregate resource management and placement,	3.2.4 3.2.8 3.7 11.7	Application
3.3	oil sands ore recovery and transport, tailings management and land reclamation type and size of mining equipment	3.2.2, 3.3, 3.5, 11.0, 3.2.4	Application
3.4	**Product Handling**		
3.4	onsite hydrocarbon storage	3.5.1	Application
3.4	containment and environmental protection	3.5.1	Application
3.4	transportation of substances	3.5, 3.6, 9.0	Application
3.4	environmental protection measures	3.6, 9.0	Application
3.5	**Water Supply and Wastewater Management**		
3.5	water requirements (normal and emergency) annual and seasonal variations	3.6.5	Application
3.5	water intake structures and pipeline address fish entrainement and navigation hazard	N/A	N/A
3.5	water and wastewater balance	3.6.5	Application
3.5	a water management plan design factors for containement	3.3, 3.6, 3.7	5.3.1 Application
3.5	water storage, treatment, sources, withdrawal minimization	3.6	Application
3.5	volume and quality of effluents: extraction, upgrading, tailings management, discharges from management works basal aquifer releases	3.3, 3.5, 3.6, 3.7	Application
3.5	characterize each liquid waste stream	3.6	Application
3.5	describe wastewater treatment systems	3.6	Application
3.5	Environmental effects of wastewater disposal	EIA	5.3.1, 5.3.2
3.5	discharges from reclamation sites	11.6, 11.7	5.3.1, 5.3.2
3.5	interchange of water between mine and water bodies implications on surface and groundwater flows wetlands and McClelland Lake	EIA	5.3.1 5.4.1
3.5	potential impact on downstream seasonal water flow, boating use, or other water withdrawals	EIA	5.3.1 5.12.3
3.5	watercourse diversions alterations to wetlands and peatlands	3.7	5.3.1 5.6.1.3
3.5	measures to prevent or minimize adverse impacts	EIA	5.3.1, 5.12.3
3.5	R&D to characterize waste streams evaluate water/waste water treatment methods	8.5	Application

3.6	**Air Emissions Management**		
3.6	characterize air emissions from each project component (normal and abnormal/upset ops)	3.6, 7.0	5.2.1
3.6	regional, long term changes, cumulative considerations	EIA	5.12.2
3.6	emission control technologies: best available, best practical, best achievable technology	3.6	Application
3.6	control technologies for volatile, hazardous, odorous pollutants	7.2	Application
3.6	life-cycle greenhouse gas emissions	1.0	5.2.1, 5.12.2
3.7	**Waste Management**		
3.7	waste management plans minimization and recycling	9.0	Application
3.7	characterize and classify mine and processing wastes	3.2.4, 3.2.8	Application
3.7	onsite disposal areas: location, timing	3.2, 9.0	Application
3.7	hazardous wastes	9.2.1	Application
3.7	contaminant release risk	EIA	5.11
3.7	liabilities to Syncrude, community residents and government	9.0	5.3.2.5, 5.6.3, 5.8.1, 5.10
3.8	**Utilities, Transportation, Other Infrastructure**		
3.8	infrastructure routing and location: components served, responsibilities, regional implications	3.6	1.4.1.7 Application
3.8	utilities components, amount and sources of energy, water needs and sources, energy and water efficiencies	3.6.2 3.6.4	1.3.1.5 Application
3.8	travel of personnel and equipment to project components during construction and ops public access	3.6.2, 9.2.2	1.3.1.4 Application
3.8	route selection construction and reclamation materials	3.6 Appendix A	1.4.1.7 Application
3.8	access: regional and local road implications: Hwy. 63, existing roads document input from RMWB and provincial authorities	3.6 12.0	5.9
3.8	route selection criteria, process selected alternative discussion	3.6 Appendix A	1.4.1.7 Application
3.8	land area disturbed by project component and phase stream crossings and wetlands	3.6.2	1.3.1 Tables 1.1.3 & 5.3
3.8	linear disturbances to permafrost soils	EIA	5.5.2
3.8	schedule and environmental protection plans	3.6, 6.0, 11.0	5.11
	Monitoring, Operating and Contingency Plans		

3.9	outline plans for monitoring of all inputs and waste streams	8.0	Application
3.9	key elements of operating plans and performance standards	8.0	Application
3.9	existing environmental protection and monitoring programs	8.0	Application
4.0	**Socio-economic Information**		
4.0	describe social impacts: employment, training, procurement, population changes, demand on local services, infrastructure, regional and provincial benefits, trapping, hunting and fishing	3.1.3	8.4.4, 5.9
4.0	describe economic impacts Alberta Industrial Benefits Strategy	EIA	8.5
4.0	workforce during construction and operations characteristics	EIA	8.5
4.0	population changes due to the proposed project	EIA	8.4.4
4.0	employment and business development opportunities	EIA	8.4.4
4.0	training needs and opportunities	EIA	8.0
5.0	**Heritage Resources**		6.0
5.0	document heritage resources review and consultation with Alberta Community Development	EIA	6.0, 7.0
6.0	**Environmental Information Assessment Requirements**		
6.1	framework existing conditions data required to assess impacts and gaps baseline conditions including previous disturbances	4.0	5.1
6.1	describe nature and significance of environmental effects	EIA	5.1
6.1	environmental protection plan	EIA	5.1
6.1	residual impacts and their significance	EIA	5.1
6.1	demonstrate environmental performance	EIA	5.1
6.1	joint industry, community, and government efforts	EIA 4.0	Table 1.5.1 Application
6.1	community concerns	12.0	3.2
6.1	demonstrate data from previous studies are valid for this EIA	EIA	4.1, 5.2.1
6.1	long term considerations for environmental protection	EIA	4.1
6.2	**Climate and Air Quality** (apply 6.1)	EIA	4.1, 5.2.1

6.2	baseline climate and air quality conditions	EIA	4.1
6.2	characterize existing air quality: key parameters, odours, fugitive emissions and climate/weather	EIA	4.1, 5.2.1
6.2	air quality modelling: selection, constraints, results other existing or planned operations in the region	EIA	5.2.1, 5.12.2 Appendix B
6.2	identify activities that affect air quality	EIA	5.2.1
6.2	effects under normal and worst case scenarios for environmental protection and public health	EIA	5.2.1
6.2	air quality monitoring: project	EIA	5.2 Application
6.2	dispersion models consider terrain local and regional	EIA	5.2.1 Application
6.2	impacts on provincial and federal commitments regarding greenhouse gases	1.0	5.2.1
6.3	**Noise** (Apply 6.1)	EIA	4.1.4, 5.2.2
6.3	baseline noise conditions noise sensitive environmental features	EIA	4.1.4
6.3	project noise by component implications measures to minimize noise	EIA	5.2.2
6.4	**Ecological Land Classification**		
6.4	provide an ecological land classification	EIA	4.6
6.5	**Geology, Soils and Overburden**		
6.5	map of bedrock and surficial geology, topography, drainage	3.2	4.2, 4.3 Baseline Reports
6.5	estimate changes to pre-development topography	EIA	5.5.1
6.5	describe changes to the Muskeg River watershed protection measures	EIA	5.3
6.5	describe overburden geology and soil types suitability for reclamation	11.0	4.2, 4.3
6.5	outline criteria for salvaging surface materials for reclamation	11.0	2.0 Application
6.5	estimate volume of reclamation material required	EIA 11.0	2.0 Application
6.5	comment on sesitivity of each ecological land classification unit to disturbance	EIA	5.6
6.5	address erosion potential topsoil depth	11.0	4.3

6.5	identify activities of potential soil contamination	EIA	5.2.2
6.6	**Vegetation and Forest Resources** (Apply 6.1)		
6.6	describe and map vegetation communities in the EIA Study Area and Muskeg River Watershed	EIA	4.6 Baseline Reports
6.6	discuss the amount of onsite and off-site vegetation affected	EIA	5.12.6
6.6	determine the amount of forest to be disturbed productive and non-productive	EIA	5.9.1
6.6	identify special status species	EIA	4.6
6.6	identify primary vegetation species of each landscape unit, used for wildlife food or shelter, indicator species for environmental effects: relative abundance	EIA	4.6 4.7 5.1
6.6	ecological land classification map successional stages landscape units importance of wildlife habitat, timber harvesting land use habitat diversity	EIA	4.6, 4.9
6.6	land disturbed: amount, nature and duration of changes, ability to reclaim to similar conditions discuss techniques used to estimate the sensitivity to disturbance and reclamation	EIA	5.6
6.6	mitigation plan for site clearing: timing, effects on runoff, water quality	EIA 4.0	5.6 Table 1.5.1
6.6	discuss objectives for post development vegetation	11.0	2.0 Application
6.6	returning self-sustaining habitat equivalent to pre-disturbance conditions; maintaining biological capability and diversity	11.0	2.0, 5.6 Application
6.7	**Wildlife** (Apply 6.1)		
6.7	use of the project area by wildlife: include seasonal use, rare and endangered species: occurrence, habitat needs	EIA	4.7 Baseline Reports
6.7	potential for adverse effects habitat fragmentation	EIA	5.7
6.7	protection of wildlife management strategies combined effects on wildlife from activities in the watershed and region	EIA	5.7, 5.12.7
6.7	special use areas (calving, nesting, movement corridors)	EIA	4.7
6.7	sensitivity to disturbance	EIA	5.7

6.7	map of habitat for key indicator species	EIA	4.7 Baseline Reports
6.7	mitigation strategies, plan and monitoring of effectiveness	EIA 4.0	5.7 Table 1.5.1
6.7	compliance with provincial and federal policies for wildlife habitat	EIA	4.7
6.8	**Aquatic Resources**	EIA	
6.8	existing fish resources and habitat species composition, movement Athabasca River, Muskeg River, tributaries	EIA	4.8
6.8	map of fish habitat: sensitive areas, spawning, rearing, overwintering habitats, seasonal use, movement pattern Athabasca River, Muskeg River, tributaries	EIA	4.8 Baseline Reports
6.8	critical life stages and requirements for key species; rationale for key species chosen	EIA	4.8, 5.1
6.8	identify construction and operation activities which may affect fish habitat, fish resources, riparian areas	EIA	5.8
6.8	alterations or diversions of watercourses	EIA	5.8
6.8	effects: nature, extent, duration: mitigation: residual impact	EIA	5.8
6.8	adherence to provincial and federal policies for fish habitat: "No Net Loss Principle"	EIA	5.8
6.8	monitoring plans: habitat quality, mitigation effectiveness	EIA 4.0	5.8 Table 1.5.1
6.8	management strategy, access control	EIA	5.8
6.8	habitat protection in the Muskeg River Watershed	EIA	5.8
	Surface Water (Apply 6.1)		
6.8	describe surface hydrology before and after project	3.7	4.4.1, 5.3.1
6.8	effects on water quantity and quality	EIA	5.3.1, 5.3.2
6.8	outline monitoring and protection of surface water, instream needs for Muskeg River, McClelland Lake Wetlands, Athabasca River	8.4	5.3.1, 5.3.2, 5.8
6.8	site run-off handling protection of banks and setbacks alterations or diversions of watercourses	3.7	5.3.1, 5.3.2 Application
6.8	wastewater, mine depressurization, runoff: timing, volume, peak flow, significance for downstream basins	3.7	5.3 Application
6.8	probable maximum flood and precipitation events	3.7	4.4.1 Baseline Reports
6.9	**Groundwater**		

6.9	describe the groundwater regime	3.2.1, 3.7.4	4.5
6.9	local and regional system	EIA	4.5
6.9	effects on groundwater	EIA	5.4
6.9	options to manage and protect groundwater	EIA 4.0, 8.4	5.4 Table 1.5.1
6.9	interrelationship with surface water: effects	EIA	5.3, 5.4
6.9	implications of groundwater effects for terrestrial and riparian vegetation, wildlife, aquatic resources: mitigation	EIA	5.5, 5.6, 5.7, 5.8
6.10	**Water Quality**	EIA	
6.10	describe water quality before and after the project	EIA	4.4.2, 5.3.2
6.10	Muskeg River and surrounding watersheds	EIA	4.4.2, 5.3.2
6.10	baseline water quality	EIA	4.4.2
6.10	seasonal variations in water quality: existing, expected activities which may influence water quality, timing and quantity (clearing, mining, reclamation)	EIA	4.4.2, 5.3.2
6.10	effects of activities on water quality: mitigation: residual effects for each stage, including post-reclamation	EIA 4.0	5.3.2 Table 1.5.1
6.10	impact on seasonal and year to year variations	EIA	5.3.2
6.11	**Land Use**		
6.11	Unique sites and special features	EIA	4.9 Baseline Reports
6.11	existing land uses and changes in use	2.0	4.9, 5.9
6.11	applicable land and resource use policies, management schemes: implications, constraints to development	11.0	4.9, 5.9
6.11	impact on land uses: mitigation	EIA 4.0	5.9 Table 1.5.1
6.11	MSL: changes to extent and timing of occupation	2.1.1	Application
6.11	potential for cumulative effects	EIA	5.12.9
6.11	recreational, commercial and Aboriginal	EIA	4.9, 6.2 Baseline Reports
6.11	mitigation strategies	3.6, 2.3, 4.0, 11	5.9 Table 1.5.1
6.11	document current dispositions and consultations with existing land users	2.3	2.0, 3.1, 4.9
6.11	visual impact	EIA	5.9.5

6.11	long term destination	EIA	5.9
6.11	regional activities and cumulative land use impacts stakeholder management issues	11.0	5.12.9
6.11	publicly available information and consultations	EIA	3.1
	Athabasca River Valley		
6.11	describe the valley, resources and current land uses	EIA	4.9, 6.2 Baseline Reports
6.11	summarize criteria and guidelines in draft IRP	EIA	4.9, 5.9
6.11	methods used to evaluate and demonstrate reclamation of disturbed lands; old growth timber along Athabasca and Muskeg rivers environmental conditions: defining physical and biological characteristics, diversity of characteristics	11.0	2.0, 4.6, 4.9, 5.9
	Wetlands		
6.11	peatland/wetland inventory of Muskeg River watershed and adjacent wetlands	EIA	4.6 Baseline Reports
6.11	differentiate types and map fens, bogs	EIA	4.6 Baseline Reports
6.11	evaluate wetlands affected consider importance for local and regional habitat, for sustained forest growth and for the hydrologic regime	EIA	4.4.1, 4.6, 5.3, 5.6, 5.7, 5.9.1
6.11	rank results using a quantitative scale	EIA	5.6
7.0	**Heritage Resources**		
	consultation with ACD	12.1	Application
	previous studies	EIA	6.0 Baseline Reports
	program and schedule of field investigations	EIA	7.0
8.0	**Reclamation**		
8.0	Conceptual reclamation plan objectives and necessary factors	11.0	2.0 Application
8.0	timeframe for completion of reclamation	11.3	1.3.2, 2.0 Application
8.0	preferences for local community end land use	11.0	2.0 Application

8.0	impacts to Mildred Lake reclamation timing	11.8.7	Application
8.0	end land use	11.9	2.0
8.0	rational for vegetation species selected	11.8	2.0 Application
8.0	processing waste and the reclaimed landscape	EIA 11.0	2.0 Application
8.0	disposal of water in the reclaimed landscape	3.7	5.3
8.0	constraints to reclamation	11.0, 8.0	2.0 Application
8.0	diversity of reclaimed landscape	11.0	2.0, 5.6, 5.7 Application
9.0	**Public Health and Safety**		
9.0	aspects of the project with health, safety implications	EIA	5.10, 5.11
9.0	potentially affected population, human health	8.0	5.10
9.0	prevent or minimize potential for adverse health effects	4.0, 8.6	5.10 Table 1.5.1
9.0	summary emergency response plan: public input to plan	10.0	Application
9.0	mitigation and emergency contingency plans for public safety wildfire	10.0	5.10 Application
9.0	higher traffic volumes	EIA	5.11
9.0	uncertainties and risks: contingency plans	EIA	5.10, 5.11

14.5 Water Resources Act

**ROAD-MAP OF APPROVALS APPLICATION
WITH RESPECT TO
THE REQUIREMENTS UNDER
THE WATER RESOURCES ACT
FOR A FENCELINE APPROVAL**

Requirement	Section within Application
Summary Description of Approval Being Requested	1.1, 3.7.4
Project location	2.1
Overview of Project Activity	3.1
Site Water Management Overview	3.6.5, 3.7
Process Water Balance Tables	Figures 3.6-8 to 3.6-11
Pre-Development Drainage and Topography	3.7.3
Yearly Status Maps	Figures 3.2-17 to 3.2-30
Closure Maps	Figures 3.2-31, 3.2-40
Creeks and Drainage Basins Map	Figure 3.7-1
Water Mangement Philosophy	3.7.2
Fence Line Approval Limits	1.1 Figure 3.7-3
Activities to be Carried out Within Approval Limits	3.7.4, 3.7.5
Major Interceptor Ditch - Cross Section	Figure 3.7-2
Approval Volumes Requested (Box Diagram)	Figure 3.7-4
Drainage Control During Operations	3.7.5
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APPENDIX A

Major Project Features: Selection Processes And Alternatives Considered

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INTRODUCTION

Syncrude Canada Ltd.'s proposed Aurora Mine Project will be located 75 kilometres northeast of the City of Fort McMurray, on the east side of the Athabasca River. It consists of lands within Leases 10, 12, 34 and 31, and to a lesser extent Leases 30 and 13.

The Aurora Mine project is made up of four stages of investment in two mining areas.

- The first mining area will be "Aurora Mine North" which will be opened on Lease 34 and will move north onto Lease 10, further west on Leases 34 and 12 and, after 2010, to a pit limit at the south Lease 13 boundary. This mining area will support two bitumen extraction trains.

- The second mining area, "Aurora Mine South", will be opened in approximately 2008 on Lease 31. The development plans for Aurora Mine South are similar to those of Aurora Mine North except for differences associated with the character of the ore body.

As part of Syncrude's planning efforts and applications for approval of the proposed Aurora Mine, a number of options or alternatives were considered for each of the major project features.

This Appendix summarizes the selection processes and alternatives evaluated for the following project features, and the rationale for selection of the preferred alternatives. It has been prepared by Syncrude with the assistance of its lead environmental consultant Bovar Environmental. This report also refers to other outside expertise that was utilized in these selection processes.

- Mine opening location options
- Plant site selection options
- Tailings site selection options
- Tailings deposition plan selection
- Corridor route selection options
- Extraction process selection
- Product transport mode selection
- Thermal electric power and make-up water options

1.0 MINE OPENING LOCATION OPTIONS

1.1 Introduction

The initial mine openings for Aurora Mine North and Aurora Mine South were selected on the basis of a number of environmental and economic. The following summarizes the major considerations and selection processes used to determine the preferred mine opening locations.

For Aurora Mine North, a 1995 geological evaluation of Leases 12 and 34 resulted in the identification of three distinctive ore zones and a number of areas unsuitable for mining. These sites and the options for mine opening at Aurora Mine North are shown on Figure 1-1. The ore zones are the East Ore Zone, Centre Ore Zone, and West Ore Zone. Each have sufficient high grade ore to qualify as an opening site for the first train in 2001.

For the Aurora Mine South, the northern portion of Lease 31 contains the surface mineable ore. Aurora's mining area includes the proposed OSLO mine plus the Lease 31 ore zones to the east and northeast of the proposed mine. Development is anticipated to commence in 2008. The area has sufficient reserves to allow mining to continue to 2035 at the Aurora train rates of 58 million tonnes per train per year.

Three potential sites (Figure 1-2) for the initial opening at Aurora Mine South were considered:

- Option 1, along the south edge of the mine pit
- Option 2, the centre of the mine pit
- Option 3 at the south west corner of the pit.

Figure 1-1 Aurora Mine, North Mine Opening Location Options

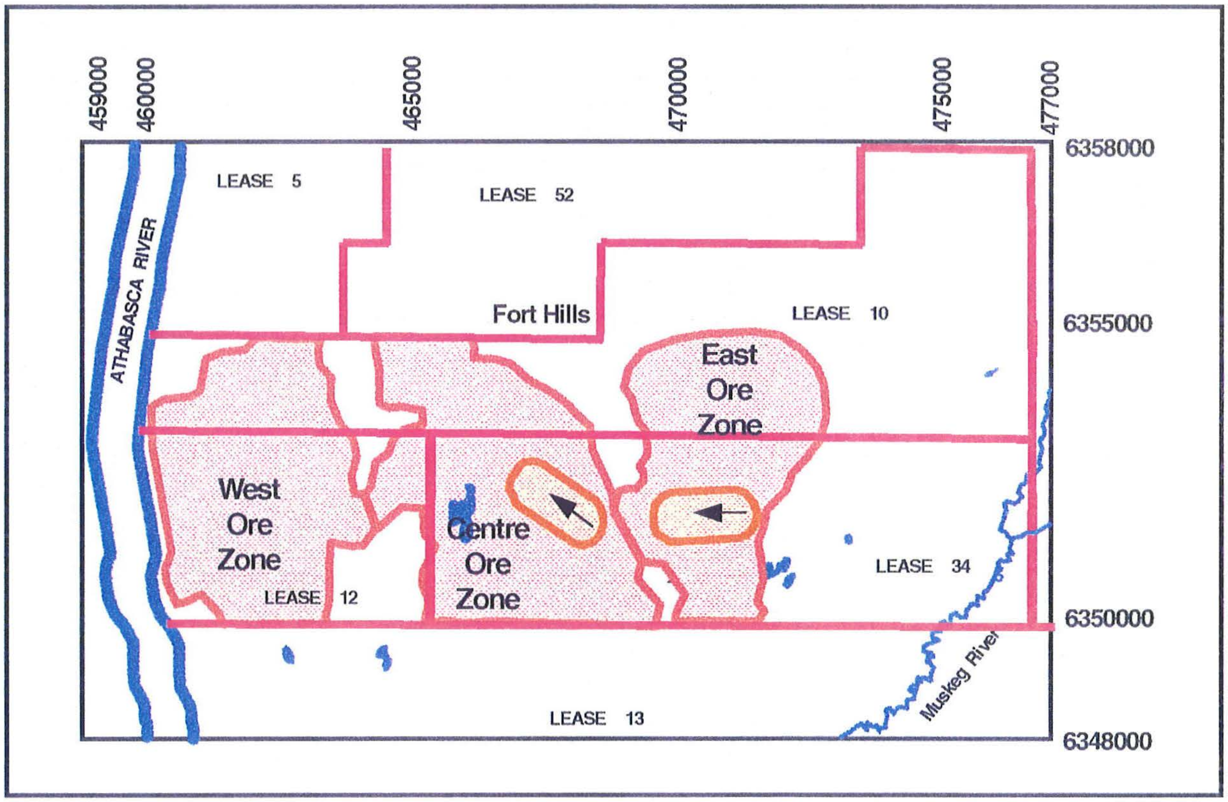
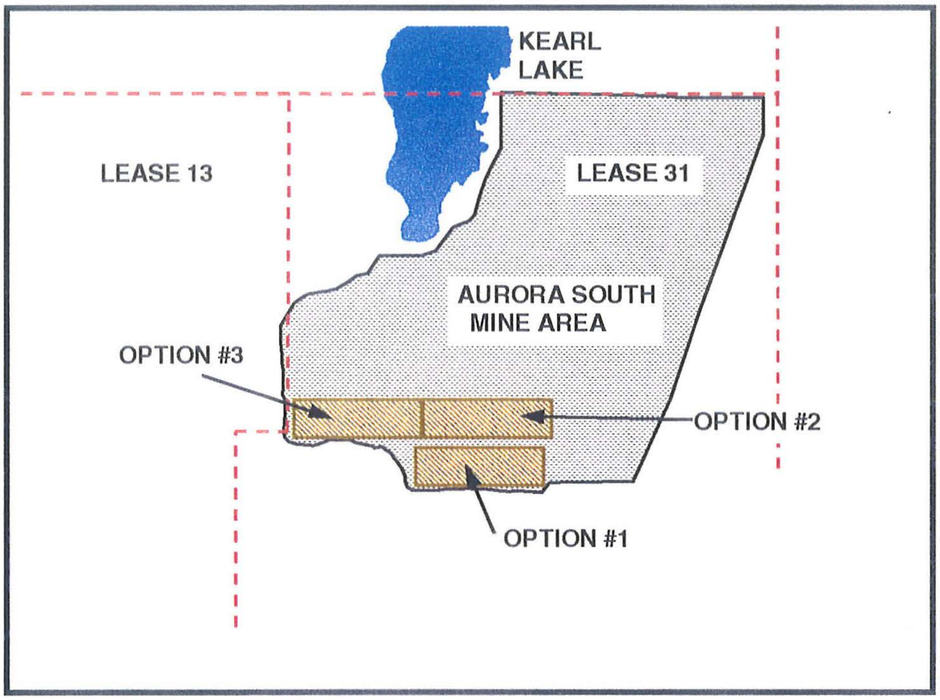


Figure 1-2 Aurora Mine South, Mine Opening Location Options



1.2 Mine Opening Selection Methodology

1.2.1 Aurora Mine North

To select the optimum location for the Aurora Mine North opening and associated facilities, a number of economic, engineering and environmental considerations were evaluated.

Initially, all possible options were identified and screened to eliminate clearly unsuitable alternatives. The more viable options were subjected to decision analysis for a more detailed evaluation to select the preferred mine opening location.

The main criteria used in the evaluation were:

Environmental Considerations:

- Supports progressive reclamation; and,
- Early overburden and tailings disposal in-pit.

Economic Considerations:

- Operating costs per barrel of bitumen;
- Overburden thickness;
- Waste to ore ratio;
- Ore grade;
- Total volume to net recovered bitumen;
- Proximity to plant site; and
- Consistent with the second train of a development on Leases 12 & 34.

In addition, because of the dominant linkage between mine opening location and plant site, an evaluation of these two components was carried out together.

To support the analysis, a number of Musts and Wants were identified. For the mine opening site selection the primary Musts were:

- The ore must be amenable to hydrotransport technology and mobile mine equipment.
- The opening must be a minimum of 5 kilometres from the plant site.

The Wants addressed 24 parameters as listed in Table 1-1.

Table 1-1 Mine Opening and Plant Site Wants

1.	Min. Net Present Costing	14.	Initial Overburden amenable to Civil
2.	Least Initial Capital	15	Suitable Foundation for Plant site
3.	Amenable to 2nd Train ($)	16.	Min. Length of Utilities
4.	Min. Sterilization of Ore	17.	Amenable to Leases 10/13
5.	Early Overburden & Tailings disposal in Pit	18.	Min. Dist. to Civil Dumps/Structures
6.	Good Ground	19.	Min. Reclaim Material Disturbance
7.	Min. Overburden Thickness (Pre Strip)	20.	Plant Close to Tailings Storage
8.	Mine Close to Plant	21.	Low Elevation for Cyclone Feeder
9.	Supports Progressive Reclamation	22.	Suitable Foundation in Base
10.	Min. Hydrological Problems	23.	Expandable
11.	Plant suitable for 2nd/3rd Pits	24.	Waste/Ore Ratio (Life)
12.	Minimize Conveyors/Maximize Pipeline		
13.	Early Installation of Facilities in Base		

1.2.2 Aurora Mine South

As with Aurora Mine North, economic and engineering considerations were used to evaluate the optimum location for the Aurora Mine South opening. There were no environmental considerations pertinent in the evaluation of a mine opening location for this area because all of the options would be mined out during the first years of operation regardless of the starting location.

Unlike Aurora Mine North, Aurora Mine South will have only one mine pit. This limited the spatial variations between the mine opening options and removed the ties between mine opening location and plant site location.

As a result, a more simplified selection process was utilized which weighed the various advantages and disadvantages of each of the alternatives.

The criteria used to select the initial opening for Aurora Mine South were:

- initial costing and economics;
- average grade of ore;
- initial waste ore ratio;
- proximity to south overburden dump;
- distance to extraction plant;
- initial haul distance to tailings starter dyke; and,
- favourable pit floor foundation for in-pit construction.

1.3 Results

1.3.1 Aurora Mine North

Table 1-2 presents the detailed results of the analysis for the three potential Aurora Mine North opening locations relative to the potential location of the plant site in each of three different locations. The East Ore Zone represented the best mine opening site for each of proposed Plant Sites 1 and 3. The Centre Ore Zone was preferred for proposed Plant Site 2.

The West Ore Zone received the lowest scores and was rejected early on because of:

- Higher up-front major expenditures to construct a barrier to control seepage from the Athabasca River;
- Located farthest from all of the more viable tailings disposal options to the east;
- Least compatible with the progressive reclamation criteria; and,
- Lower quality of ore.

The more detailed analysis focused on the East and Centre ore zones. Table 1-3 provides the results of the ore quality comparison for the East and Centre zones. Table 1-4 summarizes the advantages and disadvantages associated with mine opening in each of these zones.

Table 1-2 Aurora Mine North Opening and Plant Site Selection Analysis Results

	WANTS/ALTERNATIVES → ↓	WT	EAST ORE ZONE 1		EAST ORE ZONE 2		EAST ORE ZONE 3		CENTRE ORE ZONE • 1		CENTRE ORE ZONE 2		CENTRE ORE ZONE 3		WEST ORE ZONE 1		WEST ORE ZONE 2		WEST ORE ZONE 3	
1	Min. NPC	10	6	60	10	100	8	80	5	50	9	90	4	40	1	10	1	10	1	10
2.	Least Initial Capital	9	2	18	10	90	9	81	6	54	8	72	6	54	6	54	7	63	4	36
3.	Amenable to 2nd Train ($)	8	2	16	9	72	7	56	6	48	10	80	3	24	8	64	2	16	1	8
4.	Min. Sterilization of Ore	8	10	80	9	72	8	64	10	80	9	72	8	64	10	80	9	72	8	64
5.	Early Overburden & Tailings disposal in Pit.	7	10	70	10	70	10	70	7	49	7	49	7	49	9	63	9	63	9	63
6.	Good Ground	7	10	70	10	70	10	70	9	63	9	63	7	63	8	56	8	56	8	56
7.	Min. Overburden Thickness (Pre Strip)	5	9	54	9	54	9	54	10	50	10	50	10	50	6	30	6	30	6	30
8.	Mine Close to Plant	5	1	5	10	50	8	40	5	25	10	50	3	15	8	40	2	10	1	5
9.	Supports Reclamation (Prog.)	5	10	50	10	50	10	50	5	25	5	25	5	25	3	15	3	15	3	15
10.	Min. Hydrological Problems	4	8	32	8	32	2	8	10	40	10	40	2	8	1	4	1	4	1	4
11.	Plant suitable for 2nd/3rd Pits	4	8	32	10	40	5	20	8	32	10	40	4	16	5	20	5	20	1	4
12.	Minimize Conveyors/Maximize Pipeline	3	10	30	10	30	10	30	8	24	8	24	8	24	8	24	8	24	8	24
13.	Early Installation of Facilities in Base	3	10	30	10	30	10	30	8	24	8	24	8	24	8	24	8	24	8	24
14.	Initial O/B amenable to Civil.	3	9	27	9	27	9	27	10	30	10	30	10	30	8	24	8	24	8	24
15.	Suitable Foundation for Plantsite	3	10	30	8	24	5	15	10	30	8	24	5	15	10	30	8	24	5	15
16.	Min. Length of Utilities	3	10	30	9	27	6	18	10	30	9	27	6	18	10	30	9	27	6	18
17.	Amenable to Leases 10/13	3	6	18	10	30	2	6	7	21	10	30	2	6	8	24	7	21	1	3
18.	Min. Dist. to Civil Dumps/Structures	2	10	20	10	20	10	20	9	18	9	18	9	18	7	14	7	14	7	14
19.	Min. Reclaim Mat'l. Disturbance	2	8	16	8	16	8	16	10	26	10	20	10	20	7	14	7	14	7	14
20.	Plant Close to Tailings	2	5	10	8	16	10	20	5	10	8	16	10	20	5	10	8	16	10	25
21.	Low Elevation for Cyclone Feeder.	1	9	9	9	9	9	9	8	8	8	8	8	8	10	10	8	10	10	10
22.	Suitable Foundation in Base	1	9	9	9	9	9	9	3	3	3	3	3	3	10	10	10	10	10	10
24.	Expandable	1	10	10	5	5	9	9	10	10	5	5	9	9	10	10	5	5	9	9
25.	Waste/Ore Ratio (Life)	7	10	70	10	70	10	70	5	35	5	35	5	35	5	35	5	35	5	35
			796		1004 1		872 3		779		895 2		638		681		607		467	

Table 1-3 Aurora Mine North Opening Ore Quality Comparison

EAST ORE ZONE		CENTRE ORE ZONES	
• Average Grade	11.43%	• Average Grade	11.04%
• Ore Volumes	378 Mbcm	• Ore Volumes	378 Mbcm
• OB & C/R Volumes to end of 2010 =	142 Mbcm	• OB & C/R Volumes to end of 2010 =	185 Mbcm
• In-situ W/O Ratio	0.38:1	• In-site W/O Ratio	0.49:1
• Bitumen Produced to end of 2010	531 Mbbls	• Bitumen Produced to end of 2010	512 Mbbls

Table 1-4 Aurora Mine North Opening Advantages and Disadvantages

ADVANTAGES	
EAST ORE ZONE	**CENTRE ORE ZONES**
• Higher average ore grade • Lower waste to ore ratio • Earlier transfer of tailings to in-pit • Supports progressive reclamation • Earlier installation of crusher/conveyor system at the pit bottom	• Higher ore grade in early years • Slightly lower waste to ore ratio in early years • Approximately 20 years of pit life
DISADVANTAGES	
EAST ORE ZONE	**CENTRE ORE ZONE**
• Only 11-12 years of mining for two train operation • Earlier relocation of crushers, conveyors and hydrotransport systems to other mining area • Stockpiling of reclamation material required	• Lower average ore grade • Higher overall stripping ratio • Supports progressive reclamation to a lesser degree.

Based on this analysis, the initial Aurora Mine North opening in the East Ore Zone was selected as the preferred option. The East Ore Zone option was determined to offer the earliest opportunity to transfer tailings to in-pit, was most supportive of the progressive reclamation philosophy, and offered a lower unit operating cost per barrel of bitumen over the 10-year mining time-frame.

1.3.2 Aurora Mine South

Table 1-5 summarizes the results of the three Aurora Mine South opening locations considered.

Table 1-5 Aurora Mine South Opening Results

	OPTION #1 (Open along the south boundary)	OPTION #2 (Open in the south centre of mine area)	OPTION #3 (Open in the southwest corner of the mine area)
ADVANTAGES	• waste management benefit • O/B stripping location close to south disposal Site	• Higher grade than option #1 for initial 10 years • lower W/O ratio than option #1 • Stripping location to south disposal site 2nd best	• lowest W/O ratio • attractive waste management - no interim pit walls • foundation conditions good • Distance to tailings starter dyke is the shortest
DISADVANTAGES	• very low average feed grade for first 5 years (10%-10.5%) • Greater W/O ratio than other options • poor in-pit foundation conditions • in-pit waste storage limited as interim highwalls required for waste management • in-pit tailings delayed due to maintenance of interim highwall faces	• limited in-pit space available for waste management due to interim highwall • in-pit tailings will be delayed similar to option #1	• ore grade is lower than for option #2 • longer haul distance to the south disposal site than for either of the other two options

Based upon an evaluation of the advantages of each of the proposed sites, Option 3 (southwest corner of the mine area) was chosen as the location for the Aurora Mine South opening. It has the lowest waste to ore ratio, good foundation material, is close to the tailings starter dyke, and has no requirement for interim pit walls.

2.0 PLANT SITE SELECTION OPTIONS

2.1 Introduction

The following section summarizes the selection processes for selecting the preferred plant sites for Aurora Mine North and Aurora Mine South.

2.2 Plant Site Selection Methodology

2.2.1 Aurora North Plant Site Selection Methodology

For the Aurora Mine North area, Syncrude evaluated three potential Plant Site locations. Initially, the non-mineable designated areas from the geological assessment of the leases were evaluated as to the suitability for placement of a plant site on them. The three potential Plant Sites were: Site 1, on the west portion of the leases referred to as the Susan Lake area; Site 2, the south Centre site; and Site 3, the site on the eastern non-mineable area. Figure 2-1 shows the relative location of the three sites as well as the non-mineable areas eliminated. Key environmental, economic and engineering parameters were identified and weighed. The primary Plant Site location criteria used during the selection process included:

Environmental Considerations:

- Protection of the environment from adverse impacts, particularly to the surface and sub-surface waters

Economic Considerations:

- Minimum feed delivery costs from the mine to the plant and tailings transportation costs from plant to disposal site;
- Good foundation requiring minimum sub-excavation and backfill; and,
- Meets minimum distance requirement for the slurry pipeline.

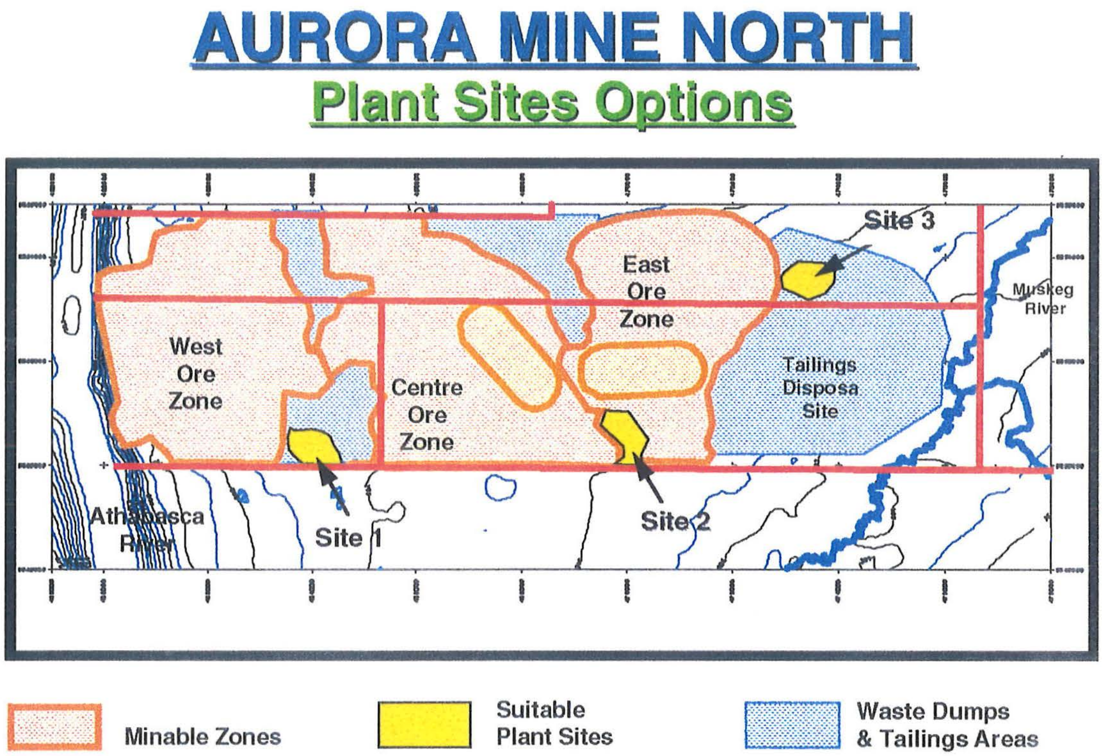
Resource Management Considerations:

- Minimum sterilization of ore reserves

For the location of the Aurora North Plant Site, the primary Musts were:

1. The proposed site must be a minimum of 25 hectares.
2. There must be no unacceptable environmental impacts.

Figure 2-1 Aurora Mine North Plant Site Options



The Wants addressed 24 parameters as listed in Table 2-1.

Table 2-1 Plant Site and Mine Opening Wants

1.	Min. Net Present Costing.	14.	Initial Overburden amenable to Civil.
2.	Least Initial Capital.	15	Suitable Foundation for Plantsite.
3.	Amenable to 2nd Train ($).	16.	Min. Length of Utilities.
4.	Min. Sterilization of Ore.	17.	Amenable to Leases 10/13.
5.	Early disposal in Pit.	18	Min. Dist. to Civil Dumps/Structures.
6.	Good Ground.	19.	Min. Reclaim Material Disturbance.
7.	Min. Overburden Thickness (Pre Strip).	20.	Plant Close to Tailings.
8.	Mine Close to Plant.	21.	Low Elevation for Cyclone Feeder.
9.	Supports Reclamation (Prog.).	22.	Suitable Foundation in Base.
10.	Min. Hydrological Problems.	23.	Expandable.
11.	Plant suitable for 2nd/3rd Pits.	24.	Waste/Ore Ratio(Life).
12.	Minimize Conveyors/Maximize Pipeline.		
13.	Early Installation of Facilities in Base.		

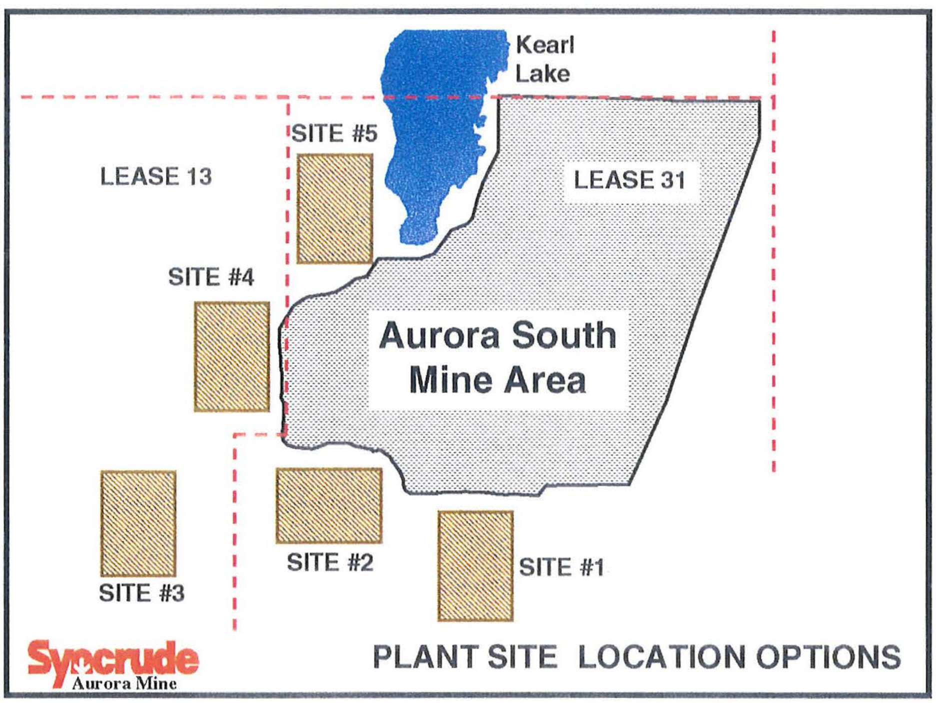
2.2.2 Aurora South Plant Site Selection Methodology

For the Aurora South area, Syncrude examined five potential plant site locations previously examined by OSLO (Figure 2-2).

- Plant Site 1, located on Lease 31 immediately south of the mine site;
- Plant Site 2, located on Lease 31 immediately southwest of the mine site;
- Plant Site 3, located on Lease 13, southwest of the mine site;
- Plant Site 4, located west of the mine site on Lease 13; and,
- Plant Site 5, located southwest of Kearl Lake on Lease 31.

For the Aurora Mine South Plant site selection process, a number of environmental, technical and economic considerations were evaluated for each of the five sites.

Figure 2-2 Aurora Mine South Plant Site Options



Environmental Considerations:

- Air quality
- Soils and reclamation
- Vegetation and forestry
- Surface water
- Historical resources
- Wildlife and habitat
- Fish resources

Technical and Economic Aspects:

- Adequate size to allow location of plant facilities
- Located well away from the mine site to allow conditioning during hydrotransport[1]
- Suitable geological conditions to minimize foundation risk and costs
- Be amenable to site drainage and preparation requirements
- Possesses room for expansion of plant facilities

2.3 Results

2.3.1 Aurora Mine North

Table 2-2 presents the analysis for the three ore zones relative to the potential location of the Plant Site in the three locations examined.

Plant Site 2 recorded the highest score in relation to each of the East and Centre Ore Zones and ranked second behind Plant Site 1 in relation to the West Ore Zone.

Plant Site 3 ranked second only in the context of the East Ore Zone, but was eliminated early in the decision analysis process primarily because the proposed site would have encroached on the preferred location for tailings disposal and thereby reduced capacity by two to three years. In addition, because of its easterly location, this site was the farthest away from the future mining activities in the Centre and West Ore Zones.

The more detailed examination of Plant Sites 1 and 2 generated a number of advantages and disadvantages as summarized in Table 2-3.

[1] An important technical and economic aspect utilized by OSLO was that the site be located in close proximity to the mine site to minimize ore delivery costs. This requirement became reversed in the selection of the Aurora Plant Site since an adequate length of pipe is required to allow conditioning of the oil sand slurry before it reaches the plant site.

Table 2-2 Plant Site and Mine Opening Selection Analysis Results

	WANTS/ALTERNATIVES → ↓	WT	EAST ORE ZONE 1		2		3		CENTRE ORE ZONE • 1		2		3		WEST ORE ZONE 1		2		3	
1	Min. NPC	10	6	60	10	100	8	80	5	50	9	90	4	40	1	10	1	10	1	10
2.	Least Initial Capital	9	2	18	10	90	9	81	6	54	8	72	6	54	6	54	7	63	4	36
3.	Amenable to 2nd Train ($)	8	2	16	9	72	7	56	6	48	10	80	3	24	8	64	2	16	1	8
4.	Min. Sterilization of Ore	8	10	80	9	72	8	64	10	80	9	72	8	64	10	80	9	72	8	64
5.	Early disposal in Pit.	7	10	70	10	70	10	70	7	49	7	49	7	49	9	63	9	63	9	63
6.	Good Ground	7	10	70	10	70	10	70	9	63	9	63	7	63	8	56	8	56	8	56
7.	Min. Overburden Thickness (Pre Strip)	5	9	54	9	54	9	54	10	50	10	50	10	50	6	30	6	30	6	30
8.	Mine Close to Plant	5	1	5	10	50	8	40	5	25	10	50	3	15	8	40	2	10	1	5
9.	Supports Reclamation (Prog.)	5	10	50	10	50	10	50	5	25	5	25	5	25	3	15	3	15	3	15
10.	Min. Hydrological Problems	4	8	32	8	32	2	8	10	40	10	40	2	8	1	4	1	4	1	4
11.	Plant suitable for 2nd/3rd Pits	4	8	32	10	40	5	20	8	32	10	40	4	16	5	20	5	20	1	4
12.	Minimize Conveyors/Maximize Pipeline	3	10	30	10	30	10	30	8	24	8	24	8	24	8	24	8	24	8	24
13.	Early Installation of Facilities in Base	3	10	30	10	30	10	30	8	24	8	24	8	24	8	24	8	24	8	24
14.	Initial O/B amenable to Civil.	3	9	27	9	27	9	27	10	30	10	30	10	30	8	24	8	24	8	24
15.	Suitable Foundation for Plantsite	3	10	30	8	24	5	15	10	30	8	24	5	15	10	30	8	24	5	15
16.	Min. Length of Utilities	3	10	30	9	27	6	18	10	30	9	27	6	18	10	30	9	27	6	18
17.	Amenable to Leases 10/13	3	6	18	10	30	2	6	7	21	10	30	2	6	8	24	7	21	1	3
18.	Min. Dist. to Civil Dumps/Structures	2	10	20	10	20	10	20	9	18	9	18	9	18	7	14	7	14	7	14
19.	Min. Reclaim Mat'l. Disturbance	2	8	16	8	16	8	16	10	26	10	20	10	20	7	14	7	14	7	14
20.	Plant Close to Tailings	2	5	10	8	16	10	20	5	10	8	16	10	20	5	10	8	16	10	25
21.	Low Elevation for Cyclone Feeder.	1	9	9	9	9	9	9	8	8	8	8	8	8	10	10	8	10	10	10
22.	Suitable Foundation in Base	1	9	9	9	9	9	9	3	3	3	3	3	3	10	10	10	10	10	10
23.	Expandable	1	10	10	5	5	9	9	10	10	5	5	9	9	10	10	5	5	9	9
24.	Waste/Ore Ratio (Life)	7	10	70	10	70	10	70	5	35	5	35	5	35	5	35	5	35	5	35
			796		1004 1		872 3		779		895 2		638		681		607		467	

Table 2-3 Plant Site Advantages and Disadvantages

ADVANTAGES	
Plant Site #2	**Plant Site #1**
Lower overall capital costs	Shorter length of utility corridor
Minimal ore volume sterilized	Shorter haul from a major gravel source
Closer to tailings disposal site	
DISADVANTAGES	
Plant Site #2	**Plant Site #1**
Longer length of utility corridor	Longer distance to tailing site
Smaller available area	Longer distance to initial mine opening
Longer haul from major gravel source	

As a result of the evaluation process, Plant Site 2 was selected as the preferred location for the Aurora North Plant Site. Locating the plant at this site was determined to offer the project several significant benefits including:

- no significant environmental drawbacks;
- lower capital cost (approximately $20 million);
- shorter distance to the preferred tailings disposal site;
- shorter distance to the mine opening in the East Ore Zone; and,
- minimum sterilization of reserves.

2.3.2 Aurora Mine South

Table 2-4 presents the results of the plant site selection process for the Aurora Mine South.

Plant Site number 4 was eliminated because of its distance from the tailings area, proximity to the mine and its position on a natural extension of the mine ore zone. Plant Site 5 was eliminated because of its distance from the tailings disposal site and low overall score.

The three remaining sites (1, 2, and 3) all received similar scores based on the unweighted criteria used for the South Mine plant analysis. However, Plant site 3 was selected as being clearly superior from an economic perspective. This is primarily due to its close proximity to the tailings disposal area.

Table 2-4 Aurora Mine South Plant Site Selection Results

CRITERIA	Plant site # 1	Plant site # 2	Plant site # 3	plant site # 4	plant site # 5
Air Quality - (distance Plant site to Tailings Disposal Site)	P	NP	NP	P	P
Soils & Reclamation - (Physical and Chemical Characteristics of Soils)	NP	NP	P	NP	P
- (Depth to the Water Table)	NP	NP	P	NP	P
Vegetation and Forestry - (Productive Forest Land and Timber Disposition)	P	P	P	P	NP
Surface Water and Drainage - (Proximity to Streams)	P	P	NP	NP	NP
- (Creek Flows)	P	P	P	P	P
Historical Resources - (Historical Resources or Potential for Historical Resource)	P	NP	NP	P	NP
Wildlife and Habitat - (Wildlife Species with Economic or Recreational Value)	NP	P	NP	P	NP
- (Critical Wildlife Habitat)	P	P	P	P	P
- (Habitat for Rare, Endangered or Threatened Species)	P	P	P	P	P
Fish Resources - (Fish Presence)	P	P	NP	P	NP
- (Sports Fish Species Present)	P	P	P	P	NP
- (Critical Habitat for Fish)	P	P	P	P	NP
Technical					
- Adequate size	P	P	P	P	P
- Located Away from Mine	NP	NP	P	NP	NP
- Suitable Geology	NP	P	P	NP	P
- Amenable to Drainage	P	P	NP	NP	NP
- Room for Expansion	P	P	P	NP	P
TOTALS					
-Preferred or Acceptable (P)	13	13	12	11	9
-Not Preferred (NP)	5	5	6	7	9

P - Development sites that are preferred based on criteria.
NP - Development sites that are not preferred based on the criteria.

3.0 TAILINGS SITE SELECTION

3.1 Introduction

During the initial development of the Aurora Mine, there will be a need for one external tailings disposal site for each of the North and South pits to manage the tailings produced from the initial mine opening. As the mine pits grow, tailings disposal will be in-pit, accommodating the process of progressive reclamation as shown in Figure 3-1.

3.2 Tailings Site Selection Process

The external tailings disposal site selection for the Aurora Mine North and South locations was based upon similar criteria, which balanced issues surrounding the individual sites. No single site was suitable to accommodate both North and South pit openings due to space limitations.

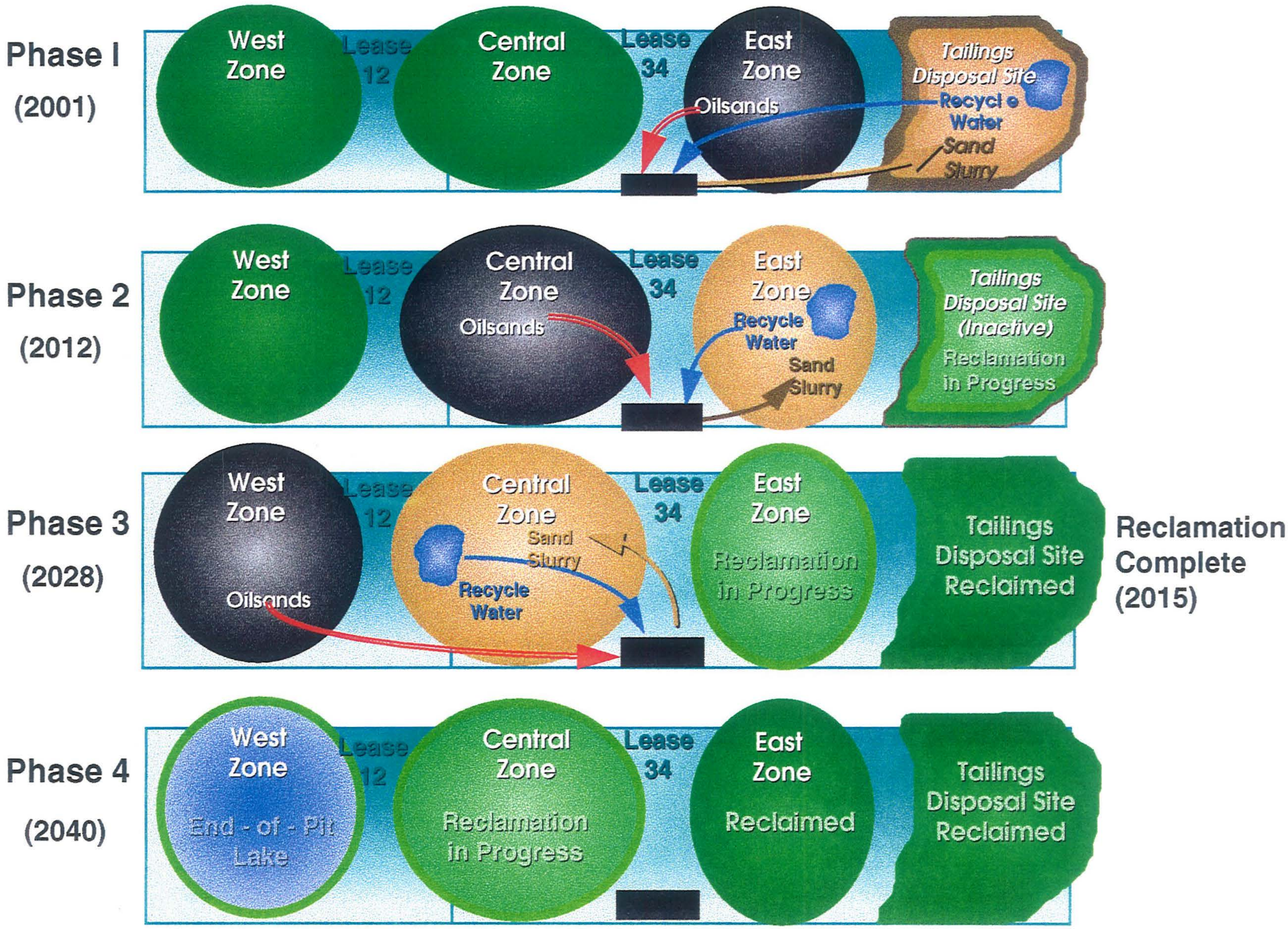
3.2.1 Aurora Mine North

For Aurora Mine North six potential sites were considered as illustrated in Figure 3-2. Brief descriptions of the sites follow. These sites are located on oil sand leases held by a number of companies including Syncrude, however they do not impact on any mineral surface leases.

Site 1 is located between the proposed East Pit and the Muskeg River with the Lease 13 boundary as the southern limit. The northern limit trends onto Lease 10 and is currently being evaluated through an exploration program. This site is approximately 2.5 kilometres east of the proposed plant site and covers about 14 square kilometres. The area exhibits low relief with a ground slope of about 0.3% towards the Muskeg River and is typified by a muskeg cover ranging in thickness between 1 to 5 metres. Geological evaluation of the drill data to date indicates suitable foundation conditions for a disposal area. The bitumen resource is of poor quality in general with one marginal channel centrally located beneath the site trending northeast. The estimated bitumen resource removed from surface mining is about 160 million barrels. Evaluations are underway to assess alternate methods of resource recovery for the marginal channel, which is more continuous than the other areas containing bitumen.

Site 2 is located in the Muskeg River valley and would require diverting the river to the east around this location. This site trends onto the Crown lease to the east and onto Lease 13 with the majority of the footprint on Lease 34. About 90% lies on areas where Syncrude holds the oil sands leases. The site is about 3.5 kilometres east of the proposed plant site, covers about 14 square kilometres, and possesses typically low relief muskeg similar to Site 1. The diversion channel would be about 9 kilometres long and would impact the local hydrological regime both during construction and operation. The estimated bitumen resource removed from surface mining is about 170 million barrels with the resources of lower quality compared to Site 1.

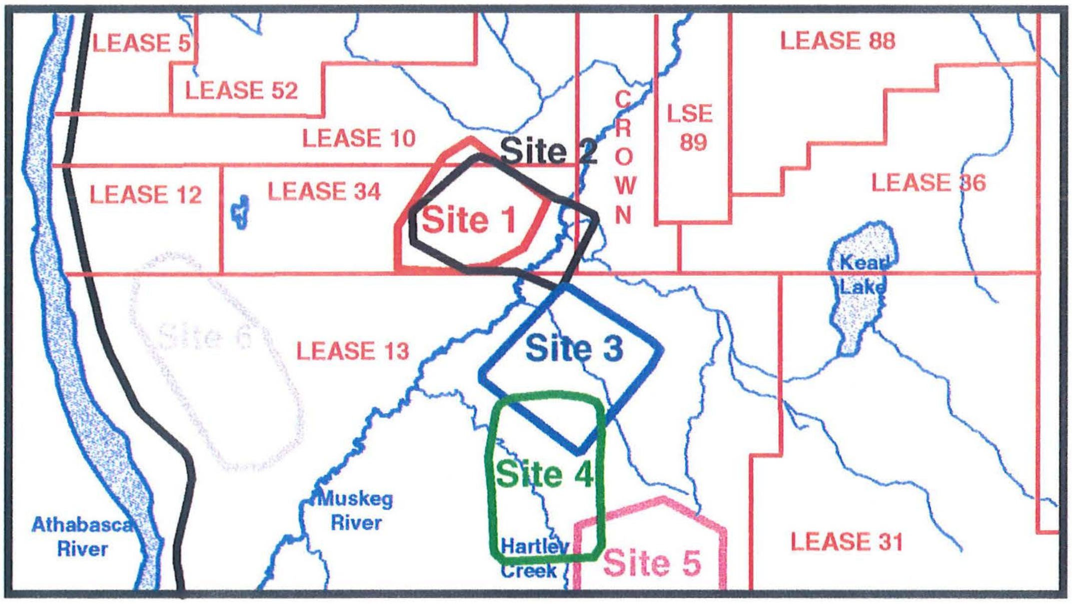
Progressive Reclamation



Plant continues in operation with ore from other leases

Syncrude

Figure 3-2 Aurora Mine North Tailings Site Alternatives



Site 3 is located entirely on Lease 13 southeast of the Muskeg River between Jackpine and Muskeg Creeks. The required area is about 16 square kilometres with the ground sloping at 0.5% towards the Muskeg River. The area is primarily treed with relatively thin muskeg cover (1-2 metres) in the clearings of and is about 5.5 kilometres from the proposed plant site. Shelly Creek would have to be diverted as it bisects the site, and a river crossing constructed over the Muskeg River would be required to provide access for manpower and the tailings slurry pipelines. This site would not suit the concept of progressive reclamation to the same degree as either Sites 1 or 2. As well, the estimated bitumen resource made innaccessible for surface mining is about 340 million barrels with portions of the resource indicated to be of good quality, which reduces the suitability of this site for tailings disposal.

Site 4 is also located entirely on Lease 13 and is bisected by Jackpine Creek. A creek diversion would affect fish habitat for grayling which are indicated to spawn near the Muskeg River junction. The area is a mix of muskeg and trees with low relief over the 17 square kilometre footprint. The subsurface of this site is the least understood due to a limited database, but the resource evaluation indicates ore of poor quality with only about 40 million barrels of bitumen underlying the site. The distance to the proposed plant site is about 6.5 kilometres and would also require a crossing of the Muskeg River similar to Site 3.

Site 5 was previously evaluated for the OSLO Project and is well delineated. This site is located 11 kilometres away from the proposed plant site, thereby creating unfavourable economics due to the longer slurry transfer distance. The site would require diversion of Pemmican Creek, a minor creek, and require a surface area of 14 square kilometres. This site covers both Lease 13 (70%) and Lease 30 (30%) and the area is characterized by a mix of muskeg and trees.

Site 6 was previously proposed for the Alsands Project and lies entirely on Lease 13. The current evaluation indicates an overall resource impact to both a large granular resource of about 25 MM^3 underlying the site which would have to be mined and stockpiled prior to placement of tailings. In addition, this site has a bitumen zone containing about 250 million barrels. This site is located about 3 kilometres west of the proposed plant site and covers an area of 14 square kilometres.

3.2.2 Aurora Mine South

The locations assessed for Aurora Mine South were based on previous studies undertaken for the OSLO Project. Five initial sites, illustrated on Figure 3-3, were reviewed.

Site 1 is located entirely on Lease 31 with a sub-surface of predominately Kc clays, a least preferred foundation material. The site requires a larger area and a higher containment dyke due to the sloping ground. The distance from the proposed plant would be about 5 kilometres.

Site 2 is located on 85% on Crown land, 13% on Lease 89 and 2% on Lease 52. The site is about 20.5 kilometres from the proposed plant site. This site is in the Fort Hills and requires a river crossing of the Muskeg River for access and pipelines. The extreme distance for slurry transport reduces the attractiveness of this site.

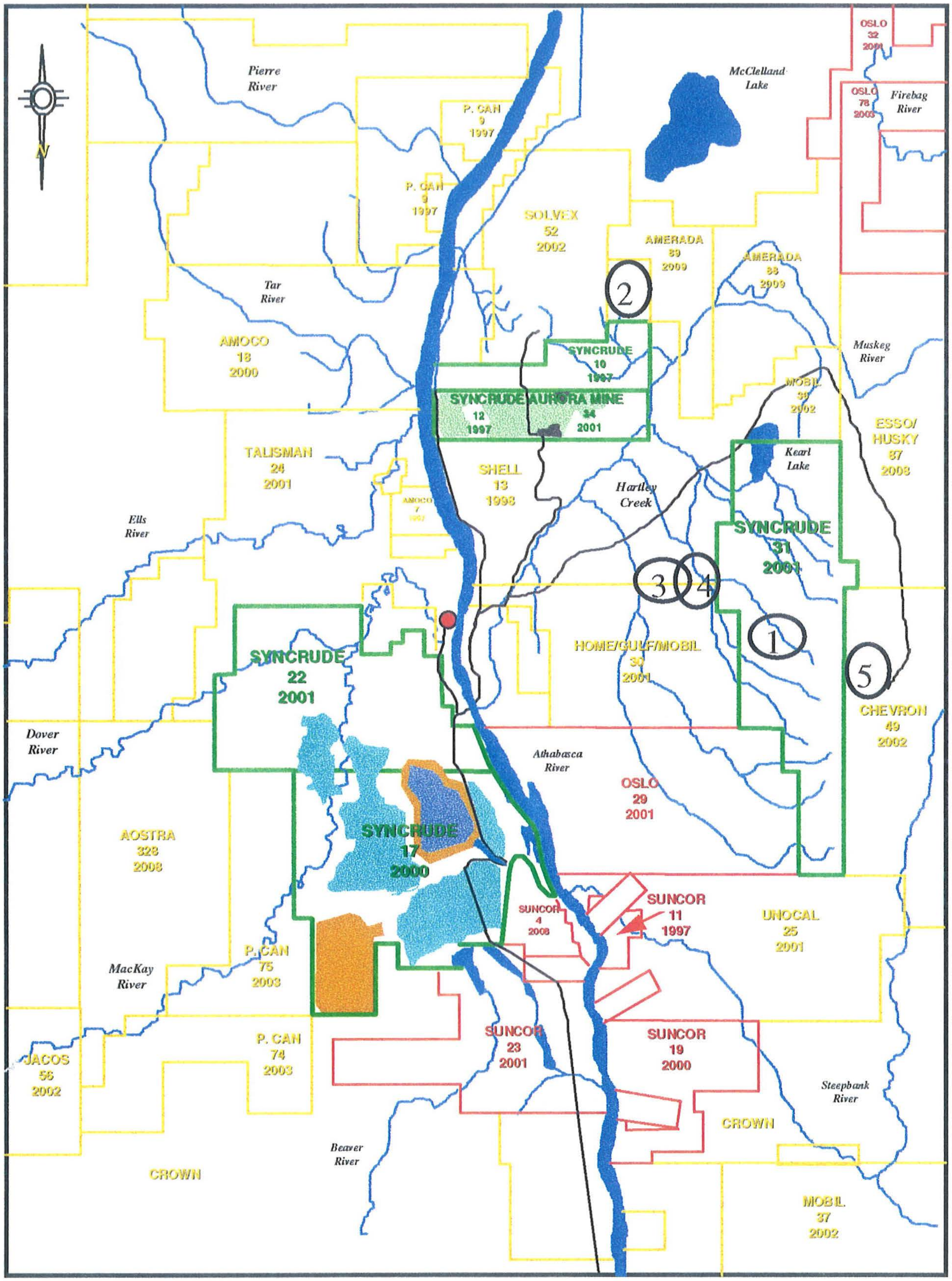


Figure 3-3 Aurora Mine South Tailings Site Alternatives

Site 3 is located about 80% on Lease 13 and 20% on Lease 30, about 6 kilometres from the proposed plant site. This site contains the Jackpine Creek valley and lies close to Gulf's (Sandalta) deposit. Jackpine Creek would require diversion which would affect grayling habitat.

Site 4 is located about 70% on Lease 13 and 30% on Lease 30, about 1 kilometre from the proposed plant site. The area is relatively flat with the foundation materials mainly Pg tills and Km formation. A buried Pleistocene channel lies beneath the northern area of the site.

Site 5 is located entirely on Lease 49, about 10 kilometres from the proposed plant site. The foundation materials are Kgr which have unknown geotechnical properties. This site is located in an area called the Muskeg Mountain at an elevation of 515 metres, about 180 metres higher than the plant site. Having to transfer tailings to a higher elevation and over a long distance from the plant site reduces the attractiveness of this site.

The basic criteria used to evaluate the various potential sites under consideration for each of the Aurora Mine North and South areas included:

Economic Considerations

- proximity to plant site
- suitable foundation for the tailings structures
- minimum of 10 years storage capacity

Resource management

- minimum sterilization of ore reserves

Environmental Considerations

- minimum potential environmental problems
- integrity of surface (seepage)
- consistent with progressive reclamation

3.3 Evaluation of Options

Each of the potential tailings disposal sites under consideration for the Aurora Mine North and South areas was subjected to a qualitative analysis addressing a number of economic, resource and environmental parameters.

3.3.1 Aurora Mine North

Table 3-1 summarizes the results for the six sites evaluated for Aurora Mine North. Site 1 is rated the best with an assessment of 15 preferred ratings out of a possible 18. Overall, this site was determined to be better from both an environmental and an economic perspective. It would not require any creek or river diversions and only a small amount of productive forest would be impacted. The area is comparable to the other sites considered with respect to impact to ungulates and would have a lower impact on fish habitat. In addition this site was determined to best suit the concept of progressive reclamation and would form an integral portion of the final landscape while still being the most economically attractive option.

Because of its proximity to Site 1, Site 2 was also given further consideration. However, it was rejected due to the fact that siting the tailings disposal area at this location would result in the need to construct a nine-kilometre water diversion channel of the Muskeg River which would impact the local hydrological regime and aquatic habitat.

Sites 3, 4, 5, and 6 were rejected on the following basis:

- Site 3 would have required a diversion of the Muskeg River with associated effects on aquatic values and would have resulted in high sterilization of ore reserves.
- Site 4 was determined to be located too far (6.5 kilometres) from the preferred plant site and would have resulted in negative impacts on Jackpine Creek.
- Site 5 is 11 kilometres from the preferred plant site.
- Site 6 is located over a massive gravel deposit that would require excavation and stockpiling prior to placement of tailings.

3.3.2 Aurora Mine South

Table 3-2 summarizes the results of the similar qualitative analysis performed for the Aurora Mine South tailings site options. It should be noted that only Sites 1 and 4 were subjected to the more detailed assessment as Sites 2, 3 and 5 were deemed to have substantial detracting features which excluded them during the early screening stage. The primary reasons for the rejection of Sites 2, 3 and 5 were:

- Site 2 is located too far (approximately 20.5 kilometres) away from the proposed plant site and would have required a pipeline crossing of the Muskeg River.
- Site 3 contains the Jackpine Creek valley and would have required diversion of streams and have disturbed valuable fisheries habitat.
- Site 5 is located 10 kilometres away in the area of Muskeg mountain, at an elevation 180 metres above the proposed plant site. This presents significant operational constraints and costs.

Of the two sites assessed in more detail (Sites 1 and 4), Site 4 was determined to be the preferred location. It has substantial economic advantages while also resulting in less land disturbance. The other environmental factors are considered to be equal.

Table 3-1 - Aurora Mine North - External Tailings Disposal Site Comparison

	SITE #1	SITE #2	SITE #3	SITE #4	SITE #5	SITE #6
ENVIRONMENTAL ASPECTS						
- low forest productivity	P	P	NP	NP	P	P
- least area of disturbance	P	P	NP	NP	P	P
- suitable for expansion	NP	P	NP	P	P	P
- creek / river flows effected	P	NP	NP	NP	NP	P
- accommodates sequential reclamation	P	P	NP	NP	NP	NP
- fish habitat	P	NP	NP	NP	P	P
- proximity to streams	NP	NP	NP	NP	NP	P
- sports fish species presence	NP	NP	NP	NP	NP	P
- wildlife habitat affected	P	NP	P	NP	P	P
GEOTECHNICAL						
- foundation conditions (geologic)	P	P	P	P	P	P
- level of confidence in data base	P	NP	P	NP	P	NP
- seepage control	P	P	P	P	P	NP
RESOURCE						
- Bitumen resource volume	P	P	NP	P	P	P
- poor resource quality	P	P	NP	P	P	NP
- other type of resources	P	P	P	P	P	NP
ECONOMICS						
- capital cost	P	NP	NP	NP	NP	NP
- operating cost	P	P	NP	NP	NP	P
- combined economics	P	NP	NP	NP	NP	NP
TOTALS - preferred area for development	**15**	**10**	**5**	**6**	**11**	**11**
- not preferred as a development site	**3**	**8**	**13**	**12**	**7**	**7**

Note: P - preferred / NP - not preferred

Table 3-2 Aurora Mine South - External Tailings Disposal Site Comparisons

	SITE #1	SITE #4
ENVIRONMENTAL ASPECTS		
- low forest productivity	NP	P
- least area of disturbance	NP	P
- suitable for expansion	NP	P
- creek / river flows effected	P	NP
- accommodates sequential reclamation	NP	NP
- fish habitat	P	P
- proximity to streams	NP	NP
- sports fish species presence	P	P
- wildlife habitat affected	NP	P
GEOTECHNICAL		
- foundation conditions (geologic)	NP	P
- level of confidence in data base	NP	P
- seepage control	P	NP
RESOURCE		
- Bitumen resource volume	P	P
- poor resource quality	P	P
- other type of resources	P	P
ECONOMICS		
- capital cost	NP	P
- operating cost	NP	P
- combined economics	NP	P
TOTALS - preferred area for development	**7**	**14**
- not preferred as a development site	**11**	**4**

4.0 Tailings Deposition Plan Selection

4.1 Tailings Deposition Selection Process

Five different options for tailings deposition were evaluated based on the following set of criteria:

- environmental acceptability;
- technical and economic achievability;
- high probability of regulatory approval;
- suitability for progressive reclamation;
- self-sustaining landscape which may be either wet or dry, or a combination of both; and
- minimal residual liabilities.

The five options evaluated include:

1. **Current operations** refers to the methods of construction and fluid containment as practised. The produced fluid portion of the tailings and the mature fine tails (MFT) would be placed below grade in the mined out areas. The sand fraction is initially placed externally and used for operational containment of the settling basin.

2. **Conventional Pond - Composite Tailings** combines current practice for out-of-pit disposal with composite tailings (CT) disposal in-pit. A large perimeter starter dyke is required prior to the commencement of operations to surround the fluid portion. Following the starter dyke, a sand shell, produced by the cell method, would be constructed for containment of the fluid tailings. Once sufficient in-pit space is available, the operation is to CT. CT is based on mixing chemically treated MFT and coarse sand into a product that does not segregate. The mixture releases water rapidly while still maintaining the fines in the sand voids. Over a period of time, the CT consolidates to a stable land form. Over time the MFT from inventory would be consumed with the external site converted to a sand disposal area forming a stable land form.

3. **Partitioned Pond - Composite Tailings** combines modified practice for out-of-pit disposal with CT disposal in-pit. The difference between this option and Option 2 is mainly in how the pond is constructed and its location. The construction would allow the fluid tailings to be located closer to the western limits of the external tailings disposal site with the north and west sides constructed from mine overburden and the south and eastern sides by the cell method, described above. For the Aurora Mine North, the main differences between this plan and Option 2 are that the fluid area is further removed from any influence of the Muskeg River, the starter dyke requires less volume to construct, and at closure surface drainage is better accommodated via a ditch through the overburden. The CT operations would be the same as for Option 2, with CT being placed into both the east and centre mining areas.

4. **Spiked Tailings** starts with current practice and then employs a spiking process with MFT when inventory is available. The results of field tests to date indicate that fines reduction can be achieved but the geotechnical stability conditions require further evaluation. The spiked mixtures

could be created at the extraction plant by either pump box modifications or by using cyclones to produce a dense sand stream, as proposed by the OSLO Project.

5. **Dry Tailings** may be produced in a number of ways such as a cake, from flocculation and filtration, or a paste, from flocculation and thickening. The dried fraction is primarily the fines fraction of the tailings with the sand handled as a slurry. The dried product and sand would be co-deposited for temporary containment until a stable land form is created. To achieve dry tailings, additional energy inputs and costs through chemicals and material handling are needed which to date do not make this an attractive option.

The subsequent evaluation qualitatively assessed a number of environmental, geotechnical, operational and economic criteria pertaining to each of the five tailings deposition plans under consideration. Each of the parameters was rated using a range from low to high, with low being the least preferred and high being most preferred.

4.2 Results

Table 4-1 summarizes the results of this analysis. Based on the evaluation, Option 3 (partitioned pond - CT) was selected as the preferred tailings deposition plan for both Aurora Mine North and South at this time. The analysis indicates that the application of the partitioned pond option will best suit the long-term environmental strategies established for the project while maintaining economic and technical viability.

Table 4-1 **Tailings Deposition Plan**

Options	1. CURRENT OPERATIONS	2. CONVENTIONAL POND - CT	3. PARTITIONED POND - CT	4. SPIKED TAILINGS	5. DRY TAILINGS
ENVIRONMENTAL ASPECTS					
- MFT at end of operations	L	H	H	M	H
- reclaimed surface - type (more/less)	wet/dry	dry/wet	dry/wet	wet/dry	dry
- evaluation	M	H	H	M	H
- progressive reclamation	L	M	H	L	H
- land form stability	M	H	H	M	H
- end land use	H	H	H	H	H
- water management	H	M	M	M	M
GEOTECHNICAL					
- long term containment	L	H	H	M	H
- seepage control	H	M	M	M	L
OPERATIONAL					
- operability (scale/simplicity)	H	M	M	M	L
- technically feasible	H	M	M	M	M
ECONOMICS					
- life cycle costs	M	H	H	M	L
TOTALS -	**H-5,M-3,L-3**	**H-5,M-6,L-0**	**H-7,M-4,L-0**	**H-1,M-9,L-1**	**H-6,M-2,L-3**

Note: L - least preferred / M - some advantages / H - most preferred

5.0 CORRIDOR ROUTE SELECTION OPTIONS

5.1 Introduction

The Aurora Mine requires road access, connection to utility services, as well as a production shipment pipeline. To take advantage of existing infrastructure, a service corridor is needed to connect Aurora to the Mildred Lake site.

A selection process was undertaken to determine the preferred location of the service corridor, including the preferred Athabasca River crossing. The service corridor will contain:

- A roadway, and
- Pipelines for bitumen froth, diesel fuel, water and natural gas.

The selection process was undertaken to identify a roadway/pipeline corridor and Athabasca River crossing that would accommodate and reflect the objectives of the draft Fort McMurray - Athabasca Oil Sands Subregional Integrated Resource Plan (1995), have the least environmental impact, and be cost effective and technically feasible from a geotechnical and engineering perspective. Syncrude also endeavoured to select a river crossing and roadway/pipeline corridor that would not prevent access to resources such as bitumen and gravel, or require relocation for a period of more than 15 years.

As part of the selection process, feasibility studies were undertaken by UMA Engineering (UMA Engineering 1996*a,* 1996*b,* 1996*c*) to develop, design and locate options for the following components of the corridor:

- Athabasca River crossing locations and river crossing methods,
- Roadway corridors from the proposed Aurora Mine to Mildred Lake, and
- Pipeline corridors from the proposed Aurora Mine to Mildred Lake.

Figure 5-1 illustrates the various options considered in the corridor route selection process. Four river crossing locations, four crossing methods and six roadway/pipeline corridors were examined by the study team. The following is a summary of the process employed for the selection of the preferred roadway/pipeline corridor and Athabasca River crossing.

5.2 Corridor Route Selection Methodology

The decision analysis completed for the route selection included the following steps:

- A study team comprised of Syncrude staff, consultant engineers and environmental experts was assembled to participate in the selection process;

- The study team chose primary criteria (MUSTS) that would be used to select options for the Athabasca River crossing and roadway/pipeline corridor (Table 5-1);

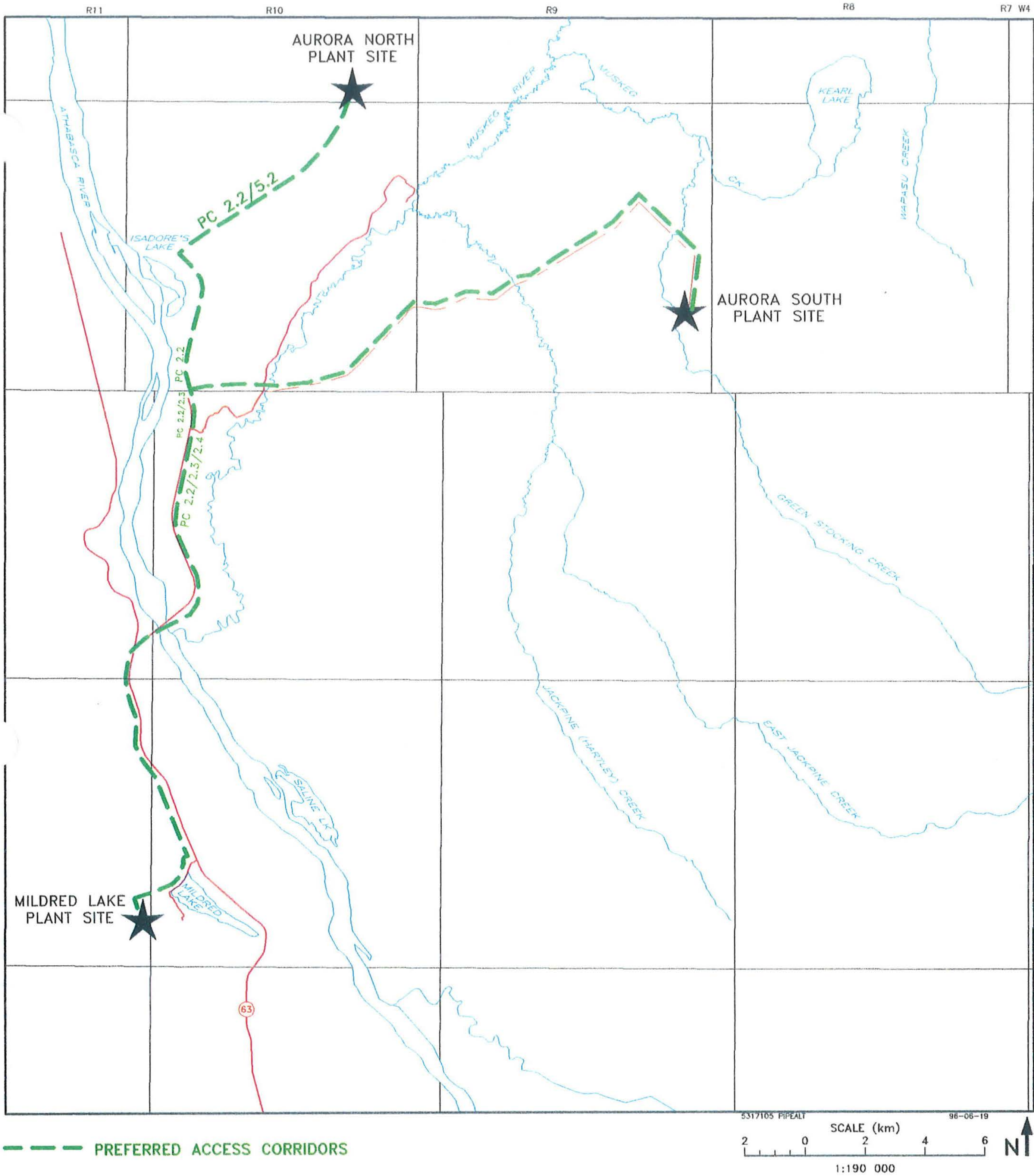


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Figure 5–1 Preferred Roadway/Pipeline/Utility Corridor for the Aurora Mine.

- The study team chose secondary criteria (WANTS) to use in evaluating each of the options for the Athabasca River crossing and roadway/pipeline corridor (Table 5-1);

- UMA Engineering selected options for the Athabasca River crossing and roadway/pipeline corridors based on the MUSTS;

- Due to the complexity of selecting among four river crossing locations, four river crossing methods and six roadway/pipeline corridors, the selection process was split into three separate phases:

- Phase I: River crossing analysis,
- Phase II: Roadway/pipeline corridor analysis, and
- Phase III: Integration of river crossing and roadway/pipeline analysis;

- The study team assigned weighting factors to use in the rankings of each of the WANTS (Table 5-1);

- Each discipline expert from the study team compiled relevant information and then scored and ranked each WANT in their area of expertise;

- The scorings and the final rankings were compiled to determine the preferred river crossing and roadway/pipeline corridors;

- The final rankings for the river crossing and the roadway/pipeline corridor were integrated into a combined river crossing/roadway/pipeline corridor matrix using weightings developed by the study team (river crossing-30%, roadway/pipeline corridor 70%); and,

- The preferred river crossing/roadway/pipeline corridor was selected by choosing the option with the highest combined ranking.

With reference to Table 5-1, it should be noted that environmental, historic and social factors were given significant weightings, representing 100 out of 180 points in the river crossing analysis, and 50 out of 100 points in the roadway/pipeline corridor analysis. It then followed that the higher weightings for the environmental historic and social factors carried through to the integrated river crossing/roadway/pipeline corridor analysis.

Table 5-1 MUST and WANT Criteria and weighting factors used in the Route Selection for the River Crossings and Roadway/Pipeline Corridor Selection Process.

MUSTS For River Crossing and Corridor:
• Must connect the Mildred Lake Facility site with the new Aurora Mine Project Site
• Must not cross Fort McKay Settlement, Indian Reserve Lands, or Beaver River Quarry Historical Resource Site
• Must be operational by July 1, 2001
• Must meet regulatory requirements
• Must be operational in all seasons (road)
• Must accommodate hydrocarbon, water and natural gas pipelines
• Must have a 15 year life, but all facilities are moveable after 15 years (no ore is sterilized)
• Must not alter the thermal regime of any watercourse during pipeline operation.

WANTS for River Crossing:
• **Environmental/Historic/Social (100)** [a]
- Minimize in stream disturbances and impacts to aquatic habitat (35)
- Minimize disturbance to sensitive historic resource areas (10)
- Maximize use of existing corridors (20)
- Minimize social impacts (35)
• **Cost (50)**
- Minimize capital costs (40)
- Minimize operational costs (5)
- Maximize capability for expansion (5)
• **Engineering (30)**
- Minimize unfavourable channel characteristics (8)
- Minimize unfavourable geotechnical conditions (6)
- Maximize ease of constructability (12)
- Maximize accessibility for maintenance (4)
Total weightings of River Crossing analysis = 180

TABLE 5-1 CONTINUED

WANTS for Roadway/Pipeline Corridor:
• **Environmental/Historic/Socio-Economic (50)** - Minimize number of stream crossings that support fish species and avoid sensitive or critical habitat at water crossings (5) - Minimize the use of areas with important terrestrial and aquatic habitat for wildlife (7) - Maximize use of existing corridors and, thereby, minimize new access to remote areas (10) - Minimize loss of timber, forest productivity and older forests (3) - Minimize impacts and access to protected areas (5) - Minimize intersection with areas with high historic resource potential and existing historic sites (5) - Avoid existing and proposed public and private facilities (5) - Minimize number of aboriginal and non-aboriginal consumptive and non-consumptive resource users affected (5) - Maximize local economic benefits (5) • **Cost (40)** - Minimize capital costs (40) • **Engineering/Geotechnical/Safety (10)** - Minimize unfavourable geotechnical conditions and maximize constructability (7) - Maximize favourable roadway geometry (3) **Total weightings for the Roadway/Pipeline Corridor = 100**
(a) Weighting Factors that indicate the relative importance of the WANT, based on the consensus of the selection process study team.

5.3 Results

5.3.1 Athabasca River Crossing

For the river crossing analysis, four methods of crossing the river and four crossing locations were investigated:

Crossing Methods

- Construction of a new pipe bridge;
- Utilization of the existing Highway 963 bridge and the proposed Suncor Bridge;
- Pipe installation by open excavation or trenching; and,
- Pipe installation by directional drilling.

Crossing Locations

- Crossing Location 1 located approximately 4 kilometres downstream of Mildred Lake;
- Crossing Location 2 located at the existing bridge, approximately 8 kilometres downstream of Mildred Lake;
- Crossing Location 5 located approximately 18.8 kilometres downstream of Mildred Lake and downstream of Fort McKay; and,
- Crossing Location 6 located at the proposed Suncor Bridge. Only the feasibility of utilizing the proposed bridge was examined.

Table 5-2 summarizes the results for the river crossing options. Based on this analysis the preferred river crossing location chosen was at the existing highway bridge. Use of the existing bridge was also the preferred crossing method. Specific reasons why Location 2 using the existing bridge was the preferred choice include:

- Lower environmental impacts to fisheries resources, historic areas, social impacts and disturbance to undisturbed areas;
- Lower capital and operation costs; and,
- Favourable engineering characteristics since the bridge was designed and constructed to accept pipelines.

TABLE 5-2 RIVER CROSSING KT ANALYSIS

WANTS	WEIGHTS	CROSSING LOCATIONS									
		Crossing Location 1		Crossing Location 2				Crossing Location 5		Crossing Location 6	
		Pipe Bridge		Existing Bridge		Pipe Bridge		Pipe Bridge		Proposed Suncor Bridge	
		SCORE	RANK	SCORE	RANK	SCORE	RANK	SCORE	RANK	SCORE	RANK
1.0 COSTS											
Minimize Capital Costs	40	1	40	5	200	1	40	0.5	20	2.5	100
Minimize Operational Costs	5	2	10	4	20	2	10	2	10	4	20
Maximize Capability for Expansion	5	4	20	5	25	4	20	4	20	3	15
Subtotal			70		245		70		50		135
2.0 ENGINEERING											
Channel Characteristics	8	3	24	5	40	5	40	2	16	5	40
Geotechnical Conditions	6	4	24	5	30	5	30	4	24	5	30
Constructability	12	2	24	5	60	2	24	2	24	3	36
Accessibility for Maintenance	4	5	20	5	20	5	20	5	20	5	20
Subtotal			92		150		114		84		126
3.0 ENVIRONMENTAL											
Instream Disturbances/Aquatic Habitat	35	3	105	5	175	2	70	3	105	5	175
Sensitive Historical Areas	10	3	30	4	40	4	40	1	10	5	50
Maximize Use of Existing Corridors	20	1	20	5	100	3	60	1	20	5	100
Social Impacts	35	3	105	4	140	2	70	3	105	5	175
Subtotal			260		455		240		240		500
TOTAL			422		850		424		374		761

5.3.2. Roadway/Pipeline Corridor

During the course of the assessment three roadway options and six pipeline corridor options were evaluated. Each of the three proposed roadway options commenced with the use of Highway 963 and then turned off towards the proposed Aurora Mine North via one of the proposed Corridors 2, 3 and 4 as illustrated in Figure 5-1.

The six options considered for the pipeline corridor are:

Pipeline Corridor 1.3 (P.C. 1.3) starts at the proposed Aurora site and parallels roadway corridor 3 until it heads south on P.C. 1.3/6.3. It then branches southwest on P.C. 1.3. P.C. 1.3 utilizes river crossing Location 1, then intersects Highway 963 and then on to Mildred Lake.

Pipeline Corridor 2.2 (P.C. 2.2) starts at the proposed Aurora site and parallels roadway corridor 2 until it intersects Highway 963 and then traverses south, utilizes river crossing Location 2 and then on to Mildred Lake.

Pipeline Corridor 2.3 (P.C. 2.3) starts at the proposed Aurora site and parallels roadway corridor 3 until it intersects Highway 963 and then traverses south, utilizes river crossing Location 2 and then on to Mildred Lake.

Pipeline Corridor 2.4 (P.C. 2.4) starts at the proposed Aurora site and parallels roadway corridor 4 until it intersects Highway 963 and then traverses south, utilizes river crossing location 2 and then on to Mildred Lake.

Pipeline Corridor 5.2 (P.C. 5.2) starts at the proposed Aurora site and parallels roadway corridor 2 until it intersects Highway 63 and then traverses south until it intersects P.C. 5.2. It then utilizes river crossing Location 5, traverses around Fort McKay until it intersects and parallels Highway 963 and then on to Mildred Lake.

Pipeline Corridor 6.3 (P.C. 6.3) starts at the proposed Aurora site and parallels roadway corridor 3 until it heads south on P.C. 1.3/6.3. It then branches southwest on P.C. 6.3. P.C. 6.3 utilizes river crossing Location 6, intersects Highway 63 and then traverses north and east to Mildred Lake.

TABLE 5-3 ROADWAY/PIPELINE CORRIDOR KT ANALYSIS

		Roadway 3/Pipe Corridor 1.3		Roadway 2/Pipe Corridor 2.2		Roadway 3/Pipe Corridor 2.3		Roadway 4/Pipe Corridor 2.4		Roadway 2/Pipe Corridor 5.2		Roadway 3/Pipe Corridor 6.3	
WANTS	WEIGHTS	SCORE	RANK	SCORE	RANK	SCORE	RANK	SCORE	RANK	SCORE	RANK	SCORE	RANK
1.0 COSTS	40	5	200	5	200	5	200	5	200	4	160	1	40
Subtotal			200		200		200		200		160		40
2.0 ENGINEERING													
Geotechnical/Constructability	7	2	14	5	35	3	21	3	21	2	14	1	7
Roadway Geometry	3	3	9	5	15	3	9	2	6	5	15	3	9
Subtotal			23		50		30		27		29		16
3.0 ENVIRONMENTAL/SOCIO-ECONOMIC/HISTORICAL													
Minimize Stream Crossings/Impact of Sensitive Habitat	5	1	5	3	15	3	15	3	15	1	5	1	5
Wildlife Terrestrial/Wetland Habitat/Movement Corridors	7	3	21	4	28	3	21	3	21	3	21	1	7
Maximize Use of Existing Corridors	10	3	30	4	40	4	40	5	50	3	30	1	10
Minimize Impacts to Forests	3	4	12	5	15	3	9	5	15	1	3	2	6
Minimize Impacts and Access to Protected Areas	5	4	20	5	25	5	25	5	25	5	25	3	15
Minimize Impacts to Historic Areas	5	3	15	2	10	3	15	3	15	1	5	3	15
Minimize Impacts to Users	5	5	25	4	20	5	25	3	15	5	25	3	15
Minimize Impacts to Existing/Proposed Facilities	5	4	20	5	25	4	20	4	20	5	25	2	10
Maximize Local Economic Benefits	5	2	10	2	10	2	10	2	10	3	15	5	25
Subtotal			158		188		180		186		154		108
TOTAL	100		381		438		410		413		343		164

Based on the results, summarized in Table 5-3, the preferred roadway/pipeline corridor was Roadway 2/Pipe Corridor 2.2, followed by Roadway 4/Pipe Corridor 2.4. Specific reasons why Corridor 2.2 was the preferred Roadway/Pipeline Corridor include:

- Lower impacts to fisheries resources, wildlife habitat, forest resources, aboriginal and non-aboriginal consumptive and non-consumptive resource users, existing and proposed private and public facilities. There would be a slightly higher impact to historic areas than some alternate corridors and less local benefits due to fewer construction related jobs and spin-off activity;
- Lower disturbance to previously undisturbed areas;
- Lower capital cost than Corridors 5.2 and 6.3; and,
- Favourable engineering characteristics in relation to geotechnical conditions, constructability and roadway geometry.

5.3.3 Integrated River Crossing and Roadway/Pipeline Corridor

To determine the preferred integrated river crossing and roadway/pipeline corridor, the results of the separate analyses were integrated. The weights assigned for the two major components were 30% for the river crossing data and 70% for the roadway/pipeline data.

The integration of the river crossing and roadway/pipeline corridor analyses showed that the preferred route is Corridor 2.2 (Table 5-4). More specific reasons why Corridor 2.2 was the preferred roadway/pipeline corridor include:

- Lower impacts to fisheries resources, wildlife habitat, forest resources, aboriginal and non-aboriginal consumptive and non-consumptive resource users, and existing and proposed private and public facilities;
- Lower disturbance to previously undisturbed areas;
- Lower capital costs than Corridors 5.2 and 6.3; and,
- Favourable engineering characteristics in relation to geotechnical conditions, constructability and roadway geometry.

TABLE 5-4 INTERGRATION RIVER CROSSING AND ROADWAY/PIPELINE CORRIDOR KT ANALYSIS

WANTS	WEIGHTS	Roadway/Pipe Corridor 1.3 SCORE	Roadway/Pipe Corridor 1.3 RANK	Roadway/Pipe Corridor 2.2 SCORE	Roadway/Pipe Corridor 2.2 RANK	Roadway/Pipe Corridor 2.3 SCORE	Roadway/Pipe Corridor 2.3 RANK	Roadway/Pipe Corridor 2.4 SCORE	Roadway/Pipe Corridor 2.4 RANK	Roadway/Pipe Corridor 5.2 SCORE	Roadway/Pipe Corridor 5.2 RANK	Roadway/Pipe Corridor 6.3 SCORE	Roadway/Pipe Corridor 6.3 RANK
1.0 COSTS													
Roadway/Pipe Corridor	28	5.0	140	5.0	140	5.0	140	5.0	140	4.0	112	1.0	28
River Crossing	12	3.5	42	4.3	51.6	4.3	51.6	4.3	51.6	2.3	27.6	2.8	33.6
Subtotal			182		191.6		191.6		191.6		139.6		61.6
2.0 ENGINEERING													
Roadway/Pipe Corridor	7	2.3	16.1	5.0	35	3.0	21	2.7	18.9	2.9	20.3	1.6	11.2
River Crossing	3	3.1	9.3	5.0	15	5.0	15	5.0	15	3.1	9.3	4.2	12.6
Subtotal			25.4		50		36		33.9		29.6		23.8
3.0 ENVIRONMENTAL													
Roadway/Pipe Corridor	35	3.2	112	3.9	136.5	3.9	136.5	3.7	129.5	3.1	108.5	2.2	77
River Crossing	15	3.7	55.5	4.6	69	4.6	69	4.6	69	3.5	52.5	5.0	75
Subtotal			167.5		205.5		205.5		198.5		161		152
TOTAL	100		374.9		447.1		433.1		424		330.2		237.4

80-951.WB2

5.4 References

Alberta Environmental Protection. 1995. Draft Fort McMurray - Athabasca Oil Sands Subregional Integrated Resource Plan.

BOVAR Environmental, Golder Associates Ltd., Lifeways of Canada Limited, UMA Engineering Ltd. 1996. Syncrude Aurora Mine Project - Utility Corridor (Roadway and Pipeline) Route Selection.

UMA Engineering Ltd. 1996*a*. Syncrude Aurora Mine: Part B - Utilities and Off Plots Pipeline Corridor Athabasca River Crossing.

UMA Engineering Ltd. 1996*b* Syncrude Aurora Mine: Part A - Road Transportation Corridor.

UMA Engineering Ltd. 1996*c* Syncrude Aurora Mine: Part B - Utilities and Off Plots Pipeline Corridor.

6.0 EXTRACTION PROCESS SELECTION

6.1 Introduction

Developing and evaluating more efficient extraction processes is an important activity for Syncrude. The company's research and development program has developed a number of new technologies applicable to the extraction of bitumen from oil sands. Examples of these new or improved technologies include:

- tailings oil recovery;
- extraction at 50°C process temperature;
- pipeline transportation and digestion of oil sand (hydrotransport);
- recovery of naphtha from froth treatment tailings; and
- froth underwash and froth heating.

As part of this research program, Syncrude has regularly evaluated extraction process technologies developed or implemented by other parties. These evaluations have been undertaken in order to:

- determine the likely economics and environmental impacts;
- understand the fundamental characteristics of the processes;
- identify the key challenges involved in development; and,
- determine potential applications.

The process leading to selection of the most appropriate bitumen extraction process for the Aurora Mine project is described in this section.

6.2 Extraction Process Selection Methodologies and Results

The selection process leading to the preferred extraction process for the Aurora Mine began in 1994 and had two stages.

6.2.1 Stage 1

Stage 1 was a Technology Screening Study in which 11 processes were evaluated against environmental, economic, regulatory and risk criteria (Table 6-1).

Table 6-1 Extraction Processes Evaluated, Criteria and Weightings for Aurora Mine

Process Options	Evaluation Criteria	Weight
Syncrude 50°C Process Stand alone	**Environment/Regulatory Issues**	
Syncrude 50°C Process Integrated	Bitumen Recovery	8
Syncrude ZEFTE Process	Land Disturbance	6
Syncrude 50 Deg C Process with NST	Energy used/ CO_2 Emissions	6
BITMIN	**Economics**	
CDN-OXY Sand Reduction Technology	Supply cost at 11%	30
PWS Technology	Supply cost at 0%	15
Oleophilic Sieve Process	**Risk Issues**	
Low Energy Extraction Process (LEEP)	Development by 2Q96	13
OSLO Hot Water Process	Process Simplicity	7
GEO-SOL Additives	Current State of Development	5

The evaluation flow plan for the screening study is illustrated in Figure 6-1.

Table 6-1 Extraction Processes Evaluated, Criteria and Weightings for Aurora Mine

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Syncrude 50 Deg C Process with NST	Energy used/ CO_2 Emissions	6
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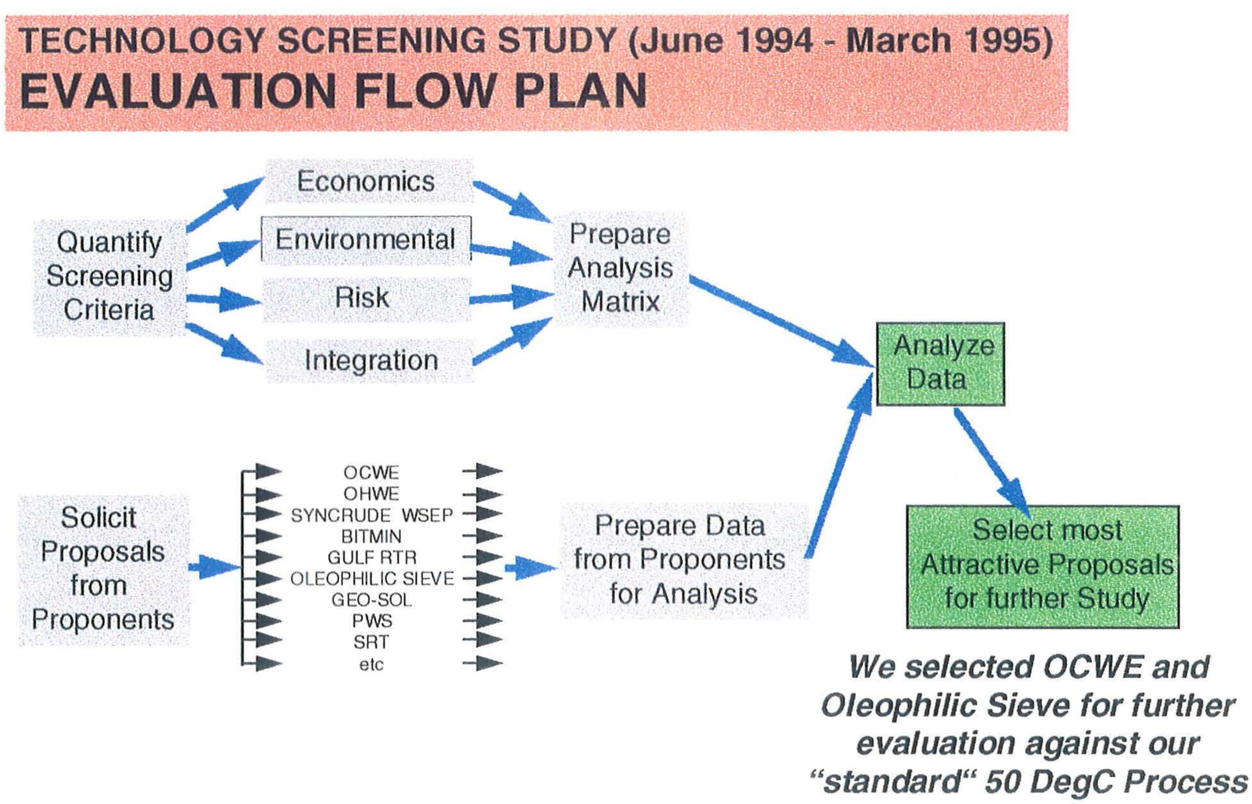
PWS Technology	Supply cost at 0%	15
Oleophilic Sieve Process	**Risk Issues**	
Low Energy Extraction Process (LEEP)	Development by 2Q96	13
OSLO Hot Water Process	Process Simplicity	7
GEO-SOL Additives	Current State of Development	5

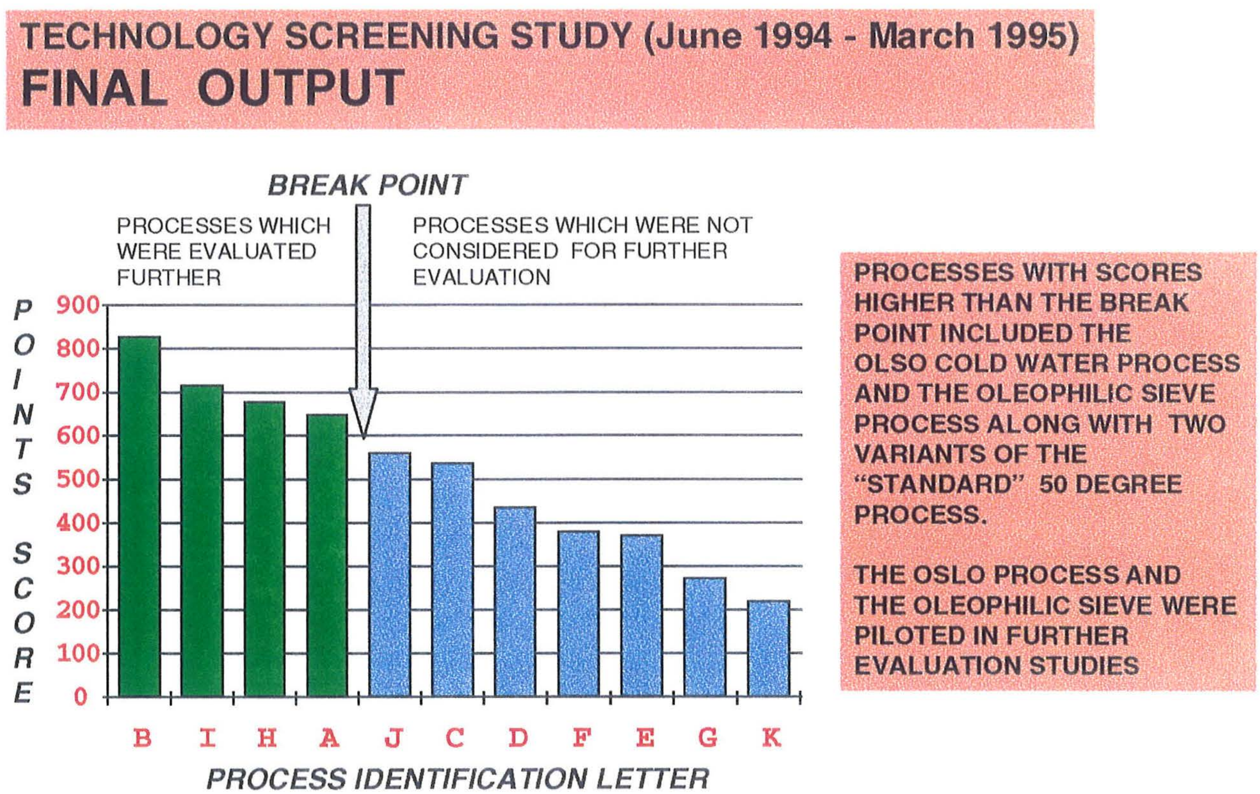
The evaluation flow plan for the screening study is illustrated in Figure 6-1.

Figure 6-1 Extraction Process Screening Study Flow Plan



The summary results are presented in Figure 6-2. Because of the confidential nature of the technologies embodied in the various proposed options, the identities of each of the processes screened are represented only by letters.

Figure 6-2 Extraction Process Selection Analysis



Key factors contributing to the screening decisions made are summarized in Table 6-2.

Table 6-2 Processes Evaluated and Basis for

PROCESS	SELECTED FOR FURTHER STUDY	KEY FACTORS IN THE DECISION
Syncrude Warm Slurry Process with integrated thermal energy supply from Mildred Lake site	Yes	Very low technical risk, very good economics, energy consumption BUT: tailings management requires long-term containment, has more land disturbance than some options
Syncrude Warm Slurry Process as "stand-alone plant" with no thermal energy integration	Yes	Very low technical risk, moderate economics (improve if integrated) BUT: tailings management issues as above, greater energy use
Low Energy Extraction Process	Yes	Very good economics, low thermal energy consumption BUT: tailings management issues as above, some technical risk
Oleophilic Sieve Process	Yes	Potentially very good economics, low thermal energy consumption, uses no chemicals BUT: high technical risk
Syncrude Warm Slurry (WSEP) Process with non-segregating tails	No	Moderate economics Requires MFT inventory NOTE: Will be implemented retrofitted when tailings go in-pit
Syncrude Zero Fine Tails Extraction Process	No	High technical risk, moderate economics
BITMIN Process	No	Moderate economics
Canadian Occidental Sand Reduction Technology	No	Poor economics, high technical risk
GEO-SOL additives	No	Poor economics, low bitumen recovery
OSLO Hot Water Extraction Process	No	Moderate economics, some technical risk
Peter W. Smith Technology High Temperature Process	No	Very poor economics, very high technical risk

Based on the screening selection process, eight of the extraction process options did not warrant further evaluation at this time. Brief descriptions of the rejected options are presented in Table 6-3.

Table 6-3 Processes Screened But Not Selected for Further Study

PROCESS	KEY PROCESS FEATURES
Syncrude Warm Slurry (WSEP) process with non-segregating tails (NST) (No heat interaction)	Syncrude warm slurry process with the addition of chemical tailings treatment to reduce the volume of mature fine tails produced.
Syncrude Zero Fine Tails Extraction process	A variant of the 50°C WSEP which allows dispersed fines to build up in the extraction circuit and traps high concentrations of fines within the coarse tailings matrix.
BITMIN Process	Multi-train dry feed process. Oil sand is conditioned in a tumbler under gentle agitation at about 60°C without chemicals. Middlings are clarified and the tails are filtered to produce dry deposited tailings.
Canadian Occidental Sand Reduction Technology	Multi-train cyclone-based process based on three stages of cycloning coupled with a froth beneficiation step. Operates at 50°C.
GEO-SOL additives	A variant of the Syncrude 50°C WSEP with proprietary chemicals to replace caustic. Claimed to increase tailings settling rate and reduce volume of tailings deposit.
OSLO Hot Water Extraction Process	A 50°C process which uses similar chemicals to the OSLO cold water process, but in lower concentrations. Produces faster initial settling of tailings. Consolidation of fine tailings is similar to hot water process.
Peter W. Smith Technology High Temperature Process	A multi-train process which operates at 220°C using a proprietary separator. Produces relatively cleaner bitumen than lower temperature processes and produces dry deposited tails.

Four processes were selected for further evaluation. These included two variants of the Warm Slurry Process, the Low Energy Extraction Process and the Oleophilic Sieve Process. Brief descriptions of each of these processes follow:

Syncrude Warm Slurry Extraction Process

Oil sand, water and caustic are mixed to form a slurry at a temperature of 50°C. Bitumen is separated from the slurry in a two stage process. In the first stage, bitumen aerated by natural air in the oil sand is floated off the top of a separation vessel. In the second stage the underflow from the first separation is processed by addition of air injected to float bitumen which was not recovered in the first stage.

In both vessels, some of the solids entrained in the froth are removed, the froth leaves the vessel, by injection of water into the froth layer. The bitumen froth from the separation vessels is de-aerated and heated by direct contact with steam in a de-aerator.

Syncrude Warm Slurry Process with Heat Integration

This process is the same as above except that most of the hot water required to run the process is transferred by hot water pipeline from the Mildred Lake site. The energy needed to heat the water is surplus heat from Syncrude's existing operation.

Oleophilic Sieve Process

In this process (Proponent: Oleophilic Sieve Development of Canada), the slurry is prepared and conditioned in a pipeline at a temperature of about 25°C and a density of about 1.5 tonnes/cubic metres without chemicals. The conditioning process takes about 25 minutes at this temperature. The conditioned slurry is admitted to a proprietary separator for recovery of the bitumen. In the separator, the bitumen is attracted to a moving oleophilic belt which lifts the bitumen out of the vessel. The bitumen is removed from the belt and passes to a second proprietary separator where water and solids are removed. The key features of the process are the avoidance of chemicals and the ability to operate at low temperature.

Low Energy Extraction Process (LEEP)

In this process slurry is conditioned in a pipeline at about 25°C and a density of about 1.65 tonnes per cubic metre. The conditioning process takes about 25 minutes, after which time dilution water, air and chemicals (kerosene and methyl-isobutyl-carbinol) are added to promote bitumen flotation in the separation step. The conditioned, aerated slurry is admitted to a two stage gravity separation process in which the aerated bitumen floats as a froth and is recovered. Bitumen recovery is maximized by processing the complete underflow from the primary stage in a secondary separator assisted by the addition of more air. In both the primary stage and the secondary stage, hot water is injected into the floating bitumen froth to wash out solids and heat up the bitumen. The bitumen froth from both vessels is then deaerated and heated further. The key benefit of this process is that it operates at a much lower temperature than more conventional processes, thereby saving energy and taking advantage of the low material handling costs inherent in hydrotransport.

All of the extraction process options selected for further evaluation were based on pipeline transportation and large scale digestion of oil sand. Syncrude's warm slurry processes are well understood and therefore scored well in the "Risk" category but were less attractive than the two lower temperature processes (Oleophilic Sieve/LEEP) in the "Economics" category due to energy consumption. Since neither of the low temperature processes had been tested in the configuration proposed, it was necessary to conduct further experimental work on these options.

6.2.2 Stage 2

Stage 2 involved pilot tests on the two low temperature processes (Oleophilic Sieve and LEEP) to validate performance under controlled conditions so that comparisons could be made with the variants of Syncrude's more familiar warm slurry processes.

The two processes were each tested on the same continuous pilot by the same experimental team using the same bitumen feed. The capacity of the pilot plant was 1.5 tonnes per hour. Bitumen recovery and froth quality were the key parameters investigated.

The final selection study was undertaken by a team of Syncrude technical staff, representatives from the Syncrude owners, the proponents of the processes and independent industry consultants.

Two different techniques were used to evaluate the pilot processes:

- A Kepner-Tregoe technique (similar to that used in the screening study);
- A risk-based economic evaluation technique developed by SDG, a group of independent consultants.

Table 6-4 summarizes the results of the second stage evaluation.

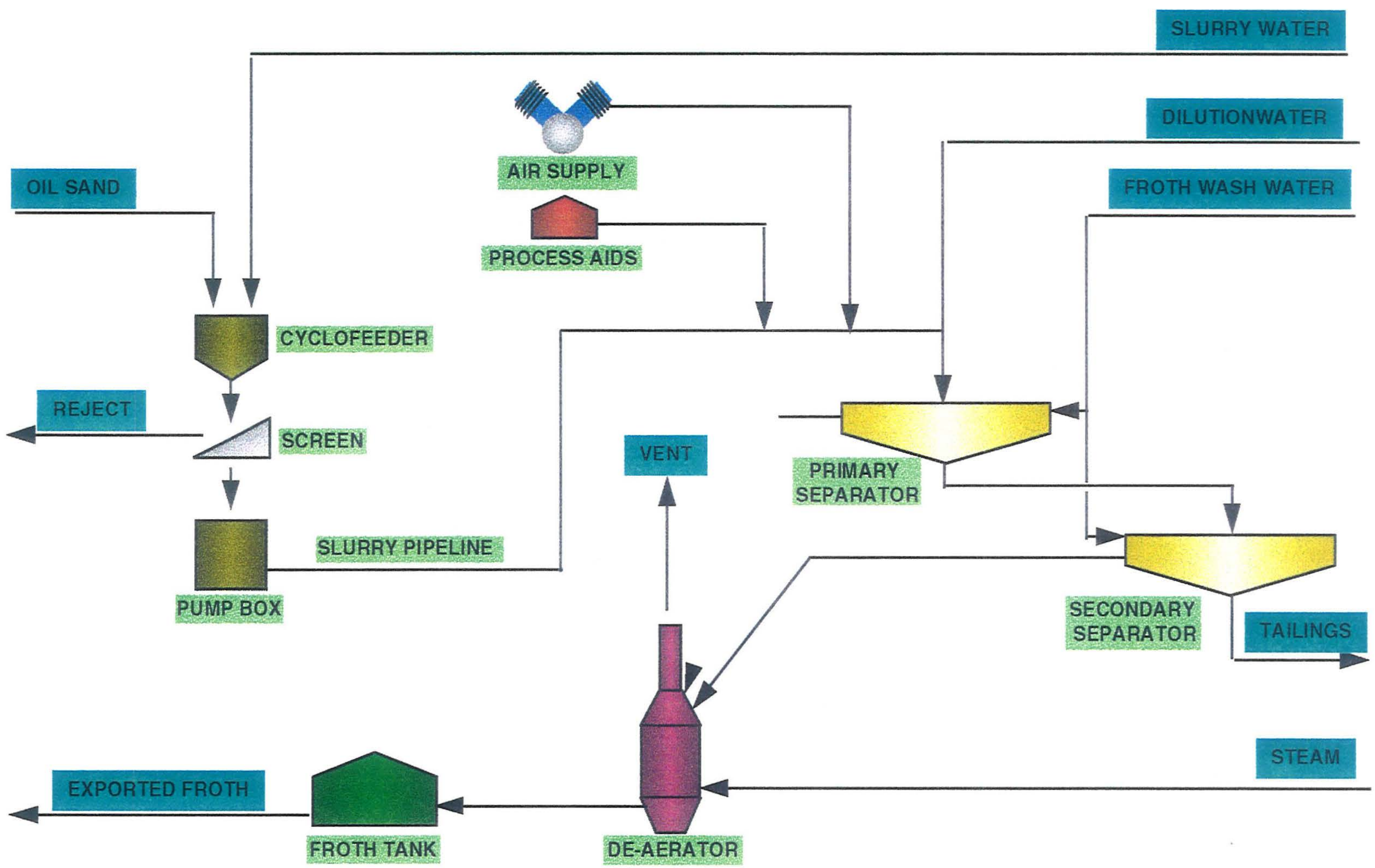
Table 6-4 Summary Of Second Stage of Evaluation

PROCESS	RESULTS
Oleophilic Sieve	-Did not meet bitumen recovery criterion -Predicted performance not confirmed
Low Energy Extraction Process	-Exceeded bitumen recovery criterion -Economics better than both Warm Slurry options -Recommended for Aurora BUT: Needs confirmatory field trial
Warm Slurry with Thermal Energy Integration	-Used as a "Benchmark" to compare the OSLO and Oleophilic processes -Adopted as contingency case

Based on the pilot testing results, the Low Energy Extraction Process was selected, subject to a further successful pilot test at 100 tonnes/hr to be carried out in the summer of 1996.

The Low Energy Extraction Process is still under development. In the event that the performance of the process falls short of expectations, a variant of the Warm Slurry Process will be used. The key difference between the processes is the operating temperature and the chemical aids used in the processes. At this stage, Syncrude is of the view that the development of the Low Energy Extraction Process will be successful.

Fig. 6-3 LOW ENERGY EXTRACTION PROCESS - BASIC PROCESS FLOWS



7.0 PRODUCT (BITUMEN) TRANSPORT MODE SELECTION

7.1 Introduction

Syncrude's proposed Aurora Mine will be located approximately 35 kilometres northeast of the Mildred Lake facility. This geographic remoteness, combined with the incentive to minimize duplication of facilities at the new location and the need for compatible (composition and properties) products with the existing Mildred Lake mine and extraction operation, triggered the need for a careful examination and evaluation of options for transporting the bitumen from the Aurora Mine to the Mildred Lake bitumen terminal.

As a result, a study was undertaken to evaluate the various options available for economically transporting product from the Aurora Mine to the Mildred Lake plant site.

7.2 Product Transportation Selection Methodology and Results

The selection process leading to the preferred option for bitumen transportation was a three stage process.

7.2.1. Stage 1

Stage 1 served to determine the most economic form of the product to be transported from the Aurora Mine to the existing facilities at Mildred Lake. Five basic product forms were considered:

- Oil sand
- Oil sand slurry
- Froth
- Diluted bitumen
- Bitumen

Table 7-1 presents the general features of the products considered. The options were evaluated using social supply cost economics at a discount rate of 10% compared to a "standard" case of diluted froth which had been used in an earlier study. Based on the Stage 1 evaluation it was concluded that froth, or a product of similar composition, would be the most attractive option to pursue further.

Table 7-1 General Features of the Potential Aurora Mine Products

PRODUCT SHIPPED	POSITIVE FEATURES	NEGATIVE FEATURES	SUPPLY COST IMPACT
Oil Sand	Requires only a mine at Aurora. Simple transfer technology.	Long cross-country conveyors transfers all sand to Ls 17/22	Penalty > $0.54/bbl
Oil Sand Slurry	Requires only mine and slurry preparation at Aurora.	Long cross-country slurry lines imports all sand to Ls 17/22 Large water import to Ls 17/22	Penalty of $0.54/bbl rising to $1.48/bbl if tailings returned to Aurora
Froth	Avoids the cost of bulk sand transfer. Avoids diluent at mine site.	Requires Extraction Plant at Aurora. Pumping technology not proven. Transfers water and froth solids with the bitumen	Nil - Base Case
Diluted Bitumen	Avoids bulk sand transfer. Transfers cleaner bitumen. Pumping technology well known.	Requires extraction AND froth treatment at Aurora. Introduces diluent to Aurora.	Penalty of $0.73/bbl
Bitumen	Eliminates diluent transfers.	Requires at Aurora: • extraction • froth treatment • diluent recovery High pumping costs. Introduces diluent to Aurora	Penalty > $0.73/bbl

7.2.2 Stage 2

In the Stage 2 evaluation, several options for transferring froth were identified and subjected to a decision analysis. These included:

- **Naphtha Diluted Froth (used in Stage 1 as Base Case)**
  The froth is diluted with naphtha to reduce its viscosity sufficiently to allow it to be pumped economically. On receipt at Mildred Lake, more diluent is added before the froth is processed in the Froth Treatment Plant. Two pipelines are required to and from Aurora -- one for froth and one for diluent;

- [2]**Heated Froth**
  The froth is heated to reduce its viscosity for pumping;

- [2]**Emulsified Froth**
  Chemicals are added to the froth to convert it to an "oil in water" emulsion which can be pumped easily at low temperature since its viscosity is akin to water rather than bitumen; and,

- [2]**Natural Froth Lubricity Process**
  The froth is pumped in a mode which generates a water layer around a core of high viscosity froth. The effective viscosity for pumping is akin to water. Froth contains approximately the right amount of water to accomplish this technique without adding extra water.

Based on the analysis, Naphtha Diluted Froth and the Natural Froth Lubricity Process were selected for further study in Stage 3. The Diluted Froth Method was selected primarily because it represented the best-known technology. The only significant concern with this method is the potential for "tight" emulsions to be formed in the pipeline.

The Natural Froth Lubricity Process was chosen because it requires only one pipeline, uses no diluent or chemicals and potentially has the best economics.

[2] Heated Froth, Emulsified Froth and Natural Froth Lubricity Process avoid the need for Diluent at Aurora

7.2.3 Stage 3

During Stage 3, experimental programs were undertaken for each of the two selected options to address key issues that arose from the techno-commercial analysis. For the Diluted Froth Option an experimental program was carried out by the Alberta Research Council focusing on emulsion formation. The primary conclusion of this research effort was that emulsion formation could be controlled by proper pump design. In the extreme, demulsifying chemicals could be added to break up "tight" emulsions.

The experimental program for the Natural Flow Lubricity Process was conducted at the University of Minnesota and was intended to determine the pumping characteristics of the foam, the tendency of froth to stick to the pipe walls and the re-start characteristics of the system. Preliminary conclusions from this research are that low-temperature froth is well suited to transfer by the Natural Flow Lubricity Process and the froth has little or no tendency to stick to the pipe walls. The re-start characteristics continue to be investigated along with engineering scale-up considerations.

Based on the results to date, the Natural Flow Lubricity Process remains the favored option, primarily because of the simplicity of the method, the fact that this system uses no chemicals or diluent and the economics appear to be better.

The key advance with this technology is that it allows the movement of bitumen in a pipeline at low pumping power using contained water as a transfer medium without the addition of hydrocarbon diluent. This eliminates the need for a diluent supply pipeline and avoids the use of diluent at the Aurora site and the need to transfer diluent over long distances. There is also no need for *en route* water injection for pipeline restarts. Overall, there is a small reduction in environmental risk by eliminating sources of light hydrocarbon emission from diluent tanks at the Aurora site and by eliminating the small risk of spillage of light hydrocarbon from pipelines. Figure 7-1 illustrates the key features of the Natural Flow Lubricity Method.

Development work on the Natural Forth Lubricity Process will continue. In the unlikely event that the preferred option fails to meet expectations, the Naphtha Diluted Froth Process will remain the contingency option. Figure 7-2 shows the principal features of this process.

Figure 7-1 Key Features of Bitumen Transfer by Natural Flow Lubricity Process

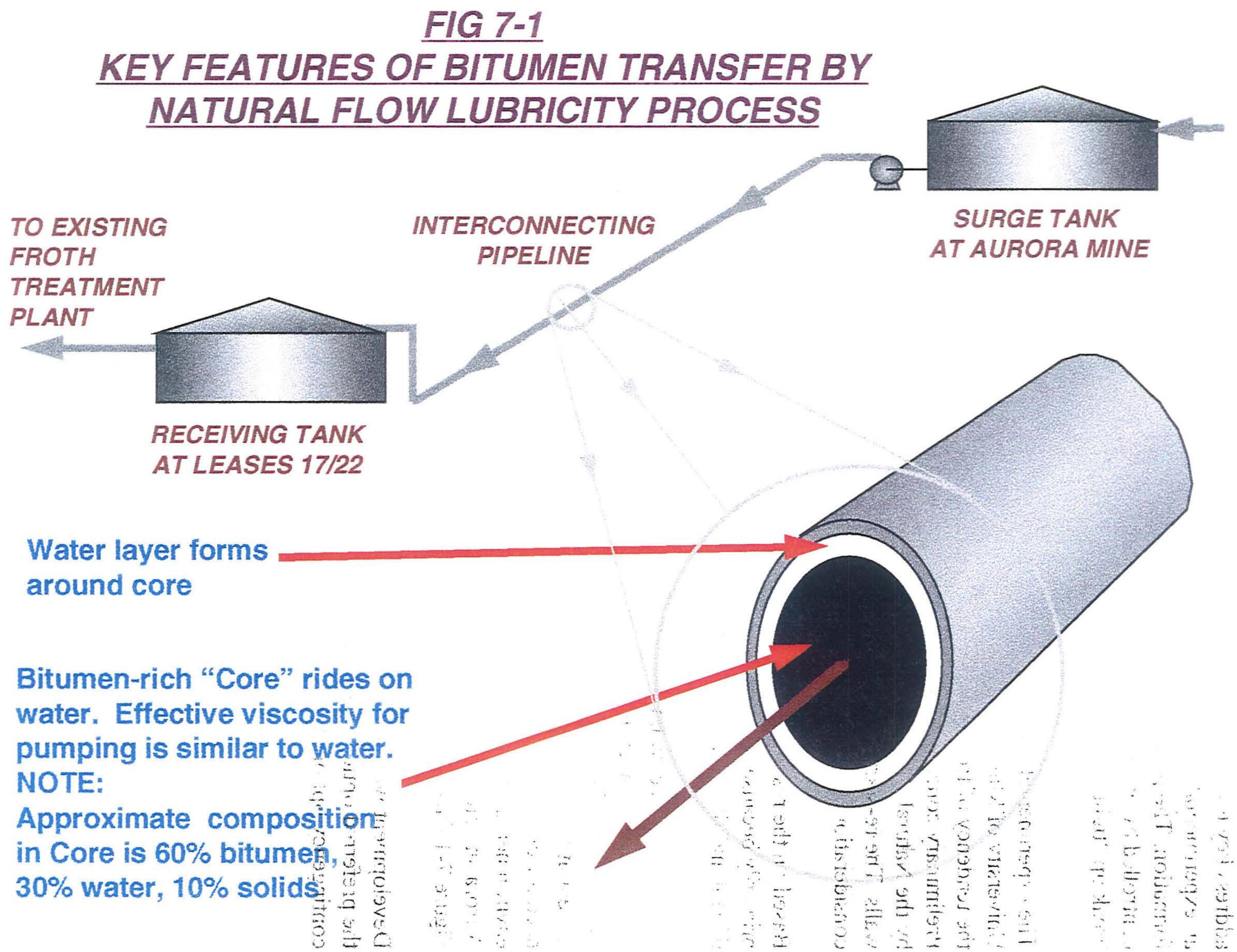
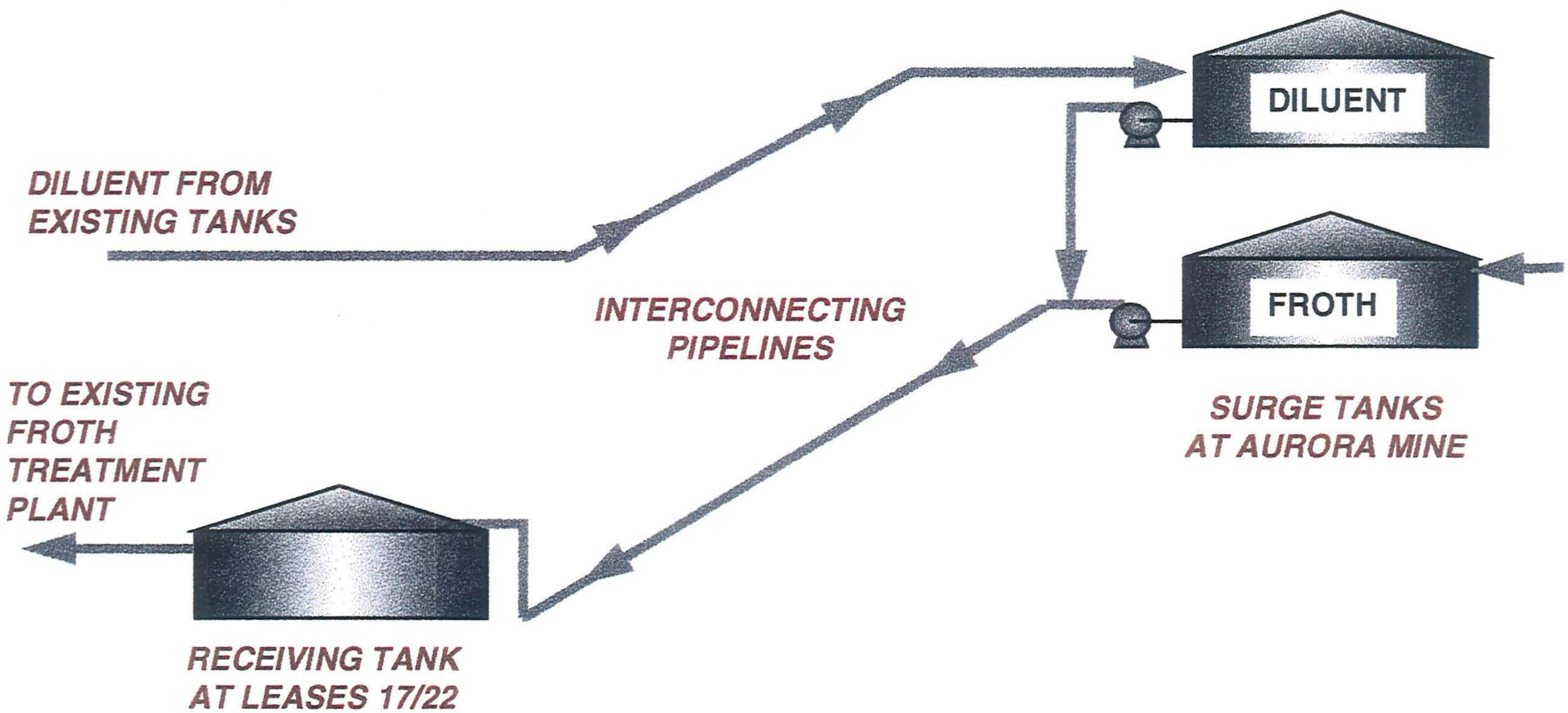


Figure 7-2 Key Features of Bitumen Transfer by Alternate Diluted Froth Process

FIG 7-2
KEY FEATURES OF BITUMEN TRANSFER BY ALTERNATE DILUTED FROTH PROCESS



8.0 Thermal Electrical Power Generation and Make-up Water Options

8.1 Introduction

The Aurora Mine Project has selected a low temperature extraction process that requires considerably less thermal energy per tonne of oil sand processed than the Clark Hot Water Process used historically. Nonetheless, thermal and power requirements will still be significant. Make-up water sources, external to Aurora, were included as part of Aurora's overall thermal-electric power generation option evaluation due to the quantity of surplus low level thermal energy available from Mildred Lake as a result of shutting down the west mining quadrants and associated extraction equipment.

8.2 Thermal Power Generation and Make-Up Water Selection Process

To assist with the selection of the preferred thermal power generation and make-up water options for the Aurora Mine four basic criteria were used:

- **Robustness:** For the Aurora Mine this attribute is critical to the long-term value (economic and environmental) of any alternative under consideration. The option must be robust enough to withstand significant changes in thermal demand (not just due to seasonal variations but also long-term reductions in process temperatures);

- **Energy efficiency:** All energy used directly at Aurora or indirectly attributable to the Aurora Mine project, including incremental change on Lease 17/22, heating of Aurora export water, Alberta Interconnected System (AIS) power import including transmission line losses;

- **Capital Cost;** and,

- **Purchased Energy Costs.**

Table 8-1 identifies the six generic options investigated as part of the Aurora thermal-electric power and make-up water selection process. These options are based upon two make-up water sources (Athabasca River, Mildred Lake) and three electrical power import alternatives (100%, None, Import as required [assuming a 48 to 50 MW GTG with OTSG]). The selected power import and make-up water arrangements set the corresponding thermal generating arrangements.

Option 1, which is a minimum capital, maximum purchased energy and minimum energy efficiency case, was used as the base case for comparing incremental capital, purchased energy cost decrements in $million/year, and energy efficiency measured as CO_2 emission decrements in tonnes/year for a single train operation. The effect of adding a second train was qualitatively evaluated.

Of all the alternatives considered, Options 2 and 6 represent the greatest purchased energy cost savings and best overall energy efficiency compared to the base case (Table 8-1). Although Option 2 purchased energy cost and CO_2 emissions decrements are marginally higher than Option 6 (by $2 million/year and 34 tonnes CO_2 /day respectively higher), capital cost for Option 2 is $20 million higher. Since an incremental $2 million/year reduction in purchased energy cost did not justify an incremental $20 million in capital cost, Option 6 was selected as the preferred method for thermal electric power and make-up water provision to the Aurora North Mine.

Table 8-1 Thermal-Electrical Power and Make-up Water Options for Aurora Mine

DESCRIPTION	CAPITAL INCREMENT $MILLION	PURCHASED ENERGY COST DECREMENT $MILLION/YEAR	ENERGY EFFICIENCY (CO_2 DECREMENT TONNES/DAY)	COMMENTS
Option 1: • Athabasca River Make-up • 100% AIS Import • Packaged Boilers	Minimum Capital Case	Maximum Purchased Energy	Maximum CO_2 Emissions	**Base Case for Comparison Purposes** Strong incentive to reduce process temperatures
Option 2: • Leases 17/22 Make-up Water • No AIS • Frame 5& WE251B12 GTG with OTSG's • 1 Packaged Boiler for Trim Heat	$28 (1st Train Increment)	$13 Can be improved if AIS export restriction lifted	1,215	Packaged Boiler S/D during summer Good thermal match at existing 30°C process temp. Little incentive to be more energy efficient in summer, Second Train Capital costs lower than first train; Purchased Energy cost savings significantly higher **High capital cost.**
Option 3: • Leases 17/22 Make-up Water • 100% AIS • Packaged Boilers for Thermal	$13.4 (1st Train Increment)	$4 (Marginal for 1st Train)	335	Second train capital & purchased energy slightly lower than for first train **Marginal first train economics relative to other alternatives**

Table 8-1 continued ...

DESCRIPTION	CAPITAL INCREMENT $MILLION	PURCHASED ENERGY COST DECREMENT $MILLION/YEAR	CO_2 DECREMENT TONNES/DAY	COMMENTS
Option 4: • Athabasca River Make-up • AIS Import as Required • GTG with OTSG • Packaged Boilers	$5.6	$6	723	
Option 5: • Athabasca River Make-up • No AIS • Frame 5 & WE251B12 with OTSG's • 2 packaged Boilers	$28.9	$8 Can be improved if AIS export restriction lifted	849	Second train capital significantly lower than first train. Potential for further purchased energy reductions for both trains **High capital cost.**
Option 6: • Lease 17/22 Make-up Water • AIS Import as Required • GRG with OTSG • 2 Packaged Boilers for Thermal	$8	$11	1,181	Second train capital slightly lower than for first train. Purchased energy savings understated. Reasonable thermal-power match. **Recommended option.**