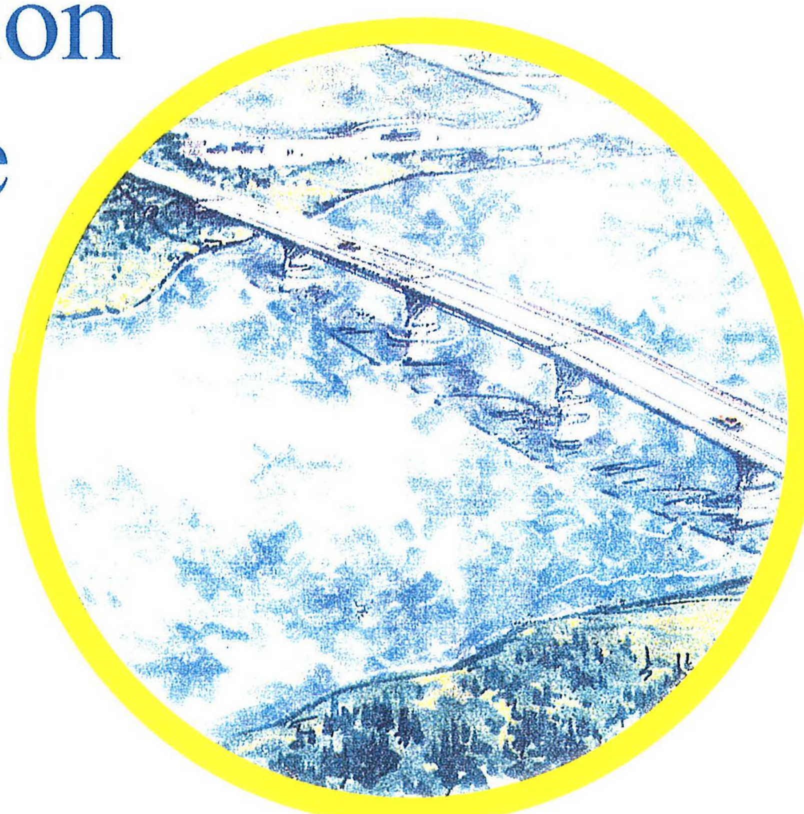
Steepbank Mine Project

1996

Supplemental Information Response



We Care

Suncor Inc.
Oil Sands Group

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Oil Sands Group

July 29, 1996

T. G. Abel
Supervisor, Mineable Oil Sands
Alberta Energy and Utilities Board
640 - 5 Avenue SW
CALGARY, Alberta
T2P 3G4

Dear Mr. Abel:

SUPPLEMENTAL INFORMATION RESPONSE
STEEPBANK MINE PROJECT
EUB APPLICATION NO. 960439
AEP APPLICATION NO. 020-95, AND FILE NO. 27551

The following information is provided in response to the Energy and Utilities Board and Alberta Environmental Protection supplemental information request dated July 12, 1996. The following response follows the outline of your supplemental request letter.

A key supporting report has been referenced in this supplemental in support of some of our answers related to the reclamation of the Steepbank Mine valley. This report, entitled "Detailed Conservation and Reclamation Plan for Suncor's Integrated Mine Plan, Lease 86/17, Steepbank Mine and Athabasca River Valley" by Golder Associates dated July 26, 1996 is being provided under separate cover. In this Supplemental it will be referenced as the "C & R Report."

1 PROJECT DESCRIPTION

Q1.1 Provide an update on the design plans for the Steepbank Mine and associated infrastructure. Include any recent changes to the development plan which may have implications for environmental protection and resource conservation.

A1.1 The Steepbank Mine Application was based on feasibility level design for the project, the planning process has continued since the application was filed in April 1996.

Detailed engineering has begun, focussing on construction plans and mine layouts. Significant project changes, affecting the environment and resource conservation, are described below.

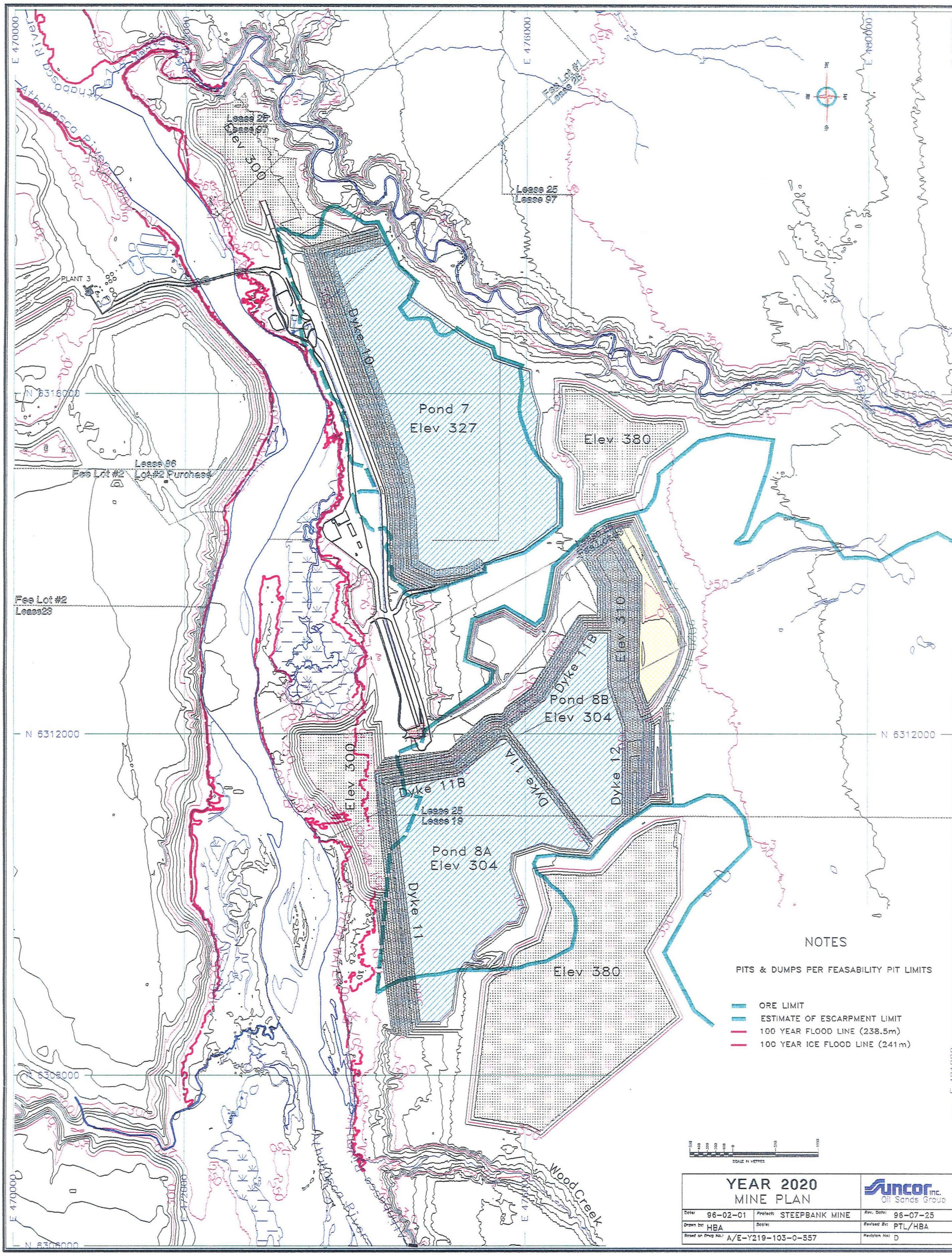
Mining boundaries as indicated on Figure 1-1, and particularly the escarpment daylight boundary, are still under revision pending additional exploration drilling, and topography mapping.

1) Steepbank / Athabasca River Peninsula

A decision was made in February 1996 following additional drilling and consultation with interested parties, to not mine ore in the northern peninsula area. The mine plan has now been reworked to exclude this area, and resulted in a loss of less than six months of reserves. The new mining boundaries are shown on Figure 1-1. There is still a requirement for an external waste dump in the peninsula area, primarily to hold the pre-stripping material for Pit 1. The waste dump is designed with a minimum setback from the Athabasca River of 200 meters, setback 100 meters from the valley break for the Steepbank River and overall slope of 3H:1V. The waste dump sides have been contoured to present a more natural landscape and will be revegetated as soon as practically as part of the valley reclamation plan. The toe of the dump will be located outside of the 1:100 year ice flood contour. The maximum height of the waste dump has not been finalized but, as shown in Figure 1-1, is anticipated to reach a height of 300 meters above sea level.

2) Project Schedule

The start-up date for the Steepbank Mine has been accelerated to provide the most economic source of feedstock to fill the excess capacity in the fixed plant starting January 1999. The strategy will be to supplement the bitumen feed from Steepbank to current mine feed to make up the capacity difference until reserves from the existing



YEAR 2020
MINE PLAN
Suncor inc. Oil Sands Group
Date: 96-02-01
Project: STEEPBANK MINE
Rev. Date: 96-07-25
Drawn by: HBA
Revised By: PTL/HBA
Based on Drwg No.: A/E-Y219-103-0-557
Revision No.: D
NOTES
PITS & DUMPS PER FEASABILITY PIT LIMITS
ORE LIMIT
ESTIMATE OF ESCARPMENT LIMIT
100 YEAR FLOOD LINE (238.5m)
100 YEAR ICE FLOOD LINE (241m)
Pond 7
Elev 327
Elev 380
Pond 8B
Elev 304
Pond 8A
Elev 304
Elev 300
Elev 310
Dyke 10
Dyke 11
Dyke 11A
Dyke 11B
Dyke 12
PLANT 3
Lease 25
Lease 97
Lease 19
Lease 86
Lot #2 Purchase
Fee Lot #2
Lease23
Fee Lot #1
Athabasca River
Wood Creek
N 6316000
N 6312000
N 6306000
E 470000
E 476000
E 481000

FIGURE 1-1

leases are exhausted. At this point all bitumen feed will come from the Steepbank operation.

The change in schedule will not alter the development footprint but, when combined with the loss of the peninsula reserves, may result in the completion of Pit 2 up to one year earlier than presented in the application. Infill drilling and reserve estimation may well increase the mining reserves to the end of the year 2020 as previously anticipated. Capital expenditures will increase by approximately $7 million to $343 million, or 2 percent of the project total. The accelerated schedule changes the distribution of construction manpower and will result in a greater overlap with the Fixed Plant Expansion workforce. No change to operational manpower will occur as a result of the accelerated timing.

A "satellite" construction camp will be erected on the Steepbank site, sized to house 120 workers, and will provide housing during plant wide manpower peaks, and during the Athabasca River break-up and freeze-up periods when regular access to the site is limited to air transport.

3) Shipyard Lake

The location of the West Waste Dump was reexamined as a result of consultation with regulators and other interested parties. Shipyard Lake wetland is an important ecological resource within the Athabasca River valley and the waste dump structure will be relocated outside of the wetlands area. The mine plan has been revised to relocate the waste dump to the south, outside of the wetlands area, this new site will hold the same storage volume. The dump location is shown on Figure 1-1. The dump is designed to have a 200-meter setback from the Athabasca River but in order to accommodate the necessary storage volume, the dump is sited within the 1:100 year flood plain. The design will include protection of the toe from erosion due to flooding.

The change in waste dump location necessitated a redesign of the drainage plan to control water flows into Shipyard Lake. A diversion bypass will maintain water flows into the lake. Excess water will be diverted directly to a new outfall to the Athabasca River. The drainage plan is discussed in section 4.2 of the C & R Report.

4) Access corridor setback from the Athabasca River

The access corridor to the shop area has been revised to provide a minimum 100 meter setback from the Athabasca River. There remains one small (100 meter length) section of road crossing a gulley which will require fill into the 100-meter setback. The western edge of the road allowance will be situated 120 meters from the river and slope of the fill will be revegetated as part of the road construction. The design for this road is discussed in more detail in Question 4.5 (a).

5) Extraction Plant and Bitumen Recovery

Since submitting the Steepbank application Suncor has revised its plans for increasing the froth treatment plant capacity to accommodate the production rate of 107 kbbl/cd. Inclined plate separator (IPS) technology will be used upstream to the existing plant. One third of the diluted froth feed to the froth treatment plant will be directed through the IPS. This is explained in more detail in the Fixed Plant Expansion Supplemental Information Response.

Suncor is committed to improving hydrocarbon recovery levels and is now targeting an average bitumen recovery of 92.5%, versus the 91.1% as stated in the Application. This recovery improvement will be achieved through a number of opportunities currently being examined including hydrocyclone overflow, and froth underwash. These projects have been discussed in more detail in the Fixed Plant Expansion Supplemental Information Response.

6) Bridge design changes

The contractor for the bridge (design-build contract) was selected in May 1996. The pier design and construction method employ a new, proven technology which shortens the construction time frame to about 14 months. Also, preliminary examination indicates the pier installation technique minimizes fisheries and environmental impacts.

The piers are constructed using two steel pilings (2.5 meters in diameter), connected with a concrete diaphragm between the pilings with a pile cap on top. The piers will be constructed using marine equipment minimizing access berms, thus minimizing impacts on the environment. Abutments will be constructed using direct placement of clean aggregate (estimated 3-6% fines) eliminating the need for coffer dams. A monitoring program will be conducted during all instream activities. If target Total Suspended Solids (TSS) criterion is exceeded instream activities will cease and additional mitigative measures would be employed.

The diesel and natural gas lines which were to be suspended below the bridge deck will now be placed in the trough on the deck.

7) Barge Landing

The need for a barge landing and associated lay down site has been reexamined to minimize disturbance in the river valley. The design has now been revised to eliminate the barge lay down area leaving only an access road from the landing site directly to the development area. This barge access will only be used during the summer of 1997, as bridge access will be available prior to the summer of 1998.

An environmental assessment update was completed by Golder Associates, to review impact hypothesis, and determine if the project changes affect the outcome of hypothesis stated in the original EIA. The assessment is included as Appendix 1 to this letter.

The assessment update drew the following conclusions:

- revisions will result in limited, put positive, changes to the environmental impacts report in the Application
- accelerated mine operation will result in levelling workforce requirements in the region
- impacts to terrestrial resources in the valley are reduced
- north-south corridor for wildlife movement will be reduced in effectiveness, though it does not appear to be an important corridor
- changes to bridge design and construction methods will result in further reduction of adverse effects to aquatic habitat or fish abundance

2 MINE DEVELOPMENT

Q2.1 Provide the conclusions of the special tests undertaken to evaluate extraction recovery performance using ores from different depositional systems. Also

describe the data obtained to define ore blending strategies and how Suncor would use the information for the operation of the Steepbank Mine *(Steepbank Mine Project Application, April 1996, Section C2.0, p.21).*

A2.1 Suncor has completed a series of processability tests on ore samples from the Steepbank Mine Project area as follows:

- 1994
  - 25 processability tests on individual samples classified by facies
  - 7 processability tests on blends of the individual samples from the east side of Pit 1
- 1995
  - 22 processability tests on individual samples classified by facies
  - 7 processability tests on blends of the individual samples from Pit 1
- 1996
  - 12 processability tests on individual samples classified by facies

The processability test program was completed to establish basic recovery data for Steepbank ore and analyse recovery data in relation to facies types. The samples primarily represent Tidal Channel Sands (TCS), Tidal Channel/Tidal Flats (TC/TF), and

Tidal Channel Breccia (TCB) facies types. The processability tests completed to date include 22 samples with less than 8 percent bitumen.

Preliminary conclusions from the results of the tests indicate reasonable recovery predictability by facies with the exception of TC/TF. which exhibits erratic recovery results. The tests on blended samples generally show no major recovery variances from the calculated recovery, based on individual samples. Three of the blends had lower processabilities than the value calculated from the constituent samples. A total of 117 additional samples were collected during the 1996 exploration program representing the various facies and range from low bitumen/high fines to high bitumen/low fines in quality.

A processability program has been initiated to test the 1996 samples and will include:

- processability tests of individual facies types over the range of bitumen grades available
- processability tests of blended samples

The results of the program, in conjunction with the previous test results, will be used to further define recovery relationships between bitumen content, fines, and facies types. A summary report of the conclusions of the processability program will be completed by the end of 1996.

The data obtained by the processability testing will be used in the derivation of a recovery curve which will define an ore grade parameter in terms of recovered barrels of bitumen per tonne. Ore processability data from blended samples may identify blending ratios that can be used to enhance recovery performance. Maintaining a consistent ore feed grade in terms of recovered barrels per tonne is a primary consideration in the development of operating mine plans. The mine planning process will incorporate any conclusive data regarding blending to optimize overall efficiency in the mining process.

Q2.2 **Provide quantitative values for the conditions used to classify portions of the McMurray formation as overburden *(Steepbank Mine Project Application, April 1996, Section C2.0, p.25)*.**

A2.2 Portions of the McMurray formation are classified as overburden according to the criteria that are used to distinguish waste and ore. The parameters used to define ore and waste in the McMurray formation are as follows:

- Minimum Mineable Thickness - a material unit must be at least 3 metres thick before it can be separated from surrounding zones of different material (i.e., waste within ore).

- Cut-off ore grade of 8% was used for the Steepbank Mine

- Drillhole sample intervals are classified as ore or waste by grade; ore if the grade is greater than cut-off grade or waste if the grade is less than cut-off grade. The classified sample intervals are processed in relation to the minimum mineable thickness to determine ore and waste zones.

The following process is currently used to determine ore and waste within the McMurray formation:

1. The individual sample intervals are checked sequentially from the top to the bottom of the hole and classified ore or waste according to cut-off grade. The

initial classification is utilized in the determination of ore and waste zones.

2. A potential ore zone begins once an ore sample interval is found. All subsequent sample intervals, regardless of grade, are included in the ore zone until a zone of contiguous waste sample intervals not less than the minimum mineable thickness is encountered. Subsequent waste sample intervals are included in the waste zone.

3. Once a waste zone is found the ore zone above is checked for minimum mineable thickness; if it is too thin it is reclassified as waste.

4. At the next ore sample interval, the process begins again with step 2.

The primary criterion in the process is that a waste zone must first be defined by a continuous series of sample intervals, at least 3 metres thick, that are individually below cut-off grade. Two waste sample intervals on either side of an ore sample interval cannot constitute an initial waste zone even if the combined grade is less than cut-off, however two ore sample intervals on either side of a waste interval can constitute an ore zone.

Resultant ore zones can be of lower grade than the cut-off grade used for sample interval classification; these ore zones are reviewed manually to ensure they fall within a reasonable tolerance of cut-off grade. The current application of cut-off grade allows the inclusion of significant quantities of below cut-off grade material in the ore zones.

Q2.3 **Describe the effect an improvement in bitumen extraction recovery would have on the average oil sands grade that could be economically processed (would lower ore cutoffs be feasible)? Discuss (in quantitative terms) the effect on project economics**

of adopting lower ore cut-off parameters (e.g. 3 metres ore thickness and 6 wt..% ore grade) in conjunction with improved extraction recoveries (recent communication with Suncor has indicated that recovery efficiencies of 92.5% are achievable vs. 91% used in the application).

A2.3 An improvement in bitumen extraction recovery would generally decrease the ore grade (bitumen %) that could be economically processed assuming the barrels recovered by mining and processing a tonne of ore would increase while costs remained the same. Improved recovery for ore grading between 6% and 8% bitumen would be required to allow a decrease in cut-off grade since each tonne of ore mined must have a positive contribution to economics.

The cut-off grade and minimum mineable thickness will determine the classification of ore and waste within the ore body. However, oil sand does not have any inherent property, such as bitumen percentage, that can be solely used to determine cut-off grade. Rather, the determination of cut-off grade is based on economics of the total production process. Factors such as insitu grade, processability, and site economics must be utilized to define cut-off grade.

A significant portion of the costs defined in the determination of an economic cut-off limit are fixed and on a unit basis depend on the output rate of the overall production process. An evaluation of the grade-tonnage distribution of the reserves identified by an economic cut-off limit must be completed to verify that the overall production capacity is maintained.

Minimum mineable thickness reflects the ability of the mining process to selectively removal thin ore bands from waste and vice versa. A minimum mineable thickness of 3m, is currently applied.

The economic pit limit ratio will define the limits of the ultimate pit which is capable of supporting costs. The value, at the mining face, of a barrel of bitumen ($ Available for Mining) is derived based on site economics. Simplified, the value of the bitumen divided by the unit mining cost ($/tonne) defines the economic pit limit ratio in terms of Total Tonnes to Bitumen Recovered. Areas with a total tonne/recovered barrel ratio less than or equal to the limit ratio for that location are included in the ultimate pit.

A project to evaluate cut-off grade relationships for the Steepbank Mine Project has been initiated. The project plan is included as Appendix 2 in this Supplemental.

Suncor is committed to the development of an ongoing process that includes recovery performance in the determination of cut-off grade which will ensure that the Steepbank Mine meets the objectives of maximizing return and conservation while minimizing environmental impacts. Reserve calculation parameters including cut-off grade and recovery prediction methods will continue to be reported during the annual mine plan approval process in accordance with Clause 30 of the Oil Sands Conservation Regulation.

Q2.4 Provide a basal aquifer isopach map and dxf file for the Steepbank mine area and provide an estimate of the annual basal aquifer depressurization volumes and water chemistry. Describe Suncor's disposition plans for this water.

A2.4 Basal aquifers in the Pit 1 mining area are thin and discontinuous and there are no plans to depressurize prior to mining. This will be confirmed with infill geology drilling. There are indications that aquifers requiring depressurization are present in Pit 2. The extent of the aquifers will be confirmed with future drilling. As with the practice on Lease 86/17 any waters from a depressurization program will be retained within tailings ponds.

Q2.5 Outline the design considerations and construction procedures Suncor has examined to ensure external waste storage is minimized (in-pit optimization). Include comment on Suncor's discard storage contingency plans (e.g. alternative external storage areas) should either the proposed discard sites be unacceptable or the capacity reduced due to unfavourable geotechnical conditions. ***(Note that the southeast limit of the south discard site cannot be approved until there is agreement on the location of the ore body limit)***

A2.5 A feasibility level mass balance was done to establish the operating cost of the new mine, especially the haul costs as these are determined by dump location of the waste and oil sands. This mass balance was based on the following:

- using all the empty space left of L86/17 after mining to accommodate tailings from the Steepbank Mine until approximately the year 2007

- Approximately 50% of each year's overburden is considered productive and is used inpit for escarpment dyke construction. This 50% number compares with actual practice on L86/17 and takes into consideration construction quality of overburden, dyke footprints being exposed for construction, and seasonal factors for dyke construction.

- The remainder of the overburden is placed in either of the north, west, east, or south dumps. The sequencing of this placement is based on the objective of minimizing haul distance to reduce energy consumption and cost.

- Only in-pit placement of tailings was considered as a surface tailings pond was considered inappropriate. At the end of 2020 year mine plan there is approximately five to six years of void in pit space to allow the operation to continue into the future.

- Conceptual planning done to date indicates that all economical external pit waste storage will be required to continue mining the leases for the next 70 or more years (based on a production rate of 107 kbpcd)

Based on the work to date alternatives other than those selected would require excessively high dumps above the nominal 40 m height used in the feasibility study or extremely long hauls to leases that are not owned by Suncor. Neither of these alternatives was considered a viable solution.

A preliminary geotechnical assessment was undertaken by Terracon Geotechnique Ltd. to review siting of dykes and dumps within the Steepbank operation. They conclude:

"The dyke footprints all appear to lie within the confines of two depleted pits (Pits 1 and 2) which lie immediately south of the Steepbank River. Consequently, the subject dykes would be constructed on the mine floor. Based on existing core drilling investigations, the exposed mine floor materials will be Devonian Limestone or indurated fluvial sands. (The variable exposure pattern of mine floor lithologies is due to the fact that there is considerable relief on the limestone surface). The indurated characteristic of the sands is due to cementations material comprised of clays and siderite. Furthermore, these basal McMurray sediments within Pits 1 and 2 do not appear to contain beds of low strength facies material (pond muds, etc.) which are commonly found in the basal zone of the McMurray Formation. Consequently, it appear that foundation conditions are consistent with the conceptual 3:1 downstream dyke slopes. Obviously, these slopes will also be dependant on other design factors including dyke materials, methods of material placement, internal dyke structure, required factors of safety, etc."

The foundation conditions for the east dump were also evaluated, mitigation actions as recommended: "Dump stability is dictated by the underlying clay-shales and, based on analysis work on similar structures with similar foundation conditions, the 3:1 dump slopes will have to be reduced or other measures taken to ensure long term stability. Similarly, to ensure long term stability conditions, the setback distances to the crest of the highwall of Pit 1 and the crest of the Steepbank Escarpment will likely need to be increased relative to the setback shown in the conceptual layout plan." will be considered.

Full geotechnical design will be completed prior to construction. All dyke designs will be approved by regulatory agencies.

Q2.6 Describe the concerns that would lead Suncor to consider foundation liners for tailings Ponds 6, 7, and 8?

A2.6 Until 1995, Suncor's long range tailings plan showed Pond 5 to be an impoundment for Mature Fine Tailings (MFT). In order to prevent the migration of fines from the MFT into fractures within the underlying Devonian limestone, Suncor constructed an overburden foundation liner in Pond 5 in 1994 as a 'fines filter'. The foundation liner was not installed as a seepage barrier, although it will impede downward seepage flow.

In 1995, Suncor adopted the Consolidated Tailings (CT) technology as its primary tailings disposal option. As this technology creates a non-segregating mix of coarse and fine tails, there is no need to provide a 'fines filter' at the base of tailings ponds as the fines are 'trapped' within the CT deposit.

The fines trapping in CT provides a second major benefit - low permeability. The initial permeability of Suncor's CT deposit will be about 10^{-6} cm/s. This will decrease with consolidation to 10^{-8} cm/s or less, making the CT deposit itself a seepage barrier.

Suncor will continue to investigate tailings dyke and tailings pond foundations as part of the design process to ensure acceptable foundation conditions. However, CT technology makes it unlikely that an overburden liner will be required in future tailings ponds.

3 ORE HANDLING/PROCESSING

Q3.1 Comment on any pilot test activity or other data that Suncor has used to confirm that the proposed 2.5 km hydrotransport pipeline distance would provide for

sufficient ore conditioning? What parameters (e.g. slurry temperature, fines content, slurry water:oil sand ratio) impact the required pipeline distance (for optimum recovery).

A3.1 Suncor has not conducted tests on the slurry transport of oil sand. The Steepbank hydrotransport design is based on Syncrude Canada Ltd. data which was made available to Suncor through a 1995 technology development agreement between the two companies.

The Syncrude hydrotransport database is extensive. Serious investigations commenced in the late 1980's, when the feasibility of pipeline conditioning of oilsand was examined in a 2-inch diameter toroidal wheel and a 2-inch diameter pipeline loop. Development continued in a 2.5 km long, 4 inch diameter pipeline; a 0.5 km long, 12 inch diameter pipeline; and a commercial prototype 2.5 km long, 24 inch pipeline. Comprehensive investigations addressed the effect of the following key operating variables on bitumen recovery:

- oil sand characteristics;
- slurry density;
- slurry temperature;
- slurry velocity;
- pipeline diameter.

Studies in the 12-inch pipeline lead to the following conclusions:

- for all grades of feed studied, at least 97% of the bitumen will be liberated from the oil sand after 1 km of travel;
- the benefit of hydrotransport distances greater than 1 km is associated with bitumen droplet aggregation, which translates to increased recovery in the separation vessel at the end of the pipeline;
- the importance of bitumen droplet aggregation increases significantly as ore

grade decreases;

- for average grade or better Steepbank ore, 2.5 km of hydrotransport will enable maximum potential recoveries of bitumen, independent of slurry velocity;
- for low grade (eg 9% bitumen, 30% fines) ore, the residence time in the Steepbank line (10 min at 4 m/s) is insufficient to achieve maximum recovery
- the shortfall is about 10% of the maximum attainable;
- the best means to maximize separation cell recovery potential when pumping low grade oil sand is to maintain a slurry density of 1.65 t/m^3;
- Steepbank bitumen recovery will be insensitive to slurry temperature as long as temperature is greater than 50° C.

Studies on the commercial prototype hydrotransport pipeline were of particular use in further evaluating the loss of bitumen to rejects. Data from this program led to the incorporation of 2 inch openings in the cyclofeeder underflow screens and a reject crusher and recycle of the crushed undersize in the design of the Steepbank slurry preparation facilities.

It should be noted that the third stage bitumen recovery from hydrocyclone overflow unit operation is expected to recover about 50% of the bitumen in the combined tailings from the separation circuit. This new addition to Suncor's extraction plant capability will offset the modest loss of recovery anticipated when low grade ore is the only feed to the hydrotransport lines.

Q3.2 Does the current process design include provision for the adjustment of slurry water temperature?

A3.2 Slurry water will be a blend of hot process water delivered from Lease 86, pump gland seal water, warm floor wash water and, in the summer months, ambient temperature mine drainage water that has contacted oilsand. As a consequence, slurry water temperature will range from about 80° C to 90° C, and oilsand slurry temperature will range from about 50° C to 55° C.

Q3.3 What, if any, facilities would be required at the Steepbank mine site for extraction process chemical addition? How will chemical (caustic) addition be controlled?

A3.3 No facilities will be required at the Steepbank mine site for extraction process chemical addition. Caustic will be added, as required, at the inlet to the hot process water delivery line on Lease 86. Caustic addition will be controlled on the basis of fines content of the ore, which will be indirectly measured through continuous measurement of middlings density in the separation cells.

Q3.4 Provide further details on the design and operation (particularly during winter months) of the pools used for the draining of the hydrotransport and tailings lines *(Steepbank Mine Project Application, April 1996, Section C4.0, p.68)*.

A3.4 Under normal operation, if a hydrotransport line has to be shut down for any reason, it will not be drained. Even in the coldest weather, it is expected that this will not create a problem unless shutdown lasts in excess of 24 hours. However, there will be occasions when the line will have to be drained and holding space will be provided on both sides of the bridge for this requirement. The material would be reclaimed by portable pumps and other mechanical equipment if necessary. The total volume contained in each line is approximately 800 cubic metres.

Tailings lines are not planned to be in operation over the bridge until approximately the year 2007. Emergency dumping of the tailings lines will also be carried out in a manner similar to hydrotransport lines.

Q3.5 Comment on the validity of Suncor's existing semi-empirical model for forecasting fine tails accumulation volumes from the operation of the Steepbank mine *(Steepbank Mine Project Application, April 1996, Section D3.0, p.20)*.

A3.5 Suncor's fine tailings accumulation prediction model is based on two basic processes:

1) Partition of the fine tailings forming minerals mined with the ore into the various streams within the extraction and tailings system as summarized below

   a) extraction oversize rejects
   b) carry over with bitumen froth
   c) capture within constructed sand dykes
   d) capture within tailings pond beaches above the mudline in the ponds
   e) recapture from fine tailings deposits as coarse sand beaches are built below the mudline
   f) accumulation in fluid fine tailings deposits.

2) dewatering of the fine tailings deposits as a function of time since deposition where the dewatering rates are expressed as a function of the clay surface water holding capacity.

The model contains many factors and constants the values for which are unique and specific to the current Suncor operation. Any changes to the system would require modifications to these values. The model was formulated initially in the early 1980's and has been demonstrated to work satisfactorily for mine volume planning purposes as seen in the Steepbank Application Figure D3.0-7. The reason for this level of agreement is that the fundamentals of the process and tailings system has not changed significantly.

Conversion to the CT process will introduce significant changes which must be incorporated in the model. For instance:

1) The relative amount of dyke construction will decline in the future as all of the Steepbank dykes are to be constructed from overburden.

2) Beaching of coarse tailings into the tailings ponds will be reduced to a minimum level.

3) Alteration of the chemistry of the extraction recycle water system as CT release water is returned to recycle inventory.

4) The CT cyclone overflow which contains the majority of the water and fine minerals will be pumped separately to tailings from the coarse fraction.

It is believed that the logic structure of Suncor's fine tails model does incorporate all of the significant aspects of the CT operation and the Steepbank tailings system. In order to predict the fine tailings accumulation rates, the factors and constants within the model have been revised in view of the changes anticipated in the system outlined above. Suncor is satisfied that the accuracy of the predictions at least meets the need for feasibility level design conducted to date. Confirmation of the revised model will be the focus of relatively intensive monitoring during and following introduction of the full CT process. It should be noted that there will be 10 years of operating experience with CT prior to starting tailings operations on the Steepbank Mine.

4 TERRESTRIAL AND INFRASTRUCTURE

The information requirements for this application include a detailed reclamation plan for the valley development component and any other conservation and reclamation activities proposed within the first ten years of development. Please review the EIA terms of reference, and questions in this supplementary information request prior to submitting the plan. A complete submission will facilitate the timely review of the plan.

Conformance with Policy for Valley Development, Wetlands and Uplands

The decision logic that resulted in the location and layout of the Steepbank Mine is presented in Section C1.0 of the Application. Surface mining was selected over insitu technology primarily because of the economics of utilizing existing infrastructure. Continuing with existing extraction technology is justified because of new tailings reclamation technology. The evaluation of surface mine options resulted in the proposed Steepbank Mine which was based on new hydrotransport technology; proximity to existing operation; and acceptable ore grades and stripping ratios. All surface mine options involved surface disturbances, interaction with the river valley and bridge access. More distant options involved corridor disturbance and high energy needs.

Given the favourable economic and technological conditions for the Steepbank Mine, Suncor assessed the environmental implications of the proposed project in order to incorporate design features to eliminate or minimize impact. Project re-design has resulted in minimized disturbance; mitigatable impact through enhanced reclamation methods; and reduced duration of impact. Details of these have been presented in the Application and supporting documents. Suncor believes that the environmental management of impacts is in appropriate balance with the economic drivers for the project.

In assessing options to valley development various combinations were considered. Common to all options is a bridge access and road/infrastructure corridor which has a level of impact that may or may not be independent of proposed facilities and overburden dumps. Irrespective of this, the other facilities and overburden dumps siting options were evaluated. Lack of storage space and further land distances are the main determining factors for siting of overburden waste dumps. Mine economics determine the optimal location of site infrastructure.

The details of assessment of relocation options are provided in subsequent responses in this Supplemental.

Q4.1 **Suncor states that the West Overburden Dump will be partially located in a wetland area, Shipyard Lake *(Steepbank Mine Project Application, April 1996, Section C3.0, p.40)*. Given the intent of the Integrated Resource Plan to protect the values of the Athabasca River valley and the desirability of conserving existing slough/marsh wetlands, what location and design alternatives has Suncor considered, to minimize the impact of this dump?**

A4.1 The west waste dump has been relocated to conserve the Shipyard Lake wetlands ecological values. The dump, however, remains in the valley, to meet the overall mass balance for materials in the minable ore bodies of Leases 97/19/25.

An alternative to siting waste dumps in the valley region was examined as part of the mine feasibility, but was not considered viable because of limited upland areas available for waste dumps. Storage of additional overburden waste in the planned upland dumps would result in an increase to the height of the east and south dumps by about 20 metres above the planned heights of 30 to 40 metres which is not consistent with original topography.

Relocation of both north and west dumps out of the valley would result in a greatly increased operating cost. For the two dumps combined an estimated $26 million in incremental operating costs would result for the longer, higher haul routes.

Q4.2 **Suncor states that while Pit 1 is being mined the discharge into Shipyard Lake will be reduced to near zero *(Steepbank Mine Project Application, April 1996, Section C3.0, pp.50,55 and Section E7.0, Fig. E7.0–2)*. Confirm whether the Shipyard Lake**

wetland will maintain its habitat for wildlife and waterfowl during this period. Also, provide a hydrological analysis and an assessment of the biological implications of a 52% reduction in water inflow and a 47 hectare reduction in size to Shipyard Lake following reclamation.

A4.2 Suncor has modified the Steepbank mine plan in relation to activities near Shipyard Lake. There will be no reduction is size of the wetlands, and water flows will be managed to maintain viability of the ecosystem. Details on the modification, and the impacts associated with changes are provided in the C & R Report, section 4.2.3 and section 5.

Q4.3 Suncor states that maintenance facilities will be developed in the new Steepbank mine between 1997 and 2000 *(Steepbank Mine Project Application, April 1996, Section C 3.0, pp.50 and Surface Drainage Plan Development, p.65).* The maintenance facilities, including a heavy vehicle maintenance shop will be located immediatley north-east of the Shipyard Lake wetland.

a) will a hazardous waste containment station *(Steepbank Mine Project Application, April 1996, Section C8.0, p.123)* be included?

A4.3a As part of Suncor's overall waste management system, waste streams that are considered hazardous and not disposable in on-site facilities are temporarily stored in the Hazardous Waste Storage Yard. From these, the waste is taken off-site for appropriate disposal or for recycling. Our current procedure for all plant facilities is for the waste to be held at source as per waste handling standards until a determination is made as to on-site disposal or off-site treatment. If destined for off-site treatment, the waste is transferred to the Yard and held until off-site treatment options have been determined and finalized.

Specifically, the Steepbank maintenance facilities will be managed in the same fashion as the existing facilities. The waste streams and the sources/holding areas are expected to be the same. Therefore, at the present time we do not envision a requirement for any dedicated "waste containment station" as a part of the Steepbank Mine development.

b) describe the construction and operational measures proposed to mitigate impacts to the wetland area, including:

- **water quality impacts from run off or accidental waste disposal, and**

- **noise impacts on the wildlife and waterfowl which utilize the wetland and adjacent areas.**

A4.3b A review of construction and operational mitigative measures which will be undertaken to mitigate impacts to the Shipyard Lake wetlands area was provided on page 21 of the document *"Impact Analysis Steepbank Mine EIA Surface Water and Groundwater."* Specifically, mitigative measures will include a separate surface drainage system for the shop area, containment sumps for liquid storage facilities, and areas graded to prevent runoff to undisturbed areas.

The mitigative measures which would be undertaken to reduce noise impacts were discussed on page 85 of the document *"Impact Analysis Suncor Steepbank Mine Environmental Wildlife Component."* These measures include maintaining treed buffers around the shop area, berms will be constructed to reduce sound transmission and the shop facility has been located further than 250 metres from the bald eagle nest. Suncor will implement the measures discussed in this report to mitigate the impacts associated with noise generated from areas near the wetlands.

Q4.4 Suncor states that intercept drainage will be collected from the east side of Pit 1 and directed into Shipyard Lake for ultimate discharge into the Athabasca River *(Steepbank Mine Project Application, April 1996, Section C3.0, p.51 and Section E7.0, p.66)*. If this discharge will be the same quality as the existing mining intercept discharge, will the quality and quantity of this water affect the viability of Shipyard Lake as a productive wetland?

A4.4 Suncor has modified the Steepbank mine plan in relation to activities associated with Shipyard Lake. Surface run-on water will be managed to maintain comparable quality to current surface drainage. Water flows into Shipyard Lake will be split to maintain baseline volume into the lake with surplus diverted to an outfall at the Athabasca River.

Shipyard Lake is discussed in more detail in section 4.2 and 5 of the C& R Report.

Q4.5 **Suncor's plan for the mine includes development within about 70 metres of the Athabasca River along a 2000 metre stretch of the river floodplain, terraces and escarpment *(Steepbank Mine Project Application, April 1996, Section C3.0, p.40)*. With reference to the values of the Integrated Resource Plan and the intent to protect the Athabasca River valley ecosystem:**

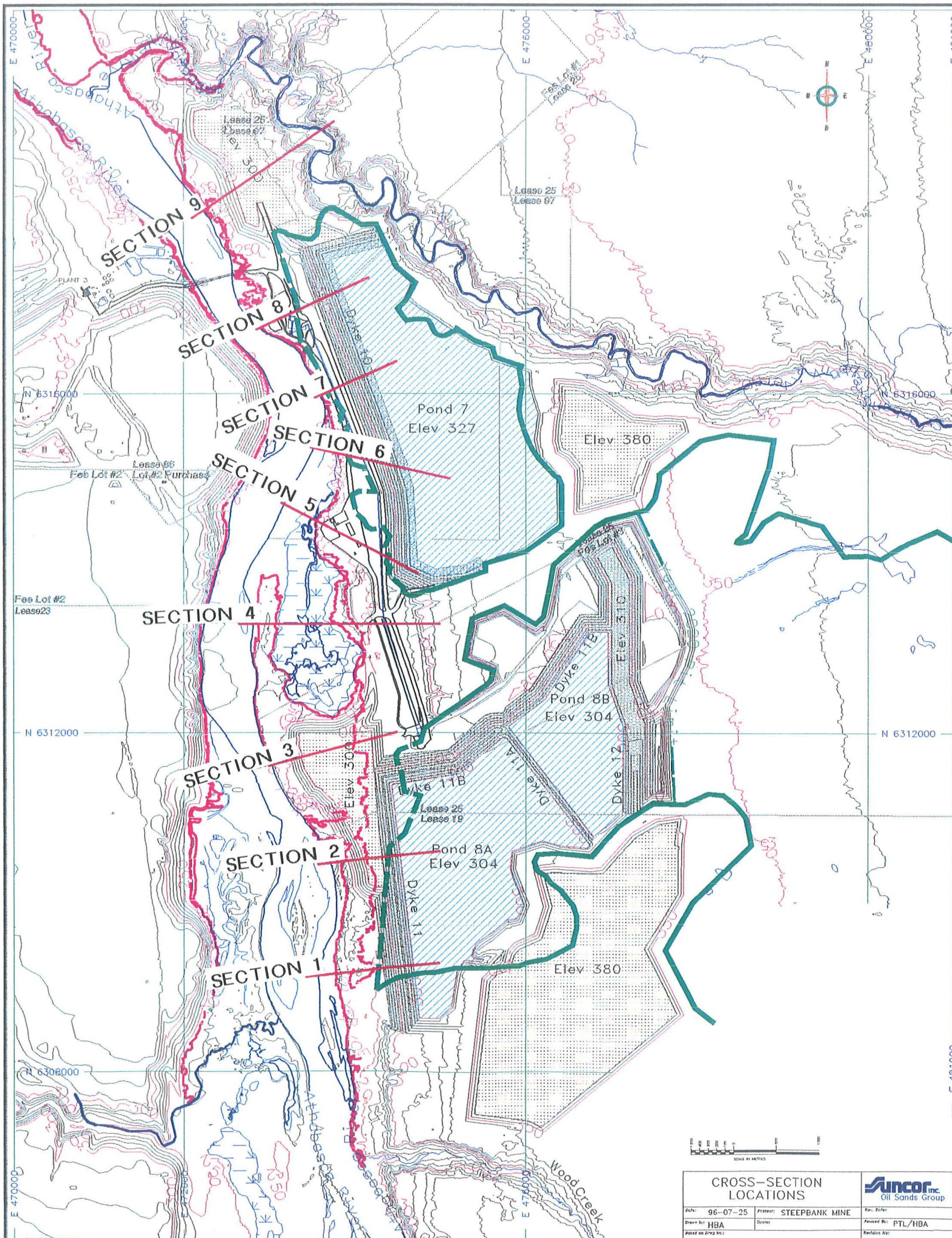
a) **Why is the proposed buffer at its narrowest 70 m when the dyke toe is 500 m from the river? Demonstrate the need to disturb any lands between the toe of the dyke and the riverbank, addressing each component of development proposed to be located in this area, i.e. why is it necessary? Can it be relocated or the disturbed area reduced?**

A4.5a The access corridor running north-south on the valley floor provides road access to the mining areas and office/shop complex. This corridor will be extended, by 2008, to the future site for the ore sizers to provide conveyor access from the sizers to the hydrotransport plant. A more detailed design of the corridor was completed, in response to concerns raised, resulting in a shift of the corridor to the east providing a larger buffer to the Athabasca River. There is one corridor section, 100 meters in length, where the western edge of the road allowance will be located 120 meters from the Athabasca River. The location of the corridor is shown on Figure 1-1, and sections through the corridor are provided in Figures 4.5-1, 4.5-2 and 4.5-3.

Design for the corridor is based on the following parameters:

- Dyke toe 500 meter setback from the Athabasca River;
- 10 meter allowance for conveyors;
- 50 meter allowance for road, including running surface, berms, ditches;
- 2H:1V side slopes in cut, 3H:1V side slopes in fill; and
- maximize undisturbed ground between the corridor and the river.

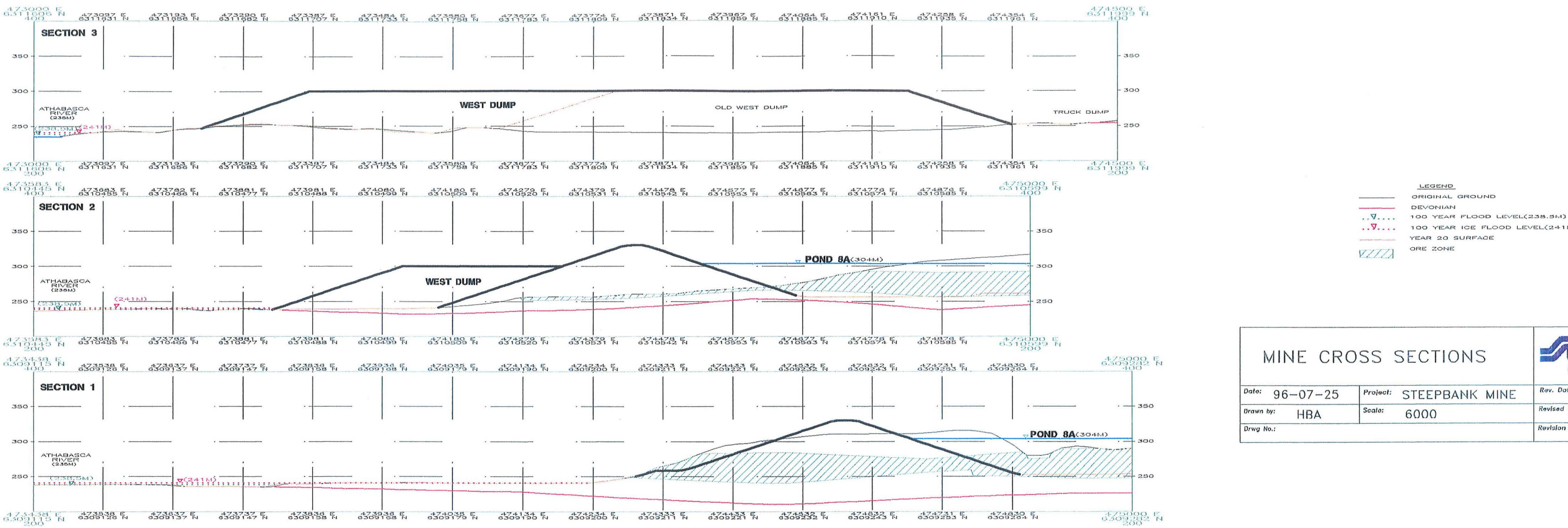
For the section of the corridor which is closest to the river, the conveyor alignment was the determining factor in siting. The alignment is based on three flights of conveyors



SECTION 9
SECTION 8
SECTION 7
SECTION 6
SECTION 5
SECTION 4
SECTION 3
SECTION 2
SECTION 1
Pond 7
Elev 327
Elev 380
Pond 8B
Elev 304
Pond 8A
Elev 304
Elev 380
Dyke 10
Dyke 11
Dyke 11A
Dyke 11B
Dyke 12
Elev 310
Elev 300
Lease 25
Lease 97
Lease 25
Lease 19
Fee Lot #2
Lease23
Athabasca River
Wood Creek
PLANT 3
N 6316000
N 6312000
N 6308000
N 6306000
E 470000
E 476000
E 480000
E 481000
CROSS-SECTION LOCATIONS
Suncor Inc. Oil Sands Group
96-07-25
STEEPBANK MINE
HBA
PTL/HBA

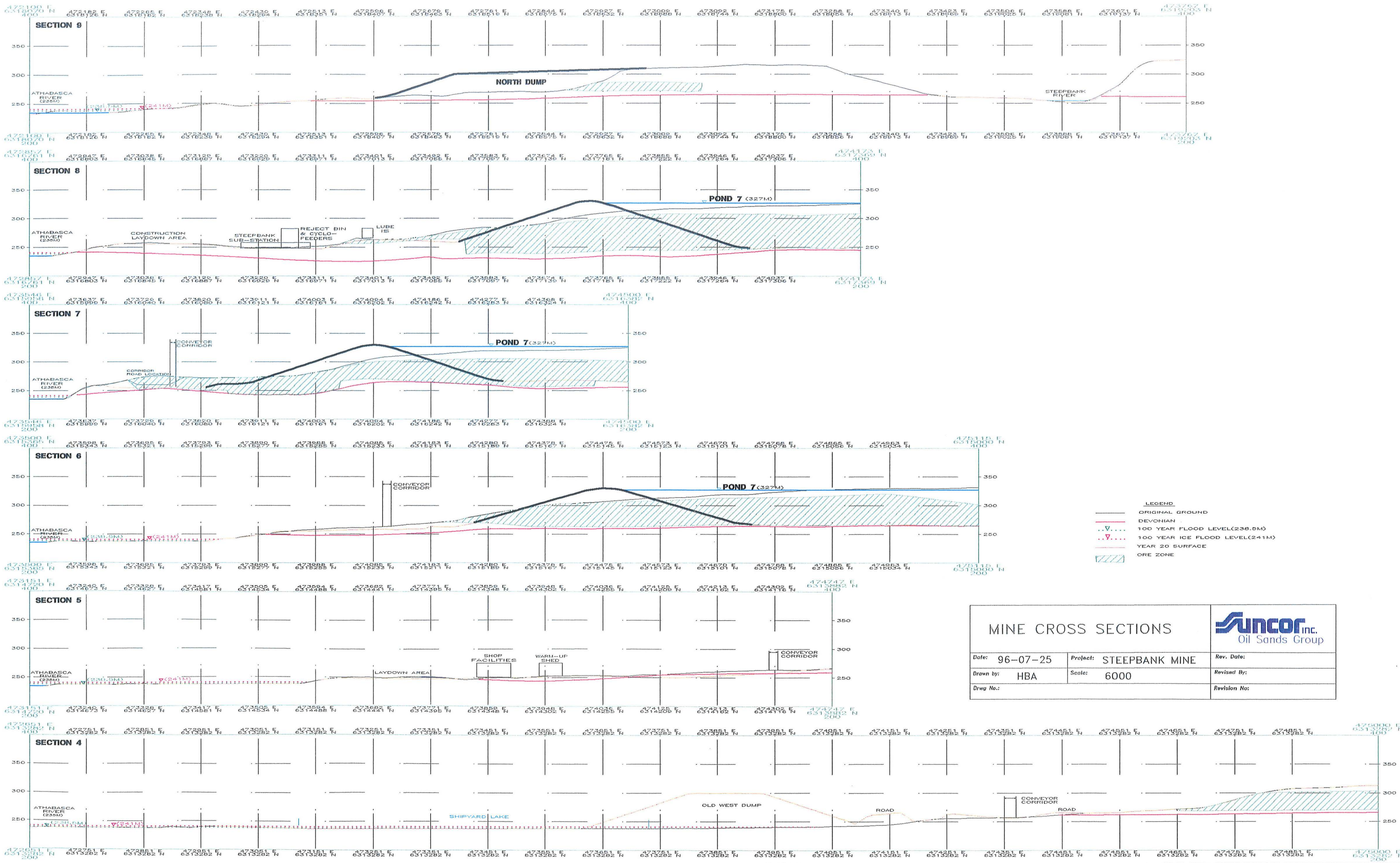
FIGURE 4.5-1

FIGURE 4.5-2



MINE CROSS SECTIONS		Suncor Inc. Oil Sands Group
Date: 96-07-25	Project: STEEPBANK MINE	Rev. Date:
Drawn by: HBA	Scale: 6000	Revised By:
Drwg No.:		Revision No:

FIGURE 4.5-3



SECTION 9
NORTH DUMP
ATHABASCA RIVER (238M)
STEEPBANK RIVER
SECTION 8
POND 7 (327M)
CONSTRUCTION LAYDOWN AREA
STEEPBANK SUB-STATION
REJECT BIN & CYCLO-FEEDERS
LUBE IS
SECTION 7
CONVEYOR CORRIDOR
CORRIDOR ROAD LOCATION
SECTION 6
SECTION 5
SHOP FACILITIES
WARM-UP SHED
LAYDOWN AREA
SECTION 4
SHIPYARD LAKE
OLD WEST DUMP
ROAD
LEGEND
ORIGINAL GROUND
DEVONIAN
100 YEAR FLOOD LEVEL(238.5M)
100 YEAR ICE FLOOD LEVEL(241M)
YEAR 20 SURFACE
ORE ZONE
MINE CROSS SECTIONS
Suncor inc.
Oil Sands Group
Date: 96-07-25
Project: STEEPBANK MINE
Rev. Date:
Drawn by: HBA
Scale: 6000
Revised By:
Drwg No.:
Revision No:

over the 5,000 meter length, necessary to accommodate the bend in the river and topography.

The access corridor will be removed, and the areas revegetated, along with the facilities relocation to the upland area by the year 2030. A small access road will be left, running along the toe of the dyke, and will be used for monitoring reclamation progress and dyke integrity.

b) **Document how the 70 m setback conforms to the wildlife (travel corridor) values identified in the Integrated Resources Plan. Demonstrate how wildlife would be able to continue to move in and out of the valley and along the valley floor during development and following reclamation of valley disturbances.**

A4.5b The Steepbank Mine development will completely disrupt some areas east of the escarpment as well as some of the escarpment areas. Studies completed as part of the EIA concluded that there was no well defined pattern of wildlife movement along the valley, but showed evidence of movement between upland and valley areas. Movement in and out of the valley will be eliminated, and consequently the potential for movement along the valley will be greatly reduced from current low levels. The bridge access will be an impediment to wildlife movement irrespective of other activities. The redesign of the road setback to increase the buffer to 100 meters is a reasonable level of mitigation for localized wildlife movement. This area is discussed further in section 4.5 of the C & R Report.

c) **Document how the 70 m setback conforms to the floodplain (setback to the 1:100 year flood level) values in the Integrated Resource Plan. Demonstrate that development within the water flood and ice flood contours will be adequately protected from flood damage and that it will not worsen flood conditions in other floodplain areas (for example, due to placement of overburden or other terrain modification within the floodplain). Provide a revised Figure C 4.0-1 showing the impact area of a 1:100 year ice flood.**

A4.5c Facilities in the valley are located above the 1:100 year flood levels, following criteria in the Integrated Resource Plan. The relocation of the West Waste Dump to a location outside of Shipyard Lake wetlands resulted in a portion of this dump placed in the flood plain. The flood contours relative to the location of facilities are indicated on Figure 1-1.

The west waste dump design will include appropriate erosion control measures for the dump toe to protect the structure from flood damage. Golder Associates concluded: "Any flow along side the waste dump during extreme floods would result in slow velocities as a result of the hydraulic resistance provided by the dense vegetation and trees in the area." An evaluation by Golder Associates, of the dump location with respect to river hydraulics during a flood event, and impact on other areas, concluded that: "The new location does not represent a significant hydraulic constriction to the river, even in the event of an extreme flood." The east side of the dump will impact Shipyard Lake, but only in floods greater that the 1 in 20 year flood. Golder Associates stated "the east side will present a barrier to infrequent river flood flows through Shipyard Lake."

d) Document how the 70 m setback conforms to the erosion (sensitive soils) and water quality values identified in the Integrated Resource Plan. Specifically, the riverbank at this location (70 m setback) is composed of oil sand which appears to be slumping towards the river. How stable is this oil sand and will disturbance cause it to accelerate its fall into the Athabasca River? How will surface run off along the 70 m setback be prevented from entering the Athabasca River if there is very little soil or vegetation at this location?

A4.5d Surface runoff from mining activities, including access roads, is controlled through engineering design and catchment ditching. The access road in the valley will be sloped to the east, diverting drainage away from the river and a provision for ditches is included in the road allowance. For the area where the road comes closest to the river, the road surface will actually be cut into the valley floor, leaving a small pillar between the road and the river, as is illustrated on Figure 4.5-3, Section 7. The river bank was investigated in March 1996 by AGRA Earth & Environmental, to examine erosion concerns along the east bank in the vicinity of proposed facilities. The report describes the "pinch point " as: "High (20 metres plus), steep and stable banks in this area consist of hard tar sand cretaceous material. This tar sand material likely overlies limestone material near river bed level based on the level of limestone in this section identified by Geological Survey of Canada (Norris, 1963). Norris also identified limestone in the section just upstream in the vicinity of the fenland outlet." The stable bank, combined with the road redesign eliminate any concerns for erosion impacts due to the road location.

e) Document how the 70 m setback conforms to the recreation (aesthetics) values identified in the Integrated Resource Plan. Specifically, since there is little vegetation at the 70 m setback, what will Suncor do to ensure a visual buffer is provided to screen mining activities from river traffic?

A4.5e The design of the setback has been explained in the answer to question 4.5(a) above. The location of the road is actually behind the river bank and traffic will be screened from view assuming a river traffic perspective. The short (100 metre) section where fill is placed to cross a gulley may be visible, but the impact considering such a short distance, combined with revegetation on the fill embankment will be low.

f) If these values are being impacted, what mitigation is being proposed?

A4.5f Mitigation for impacts of the access corridor to the Integrated Resource Plan values consist of the design features discussed, namely: increasing buffer width to the river, cutting the road into the valley floor to prevent erosion, and siting facilities outside of the flood plain.

g) What will the impact on the project be, if the buffer (setback) is increased? Provide appropriate supporting information to explain the significance of the

impact. Include additional plans and cross sections through the subject portion of the valley floodplain, terraces and escarpment to illustrate the alternative setbacks and their impact on the project.

A4.5g To increase the buffer between the corridor and the river would require a relocation of the dyke toe or adding a fourth flight of conveyors to the future sizer location. Both of these options are undesirable to Suncor. Moving the dyke toe to the east, further from the river, would require an increase of pond height, causing tailings to be stored above ground. To change the conveyor alignment, adding a fourth flight, would add approximately $5 million in capital expenditures for two head stations, and would result in a 1 to 2% reduction in mine availability.

Q4.6 The North Overburden Dump is shown in Figure C3.0–3 and discussed in the application (*Steepbank Mine Project Application, April 1996, Section C3.0 , pp.40,64).* With reference to the intent of the Integrated Resource Plan to protect the valley ecosystem:

a) What alternative locations or configurations have been assessed?

A4.6a The north dump site was selected based on an overall mass balance for material movement considering all ore bodies in the area of Leases 97/19/25. The mass balance also considered hauling economics and mine development plans. Alternatives and implications are described in the answer to question 4.1.

b) How do the development plans and the reclamation plan for the dump protect the Athabasca River valley ecology and aesthetics?

A4.6b The north dump design considers its valley siting and the IRP criteria. The dump is placed above the flood plane and is set back 200 metres from the Athabasca River and 100 metres from the Steepbank escarpment crest. Enhanced surface reclamation techniques are proposed. "Micro-terrain" modifications will be made prior to soil application. Shallow (only surface) soil excavation will be employed to salvage and place this material on the dump as construction proceeds. Selection of woody plant species for out planting will be site-specific supplements with "island" transplants. Details of these techniques are provided in the report C & R Report.

Q4.7 Suncor's *Facility Site Rationale* relies upon the "temporary nature" of impacts on the river valley ecosystem to justify the development of facilities in the Athabasca River valley *(Steepbank Mine Project Application, April 1996, Section C4.0, p.64)*. With reference to the intent of the Integrated Resource Plan to protect the valley ecosystem:

a) What are the implications of locating the facilities (maintenance compound and access road, hydrotransport facility, transformer station) outside of the river valley, particularly since they will eventually be moved further into the Steepbank site as the project progresses?

A4.7a Facilities were located in the valley to provide the best economics for the project. Suncor believes that the impacts to the environment are mitigated through the project design and are temporary in nature. All facilities, with the exception of the bridge, will be moved to an upland location prior to the year 2030.

The economics for placing the plant and shop area above the escarpment was evaluated during project design. This evaluation, including moving waste dumps out of the valley, would result in an increased capital cost of over $20 million and a project operating cost increase of $120 million.

The largest component of both capital and operating cost is associated with the relocation of the hydrotransport and ore dump facilities (approximately $18 million capital and $92 million operating). The dump relocation cost, which is part of the $120 million, is $26 million as identified in question 4.1 and 4.6 (a).

b) What location and design alternatives have been assessed so that the project better conforms to the intent of the Integrated Resource Plan to protect the valley from disturbance? Provide a detailed rationale for each facility component with appropriate scheduling, economic, resource and design details.

A4.7b A macro-scale assessment was conducted to establish economic impacts which was provided in 4.7(a) above. Detailed design and specific facility components were not developed for this assessment. The alternative site for both, the hydrotransport complex and the maintenance shop was on the upland exclusion area between Pit 1 and 2.

As evident from the cost analysis, the costs of relocating the maintenance facilities are minor relative to the hydrotransport and ore handling facilities. Relocation of the maintenance facilities only, would not alleviate impacts associated with the access corridor because this location is determined by the conveyor alignment to the ore dump/sizer relocation scheduled for 2008. Therefore, the substantial cost penalty of the hydrotransport complex relocation is the key driving factor in valley facility siting.

Therefore, Suncor has weighed the economic implication of facility relocation against the ability to conform to the intent of the IRP. The proposed environmental management plan during active operations and the reclamation plan for post-mining conforms with IRP criteria.

Q4.8 Suncor has advised that it will submit a detailed reclamation plan for the river valley component of the Steepbank Mine by July 1996 (*Steepbank Mine Project Application, April 1996, Section D3.0, p.65*), to demonstrate that a satisfactory level of mitigation of the adverse impacts of development on the resources and values of the Athabasca River valley can be achieved, in accordance with Integrated Resource Plan objectives:

a) provide the detailed conservation and reclamation plan noted on p.65 of Section D3.0

b) include detailed plans and proposed performance criteria regarding materials handling, materials placement, contouring, revegetation as well as end use objectives, comparisons of pre- and post-disturbance landscapes and proposed milestones for reclamation.

c) **explain how the implementation of the plan during construction and operations stages and following relocation of valley facilities will mitigate the impacts of development on the river valley floodplain, river terraces and escarpment ecosystems and attempt to replace the existing natural ecosystems during reclamation. Identify the key indicators for successful mitigation of escarpment lands (be site specific), and how Suncor proposes to demonstrate to stakeholders the successful mitigation of mining through the valley break.**

d) **explain which aspects of the plan have been developed specifically to enhance the timing and maximize the success of reclamation in river valley floodplain, river terrace and escarpment sites. Include a discussion of Suncor's plans in relation to these possible mitigative strategies:**

- **terrain contouring, soil placement, erosion stabilization and revegetation of early stages of development (i.e. toes of dykes and dumps) while later stages are being constructed;**
- **selective soil conservation and replacement of mineral topsoil and subsoil material to enhance reclamation and revegetation of the valley area;**
- **"hot placement" of soils salvaged from river terrace and escarpment sites to comparable sites which are ready for soil replacement (as a means of preserving and returning terrain-suitable native species of non-woody plants); and**
- **terrain contouring to produce comparable aesthetics and micro habitat diversity to the original. Include a detailed discussion of the potential to construct dykes which resemble a natural landscape, while maintaining their geotechnical stability.**

A4.8 A detailed reclamation plan for the Athabasca River valley is included in the C & R Report.

Q4.9 Suncor stated that environmental considerations were not a driving force in the decision of a proposed location for a new mine site because each alternative would entail similar environmental disturbances. Suncor also indicated that economic considerations, capital cost and technical risk exposure were the main considerations (*Steepbank Mine Project Application, April 1996, Section C1.0, p.6*), and that maintaining a 100 metre setback from the valley break was considered, but rejected because 256 million tonnes of ore would be sterilized *(Steepbank Mine*

Project Application, April 1996, Section C1.0, p.15). **Provide additional information to demonstrate the need to mine through the valley break as part of the Steepbank Mine project, including:**

a) **the impact on the viability of the Steepbank Mine project if the 100 metre setback were used as the limit of mining for the project. Include an evaluation of the sensitivity of the mine plan to averaging the cost of recovery for low strip ratio ore near and within the escarpment with higher strip ratio ores in upland areas.**

A4.9a In the lease areas owned by Suncor significant ore reserves are in the valley area. As stated in the Steepbank Application, to maintain a 100 metre setback from the Athabasca escarpment would result in a loss of 256 million tonnes of ore or 138 million barrels of oil.

The Steepbank concept offers the best use of oil sand reserves to the provincial and federal governments and best economics to Suncor. There would be approximately $144 million of direct revenues lost to government based on an estimate of taxes and royalties. Suncor would lose a revenue stream of $3.5 billion based on a selling price of $25 Cdn. per barrel of oil.

Additionally, the alternative plan of a 100 metre setback mining option resulted in an increased capital cost of $18 million and operating cost for the 20 years of $226 million.

A mine plan sequence is designed to provide the best Net Present Value (NPV) for the project and to provide necessary cash flow in early years to fund capital expenditures. This is achieved by selecting a sequence which provides the lowest capital and operating cost in the early years, followed by expenditures as necessary to acheive production requirements. In mining, the most significant operating cost is from the movement of materials, both ore and waste. Hauling costs are a function of distance, elevation and volumes moved. The chosen mining sequence optimizes the hauling profiles to ore dumps, waste dumps and shop facilities, and begins operations in the area of lowest waste volumes (i.e. lowest stripping ratio).

Because the period of daylighting along the river valley is relatively brief, and the escarpment can be re-established immediately after completion of mining the escarpment reserves, the economic impacts associated with the 100 metre setback are not justified.

b) the impact on the mine plan, scheduling and project viability of delaying the mining of the portion of the ore body located within 100 metres of the escarpment. Provide appropriate supporting information.

A4.9b Delayed mining of the escarpment area was not included in mine sequencing options for the feasibility study. It is likely that this would not be a viable option due to tailings management issues and would result in a lower NPV for the project by advancing capital and operating costs to early years.

Conceptually, to defer mining of the escapement ore, operations would begin at a setback from the escarpment crest leaving a pillar of ore in place for later recovery. Tailings structure design would be required to ensure access to the ore pillar was not impacted and to ensure that other economic ore zones were not sterilized. Tailings dykes, well above the surface elevation of the uplands would be required to hold the volumes of waste, resulting in a topography very different from current conditions. Given the geometry of the area it is likely that a design, to accommodate storage of tailings without sterilizing the escarpment ore, would not be possible.

Surface disturbance in the area would be the same for both the current concept and a delayed escarpment mining scenario. Therefore , environmentally, there is no advantage to defer mining of the escarpment.

Q4.10 Clarify Suncor's commitment regarding the proposed 100 metre set-back from the Steepbank River as related to pit limits, overburden storage or other surface disturbance. What sensitivities (river-bank stability, visuals, wildlife etc.) is the buffer zone meant to address?

A4.10 Suncor is committed to a set-back from the Steepbank River which is 100m away from the crest of the escarpment. The set-back will essentially be the mining limit for Pit 1 and the limit for siting of the north and east overburden waste dumps. It will be used to locate a perimeter access road around the back of Pit 1 and a drainage cut off ditch.

The buffer zone is meant to address, primarily, river bank stability. That is, it will minimize the interaction of mining activity that can impact river water quality and fisheries habitat. It will address other sensitivities including wildlife habitat/movement and geological interpretive potential.

Tar Island Dyke

Q4.11 Suncor conceptually outlines reclamation activities for Tar Island Dyke *(Steepbank Mine Project Application, April 1996, Appendix IV, p.6, Table IV–4)*. To assist in understanding the reclamation schedule of the dyke:

a) discuss the implications to Suncor of accelerating the reclamation of Tar Island Dyke.

A4.11a Pond 1 (Suncor's original tailings pond) commenced operation in 1967. The pond is currently receiving only a small tailings stream from the Extraction centrifuge plant and periodic flows from the Upgrader. At its deepest point it contains a deposit (about 30 m deep) of exceptionally viscous mature fine tailings and about 2 m of recycle water.

As the fine tailings currently in the pond will not settle to form a soil-like material for hundreds of years, these materials will be removed and replaced with stable infill. Pond 1 will thus be transformed into a stable, trafficable and revegetated landform.

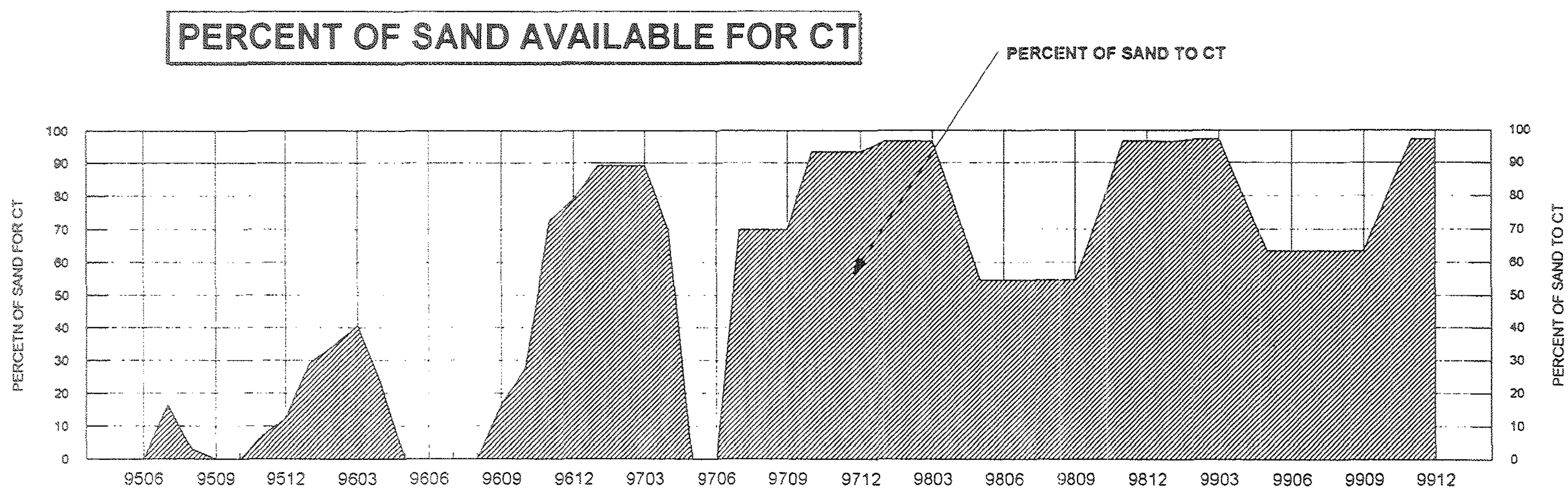
The schedule to accomplish the reclamation of Pond 1 has been significantly impacted by conversion to the Consolidated Tailings reclamation process and integration with the Steepbank Mine. Prior to CT, it was planned to pump fine tailings from Pond 1 to Pond 5. This operation could be conducted relatively independently of the rest of the tailings operation, and the target date to begin revegetation of the infilled Pond 1 was 2002. The following constraints and opportunities have guided development of the reclamation schedule for Tar Island Pond:

- As part of the conversion to the CT process, it is intended to reduce the current 100 Mm^3 inventory of fine tailings contained in all the tailings ponds, which has accumulated over the past twenty-eight years, to a minimum working level of about 25 Mm^3 by 2020. This target time frame is driven by the advance of mining and tailings operations far enough away from Lease 86 that it may be uneconomic to pump fine tails from Lease 86 to incorporate in subsequent CT deposits. The plan is for all fine tailings currently contained in Pond 1 to be incorporated into CT deposits in Ponds 5 and 6 on Lease 86.

- In order to accomplish this goal, as much tailings sand as possible will be deposited as consolidated tailings. Since suitable overburden dyke construction materials are in short supply on Lease 86/17, there is still a requirement to construct portions of Dykes 8 and 9 from tailings sand. Figure 4.11-1 shows that the availability of sand for CT increases, as construction of sand Dykes 8 and 9 is completed. All dykes planned for construction on Steepbank Mine will utilize overburden only, which leaves up to 95% of sand available for CT.

- The amount of sand available for CT controls the amount of fine tailings which can removed from the fine tailings inventory in Ponds 1, 1A, and 2/3 because CT is mixed to a specified sand /fines ratio. The CT sand to fines ratio

FIGURE 4.11-1


PERCENT OF SAND AVAILABLE FOR CT
PERCENT OF SAND TO CT
PERCETN OF SAND FOR CT
PERCENT OF SAND TO CT
0
10
20
30
40
50
60
70
80
90
100
9506
9509
9512
9603
9606
9609
9612
9703
9706
9709
9712
9803
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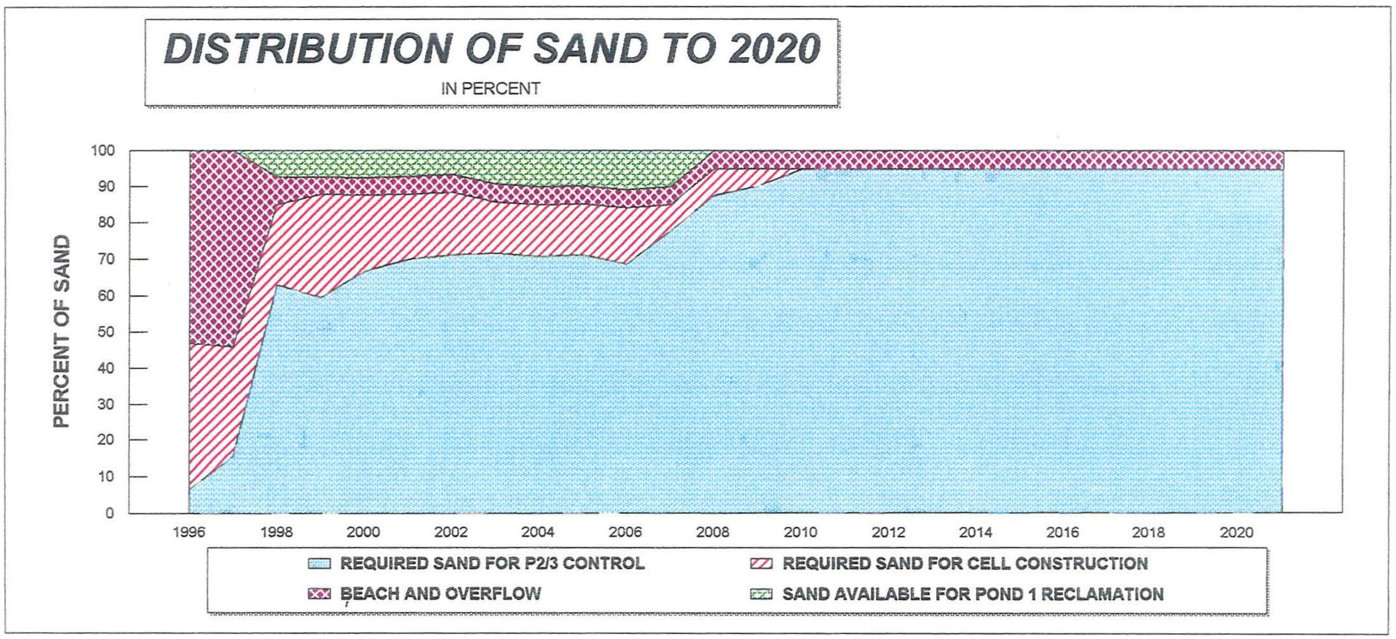
9809
9812
9903
9906
9909
9912

combined with the rate of fresh tailings sand production which can be diverted to CT disposal establishes the consumption rate for existing fine tailings inventory. Selection of an average sand to fines ratio of approximately 4:1 balances the desire to reincorporate the fine tailings inventory into stable deposits by 2020 with the desire to minimize surface settlement of the deposits in the reclamation time frame.

- Pond 2/3 will receive fresh fine tailings contained in the CT process cyclone overflow. Dewatering of the fine tailings will occur in Pond 2/3 in preparation for future use in CT. Pond 2/3 is currently at its maximum operating water level. The fine tailings mudline has risen to an elevation such that it will interfere with withdrawal of recycle water for extraction. It is critical for the next few years that thickened fine tailings must be removed from the pond and incorporated in CT at a rate at least equal to the accumulation of fresh fine tailings to prevent loss of the recycle water required for Extraction operations.

- The operating priority must be to withdraw fine tails from Pond 2/3 for CT in order to control the mudline in Pond 2/3. Due to the heavy demand for sand to build dyke 8 in the next few years, the volume of fine tails required for CT, to match the amount of sand which is available for CT, is approximately what is required to maintain the mudline under control. Therefore, until the demand for sand for construction of Dyke 8 declines, there is limited opportunity to remove fine tails from Pond 1 without jeopardising the mudline in Pond 2/3. Eventually, more and more sand will become available for CT construction and removal of fine tailings from Pond 1 can accelerate. The distribution of sand placement to the year 2020 is shown in Figure 4.11-2.

FIGURE 4.11-2


DISTRIBUTION OF SAND TO 2020
IN PERCENT
PERCENT OF SAND
100
90
80
70
60
50
40
30
20
10
0
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
REQUIRED SAND FOR P2/3 CONTROL
REQUIRED SAND FOR CELL CONSTRUCTION
BEACH AND OVERFLOW
SAND AVAILABLE FOR POND 1 RECLAMATION

- Suncor is actively investigating alternative tailings handling strategies in order to accelerate Pond 1 decommissioning and reclamation. For example, Pumping of Pond 1 fine tails requires a dilution fluid due to its high viscosity. One of the options being explored is to use Pond 2/3 fine tails as this dilution fluid rather than recycle water. This has the advantage of also reducing the mudline in Pond 2/3. Although this approach must be confirmed by detailed planning and hydraulic analysis, if successful, the schedule for Pond 1 might be advanced by up to 5 years.

b) provide additional cross sections through the dyke, showing the existing materials and proposed changes.

A4.11b Cross sections of Pond 1 showing the removal of fine tailings and replacement with infill material are attached as Figures 4.11-3 through 4.11-6.

Q4.12 Suncor has evaluated the impact of seepage from the dyke on water quality (*Athabasca River Water Releases Impact Assessment, May 1996).*

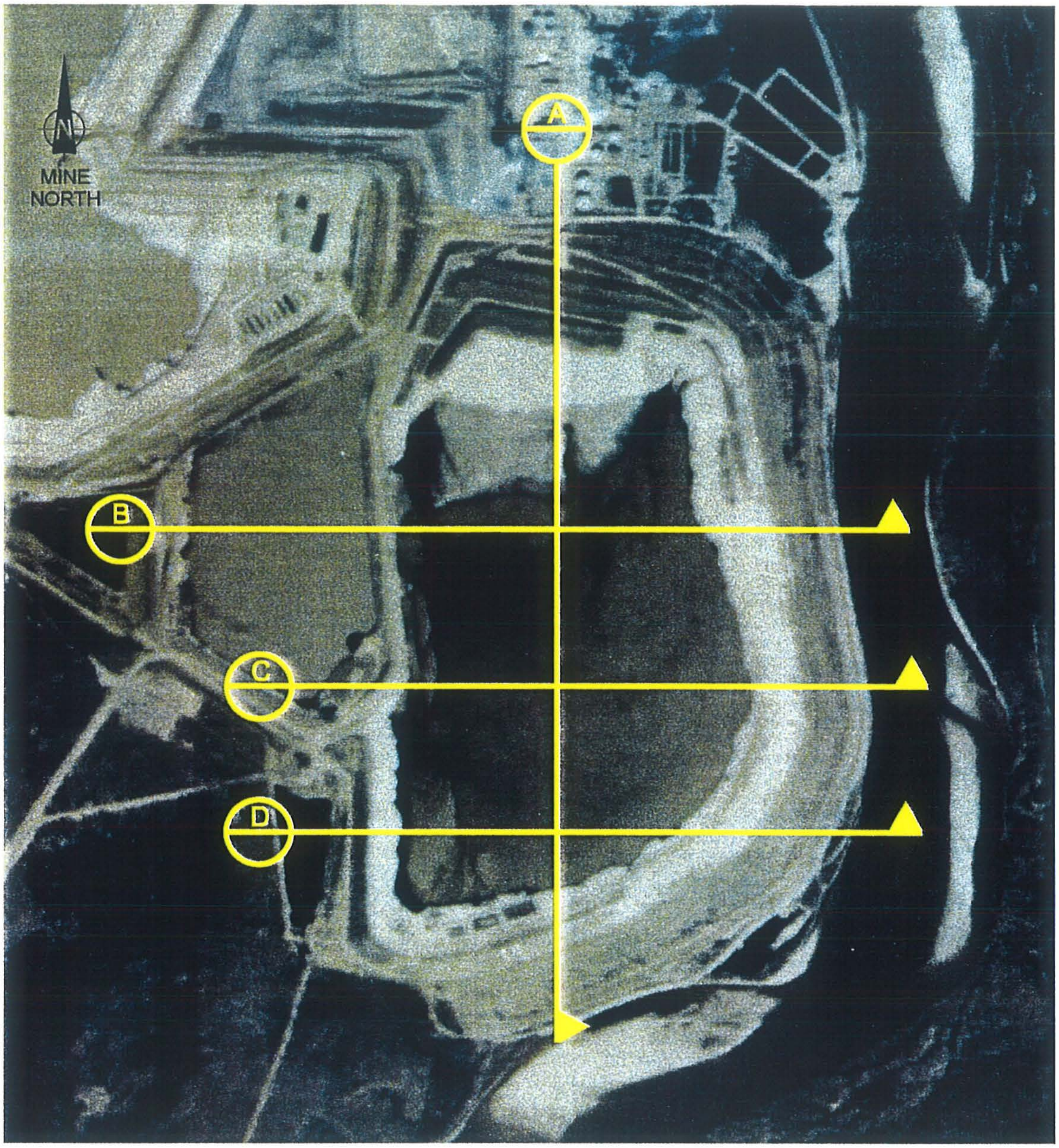
a) Confirm whether the rate of seepage from Pond 1 into the Athabasca River that was used to calculate the risk associated with this release was based upon all seepage pathways including, in the long term scenario, seepage directed through swales to the Athabasca River (*Athabasca River Water Releases Impact Assessment, May 1996, Table 3.1–1).*

b) Over the long term, seepage rates are expected to decrease and the quality of seepage water is expected to improve. Under what time frame will the rate of seepage be significantly reduced and the quality of seepage water improved? What variables will influence the rate of improvement?

A4.12 Seepage analyses of Tar Island Dyke (detailed in the AGRA report '*Pond 1/Tar Island Dyke Water Balance Study Phase 2*') have recognized 3 major discharge pathways:

- the foundation clay
- the Snye channel
- the toe of the dyke

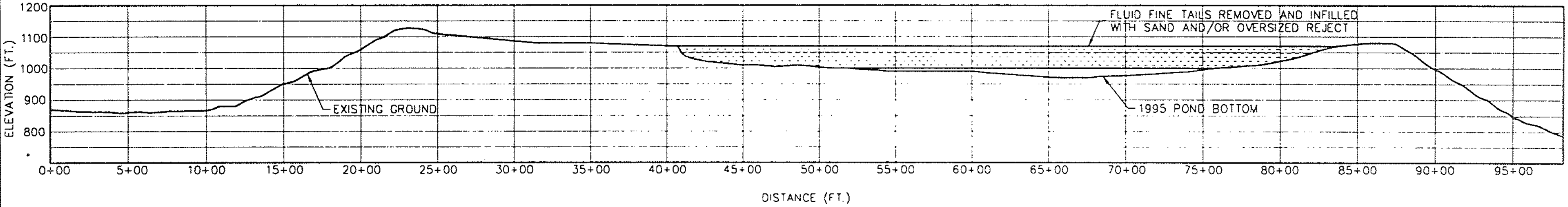
FIGURE 4.11-3



Scale 1" = 2000'

AGRA Earth & Environmental Limited ENGINEERING & ENVIRONMENTAL SERVICES	CLIENT: SUNCOR INC.	DATE: 96/07/17	
	TAR ISLAND RECLAIMED AREA CROSS-SECTION LOCATIONS	JOB No.: EG07845	
		COREL FILE: EG\07845900	
		FIGURE 1	REV. -

FIGURE 4.11-4

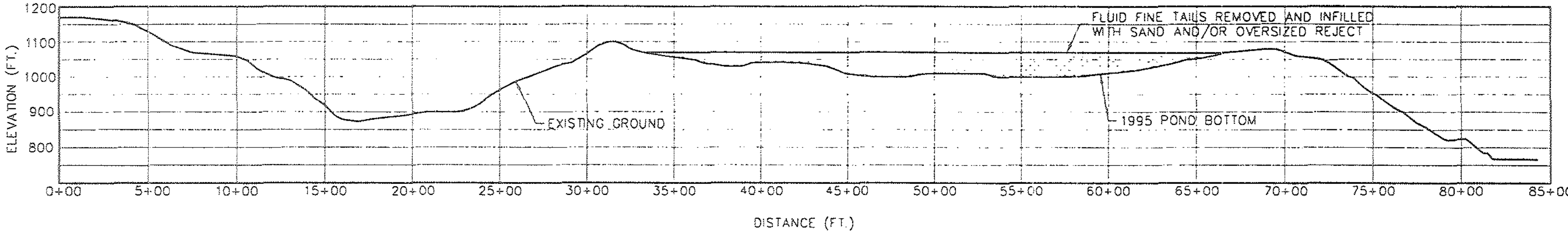


A SECTION
H: 1"=1000' V: 1"=500'

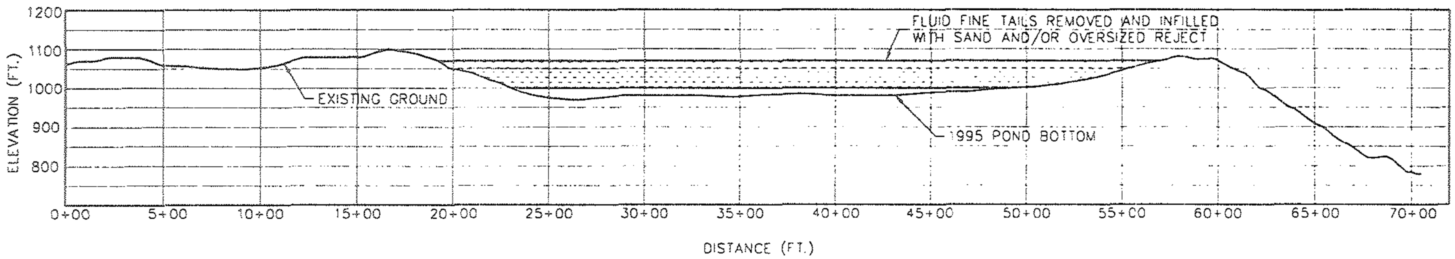
AGRA
Earth & Environmental Limited
ENGINEERING & ENVIRONMENTAL SERVICES

CLIENT: SUNCOR INC.	DATE: JULY 1996	
PROJECT:	JOB No. EG07845.00	
CROSS SECTION THROUGH TAR ISLAND RECLAIMED AREA SHEET 1 OF 2	CAD FILE: EG07845 1:1000=11•8.5	
	FIGURE: FIGURE 2	REV. 0

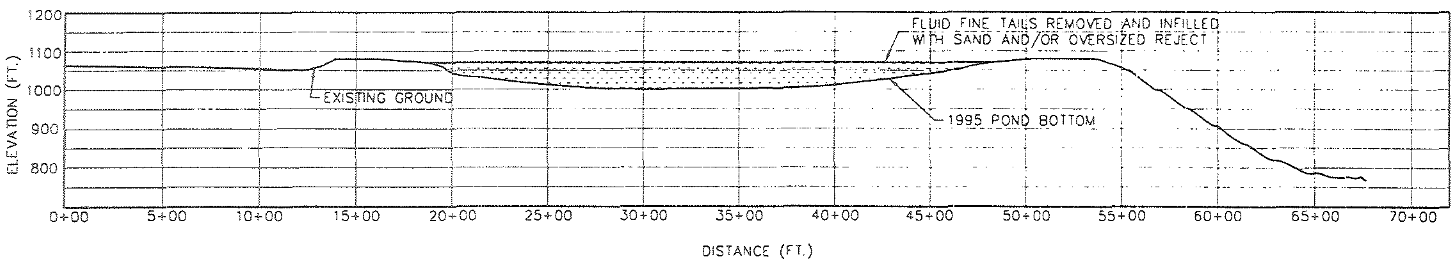
FIGURE 4.11-5



B SECTION
H: 1"=1000' V: 1"=500'



C SECTION
H: 1"=1000' V: 1"=500'



D SECTION
H: 1"=1000' V: 1"=500'

AGRA
Earth & Environmental Limited
ENGINEERING & ENVIRONMENTAL SERVICES

CLIENT: SUNCOR INC.

PROJECT:

CROSS SECTIONS THROUGH TAR ISLAND RECLAIMED AREA SHEET 2 OF 2

DATE: JULY 1996

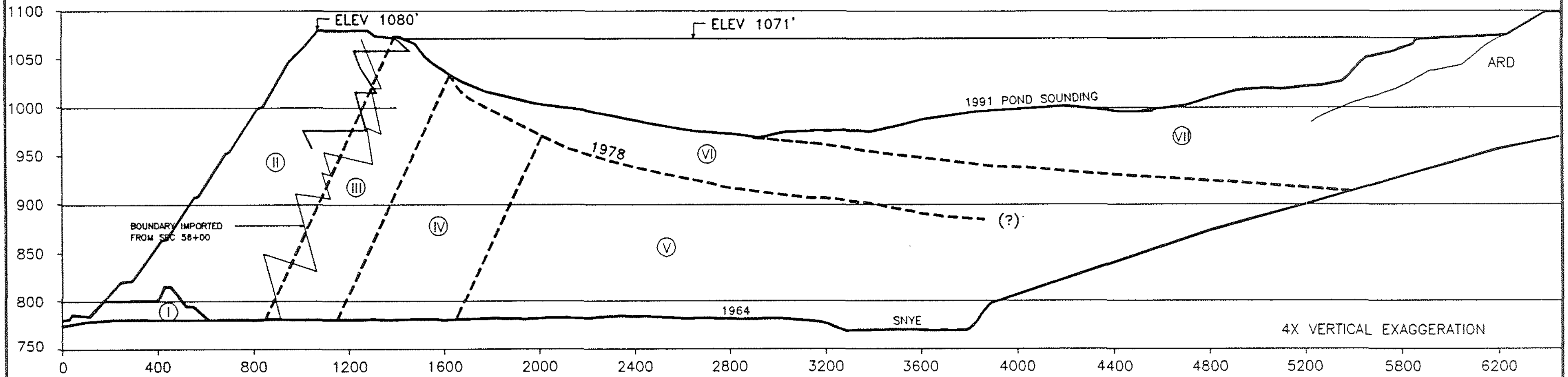
JOB No. EG07845.00

CAD FILE: EG07845 1:1=11•8.5

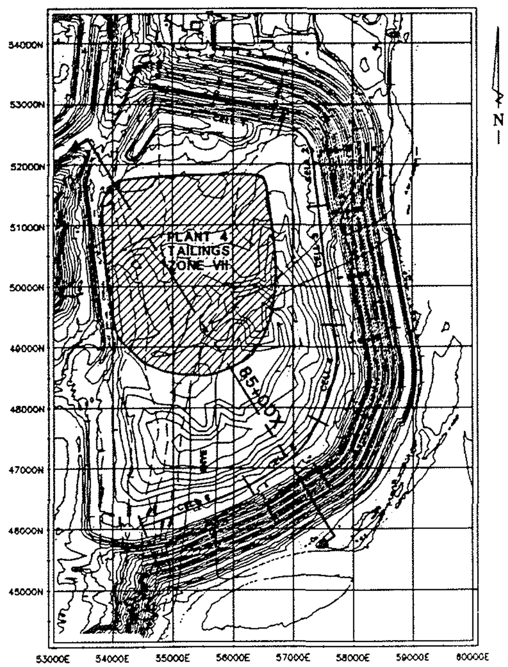
FIGURE: FIGURE 3

REV. 0

FIGURE 4.11-6



SECTION 85+00X



KEYPLAN SHOWING LOCATION OF SEC 85+00X

ZONE	MATERIAL	DESCRIPTION
I	STARTER DYKE	COMPACTED OVERBURDEN
II	COMPACTED CELL	CLEAN SAND, DENSE
III	BAW/BBW 1	CLEAN SAND, SOME THIN LAYERS OF BITUMEN IMPREGNATED SAND AVERAGE $(N_1)_{60} \approx 16$
IV	BBW 2	CLEAN SAND, THIN LAYERS OF BITUMEN IMPREGNATED SAND AVERAGE $(N_1)_{60} \approx 14$
V	BBW 3	CLEAN SAND, THIN LAYERS OF BITUMEN IMPREGNATED SAND AVERAGE $(N_1)_{60} \approx 7$
VI	BBW 4	SILTY CLAYEY SAND, DARKER THAN ABOVE SANDS $(N_1)_{60} \approx 0$, TYPICALLY
VII	PLANT 4 TAILINGS	PLANT 4 TAILINGS MOSTLY BBW, $(N_1)_{60} = 0$

AGRA
Earth & Environmental

SUNCOR INC.
OIL SANDS GROUP
POND 1 RECLAMATION PROJECT
TIRSS CROSS-SECTION 85+00X

SCALE: SHOWN	DATE: DEC/95	MADE: MJL	CHKD: AGK	JOB: EG07766	FIGURE:

Seepage through the toe of the dyke accounts for seepage directed through swales. Seepage volumes from all three of these pathways were included in the calculation of risk associated with this release.

In the long term, the volume of seepage from Tar Island Dyke will be reduced as the phreatic surface drops. The time required to achieve equilibrium conditions is expected to be between 60 and 160 years. The quality of water is also likely to improve over this time frame, however, not simply due to the reduction in flow volume.

Dry tailings sand still contains precipitates of many of the chemicals associated with oil sands tailings fluids. However, repeated flushings with fresh water (2-3 times pore volumes) removes these chemicals. Fresh water input in the form of precipitation infiltration will flush the oil sand related chemicals from the major flowpaths (i.e., the downstream slope of the dyke) in the same time frame as the achievement of equilibrium flow conditions.

Q4.13 Suncor discusses bank erosion and geotechnical stability in general terms in the application *(Steepbank Mine Project Application, April 1996, Section E4.0 , p.35 and Section D3.0, pp.8,52)*. Provide a detailed summary of Suncor's evaluation of the risk of river erosion or other causes of destabilization producing slides on Tar Island Dyke, and the possible consequences for water quality in the Athabasca River.

A4.13 The issue of erosion of Tar Island Dyke due to action of the Athabasca River has been discussed in the references cited in the Steepbank Application (AGRA Earth and Environmental, 1996e) in which it was concluded that the Athabasca River channel is a very stable feature and that direct attack on the dyke is unlikely. If lateral erosion was to occur, hundreds of feet of lateral erosion would be required to trigger a major earth material movement and the likely time to achieve this magnitude of lateral erosion would be centuries. Therefore it is justified to assume that the risk of a major discharge of material to the river is very low.

Another cited report (AGRA Earth and Environmental 1996b) has considered the erodability of the tailings sand slopes due to high rainfall events following a forest fire. It has been found, based on field testing, that the erosion rates were very low. This has been attributed to the high infiltration capacity of the tailings sand. It was concluded that the risk of significant discharge to the River were very low.

However, in order to assess the potential consequences of such mass movements, Suncor has initiated a joint study to be conducted by AGRA and Golder consulting firms to examine a range of theoretically possible releases of tailings materials due to erosion or slumping. The study will determine the probable volume of material involved, the composition of the material and the rate of transport of these materials into the river. The environmental impact of these hypothetical releases will be estimated using the probabilistic performance assessment techniques utilized throughout the EIA process. It is expected that this report will be available in mid-September, 1996.

Q4.14 Suncor outlines plans to construct berms for tailings lines on the north side of Tar Island Dyke and to drive steel pilings for the west abutment of the bridge into Tar Island Dyke *(Steepbank Mine Project Application, April 1996, Section C4.0, pp.67,70)*. Provide more detailed information about these plans and the evaluations undertaken to ensure that the stability of the dyke will not be adversely affected.

A4.14 Bridge abutment piles and fill are presently at a location in the river channel and will be designed such that it meets the bridge requirements and does not impact Tar Island Dyke.

An embankment fill on the north end of Tar Island Dyke for conveyors was assessed by AGRA Earth and Environmental Limited during the feasibility stage.

A detailed design of the corridor from the bridge to the extraction plant is in progress. This design will incorporate the mitigative measures recommended by AGRA for the conveyor embankment. The final design will undergo a geotechnical assessment.

Consolidated Tailings (CT)

Q4.15 Describe the preliminary findings of the 6 month commercial trial of CT technology in order to assess the probability of this technology to achieve dry tailings reclamation. Discuss the findings in terms of the surface settlement rates and other implications for reclamation. (*Steepbank Mine Project Application, April 1996, Section D3.0, p.32)*

A4.15 The Consolidated Tailings Commercial Trial was conducted over the period from November 1995, to May, 1996. Much of the data from the Trial has been analysed with the major outstanding component related to obtaining and analysing samples from the Pond 5 deposit. The final report will not be completed until mid-August. However, the following preliminary indications are available:

The major process equipment performed successfully. The cyclone systems produced a consistent high density underflow sand stream. The temporary gypsum addition system to add the commercial gypsum, until Suncor's Flue Gas Desulphurization gypsum is available, worked reasonably consistently. The major operating problems centred around the supply and quality of fine tailings from Pond 2/3 under harsh winter conditions.

The chemistry of the release water is close to predictions, and is mineral free. The LC50 toxicity measurements exceed 95% for undiluted release water, which is a major improvement over tailings recycle water and dyke seepage water. There is little hydrocarbon odour in this water.

The fines capture in the CT deposit was not as high as desired, being about 60% versus a target for the trial of about 90%. However, even this rate of capture is substantially better than would be expected in a normal tailings operation and represents a major reduction in fine tailings accumulation rate versus current operation. The principal reasons for reduced fines capture during the test are: low clay mineral content fine tailings at the shore mounted pumping location and excessive dilution of the CT mixture with various water streams.

Suncor is confident that capture rates exceeding 90% can be achieved in full commercial operation. The fine tailings pumping raft has been relocated from the shore to a mid-pond location thereby obtaining an increased lay content fine tailings. The dilution streams have been identified and diverted where feasible. In addition, a spigot discharge strategy into Pone 5 has been adopted to reduce turbulence.

Q4.16 The hydraulic conductivity of the settled fine tailings has been estimated at 10^{-6} cm/sec which is further reduced to 10^{-8} cm/sec when the fine tailings consolidate *(Steepbank Mine Project Application, April 1996, Section B1.0, p.15)*. Explain what methods were used to obtain these values.

A4.16 Hydraulic conductivity is a very important parameter which is required to predict large scale dewatering behaviour of fine tailings or CT deposits over long periods of time based on lab and pilot scale testing. This parameter is very sensitive to clay content, clay mineralogy, void ratio and pore fluid chemistry.

Hydraulic conductivity in the tailings context is defined by the equation $k=Q/ia$, where Q is the flow passing through a crossectional area (a) which is induced by a hydraulic gradient (i). In typical geotechnical engineering testing a cylinder of soil of known crossectional area and length is subjected to an elevated pressure at one end and the flow passing through the cylinder is measured. This technique provides acceptable permeability data for soils which have sufficient strength such that the structure of the sample is not significantly altered by the stress imposed by the hydraulic gradient.

Fine tailings have essentially no strength at the solids concentrations (or void ratio) which are typical of pond conditions. The samples are significantly altered by the imposition of even small stresses. The standard test techniques described above cannot be used for these samples.

For fine tailings materials, it is routine in the testing industry to develop hydraulic conductivity data based on sedimentation testing. This involves recovering samples from the tailings ponds, or making fresh samples from the extraction process, and placing them in vertical columns which allow periodic subsampling at several depths in the column to determine dewatering with time. In addition, pore pressure measuring instrumentation is installed in the column to allow determination of the hydraulic gradient and the consolidation state within the column. Using these data, it is possible to compute the hydraulic conductivity at the various stress levels in the column.

Once sufficient dewatering has occurred that the sample has achieved some strength, additional stress can be placed on the sample. This stress may be induced by placement of a small sand layer on the top of the column or by loading with a piston. Standard geotechnical calculations are then used to determine the hydraulic conductivity based on these data.

Once the hydraulic conductivity data are determined for a range of void ratios or effective stresses, dewatering models based on finite strain consolidation theory are used to compute the dewatering behaviour of the column, thereby verifying and calibrating the model. The model can then be used to predict larger scale deposit performance.

Q4.17 Suncor chose its CT technology based on effectiveness, operational feasibility and cost *(Steepbank Mine Project Application, April 1996, Section D3.0, p.23)*. CT technology is being tested now at a field scale. What variations in the volume and quality of fine tails are manageable with Suncor's CT technology and associated tailings management plans? What alternative reclamation strategies will Suncor use if CT technology is not as successful as anticipated?

A4.17 Suncor's current tailings handling and reclamation practices involve direct operating costs and generate a long term liability. Suncor is determined to reduce these operating costs and accelerate the reclamation process. Consolidated Tailings technology is the culmination of 25 years of development work and represents the best known alternative to achieve the above goals. Although Suncor is confident that the CT technology implementation will be successful, it is instructive to determine where something could go wrong.

It should be noted that the problem of separation of fines and coarse tailings fractions is not unique to the oil sands industry, and there are numerous precedents for the recombination of fines and coarse materials and stabilization of the mixture with a chemical additive. From a conceptual perspective there is nothing novel about the CT process. The novelty lies in the use of gypsum recovered from the Flue Gas Desulphurization (FGD) process as the chemical additive, and the issues of release water handling and reclamation.

There is an extremely low risk that gypsum will not work as the chemical treatment. This conclusion is based on fundamental physical chemistry clay colloid science supported by a large amount of laboratory and pilot scale testing. If the FGD gypsum was found to be unsuitable for the CT process, Suncor would determine if modification of the FGD gypsum was feasible. If not, other alternatives (commercially available gypsum, lime or flocculants, which would achieve comparable reclamation landscapes) are known and available for evaluation.

There is a very low risk that the basic CT ingredients (fine tailings, sand and water) cannot be obtained and mixed to make a non-segregating mixture.

The process has been pilot tested by Suncor in 1993 and followed in 1995 by a much larger pilot at Syncrude. Both tests were successful. Commercial scale testing was conducted at Suncor in the winter of 1996 - 1996 which, although generally successful, identified some scale up issues which have been addressed prior to renewed operation in 1996.

The area of some (minimal) uncertainty is the chemical composition of the CT release water and how best to manage the volume of this water. If this proved to be a problem, the question would be as to how best to modify this chemistry. The first response would not be to abandon the CT process.

In spite of the above, there is always a risk associated with the introduction of new technology. In the event that ongoing research associated with CT technology delays the incorporation of CT into a full scale operation, Suncor has the ability to return to the current technology until an acceptable alternative is developed, although at a significant economic penalty. If an alternative could not be found, then the water capped fine tails lake concept remains as a viable alternative, with the most probable long term storage location identified somewhere on Lease 25 well to the east of the Athabasca River.

Q4.18 Suncor plans to "mitigate any risk of plant uptake of chemicals by capping less-desirable material (e.g. CT) with better quality materials." ***(Steepbank Mine Project Application, April 1996, Section D3.0, p.71).***

a) How and when will Suncor decide which materials will be used?

A4.18a The volumes of materials expected to be required for capping mean that Suncor will be using those materials readily available from the lease area or operation at the time of need. Therefore, it is expected that the materials to be employed will be either tailings sand or lean CT (e.g., 8:1 sand:fine mixes). Suncor has and will continue to evaluate these materials for potential impacts to plants, using both laboratory and field studies. Research on reclamation areas on tailings sand have shown little or no impact to plants from this material. Indications for lean CT mixes are that potential impacts to plants are limited. Areas capped with the probable capping materials will be covered with the typical Suncor reclamation soil amendment layer prior to revegetation.

b) Which materials have the capability to minimize the potential for erosion to expose CT soils, and under which circumstances will they be used?

A4.18b Capping materials are used on the basis of two needs: provision of a subsoil for plant growth and reduction of potentials for direct exposure of CT materials. In all cases, CT deposits will be level, capped, and revegetated. Drainage systems will be designed to minimize erosion. Therefore, erosion potential for reclaimed CT deposits is negligible.

c) What depth of capping layer is necessary to minimize the risk to wildlife from exposure to plants grown on CT, or surface water run-off from CT deposits?

A4.18c The required capping layer depth will be determined based on field-demonstration studies to be initiated in 1996. See response to Question 7.4 for details of the planned study.

Q4.19 Suncor evaluated the health risk associated with chemicals in CT deposits. *(Steepbank Mine Project Application, April 1996, Section D3.0, p.72)*. In addition to evaluations of potential toxicity, how has Suncor evaluated the physical and chemical properties of CT deposits, related to reclamation feasibility and capability?

a) What chemical and physical properties of CT have been evaluated regarding its suitability as a reclamation material? What ions (concentrations) are present in

CT after consolidating in Pond 5? Have electrical conductivity and Sodium Adsorption Ratio been evaluated?

b) **What is CT's structure and texture after settling and use under field conditions?**

A4.19 By design, about 20% of the minerals in CT are from fine tailings and the remaining 80% are from coarse tailings sand. Approximately 60% of the minerals in fine tailings are clay minerals, consisting of kaolinite and illite. A more detailed discussion of the mineral composition would be found in the *"Final Report of the Fine Tailings Fundamentals Consortium."* The resulting soil is classified as a sandy loam and does not display significant shrinkage cracking on drying.

Chemical analysis of the sediments from Pond 5 has not been completed as yet. However, the pore fluid chemistry of laboratory CT samples indicate the following:

ION	CONCENTRATION (ppm)
Ca	75
Mg	22
Na	516
SO_4	792

Suncor recognizes that CT is a new material and that there is a need to establish its role in the reclamation context. Plant growth studies have been initiated under greenhouse and small field plot conditions. These studies include the determination of the levels of any uptake of organic and inorganic chemical species and the determination of the mechanisms of any impact on plant health. These studies are necessary to establish the requirements for capping materials to be placed over the CT deposits. These small studies will be followed in 1997 with larger field plot studies which will cover a range of topsoil compositions and thicknesses. The results of these studies will be used to design the revegetation program included in the CT Reclamation Demonstration Test Site which is scheduled for planting in 2000 as discussed in question 7.4.

Conservation and Reclamation Plan (C&R)

Q4.20 The Clearwater Formation is excavated during Pit 02 mining of the Steepbank proposal *(Steepbank Mine Project Application, April 1996, Section C2.0, p.25, Figure C2.0–9)*. Does Suncor intend to selectively handle and stockpile this unsuitable reclamation material? How does Suncor intend to deal with this material in soil reconstruction?

A4.20 The material from the Clearwater Formation is not expected to be selectively handled or stored in a separate waste area from those illustrated in the mine plan. Based on Suncor's experience on Lease 86/17, segregation of this material from surface reclamation soils is not warranted. Sodium Adsorption Ratio (SAR) values in Steepbank overburden are expected to be in the range of Lease 86/17 values. Data for the Steepbank Mine is provided in Question 4.21, but the interpretation is not complete. Previous studies and long-term reclamation monitoring have shown that Clearwater material do not restrict revegetation significantly. SAR decreases from insitu values through the materials handling process. Upon soil and revegetation treatment and with time SAR values are reduced further. Should areas of excessively high SAR become evident on the reclaimed areas, to the point where natural processes are insufficient to improve the soil quality, mitigative action would be taken.

Q4.21 Suncor states "Sodium Adsorption Ratio tests have been completed on a few selected overburden materials." *(Steepbank Mine Project Application, April 1996, Section C2.0, p.25)*. Provide the results of these tests.

A4.21 The results of overburden testing for sodium adsorption ratio (SAR) follow in Tables 4.21- 1 through 4.21-3. Sampling was done on clay materials within the overburden zone in 1994 to 1996. This data does indicate some areas of high SAR values, but the

Table 4.21-1

Sodium Adsorption Ratio Data - 1994 Overburden Drilling

Hole	Depth(ft)	Facies /unit	% Water**	Concentration (meq/L) Na	Ca	Mg	SAR
SUN19003	36-41	PGt	43.64	11.34	6.19	2.63	5.40
SUN19003	65-70	PGtc	47.45	14.70	3.83	1.75	8.81
SUN19003	87-92	PGtc	25.86	23.78	2.40	1.31	17.46
SUN19003	102.5-106	upper Kcb	168.06	73.87	2.22	1.85	51.81
SUN19003	113-118	lower Kcb	135.43	26.19	0.37	0.28	45.98
SUN19003	128-133	Kca	177.69	30.71	0.42	0.33	49.88
S19ALT08	56-61	Kcc	110.45	37.32	1.03	0.90	37.98
S19ALT08	71-76	Kcc	161.52	40.16	1.17	1.14	37.36
S19ALT08	85-90	upper Kcb	104.30	57.65	1.28	1.11	52.83
S19ALT08	99-104	lower Kcb	99.46	44.48	1.57	1.58	35.46
SUN19014	150-162	PGc	38.56	11.88	3.10	1.78	7.61
SUN19014	99.5-113	PGt	30.21	11.87	0.91	0.47	14.28
SUN19015	42.5-55	PGt	34.99	13.37	0.95	0.58	15.30
SUN19015	86-94	PGt	34.03	9.71	0.95	0.48	11.51
SUN19015	112.5-120	PGt	32.27	16.95	0.51	0.30	26.63
SUN19015	128-133	Kca	148.54	15.07	0.19	0.10	39.35
SUN19015	148-150	MSF	62.80	21.69	0.64	0.43	29.71
SUN19012	57-63	PGtc	29.85	20.40	1.18	0.64	21.36
SUN19012	87-92	PL	31.14	17.16	0.91	0.44	20.82
SUN19009	22-50	Pfs/Pl	36.01	4.15	2.50	1.48	2.94
SUN19009	85-105	mid Kcc	81.36	18.67	0.43	0.23	32.45
SUN19009	105-136	lower Kcc	112.94	16.81	0.17	0.13	43.23
SUN19009	136-155	Kcb	100.83	15.03	0.31	0.19	30.12
SUN19009	155-176.5	Kca	132.96	13.80	0.26	0.13	31.26
SUN19009	176.5-181	Kcw	47.17	26.29	0.26	0.32	48.66
SUN19006	106-110	Kcw	51.79	18.69	0.38	0.29	32.25
SUN19007	78-92	PGtc	38.13	11.51	0.52	0.71	14.70
SUN19009	92-100	Kca	138.69	14.52	0.04	0.14	48.85
SUN19009	105.5-115	Kcw	65.05	20.67	0.26	0.22	42.18
SUN19008	41-56	PGc	56.88	5.82	2.37	1.15	4.39
SUN19008	68.5-81	PGt	39.57	9.64	1.15	0.55	10.46
SUN19008	105-126	Kca	126.50	16.39	0.17	0.18	39.19
SUN19008	126-134	Kcw	51.17	29.95	0.42	0.47	44.90
SUN23007	94-106	OM	44.36	41.08	0.33	0.33	71.35
SUN23005	20-30	Kcc	85.39	18.13	0.15	0.16	46.15
SUN23005	30-46	Kcb	122.83	16.09	0.09	0.06	59.55
SUN23005	64.5-76	Kcw	60.49	23.45	0.13	0.14	64.01
SUN23005	76-78	OM	51.55	28.72	0.32	0.25	53.73
SUN19010	44-49	PGc	39.48	9.94	1.71	0.78	8.90
SUN19010	56.5-74	PGtc	52.09	12.23	0.37	0.22	22.38
SUN19010	108-120.5	Kcc	115.54	16.62	0.16	0.10	45.69
SUN19010	149-168	Kca	139.31	13.82	0.17	0.11	36.95
SUN23018	133-142	TFS	35.06	18.58	0.17	0.13	47.91
SUN23009	148-155	TFM	33.86	64.13	0.53	0.83	77.78
SUN23017	62-72	PG(till)	29.90	9.30	0.56	0.33	13.96

** Percent water content at saturation (dry weight basis)

TABLE 4.21 - 2
Sodium Adsorption Ratio Data - 1995 Overburden Drilling

Hole	Depth (m)	Facies	% Water	pH	EC	Na	Ca	Mg	SAR
L9795016	8.1-9.6	Pgc	74.8	8.55	1.16	10.12	0.32	0.16	20.65
L9795013	6.2-10.6	Pgtc	85.7	8.60	1.27	11.88	0.22	0.15	27.62
L9795017	9.7-11.2	Pgtc	70.9	8.85	1.14	10.06	0.19	0.09	26.88
L9795ALT5	5.7-7.5	Pgtc	71.6	8.50	1.01	8.65	0.26	0.16	18.87
FL195002	3.7-4.9	Pgc	68.1	8.10	1.16	7.73	1.43	1.08	6.90
L9795012	13.7-15.2	Pgc	61.0	8.75	1.11	10.20	0.18	0.10	27.26
FL195001	4.2-5.6	Pgc	62.3	7.89	0.95	6.71	1.26	1.26	5.98
L9795002	13.9-15.2	KCa	160.4	9.20	1.06	9.18	0.19	0.08	24.98
L9795010	17.0-20.0	KCa	211.2	9.30	1.33	11.86	0.12	0.08	37.50
FL395003	18.5-20.0	KCa	171.9	9.3	1.03	9.46	0.14	0.08	28.40
L2595004	19.0-22.0	KCb	47.5	9.3	1.32	12.61	0.10	0.06	43.67
FL395002	12.8-15.2	KCw	57.7	8.7	1.75	17.91	0.16	0.14	46.14
L2595006	16.6-18.4	KCw	70.8	9.00	1.72	15.36	0.21	0.12	37.81
L9795ALT1	5.7-7.0	KCw	44.3	8.49	1.07	8.64	0.40	0.34	14.20
L9795ALT1	7.0-9.3	KCw	64.0	8.90	0.85	7.60	0.17	0.11	20.31
L9795007	14.5-16.0	KCw	75.0	9.30	1.25	12.61	0.11	0.08	38.45
L2595007	17.5-19.3	KCa/KCw	65.3	9.1	1.31	13.98	0.18	0.12	35.89
L9795009	19.7-21.7	MSF	68.7	9.15	1.31	12.10	0.40	0.15	23.07
L9795ALT1	9.6-11.5	MSF	75.6	9.30	0.90	8.55	0.10	0.07	29.32
L9795019	8.5-11.5	MSF	51.7	7.6	0.4	0.39	0.83	2.89	0.29
L9795003	21.5-23.0	TFM	46.7	8.50	1.48	14.68	0.17	0.10	39.95
L9795006	36.5-38.0	TFM	48.6	8.50	3.04	26.06	0.30	0.18	53.19
L2595006	38.0-40.6	TFM	44.3	8.25	3.20	28.33	0.30	0.22	55.55
L9795011	49.6-51.1	TFM	43.6	8.35	1.13	10.72	0.23	0.12	25.62
L9795008	34.0-35.5	TFM	49.9	8.40	1.82	16.40	0.22	0.12	39.77
L9795010	32.0-37.0	TFM	40.0	8.60	2.01	16.84	0.22	0.12	40.84

% water is measured at saturation

TABLE 4.21 - 2

Sodium Adsorption Ratio Data - 1995 Overburden Drilling

Hole	Depth (m)	Facies	% Water	pH	EC	Na	Ca	Mg	SAR
L9795018	39.5-41.0	TFM	44.9	8.28	1	9.88	0.16	0.07	28.82
L9795022	26.2-27.7	TFM	54.5	8.81	1.37	12.35	0.17	0.08	34.96
L9795025	58.5-59.5	TFM	50.9	8.45	3.24	27.92	0.20	0.24	59.95
L2595004	64.0-66.9	TFM	53.7	8.3	4.83	41.73	0.51	0.26	67.36
L979ALT5	32.0-33.8	TFM	45.7	8.22	1.66	15.92	0.21	0.14	38.05
L9795005	23.0-25.2	TFM	44.3	8.50	0.95	10.59	0.19	0.08	29.23
L979ALT6	25.4-28.0	TFM	51.4	8.50	1.37	14.09	0.12	0.07	46.58
L2595007	61.0-62.5	TFM	63.4	8.5	4.98	41.87	0.32	0.36	71.52
L2595007	33.0-36.0	TFM	50.7	8.7	1.83	17.33	0.18	0.11	45.54
FL395001	36.0-39.0	TFM	49.7	8.28	3.61	33.79	0.41	0.30	56.79
FL395003	42.0-43.5	TFM	53.6	8.19	4.45	40.67	0.34	0.41	66.48
FL395004	49.0-52.0	TFM	47.9	8.2	3.68	31.04	0.70	0.27	44.62
L9795ALT6	36.7-38.5	TFM	48.3	8.3	1.13	11.29	0.15	0.07	34.10
L9795005	16.0-19.0	TFS/TFM	42.6	8.65	1.09	10.81	0.14	0.10	31.73
L9795016	15.8-17.0	TFS	38.8	8.70	1.65	14.44	0.36	0.17	28.05
L9795020	20.7-23.0	TFS	40.8	8.61	0.8	7.61	0.10	0.05	27.18
L2595002	32.0-34.0	TFS	43.6	8.65	1.18	9.98	0.24	0.10	24.16
L2595004	41.0-43.0	TFS	47.4	8.4	1.61	13.64	0.24	0.08	33.78
L2595001	27.0-30.0	TFS	39.3	8.65	2.04	16.25	0.17	0.11	43.42
L2595001	33.0-34.5	TFS	40.8	8.79	2.94	23.49	0.31	0.16	48.45
L9795ALT4	9.9-11.4	Pgc/MSF	40.5	8.49	1.24	10.67	0.16	0.11	29.04
L9795022	18.1-20.4	PgKc	140.2	9.3	1.16	10.66	0.20	0.09	28.19
L9795012	15.2-16.5	Pgc/KCw	94.4	8.83	1.26	11.32	0.30	0.12	24.70
L9795009	17.2-18.3	KCa/KCw	165.2	9.30	1.08	9.39	0.09	0.06	34.28
L2595005	20.2-23.2	KCa/KCw	173.4	9.40	1.30	11.68	0.10	0.07	40.06
FL395005	18.5-25.0	LB/MSF/TFS	45.0	8.6	1.62	14.10	0.04	0.09	31.59

% water is measured at saturation

TABLE 4.21 - 2
Sodium Adsorption Ratio Data - 1995 Overburden Drilling

Hole	Depth (m)	Facies	% Water	pH	EC	Na	Ca	Mg	SAR
L9795023	12.2-15.7	KCa/KCw	124.8	9.18	1.35	13.15	0.09	0.06	49.13
L9795025	29.6-31.2	KCa/KCw	94.7	9.15	1.89	17.20	0.15	0.10	48.43
L9795021	18.8-21.8	KCw/MSF/LB	82.1	8.88	1.56	13.81	0.17	0.13	35.56
L2595003	23.5-26.5	MSF/TFS	45.4	8.61	0.82	6.96	0.28	0.08	16.42
FL195002	11.0-13.2	MSF/TFS	46.3	8.59	0.97	9.12	0.14	0.10	26.40
L9795018	22.9-25.2	TFM	44.3	8.45	1.44	13.95	0.17	0.10	38.24
L9795ALT4	14.0-15.8	TFM/TCTF	37.8	8.50	1.41	12.40	0.22	0.13	29.64
L9795006	56.0-57.5	TFM	37.7	8.55	20.40	17.84	0.24	0.13	41.47
FL395004	30.5-32.7	OFM/TFM	52.0	8.62	1.39	12.29	0.16	0.09	34.45
L9795013	13.4-15.0	LB/MSF	33.7	8.75	0.91	8.47	0.14	0.08	25.53
L9795019	15.0-18.0	LB/MSF	43.4	7.55	0.53	0.71	1.32	2.91	0.49
L9795015	2.1-3.9	LB/MSF	37.7	7.50	0.58	3.32	1.09	0.61	3.60
L9795024	26.6-30.3	LB/MSF	56.8	8.7	1.64	15.31	0.19	0.11	39.56
L9795021	21.8-24.9	LB/MSF	47.3	8.70	1.72	15.24	0.19	0.11	39.16
L9795023	20.0-23.0	LB/MSF/TFM	48.0	8.6	1.9	18.30	0.18	0.15	44.81
L9795011	4.3-5.8	MB	43.8	7.80	0.38	1.08	1.40	0.73	1.04
L9795020	18.3-20.7	LB	43.5	8.70	1.22	11.39	0.27	0.14	25.20
L2595002	23.7-25.6	LB	55.2	8.9	1.93	17.86	0.37	0.12	36.13
L9795008	27.1-29.5	SMS/TFM	51.8	7.90	1.05	9.52	0.36	0.16	18.67
L9795003	15.6-17.2	OFM	146.4	9.20	1.20	10.31	0.18	0.10	27.55

% water is measured at saturation

TABLE 4.21 - 3
Sodium Adsorption Ratio Data - 1996 Overburden Drilling

Hole	Depth (m)	Facies	Ca	Mg	Na	SAR
L9796002	14.8-16.3	Kc	12.70	3.04	498	32.56
L9796004	4.0-8.0	Kca/Kcw	82.70	121.00	1065	17.47
L9796013	17.8-22.3	Kca/Kcw	7.60	2.41	468	37.87
L9796004	0.6-4.0	Kcb	231.00	226.00	1049	11.76
L9796020	21.9-24.8	LB	7.51	2.00	502	42.03
FL196004	10.5-14.7	LB/MSF	10.10	7.37	486	28.38
L9796018	0.90-4.30	LB/MSF	7.20	2.60	475	38.58
L9796003	9.9-13.0	LB/MSF	9.83	2.36	264	19.61
L9796007	14.3-18.5	MSF	7.95	28.30	440	16.41
FL196011	9.6-11.0	MSF	8.88	3.58	213	15.25
L9796024	18.5-22.2	MSF/TFM	7.03	2.00	524	44.88
L9796015	18.4-22.2	OFM	6.64	11.40	439	23.99
L9796013	4.9-13.0	Pfs	73.80	2.00	264	8.27
FL196006	8.4-11.5	Pgc	10.90	4.47	519	33.43
FL196012	9.20-10.7	Pgc	15.40	7.68	284	14.76
L9796015	12.5-14.9	Pgtc	9.64	2.73	420	30.74
L1996003A	10.4-13.4	Pgtc	11.50	3.77	413	27.01
L9796016	1.5-2.6	Pgtc	54.90	24.40	21	0.59
L1996005	67.3-79.0	SMS	6.29	2.98	1171	96.32

% water is measured at saturation

% water is measured at saturation

analysis to quantify the extent has not been completed. At this point Suncor does not have any reason to believe that any change to current practice for placement of overburden will be necessary.

Q4.22 Suncor states that about 65% of the reclaimed area will be returned to upland forest ***(Steepbank Mine Project Application, April 1996, Section D3.0, p.10).***

a) How will Suncor demonstrate that the reclaimed forests have the same productivity as pre-disturbance forests?

A4.22a Suncor is applying forestry criteria from the "Free To Grow Standard." This standard requires an acceptable spruce tree growth on a harvested cut block to reach 50 cm height while acceptable pine are to be 100 cm after eight years. In the surveys completed on the reclamation areas surveyed to date, most trees found in the surveys have achieved the fourteen year growth requirement of 150 cm and 200 cm, respectively, by the time of the eight year survey. Deciduous species surveyed on the reclamation areas also show better growth characteristics than the natural sites.

The rooting study (pp199-206 of the Suncor Application for Renewal of Environmental Operating Approval, Feb. 1995) indicated that although the trees excavated on reclaimed tailings sand and overburden sites were younger, the growth performance was superior. Thus Suncor is of the opinion that the performance indicators have shown that the tree growth is as good as or better than that documented on natural undisturbed sites in the region. However, Suncor also recognizes that continued monitoring of the reclaimed sites is necessary to further document the development of trees and herbaceous vegetation as the sites mature.

Suncor will continue to implement a system of monitoring and assessing performance of forest vegetation utilizing a number of indicators and comparing to standards or natural references.

b) **How will the reclaimed land base provide for the same conifer:deciduous ratio of forest species in the post-mining scenario?**

A4.22b The reclaimed land in the Steepbank Mine valley will be replanted to a similar species mix and area ratio to that which existed previous to the mine development. The major difference will be evident only after reclamation of areas to the east of the river valley escarpment. On the reclaimed consolidated tailings areas and overburden waste dumps, a forest vegetative community dominated by aspen, poplar, and white spruce will be established on areas where black spruce or muskeg was found prior to the mine development. This change is in keeping with the projected improvements in land capability following reclamation which allows for a more productive forest ecosystem to be established. The capability improvement is defined in section 3.3 of C& R Report.

Q4.23 **Suncor states "For lease 86/17, this information (soils handling plan) has been provided in the Environmental Operating Approval Application in 1995"** ***(Steepbank Mine Project Application, April 1996, Section D3.0, p.60).*** **Does this statement imply that soil reconstruction on lease 86/17 continues as outlined in this application, or will Suncor use the new forest capability system for unreclaimed land on lease 86/17?**

A4.23 Suncor is using the new "Land Capability Classification for Forest Ecosystems in the Oil Sands Region" to evaluate the pre-disturbance, current, and past reclamation as well as design the reclamation plan for the remainder of lease 86/17. Suncor believes that this tool provides a more consistent and better method of assessing the pre-disturbance and post reclamation landscapes than was previously available. The pre-development and post-reclamation land capability is defined in section 3.3 of the C & R Report.

Q4.24 **Suncor's current soil reconstruction technique has been used on an operational scale since 1984** ***(Steepbank Mine Project Application, April 1996, Section D3.0, p.61).*** **This technique does not currently involve selective handling of mineral topsoil and subsoil materials. Will Suncor selectively handle different quality mineral topsoil and subsoil materials, for reclaiming upland areas, the river valley**

and the escarpment? If not, provide a detailed rationale explaining why topsoil and subsoil materials cannot or should not be selectively salvaged and replaced.

A4.24 Suncor's approach to soil salvage and reconstruction is based on the nature of surface soils in the Boreal Forest and specifically at the mine-sites. Forest soils usually have an organic (or peaty) layer in poorly drained areas or a shallower forest litter layer in upland areas. Both overlay parent materials. By definition, topsoil and subsoil are the products of well developed soils where subsoil is referred to as the stratum beneath the biologically active surface layer known as A horizon. Subsoil generally includes parent material.

Therefore from a soil salvage perspective, it is of no advantage to attempt to separate topsoil from subsoil, because the reclamation substrates (i.e., tailings sand and overburden waste) can be considered parent materials. Suncor's strategy has been to salvage the organic layer, but with consideration of the underlying mineral overburden. For example, finer - textured overburden is excavated with the organic soil to create a "loamy" topsoil on tailings sand. This increases the soil capability for forest vegetation. Suncor is now exploring the selective handling of the shallow, upland top soils for application to overburden areas which should result in higher capabilities and effective revegetation as well.

Suncor's mine and reclamation operations involve selective handling of earth materials. For overburden dykes, more competent clay materials are used; for overburden waste dumps, similar materials, but with less stringent specifications, are used. With respect to reclamation soils, Suncor is segregating surface soils, but on the basis of above rationale. This strategy is demonstrating to achieve capability standards on the current Lease 86/17 operation and Suncor intends on continuing this practise.

For the Steepbank Mine valley, enhanced revegetation techniques are proposed to ensure rapid and effective restoration of land capabilities and other ecological values. This involves methods such as direct placement and selective handling of surface soils. These details are provided in the C & R Report.

Q4.25 **Suncor states "a detailed reclamation soils handling plan has not been developed for the Steepbank Mine because of the conceptual level of the mine plan *(Steepbank Mine Project Application, April 1996, Section D3.0, p.61)*. When will Suncor provide a detailed C&R plan for the Steepbank Mine outlining the soil salvage and handling operations for the next 10 years? Include in the plan detailed information on the location of soil stockpiles, stockpile volumes and suitability rating of materials.**

A4.25 Suncor would like to clarify the statements in Section D3.0, page 61. Suncor prepared its Steepbank Application consistent with new regulatory philosophy to streamline the approval process and to move to a regulatory process of auditable criteria.

Firstly, information requirements have differed for EUB and AEP applications for approval. The guidelines for C & R applications under AEPEA require a higher level of detail than EUB guidelines for OSCA applications. This is generally a higher level of information that is available at a "feasibility" level of project engineering which was the basis of the Steepbank Application.

Secondly, Suncor developed a format for the C & R section of the Application which follows the life cycle of a mine project with goals, guidelines and design criteria for each phase. Conceptual plans and methods were described for each phase which are intended to meet these criteria. Post-approval regulation would involve periodic audits against criteria such as revegetation percentages and soil utilization.

Suncor recognizes the above processes require further development in cooperation with industry, regulators and public stakeholders. Therefore, to ensure adequate information for both agencies in transitional stages of regulatory process change and to provide further elaboration of how IRP criteria will be achieved, a report has been prepared and referenced throughout this supplemental C & R Report.

Q4.26 Suncor provides conceptual information about the revegetation plan for the Steepbank Mine *(Steepbank Mine Project Application, April 1996, Section D3.0, pp.10,63)* Provide a conceptual land capability map depicting reclaimed lands on the Steepbank Mine (2020). Include:

a) percentages of each forest capability class, wetland areas and waterbodies.

A4.26a This information is provided in the C & R Report.

b) the distribution of each area on the reclaimed mine site and a description of their use (e.g. end land use for end pit lake 07).

A4.26b The distribution of each area of the reclaimed mine site is discussed in the C & R Report.

The end pit lake has not been discussed in detail because of the expectation that mining activities will continue after 2020. However, a final mine pit will exist at some point in the future. This end pit will evolve to an aquatic ecosystem, with drainage being the key controlling variable. The ultimate reclamation design for the end pit will be predicated by end use possibilities. Suncor proposed the development of a regional , multi-stakeholder end use planning process in the Steepbank Mine Application. One of the outcomes of this process would be the definition of end use possibilities for the end pit lake as well as other reclamation areas.

c) larger scale maps showing:

- **the area and percent of each forest type, including grasslands,**
- **the forest capability of each forest type, and**
- **the ecosystem types in the pre- and post- disturbance landscape and how they relate to each other (i.e. how do they differ?) and to the forest types.**

A4.26c This information is provided in the report entitled "Detailed Conservation and Reclamation Plan for Suncor's Integrated Mine Plan - Lease 86/17, Steepbank Mine and Athabasca River Valley."

Q4.27 Suncor describes reclamation waters in part as waters which will not be controlled through human intervention under final reclamation conditions *(Steepbank Mine Project Application, April 1996, Section D3.0, p.9).*

a) What range of precipitation and run-off conditions has Suncor evaluated in the design of the reclamation drainage system, to ensure that future erosion rates and water quality are consistent with pre-development drainage conditions and reclamation objectives?

b) Provide a summary of the evaluation methods, design parameters and results.

A4.27 The drainage systems for the reclamation scenario were designed considering precipitation and run-off conditions up to the peak mean flood (PMF) event.

The design details for the reclamation drainage plan for Lease 86/17 including precipitation and runoff conditions, evaluation methods, design parameters, and results are discussed in the reports '*Water Balance of Suncor's Mine Closure Drainage System*' and '*Reclamation Drainage Plan for Suncor's Lease 86/17*' both by AGRA Earth and Environmental.

Steepbank reclamation drainage planning followed the same basis and criteria as for Lease 86/17, with specific site details provided in the reports "*Hydrology Baseline Steepbank Oil Sands Mine*" and "*Impact Analysis Suncor Steepbank Mine EIA Surface Water and Groundwater*" both by Klohn-Crippen.

Q4.28 Suncor outlines a proposed sequence of reclamation activities, including wetlands *(Steepbank Mine Project Application, April 1996, Section D3.0, p.65).* Provide a management plan and a schedule for the provision of the following information:

a) **details supporting the viability of the wetlands proposed as part of the reclamation scheme. Include the size (average, range), number, location, water quality, water quantity and biological properties of the wetlands. Include conceptual water balances.**

A4.28a Suncor has completed a five-year research program to develop design criteria (i.e., land area requirements for treatment of various flows of mine release waters). Data from this research indicates a treatment capacity of from 4,300 to 9,000 m^3/ha/month during the open water season. This research also indicates that these treatment wetlands will be ecologically viable and self-sustaining. The biological characteristics of these wetlands and the quality of discharge water will be comparable with other natural wetlands in the oil sands area.

Suncor is continuing its study of the utility of wetlands for treatment of reclamation waters. These on-going studies will focus on evaluating the effects of reclamation waters on the ecology and sustainability of the treatment wetlands. Please refer to Question 5.4 for a schedule of various studies related to wetlands.

b) **additional details and discussion to support Suncor's claim that impacts to existing wetlands will be fully mitigated or compensated by these proposed reclaimed landscape units.**

A4.28b Most existing wetlands are low nutrient, unproductive peatlands. Therefore, the impact of increased surface flows of water, which will contain moderate levels of nutrients, into treatment wetlands will be positive in terms of biological productivity and diversity.

Q4.29 Suncor states that lands will be reclaimed to equivalent or better capability *(Steepbank Mine Project Application, April 1996, Section D3.0, p.11)*. On p.75 Suncor appears to contradict the statement on p.11 by saying trees on reclaimed lands would be expected to grow slower than on undisturbed sites. Provide further discussion, document what forest productivity/growth rates on reclaimed lands at the Steepbank Mine are expected, and compare the anticipated productivity to pre- disturbance rates. Where appropriate, be site specific.

A4.29 Suncor is committed to reclaiming its mined land to, at minimum, the standard of equivalent capability. The application of this standard takes into account the entire development area before and after disturbance and considers land uses. Therefore, it would be inappropriate to relate the productivity of vegetation on Tar Island Dyke as a measure of achievement of the capability standard.

The study referenced in Section D on page 75 of the Application has the objective of assessing the sustainability of vegetation on the slopes of Tar Island Dyke. Generally, the study indicated that current methods are resulting in sustained soil and vegetation development similar to natural ecosystems. The finding regarding the slower growth rates could be the result of study constraints. The age of certain stands of woody plants on Tar Island Dyke was overestimated because of shortage of field time. Comparison to natural stands of same age could account for the difference in growth. The other key factor could be the ground conditions in early stages of tree growth. In the early years of reclamation on Tar Island Dyke, a herbaceous ground cover was established for erosion control purposes. These conditions are still prevalent and could be inhibiting tree growth. Methods have changed to reduce this competition, however, there was insufficient woody volume to rate these areas in the study.

When comparing tree productivity to forestry standards most species on both tailing sand and overburden exceed these. For further discussion on productivity see Question 4.22.

For the Steepbank Mine, extrapolation of tree productivity begins with the overall land capability assessment. This is provided in the C & R Report referenced in this Supplemental. Overall capability will be increased for forestry use because of a better drained landscape with new soil materials. Based on Suncor's experience with reclamation of overburden structures on Lease 86/17, it is expected to achieve similar productivity to natural species with similar conditions. For the CT sites, the topography (and drainage) will be the key controlling factor related to moisture conditions. Therefore, productivities comparable to natural systems are expected.

To verify the new land capability system which is being used for this Application, further field assessment is underway. Vegetation productivity, which is an indicator of land capability achievement, will continue to be monitored routinely.

Q4.30 Suncor conceptually illustrates expected vegetation polygons at the end of reclamation *(Steepbank Mine Project Application, April 1996, Section D3.0, Figure 3.0–36)*. The future landscape appears to be simplified, in comparison to Figure 5.0–3 (current vegetation), with larger average polygon size. Provide a detailed comparison of the two landscape types (using spatial statistics and, if appropriate more detailed maps) and discuss the biological implications of the differences in complexity of the pre- and post-disturbance landscape.

A4.30 Revegetation for the footprint of the Steepbank Mine will result in changes to the balance of vegetation communities from the pre-disturbed state. The revegetation plan is based on relationships between reclaimed landscapes, soil capability, soil drainage conditions vegetation establishment over time. A discussion on the revegetation plan and implications of the differences is provided in section 4.4 of the C & R Report.

Q4.31 Suncor states that relatively small sinkholes of several tens of metres in diameter, similar to those encountered in Lease 86/17 Mine, are expected in the Steepbank Mine *(Steepbank Mine Project Application, April 1996, Section C2.0, p.25)*.

a) Confirm whether an objective of pre-production infill drilling will be to identify sinkholes, and summarize the actions which Suncor will take when a sinkhole has been identified. For example, will the existence of a sinkhole influence the materials or sequence of materials placed in a pit during reclamation?

b) Comment on the suitability of any pits underlain by sinkholes, to receive fine tailings, gypsum, coke and consolidated tailings. Summarize the containment characteristics of pits with sinkholes, as compared to pits where sinkholes are absent. Also, briefly compare the expected performance of water flows in relation to the sinkholes before mining, during operations and after reclamation of the pits.

c) **Can sinkholes provide short-circuit pathways for water from the pits to the Steepbank River or the Athabasca River?**

A4.31 Identification of sinkholes is not a direct objective of pre-production drilling. However, if sinkholes are encountered, they will be recorded on Devonian surface topography maps. Suncor will investigate sinkholes that are located beneath dykes and/or tailings ponds if have they appear to present a geotechnical and/or environmental hazard (e.g., the infill is soft and has a high permeability). However, there is currently no evidence to suggest that sinkholes on the Steepbank mine are different from those encountered on Lease 86/17 where sinkholes have created no issues.

Sinkholes on Lease 86/17 are generally infilled with dense, low permeability materials which do not pose a settlement hazard and do not provide a pathway for concentrated flow of fluids into the Devonian limestone. None of the sinkholes encountered on Lease 86/17 have been infilled with oil sand, suggesting that the age of the sinkholes/infill is pre-Cretaceous and that the process of sinkhole development in the area may have ceased.

Because the sinkholes encountered to date have presented no geotechnical or environmental risk, the presence of the sinkholes has not influenced the materials or sequence of materials placed in pits or tailings ponds, nor has it influenced the types of materials placed within the ponds. The containment characteristics of ponds with sinkholes (Pond 5) appear to be the same as those without (Pond 2/3). Continued monitoring will be carried out to confirm this.

Sinkholes with permeable infills could provide a pathway from a tailings pond to fractures within the limestone which could then flow into the Steepbank or Athabasca river. However, Suncor's experience to date suggests that sinkholes may actually provide more of a 'plug' in the limestone rather than a pathway due to the low permeability of the infill materials.

Q4.32 Discuss conceptual final reclamation plan following completion of the Steepbank mine. Discuss plans for the bridge and comment on the volume, disposition and reclamation of fine tails that would remain at the conclusion of mining.

A4.32 The Steepbank Mine has been defined as a 20-year mine plan. The Application has depicted the "continue-mining" scenario because of the likelihood of proceeding beyond 2020. This scenario has the entire mining area being backfilled with overburden and CT material and with final reclamation treatment beyond 2020.

If mining ceases in 2020, Pond 7 would be backfilled with CT to final design elevation and reclaimed. Pond 8 would be backfilled to a lower-than-design elevation. These elevations and layouts can be referenced in Figure C3.0-15 of the Application. This would result in an "end" pit which would evolve to an aquatic ecosystem with drainage being the key controlling variable. The final design for the end pit would be dependent on end use possibilities for which Suncor is proposing a regional, multi-stakeholder planning process.

Regarding the bridge, the ultimate disposition will be determined with regulators and other regional stakeholders. Public use or decommissioning are the obvious options; however, Suncor believes resolution of bridge disposition is a future consideration.

Coke Handling and Storage

Q4.33 Suncor indicates a 40 % increase in coke production due to planned increases in plant production *(Steepbank Mine Project Application, April 1996, Section C7.0, p.104)*. Suncor also states that it "is evaluating the transfer of coke after 1999 to a site yet to be determined." *(Steepbank Mine Project Application, April 1996, Section B1.0, p.14)*.

a) **Describe how the change in coke production will affect the maximum capacity of the coke stockpile, which is expected to be exceeded in 1999.**

b) **Provide a detailed schedule and plan for coke disposal.**

c) **Provide a detailed schedule and plan for reclamation if the coke stockpile remains on site.**

A4.33 The change in coke production, as a result of increased production rates, will utilize the maximum capacity of the coke stockpile by the end of 1999. Consistent with Suncor's long term commitment to oil sand development, the coke stockpile will be managed to meet environmental objectives in the current location.

Suncor's primary objective in long term disposal is to develop an economical use for coke. Although a market for the by-product has not developed, discussions with prospective customers are ongoing.

Once the existing stockpile capacity is reached, Suncor proposes to dispose of the coke by pumping it in a slurry form for inclusion in the consolidated tailings stream. The coke stockpile would be removed once a market develops, resulting in temporary storage capacity. Coke disposal within the tailings stream would cease until the coke stockpile capacity was reached again.

If there is no possibility of marketing or economically utilizing the stockpiled coke, the stockpile will be reclaimed in place subject to the development of an environmentally acceptable long term reclamation plan. The coke stockpile will be disposed of with the tailings stream in the event that a manageable long term reclamation plan is not possible.

Infrastructure and General Information

Q4.34 Suncor states that it will work with Alberta Transportation and Utilities and the Regional Municipality of Wood Buffalo to address any Highway 63 issues related to the Steepbank Mine project *(Steepbank Mine Project Application, April 1996, Section E3.0, p.26)*. Provide more information as to Suncor's plans to improve overall safety and operational concerns at the Highway 63 intersection. This should include a detailed design and estimated turning movements for the intersection. Indicate the timing for plan implementation and confirm Suncor's responsibility for the costs associated with the improvements, including engineering and design.

A4.34 Suncor has held discussions with Alberta Transportation regarding the access road intersection with Highway 63. It is Suncor's understanding that the intersection meets Alberta Transportation guidelines for current traffic volumes. The increase in traffic due to the Steepbank operation is low, therefore, a change to the intersection based on traffic volumes is not warranted.

This assessment was provided to Alberta Transportation in a letter to Mr. Jim Der, dated July 15, 1996.

Q4.35 Suncor states that the limit of mining will be well above the 1:100 year flood level *(Steepbank Mine Project Application, April 1996, Section A2.0, p.10)*. Provide a more detailed contour map (1:20,000 scale) and cross sections through the escarpment area showing the proposed limit of mining in relation to the water and ice flood levels. In addition, advise whether Suncor expects to add provisions for flooding contingencies to its emergency response plan, before excavating close to the flood elevation.

A4.35 A contour map showing the flood contours in relation to mining boundaries and facilities siting is provided in Figure 1-1. Cross sections through the escarpment area are provided in Figures 4.5-1 to 4.5-3. These figures show that all mining activity, shaded in green, is well above the flood plain.

Suncor will revise the emergency response plan to include Steepbank operations prior to commencing operations. This will include the potential for flooding.

Q4.36 Suncor outlines mitigation plans to protect aquatic habitats and water quality *(Steepbank Mine Project Application, April 1996, Section A4.0, p.33)*. Provide additional details to show how the physical habitat impacts resulting from construction of access roads, barge facilities or placement of the bridge piers will be mitigated.

A4.36 All access roads will be subject to a 100-metre setback from the Athabasca and Steepbank Rivers. No runoff from access roads will be diverted directly to the rivers. Other than the Athabasca River crossing, no access roads will cross fish-bearing watercourses. As noted on pages 69 and 70 of the report "Impact Analysis of Aquatic Issues Associated With the Steepbank Mine," erosion control measures will be implemented on a site-specific basis, and where appropriate, the following measures would be used: restoration of vegetation by seeding and mulching techniques; check dams and ditch blocks; diversion ditches discharging to vegetated areas; filtering permeable berms; siltation ponds, sediment traps or sumps; gravel paving or riprapping; synthetic material liners; drop structures; and, parabolic or trapezoidal channels instead of v-ditching. For cut and fill slopes of approach roadways, erosion control measures such as the following will be used: step backslopes and sideslopes; seed and mulch backslopes and sideslopes; construct berms at tops of cuts to redirect surface drainage; construct interceptor channels or diversion channels on cut slopes; scarify and compact slopes to increase roughness; and, use of erosion control measures in channels as identified above.

In reference to bridge construction, more details are available on proposed construction techniques and likely impacts. Also, please note that there was an error in the *Aquatic Impact Analysis* in the reporting of habitat loss due to the bridge. The actual loss of habitat resulting from bridge construction is 0.65 ha, rather than the 6.5 ha originally reported.

The actual habitat loss at the site of the abutments and piers, as determined from the detailed bridge design specifications, will be 1.4 ha. This is slightly greater than for the original assessment of 0.65 ha but is still only a small portion (approximately 0.18%) of the total habitat available in the Steepbank Mine section of the Athabasca River.

The potential for sediment loading would be reduced significantly as a result of the present bridge design, in which concrete piers are replaced with large diameter piles that are driven directly into the river substrate, using marine equipment. No cofferdams would be required for either the pier or abutment construction. The abutments will be created by the direct application of clean aggregate (3 to 6% fines). If working berms are required (possibly for piers one and four), the working berms will also be constructed from the clean aggregate. The aggregate would not be end-dumped into the river, but would be stock piled and bulldozed into the river, to minimize exposure to scour. The initial loading surface for the aggregate will be maintained close to prevailing water elevation, to reduce momentum and associated mixing of aggregate with the water column. The leading edge of the abutments/working berms would be constructed first, such that the majority of the aggregate is placed in slow-moving water. Instream construction activities will be monitored, and if the criterion of 10 mg/L TSS above background is not met at a distance downstream as agreed upon by the regulatory agencies and Suncor, additional mitigation will be pursued. This would include the placement of a riprap weir in front of the abutments/working berms, to direct flow away from these structures. Silt fences may also be installed, if feasible.

All instream works would comply with restrictions on instream construction activities as identified by Fisheries Management Division.

The abutments will be protected with Class 1 riprap. Class 1 riprap will also be applied to the approach slopes to elevation 242 m, which is about 7 m above mean water elevation. Above this elevation, the approach slope will be 2 (horizontal) to 1(vertical), which meets the guidelines for unprotected bridge headslopes.

Q4.37 Suncor indicates that storm water retention ponds will be constructed ***(Steepbank Mine Project Application, April 1996, Section C3.0, p.50 and Figure 3.0–22).*** **Provide the above-ground storage volumes of the retention ponds.**

A4.37 The design of the retention basins will be completed as part of the detailed mine drainage plan. However, the basins are planned to be below grade as much as possible. Where above grade retention is required, the berms surrounding the basins will be designed and constructed in accordance with Canadian Dam Safety guidelines with provision for adequate freeboard, crest width, etc. Suncor will obtain AEP Dam Safety approval for any retention basin with above grade retention volume in excess of 50 acre-feet or any retention berm in excess of 25 ft. in height.

Q4.38 Suncor discusses spill prevention in relation to pipelines and the Athabasca River bridge ***(Steepbank Mine Project Application, April 1996, Section C3.0, p.60 and Section C4.0, pp.69-71).***

a) Provide details on the "catchment structure" at the expansion joints.

A4.38a The design of the catchment structure has not been completed at this time. However, the bridge is designed as a continuous structure and will require expansion joints only at the abutments. Conceptually, open tanks will be located under the bridge deck at each joint near the abutments. Spill material and runoff will drain to these tanks for transfer to a holding pond (all by gravity flow). The design of these tanks will ensure the containment of the contents of the largest single pipeline rupture. The holding ponds will have a larger capacity.

b) Provide information on how the bridge containment system will be tested.

A4.38b As a matter of policy, Suncor conducts a hazard-operability assessment of any new or modified designs. Based on this assessment, testing will be recommended.

c) How would leaks or spills be detected from the diesel line under the deck?

A4.38c The diesel line design has been relocated to the pipeline corridor on the bridge deck. Spill detection is addressed in Section 9.2(a) of this Supplemental.

d) How will possible tanker truck ruptures on the bridge be contained?

A4.38d The road component of the bridge deck is being designed to highway standards. Given the nature of vehicular traffic expected, Suncor believes upgraded standards are not warranted.

The main vehicular traffic expected on the bridge include: light vehicles, mining equipment, and material truck-trailers. Vehicles with tanks would be limited to mine fuel trucks and vacuum trucks. Any such vehicles would be equipped with the safeguard s required for regular highway transport.

Q4.39 Suncor describes wastes and waste management plans in general terms in the application *(Steepbank Mine Project Application, April 1996, Section C8.0, pp.121-123 and Section D1.0, p.1).* Provide the following additional information:

a) In a Table, document the types and amounts of each solid waste and hazardous waste stream which will be produced by the mine development and processing of oil sands.

b) Identify any differences between the proposed waste streams (quantity or composition) and existing waste streams from the Suncor operations.

c) Classify each waste stream according to the Waste Control Regulation.

A4.39 The waste system streams associated with the Steepbank Mine will generally be comparable to the existing operation. The following table provides the waste stream and volumes, any anticipated changes, and the classification. The scope of this estimate includes the field mining activities, from overburden removal to delivery of ore to the Extraction Plant, and the maintenance shops. The hydrotransport plant operations are not expected to generate new or significant waste streams. The table combines crude estimates and qualitative guesses of changes.

Table Q4.39-1 - Steepbank Waste Streams

Waste Name	1995 Generation Rate	Hazardous (yes/no)	Waste Class	Changes
used lead acid wet cell batteries	600/year	yes	8	slight increase
used oil	770m^3/year	yes	9.3	same*
used oil filters	15,000/year	yes	9.3	same*
spent aerosol cans	5000/year	yes	2	possible decrease**
spill and leak debris				
- flammable solvents	small and variable	yes	3	same
- corrosives	small and variable	yes	8	same
- other TDG regulated substances	small and variable	yes	variable	same
used tires	400 (off-road)/ year	no	NR	same*
	50 (road-size)/ year	no	NR	same*
general refuse	15,000m^3/year (uncompacted)	no	NR	same

* for 10 year Approval Period (1996 - 2005) rates expected to be about the same, with slight increases later due to increased mining equipment fleet.

** could anticipate new products shift

Q4.40 Suncor describes the Lease 86/17 Lease reclamation drainage scheme *(Steepbank Mine Project Application, April 1996, Section D3.0, p.57)* and indicates that, after reclamation, there will be three to four times as much water going down Poplar Creek as there is currently. There is a significant amount of erosion currently occurring east of Highway 63 bridge over Poplar Creek. Will the proposed drainage reclamation scheme address the current erosion condition and the potential for increased erosion as flow rates increase? What fisheries habitat will Poplar Creek have after reclamation (consider physical and chemical characteristics)?

A4.40 The base flow in Poplar Creek (i.e., runoff from the Poplar Creek Basin) in a year of average precipitation is about 0.5 m^3/s. Currently there is about 3 times this flow in the lower reaches of Poplar Creek due to the realignment of Beaver Creek. This volume will increase to about 4 times the base Poplar Creek flow following reclamation (see Tables 7.6 to 7.10, Node 14, in the AGRA report '*Water Balance of Suncor's Mine Closure Drainage System*).

Although both Suncor and Syncrude have developed conceptual reclamation drainage schemes, Suncor proposes that detailed drainage planning on a regional basis be conducted through a multi-stakeholder regional planning process. This has been suggested for end use planning in Section D of the Application. Poplar Creek issues could be addressed through this planning process.

Habitat

Q4.41 Suncor discusses plans for wildlife migration mitigation in relation to the access corridor *(Steepbank Mine Project Application, April 1996, Section A4.0, p.31 and Section C4.0, p.68)*. Provide specifications on the wildlife corridor under the east bridge access and an assessment of its effectiveness to provide wildlife movement through the river valley, particularly in light of other infrastructure in the immediate area such as the primary substation.

A.4.41 The wildlife bypass included in the design for the east abutment consists of a 7 metre wide pathway at elevation 237 ASL above the mean water elevation of 235.2 metres. Vegetation cover will be planted on both approaches to the bypass as well as on the segment of the bypass under the bridge deck. This will permit wildlife to move under cover throughout the length of the bypass as discussed in Questions 4.5 and 10.1(a). Potential use of a north-south corridor by wildlife will be reduced from current low levels. Impacts to wildlife are discussed in section 4.5 of the C & R Report.

Q4.42 Suncor illustrates the expected changes in habitat *(Steepbank Mine Project Application, April 1996, Section E6.0, Fig. E6.0–2)*. In this figure, the expected decline in regional furbearer habitat does not appear to be explained in, or supported by, the discussion in the text.

a) Discuss and resolve this difference.

b) Provide a revised figure with more specific and descriptive categories (e.g. "woodland birds" or "semi-aquatic furbearers").

c) Reference this information to projected ecological land classification maps or reclamation plans, or provide additional maps showing where the reclaimed excellent, good and moderate habitat would be located and how the new scenario compares with existing conditions.

A4.42 A re-examination of the Cumulative Vegetation Impact Assessment indicates that the amount of furbearer habitat in the Regional Study Area will decline very slightly from 1995 to 2020. It is expected that the amount of "excellent" furbearer habitat will decline from approximately 87,000 to 83,000 ha, a decline of 4%, while the area covered by "good" habitat will decrease from 415,000 to 406,000 ha, a decline of only 2%. In contrast, the analysis indicates that the amount of "moderate" habitat would increase from 163,000 to 173,000 ha, an increase of 6%. With consideration of these three habitat classes together, the amount of furbearer habitat in the study area declines by about only 0.4% (from 665,000 to 662,000 ha) between 1995 and 2020. Thus Figure E6.0-2 from the Application was incorrect.

The breakdown of available habitat types, terrain types and furbearer habitat class for

1995 and 2020 is provided in the table below. The data shows an overall decrease in habitat availability for furbearers between 1995 and 2020 of less than 0.01%. Additionally, the breakdown of habitat available for furbearers reveals little change in relative ELC availability during the 1995 and 2020 period.

Map V2, within the C & R Report , provides the areas and locations of vegetation classes associated with the reclamation structures on the Steepbank Mine. Pre-development vegetation classification areas and locations are provided on Map V1 in that document.

Table Q4.42-1 - Cumulative Changes to Furbearer Habitat

Vegetation Class	**Total Area**	**Riparian**	**Escarpment**	**Upland**	**Furbearer Habitat**		
					Excellent	**Good**	**Moderate**
1995							
Closed Jack Pine	29119	1456	1456	26207			29119
Closed White Spruce	43728	2186	2186	39355		43728	
Closed Deciduous Forest	78738	3937	3937	70864	3937	3937	70864
Closed Mixedwood	62530	3127	3127	56277			62530
Closed Mixed Coniferous, Black Spruce Dominant	86989	4349	4349	78290	82640		
Peatland: Closed Black Spruce Bog	42494	2125	2125	38245		40369	
Peatland: Closed Black Spruce - Tamarack Fen	50720	2536	2536	45648		48184	
Closed Mixedwood, White Spruce Dominant	129594	6480	6480	116635		129594	
Peatland: Black Spruce Tamarack Fen	80554	4028	4028	72499		76526	
Peatland: Open Tamarack Fen	57951	2898	2898	52156		55053	

Wetland Shrub Complex	272960	13648	13648	245664			
Disturbed/ Herb-Grass	18073	904	904	16266		18073	
TOTAL					86576	415465	162513
GRAND TOTAL							664555
2020							
Closed Jack Pine	26551	1328	1328	23896			26551
Closed White Spruce	23151	1158	1158	20836		23151	
Closed Deciduous Forest	95640	4782	4782	86076	4782	4782	86076
Closed Mixedwood	60383	3019	3019	54345			60383
Closed Mixed Coniferous, Black Spruce Dominant	82409	4120	4120	74168	78289		
Peatland: Closed Black Spruce Bog	38513	1926	1926	34662		36587	
Peatland: Closed Black Spruce - Tamarack Fen	48882	2444	2444	43994		46438	
Closed Mixedwood, White Spruce Dominant	110858	5543	5543	99772		110858	
Peatland: Black Spruce Tamarack Fen	79030	3952	3952	71127		75079	
Peatland: Open Tamarack Fen	57315	2866	2866	51584		54449	
Wetland Shrub Complex	263311	13166	13166	236980			
Disturbed/ Herb-Grass	54477	2724	2724	49029		54477	
TOTAL					83071	405821	173010
GRAND TOTAL							661902

Q4.43 Suncor addresses the impact of the Steepbank Mine project on local and regional biodiversity *(Steepbank Mine Project Application, April 1996, Section E6.0, p.55)*. Describe the nature and degree of the reduction in biodiversity. If possible, be site specific. Explain how the reclamation plan for the Steepbank Mine project supports the goals of the Canadian Biodiversity Strategy.

A4.43 The Steepbank Mine development impacts to biodiversity were discussed in the report *"Impact Analysis of Terrestrial Resources Associated with the Steepbank Mine"* (Golder 1996, pages 89 - 109). Reclamation plans for the disturbed areas are designed to ensure re-establishment of biodiversity through terrain and drainage modification; surface soil salvage and reconstruction; and enhanced revegetation techniques. The C & R Report describes in more detail the methods for reclamation of the Steepbank site.

Q4.44 Suncor discusses anticipated changes to aquatic habitat and associated reclamation plans *(Steepbank Mine Project Application, April 1996, Section E8.0, pp.76,77).*

a) What effects are anticipated in Wood Creek due to increased flows and what mitigative measures are to be undertaken to minimize the effects (i.e. erosion)?

A4.44a The mine drainage plan has been amended, primarily to protect the wetland values in Shipyard Lake. As a result, there will be no changes to the discharges in Wood Creek. Flows from Leggett Creek will be routed to Shipyard Lake, to maintain the quality and quantity of water in the wetland. Likewise, flows from Unnamed Creek will also be routed to Shipyard Lake; any excess water from the unnamed creek drainage that is not required to maintain Shipyard Lake will be routed to the outlet channel of Shipyard Lake. Further discussion on issues associated with aquatic habitat changes associated with the Steepbank Mine are discussed in Section 4.2 of the C & R Report.

b) Comment on the potential for Leggatt and the unnamed creeks to be reclaimed to support a sport fishery.

A4.44b Neither of these creeks presently support a sport fishery. As these creeks will be totally reconstructed during the reclamation phase, there would be no difficulty in designing and constructing a creek or creeks that provide fish habitat.

c) Provide the results of the 1996 fisheries habitat study, which we understand has identified potential pike spawning sites in Shipyard Lake and the unnamed creek.

A4.44c The report entitled, *"Addendum to Suncor Steepbank Mine Environmental Impact Assessment: Spring 1996 Fisheries Investigations,"* (Golder 1996) has been completed and is available on request.

5 WATER RELEASE

Discharge and Treatment Methods

Q5.1 Suncor states that using consolidated tailings (CT) technology will result in the need to discharge tailings release water to the environment. Suncor intends to apply for approval to discharge this stream following the completion of treatment technology evaluations, but before expected storage capacity is exceeded. Suncor will ensure that treated water quality is environmentally acceptable and meets regulatory standards *(Steepbank Mine Project Application, April 1996, Section D2.0, p.3 and Section D3.0, pp.48,50).*

a) If a future application for CT wastewater release was not approved, what options would be available to Suncor? Will Suncor be providing alternative approaches to releasing CT wastewater?

b) Discuss the potential for recycling CT wastewater, indicating known and possible constraints to the complete recycling of CT wastewater and the studies that are underway and contemplated to address these constraints.

c) AEP policy (as substantiated in Oil Sands Water Release Technical Working Group) requires secondary treatment of process affected waters. Thus, even in the absence of projected water quality impacts, it is expected that some form of secondary treatment will occur on any CT release waters in the future. Suncor has not been explicit in its commitment to this principle, although it has recognized that some form of treatment "may" be necessary to prevent impacts. Does Suncor understand and is Suncor committed to this requirement?

A5.1 In Section D3.4.4 Site Water Management, on page 37 of its Steepbank Mine Application, Suncor has discussed the problem of the accumulation of water inventory well beyond process requirements from about 25 MCM today to about 130 MCM. This increase in inventory is a temporary problem driven by consolidation of what are now fine tailings deposits. Once the existing inventory has been consolidated, around the 2020 time frame, a further increase in inventory is not anticipated. Storage of this excess water on site is not feasible due to the cost of construction of containment facilities as well as being inconsistent with dry landscape reclamation. Two strictly hypothetical base cases were examined to show that management of this temporary problem is possible:

1) reducing intake from the River by about 50%, or
2) discharging about 20% of the CT release water, the remaining 80% being used for recycle.

As discussed in Section D3.4.4, reducing river water intake by about 50% leads to no net accumulation of water inventory. This would imply full recycling of all CT release water. The CT release water will have the chemical signature of the FGD and CT processes. The concentration of some dissolved species in the release water are forecast to rise to levels of concern under these full recycle conditions, based on modelling from FGD pilot plant data. Magnesium accumulation may impact extraction performance, and further investigation of the tolerable level of magnesium is under investigation. Sulphate is also forecast to rise above 2000 ppm. The threshold level of concern for sulphate is under investigation both from an environmental and operation perspective.

The most significant unknown in this discussion is the actual chemistry of the FGD gypsum stream. This chemistry will be determined by the amount of dissolvable components in the local limestone used in the FGD process, plant process factors and the amount of water trapped in the sediment in the FGD clarification pond. These factors will be investigated thoroughly once the FGD plant is in operation, with expected startup in August 1996.

Suncor will actively investigate all options to use or reuse this water to the maximum practical extent within the plantsite prior to an application for discharge. It is Suncor's desire that all interested parties be fully involved in the findings from these investigations. It should be noted that there is sufficient time prior to the 2000 time frame for the required decision on this issue to conduct a careful and reasoned investigation and discussion of this issue. If, in the end, it is Suncor's decision to apply to discharge a portion of the CT release water, Suncor will be committed to meeting all policy requirements. A number of options for treatment have been outlined in the Application. Selection of the best technology for water treatment must wait until the chemistry of both the Flue Gas Desulphurization gypsum and the CT release water are defined through actual sample analysis. It is anticipated that mid-1997 would be the earliest that these values can be defined adequately.

Effects Assessment

Q5.2 Suncor indicates that effluent discharges from pulp mills, municipalities and Syncrude have been considered in the analysis of water quality. Explain how Suncor's calculations and predictions take these other discharges into account, and confirm whether the methods and results account for future releases from other oil sands developments. What assumptions were made? For instance, was any increase of contaminants considered from Syncrude?

A5.2 The calculations and predictions of future water quality conditions in the Athabasca River are explained on p. 37-38 of the report entitled *Impact Analysis of Human Health Impact Issues Associated with the Steepbank Mine*.

" upstream developments are accounted for directly by measuring water quality in the Athabasca River immediately upstream of Suncor. Both Solv-Ex and Syncrude's proposed Aurora mine are located on the opposite side of the river from most of Suncor's discharges, so they will not contribute to increased concentrations within Suncor's mixing zone (where maximum in-stream concentrations are expected). Release water associated with reclamation from Syncrude's existing leases may contribute an additional load to the Athabasca River from the old Beaver River channel, and this extra load was accounted for in the simulation of post-reclamation conditions"

The same modelling assumptions were used for evaluating both human health and aquatic impacts, so the above statement holds for the Aquatics assessment. We have assumed that future water quality conditions in the Athabasca River would not decrease from historical conditions.

The analysis accounts for future releases from oil sand development and inputs from Syncrude are described on p. 93 of the report entitled *Impact Analysis of Aquatic Issues Associated with the Steepbank Mine*:

" Syncrude's reclamation of existing mines involves construction of end-pit lakes. The water quality of these lakes is expected to develop over time to moderately productive lakes comparable to natural lakes in the region. Water quality in the lakes will be suitable for sensitive aquatic biota within a few years following capping, and prior to any release from the lake to the Athabasca River. Hence, discharge is not expected to add a significant source of load to the Athabasca River; even so this source of water was incorporated into the future water quality projections. Presently, no information is available on water releases from Syncrude's proposed Aurora Mine. Thus, potential contributions to cumulative impacts from the Aurora Mine are not included in this assessment. They will, however be assessed as part of the Aurora Mine EIA."

These assumptions are further defined on pages 25-26 of *Impact Analysis of Human Health Impact Issues Associated with the Steepbank Mine.*.

Q5.3 Suncor stated that "..Since future chemical concentrations in water releases to the Athabasca River are predicted to be lower than current conditions, future populations of fish should continue to be healthy" *(Steepbank Mine Project Application, April 1996, Section E8.0, p.7).* Provide further documentation to support this statement.

A5.3 This statement is out of context in the summary of fish health assessment provided in Section E. A more complete description is given on pages 87-91 in *Impact Analysis of*

Aquatic Issues Associated with the Steepbank Mine. In that report, it is concluded that under worst-case conditions (Year 2020 which is expected to have the highest loads of most chemicals), no adverse effects on fish are anticipated. The above statement was meant to refer to expected conditions following 2020 and is inappropriate. More appropriate wording is given on p. 90 in 87-91 in *Impact Analysis of Aquatic Issues Associated with the Steepbank Mine*:

"In post-reclamation conditions, concentrations are much lower than in 2020 (Figure F3.0-10). All concentrations are well below the NOEL. Thus, no effects on fish populations would be expected in post-reclamation conditions"

Q5.4 Provide a table of all water related studies that are ongoing and proposed, giving scope, start and completion dates.

A5.4

Table Q5.4 - Aquatic Studies

Project	Scope	Completion Date
Fish Health and Tainting Study for Wastewater Treatment System Discharge Waters	• Evaluate potential health effects in fish exposed to different concentrations of Wastewater Treatment System discharge waters • Evaluate tainting and depuration of fish exposed to concentrations of Wastewater Treatment System discharge waters	1996/09/30
Spring Aquatics Study for Unnamed, Leggett and Wood Creeks, Shipyard Lake and Horseshoe Lake	• Document habitat quality and quantity in Unnamed Creek that drains into Shipyard Lake, the outlet of Shipyard Lake, Leggett Creek and Wood Creek • Document fish utilization of these streams plus Shipyard and Horseshoe Lakes, particularly with respect to sport fish usage	1996/07/19
Effects of CT Release Waters on Aquatic and Terrestrial Plants	• Assessment of the impacts of CT release waters on the sustainability of aquatic and terrestrial plants • Preliminary assessment of impacts to wetlands zooplankton, phytoplankton and benthic invertebrates	1996/12/31

Salt Tolerance of Reclamation Plant Species	• Evaluate the effects of consolidated tailings waters on different woody stemmed plant species	1996/09/30
Phytotoxicity of Reclaimed Fine Tails and Tailings Sands	• Evaluate the phytotoxicity of soil enriched in consolidated tails and consolidated tails release waters on plant species of the boreal and subboreal forests	1996/12/31
Plant Metal Uptake from CT and Other Tailings	• Monitor the performance of different plants species grown in different oil sands fine tailings and consolidated tailings under various treatment conditions • Evaluate the uptake of metals by the above plants during their second growth season	1996/12/31
Environmental Dynamics of Base/Neutral Compounds	• Year two of a three year study to determine the relative rates of biodegradation of nine PAH model compounds in the laboratory	1997/12/31
Preliminary Studies on Immune Function Assays in Tree Swallows and Mallard Ducks	• Development of techniques to study immune function in Tree Swallows and Mallard; these techniques will be employed in future assessments of ecological effects within wetlands treating oil sands wastewaters	1996/12/31
Use of Constructed Wetlands to Treat Oil Sands Wastewaters	• Establishment of a reference plant community structure as well as baseline values and exposure experiments for fish within wetlands systems to be included in a proposed two year ESTAC project (to commence in 1997)	1998/12/31

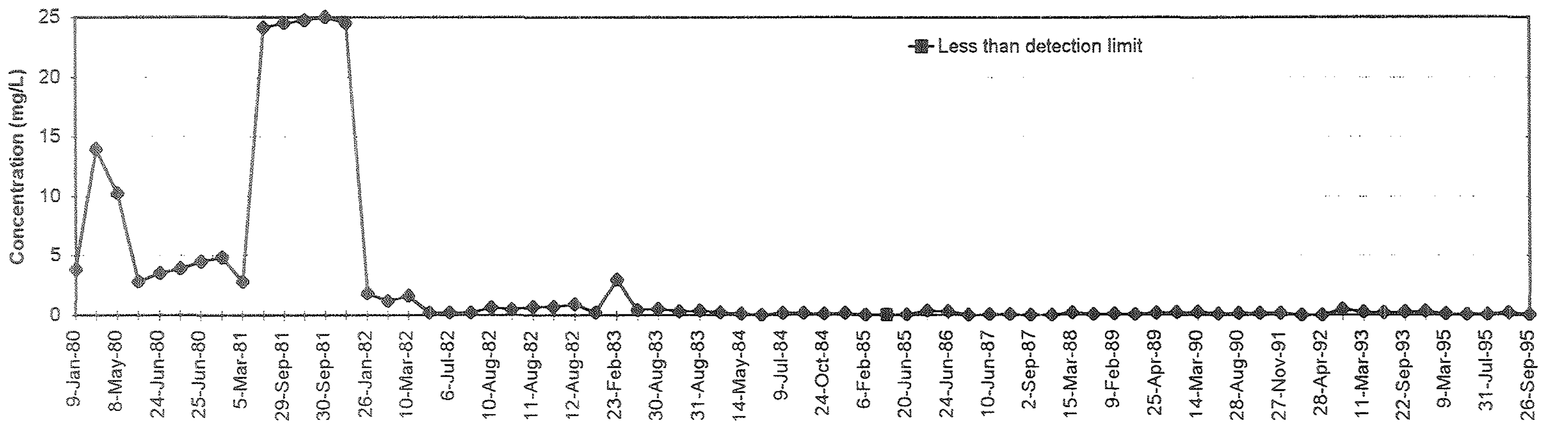
Q5.5 Provide time series graphs of wastewater concentrations/loadings for ammonia, chromium, copper, and cyanide *(Athabasca River Water Releases Impact Assessment, May 1996, p.23).* Table 4.1–3 could not be located as referenced. What plans does Suncor have to monitor these substances in the future?

A5.5 Time series graphs of wastewater concentrations for ammonia, chromium, copper and cyanide are shown in Figures 5.5-1, 5.5-2, 5.5-3 and 5.5-4, respectively. Table 4.1-13 was incorrectly referenced. The correct reference is Table VI-11.

Chromium and copper are monitored quarterly from the wastewater outfall as part of

Figure 5.5-1

Total Ammonia Concentrations in Suncor's Wastewater System



Total Ammonia Loads from Suncor's Wastewater System

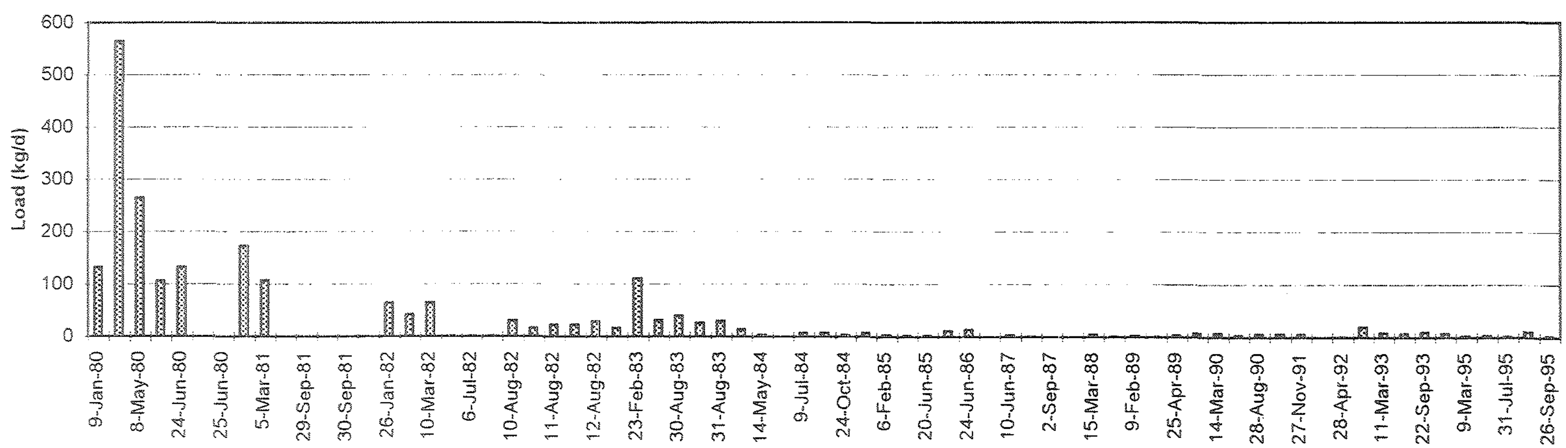
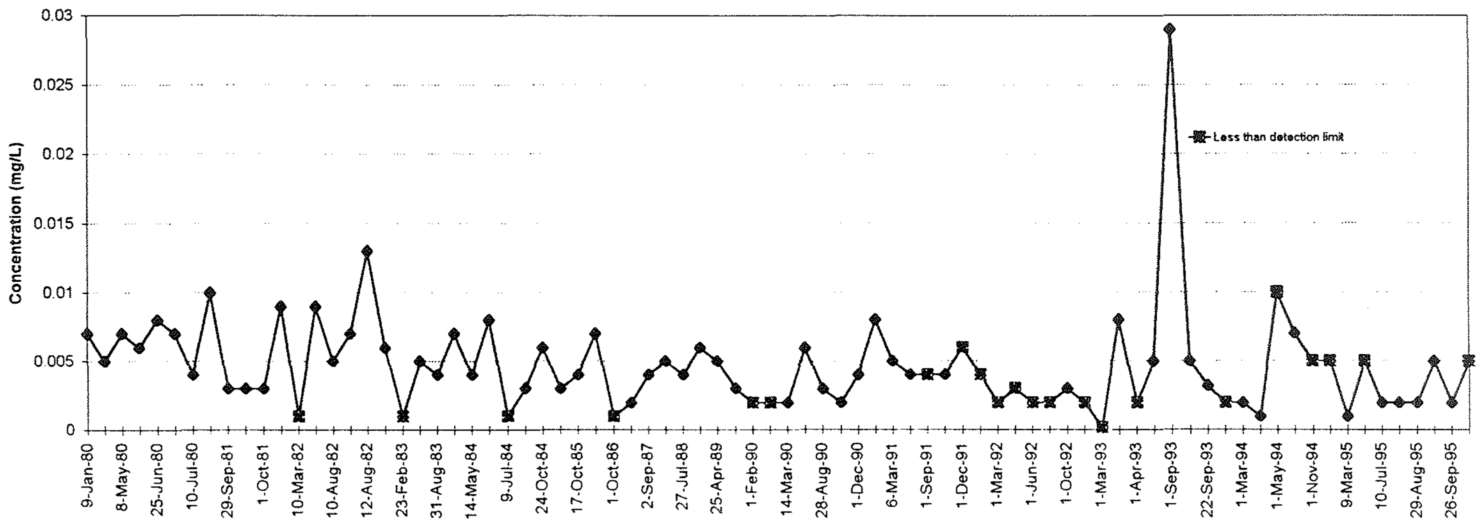


Figure 5.5-2

Chromium Concentrations in Suncor's Wastewater System



Chromium Loads from Suncor's Wastewater System

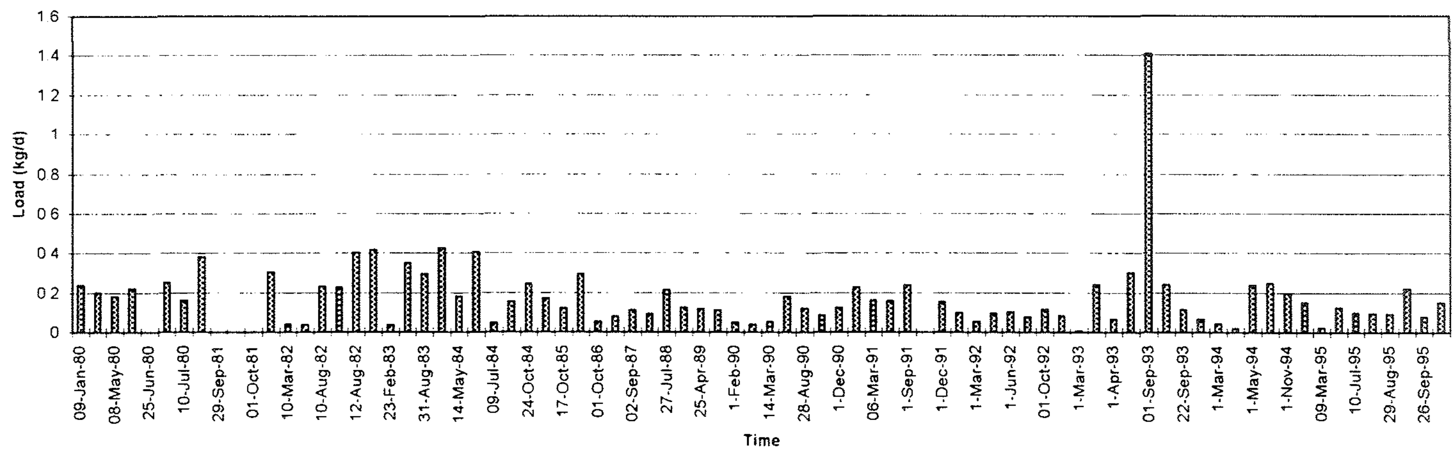
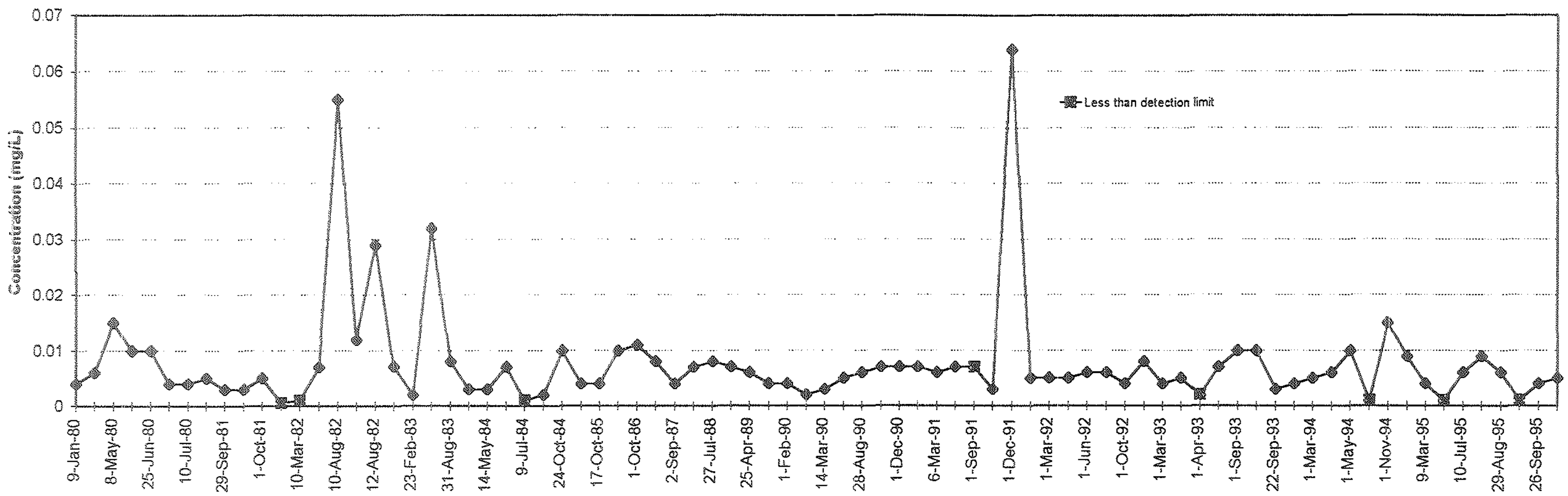


Figure 5.5-3

Copper Concentrations in Suncor's Wastewater System



Copper Loads from Suncor's Wastewater System

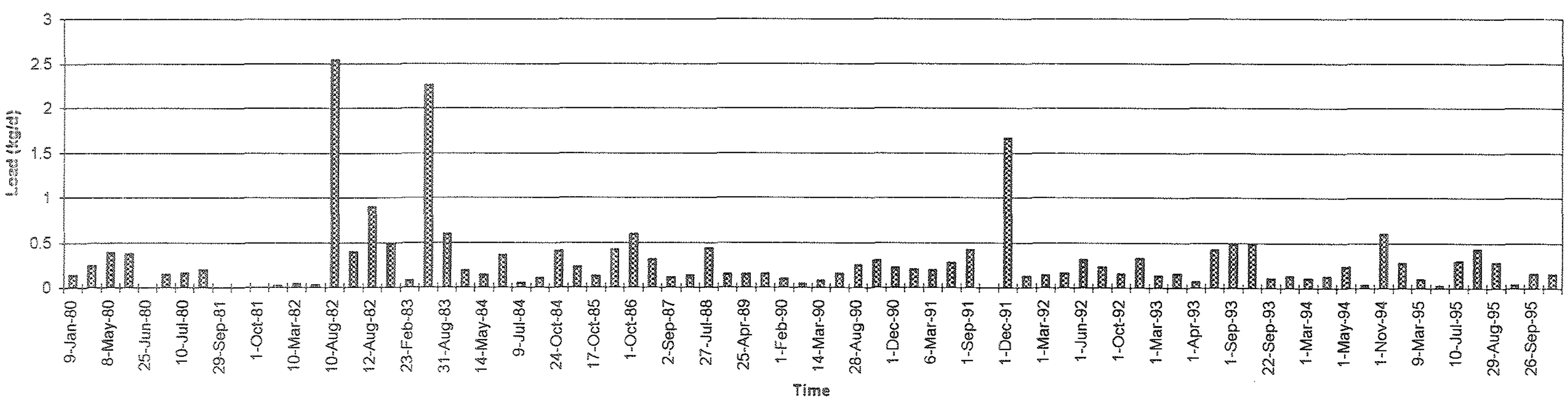
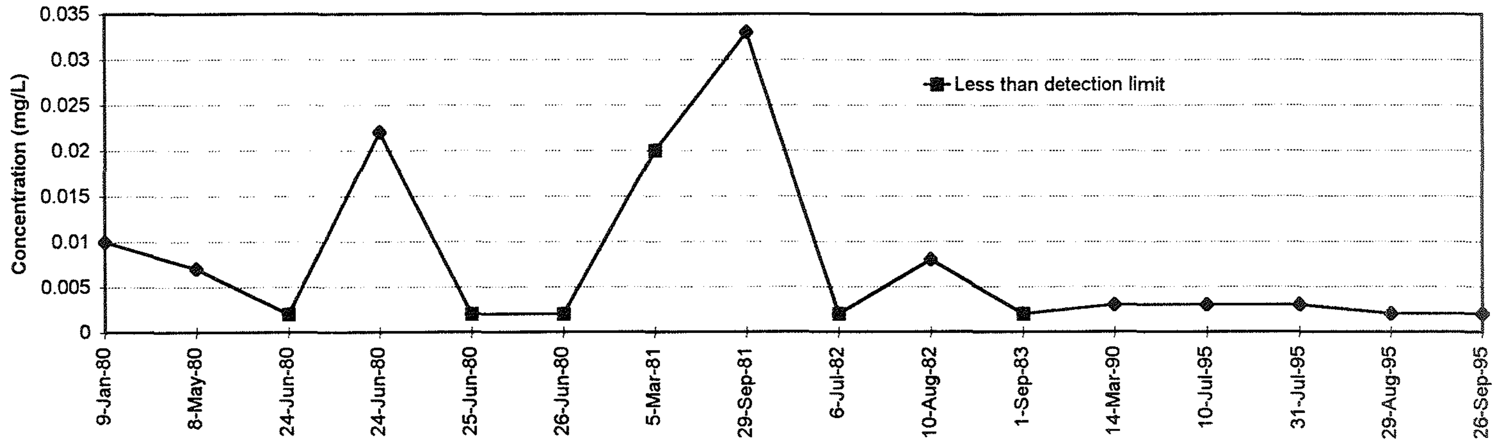
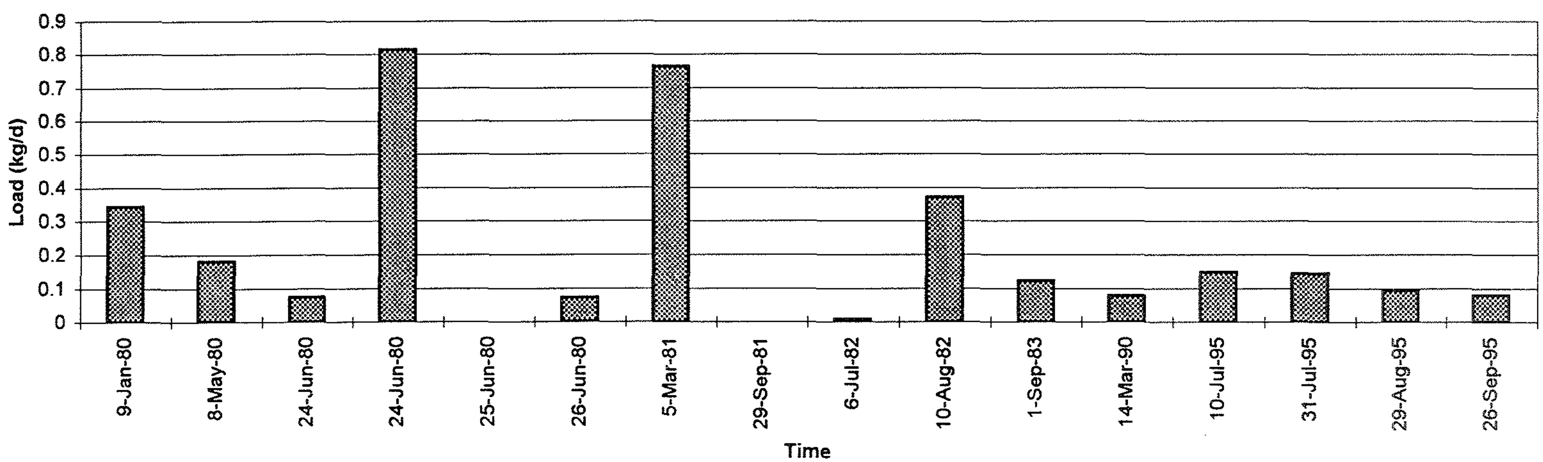


Figure 5.5-4

Total Cyanide Concentrations in Suncor's Wastewater System



Total Cyanide Loads from Suncor's Wastewater System



Suncor's Approval NO. 94-01-00. Ammonia is monitored daily. Cyanide is monitored as part of special studies or investigations. A detailed environmental monitoring program is under development to confirm EIA predictions and to assess potential impacts associated with water releases from Suncor's existing and proposed operations. This program will be developed with stakeholder input and is expected to be finalized by September 30, 1996.

Q5.6 Provide time series graphs of wastewater concentrations/loadings for aluminum, mercury, phenols, molybdenum, and strontium *(Athabasca River Water Releases Impact Assessment, May 1996, p.23)*. What plans does Suncor have to monitor these substances in the future?

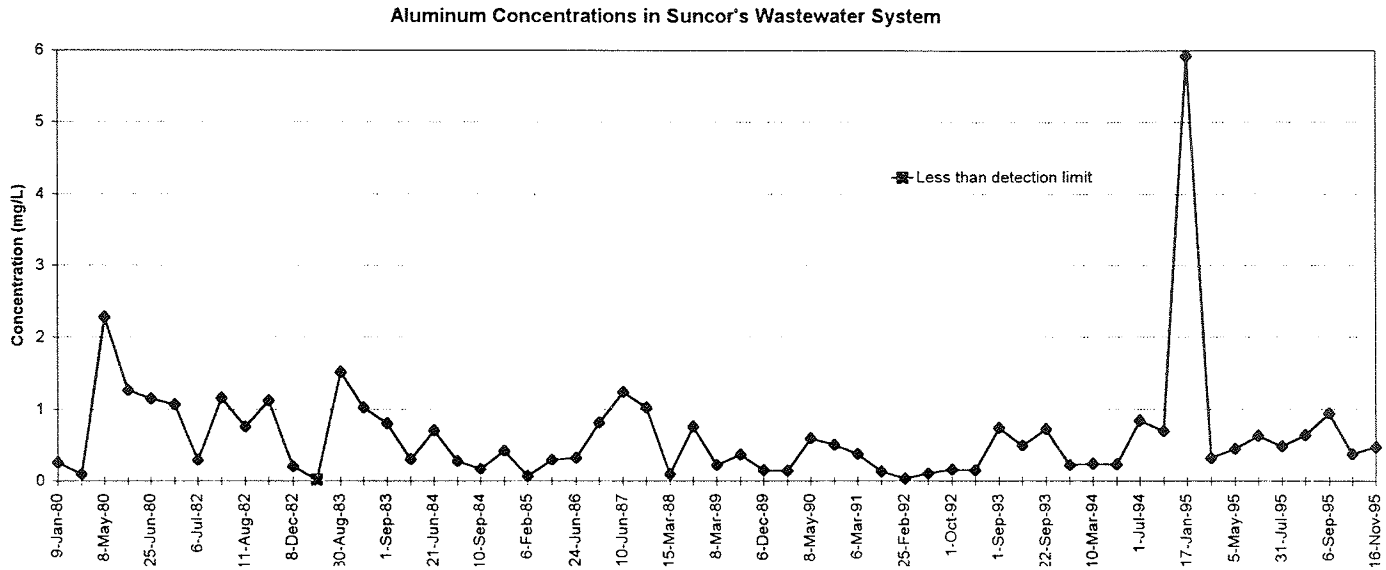
A5.6 Time series graphs of wastewater concentrations are shown in Figures 5.6-1 to 5.6-5 for aluminum, mercury, phenols, molybdenum and strontium, respectively.

Aluminum, mercury and molybdenum are monitored quarterly from the wastewater outfall as part of Suncor's Approval NO. 94-01-00. Phenol is monitored daily. Strontium is monitored as part of apecial studies or investigations. A detailed environmental monitoring program is under development to confirm EIA predictions and to assess potential impacts associated with water releases from Suncor's existing and proposed operations. This program will be developed with stakeholder input and is expected to be finalized by September 30, 1996.

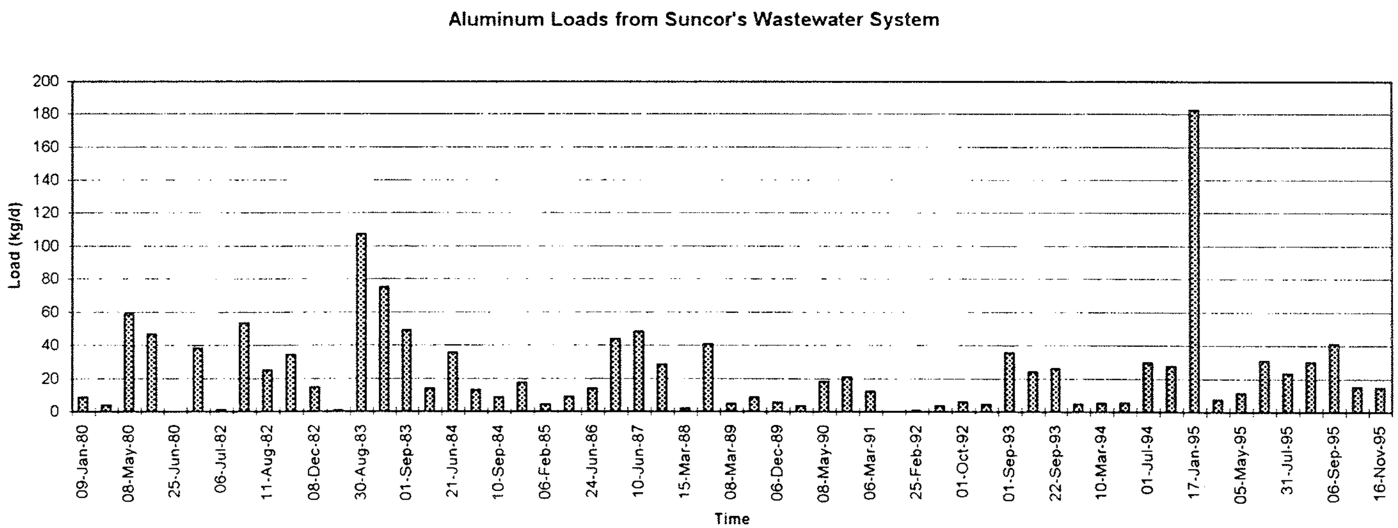
Q5.7 Molybdenum exceeded the chronic guideline after a 10% dilution *(Athabasca River Water Releases Impact Assessment, May 1996, Table VI–10)*. What is the impact of this compound?

A5.7 This chemical is discussed on p. VI-15. The guideline was based on irrigation water quality, which is not applicable to protection of aquatic biota. Suter and Mabrey

Figure 5.6-1

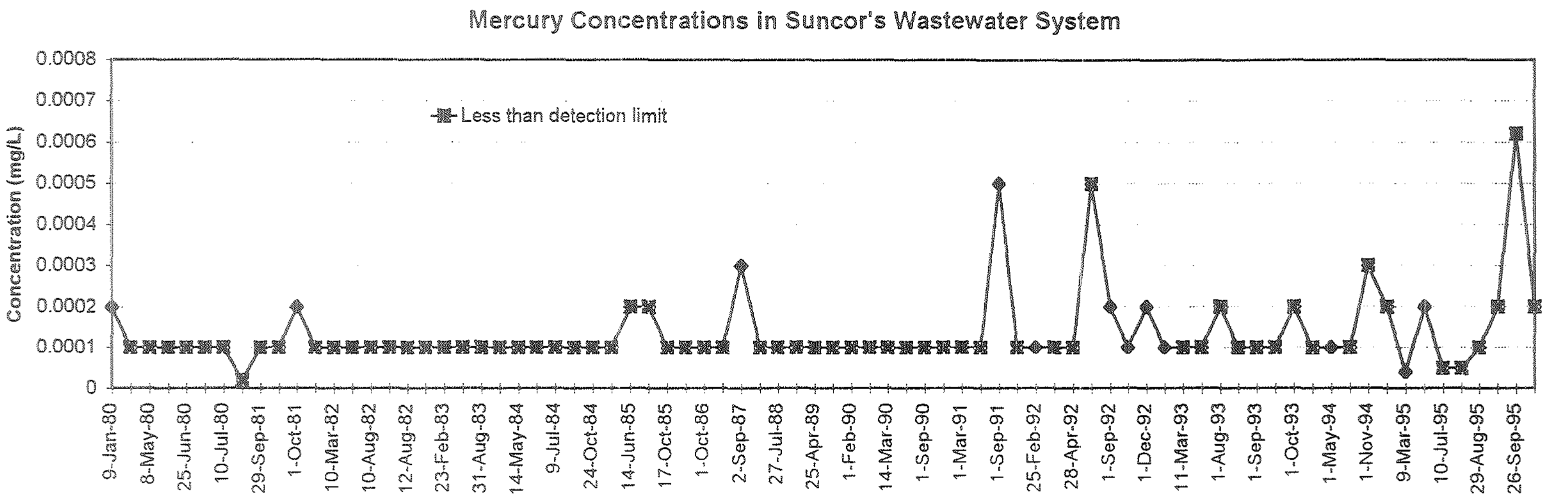


Aluminum Concentrations in Suncor's Wastewater System
Concentration (mg/L)
Less than detection limit
9-Jan-80
8-May-80
25-Jun-80
6-Jul-82
11-Aug-82
8-Dec-82
30-Aug-83
1-Sep-83
21-Jun-84
10-Sep-84
6-Feb-85
24-Jun-86
10-Jun-87
15-Mar-88
8-Mar-89
6-Dec-89
8-May-90
6-Mar-91
25-Feb-92
1-Oct-92
1-Sep-93
22-Sep-93
10-Mar-94
1-Jul-94
17-Jan-95
5-May-95
31-Jul-95
6-Sep-95
16-Nov-95



Aluminum Loads from Suncor's Wastewater System
Load (kg/d)
Time
09-Jan-80
08-May-80
25-Jun-80
06-Jul-82
11-Aug-82
08-Dec-82
30-Aug-83
01-Sep-83
21-Jun-84
10-Sep-84
06-Feb-85
24-Jun-86
10-Jun-87
15-Mar-88
08-Mar-89
06-Dec-89
08-May-90
06-Mar-91
25-Feb-92
01-Oct-92
01-Sep-93
22-Sep-93
10-Mar-94
01-Jul-94
17-Jan-95
05-May-95
31-Jul-95
06-Sep-95
16-Nov-95

Figure 5.6-2


Mercury Concentrations in Suncor's Wastewater System
Less than detection limit
Concentration (mg/L)
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
9-Jan-80
8-May-80
25-Jun-80
10-Jul-80
29-Sep-81
1-Oct-81
10-Mar-82
10-Aug-82
12-Aug-82
23-Feb-83
31-Aug-83
14-May-84
9-Jul-84
24-Oct-84
14-Jun-85
17-Oct-85
1-Oct-86
2-Sep-87
27-Jul-88
25-Apr-89
1-Feb-90
14-Mar-90
1-Sep-90
1-Mar-91
1-Sep-91
25-Feb-92
28-Apr-92
1-Sep-92
1-Dec-92
11-Mar-93
1-Aug-93
1-Sep-93
1-Oct-93
1-May-94
1-Nov-94
9-Mar-95
10-Jul-95
29-Aug-95
26-Sep-95

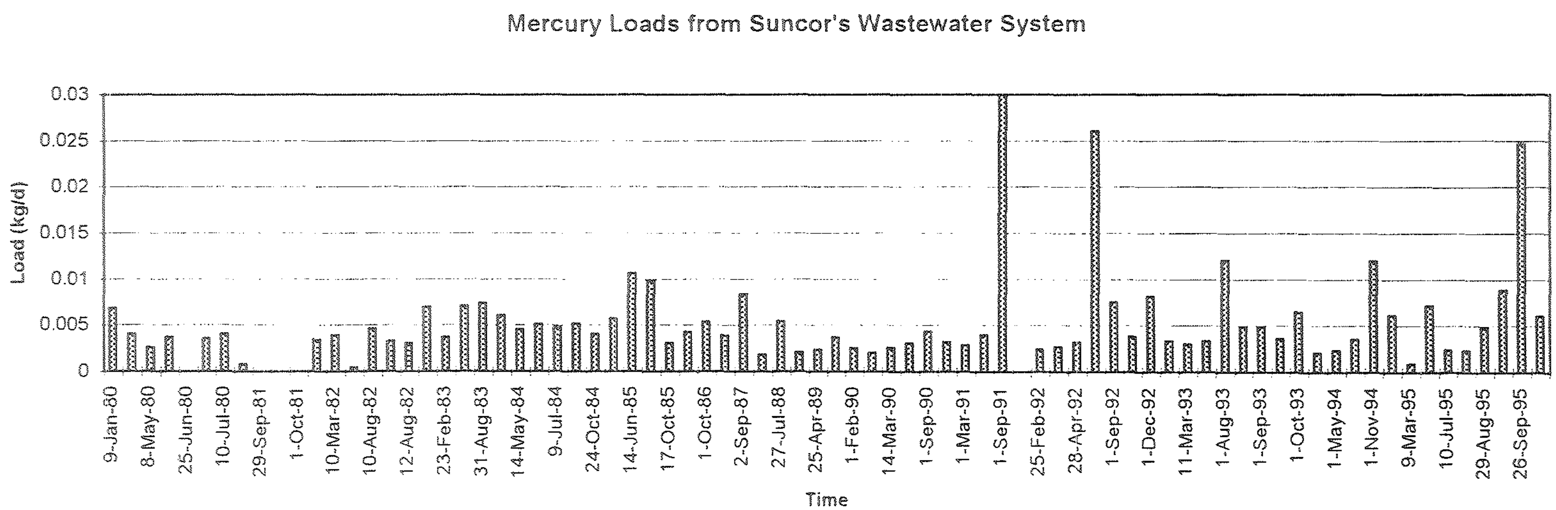
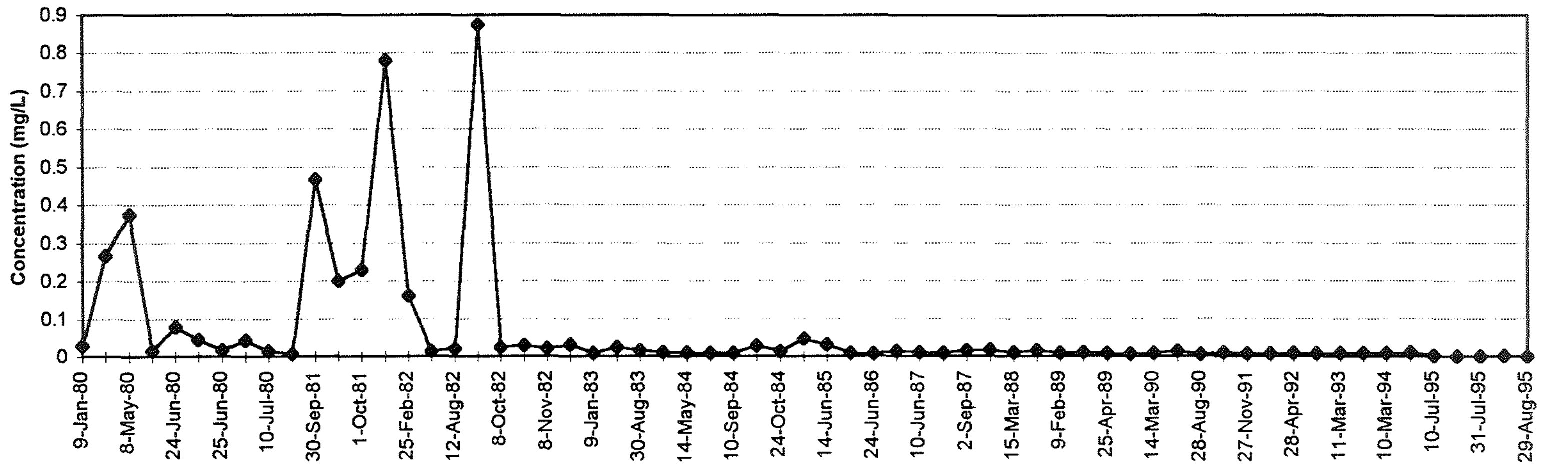

Mercury Loads from Suncor's Wastewater System
Load (kg/d)
0.03
0.025
0.02
0.015
0.01
0.005
0
9-Jan-80
8-May-80
25-Jun-80
10-Jul-80
29-Sep-81
1-Oct-81
10-Mar-82
10-Aug-82
12-Aug-82
23-Feb-83
31-Aug-83
14-May-84
9-Jul-84
24-Oct-84
14-Jun-85
17-Oct-85
1-Oct-86
2-Sep-87
27-Jul-88
25-Apr-89
1-Feb-90
14-Mar-90
1-Sep-90
1-Mar-91
1-Sep-91
25-Feb-92
28-Apr-92
1-Sep-92
1-Dec-92
11-Mar-93
1-Aug-93
1-Sep-93
1-Oct-93
1-May-94
1-Nov-94
9-Mar-95
10-Jul-95
29-Aug-95
26-Sep-95
Time

Figure 5.6-3

Total Phenolics Concentrations in Suncor's Wastewater System



Total Phenolics Loads from Suncor's Wastewater System

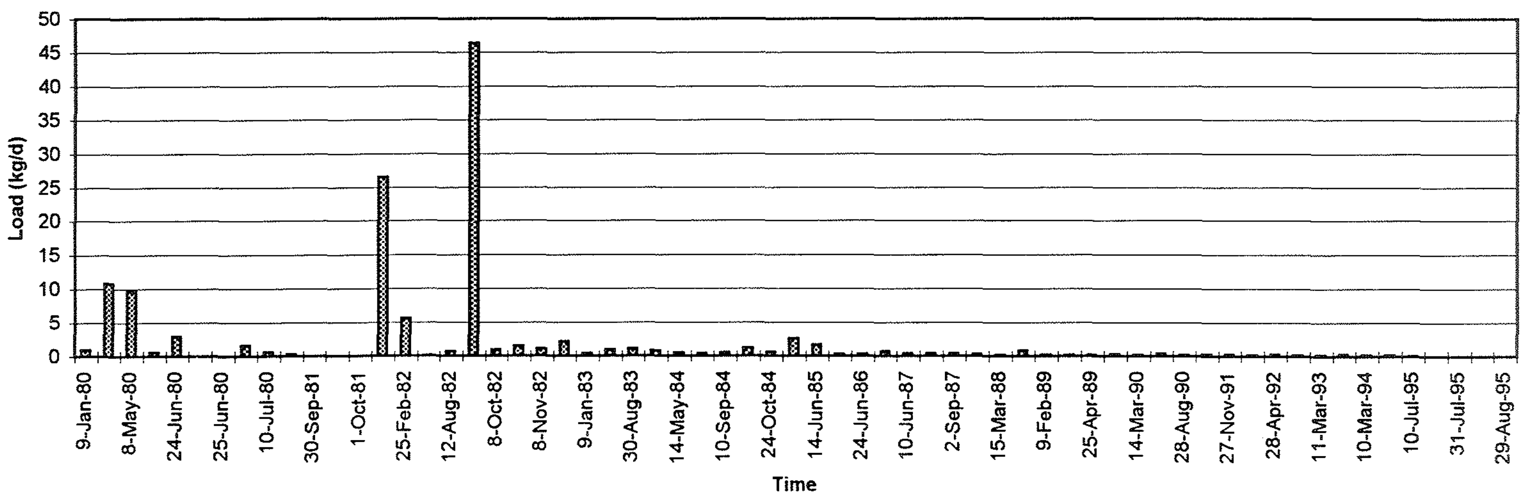
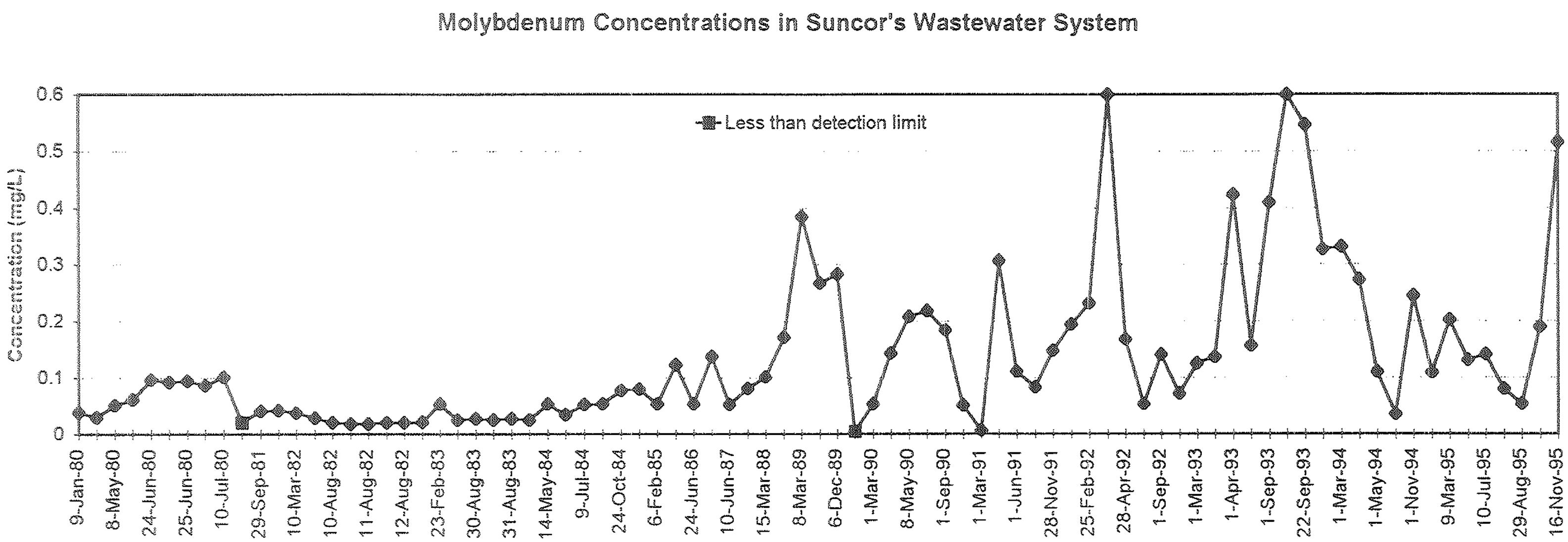
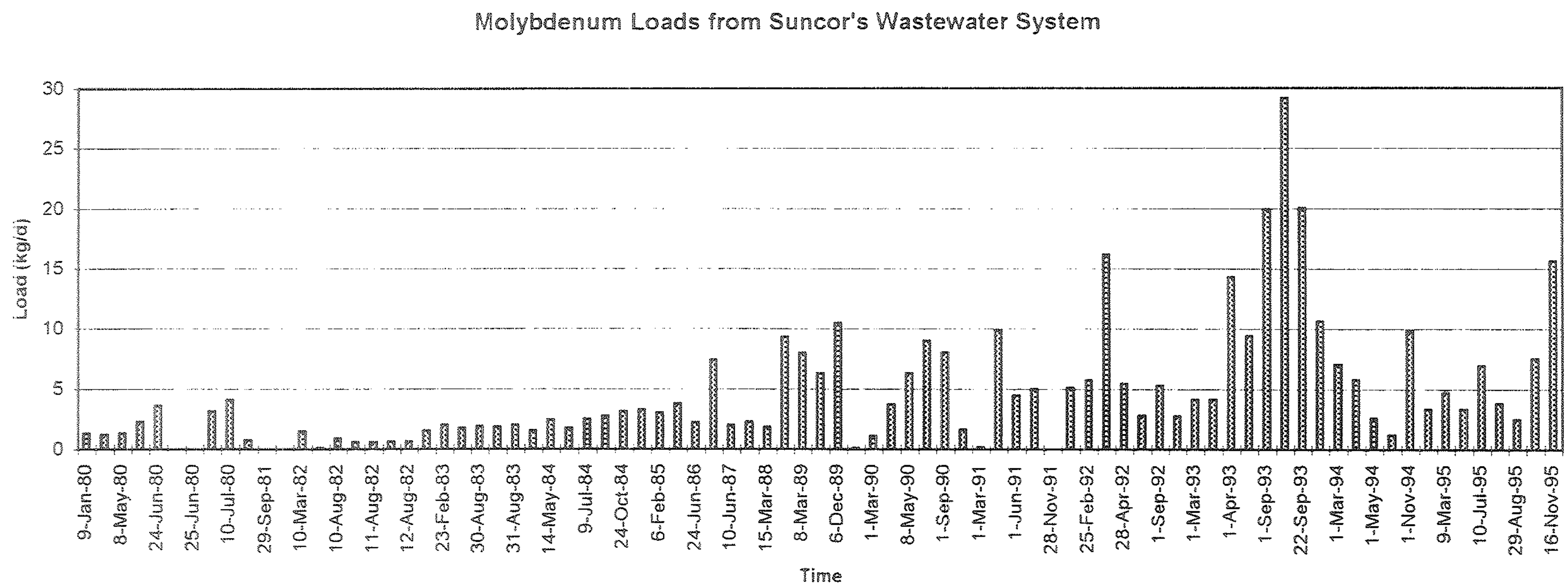


Figure 5.6-4

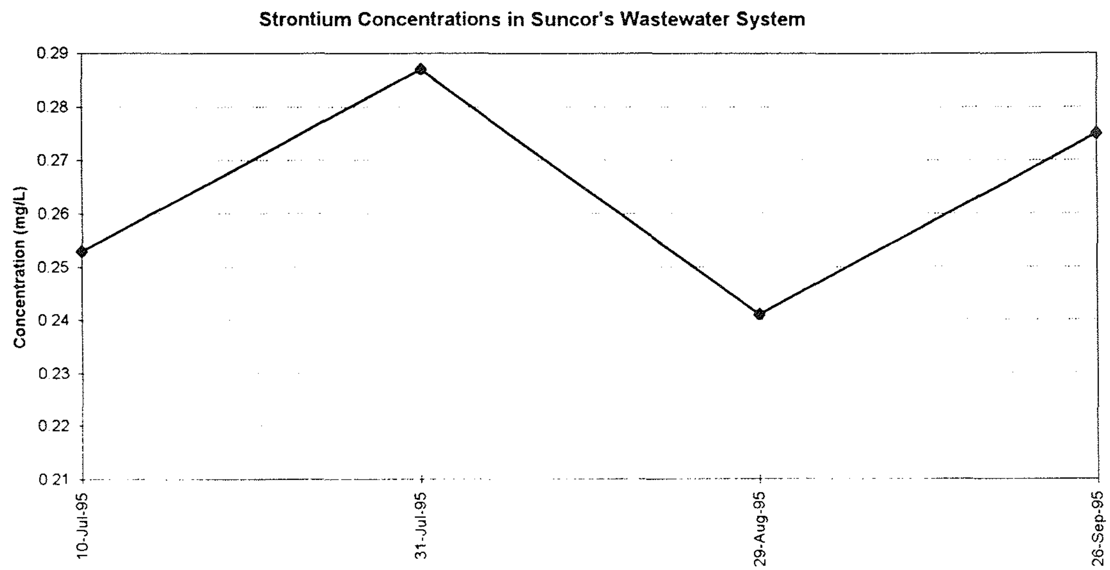


Molybdenum Concentrations in Suncor's Wastewater System
Less than detection limit
Concentration (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0
9-Jan-80
8-May-80
24-Jun-80
25-Jun-80
10-Jul-80
29-Sep-81
10-Mar-82
10-Aug-82
11-Aug-82
12-Aug-82
23-Feb-83
30-Aug-83
31-Aug-83
14-May-84
9-Jul-84
24-Oct-84
6-Feb-85
24-Jun-86
10-Jun-87
15-Mar-88
8-Mar-89
6-Dec-89
1-Mar-90
8-May-90
1-Sep-90
1-Mar-91
1-Jun-91
28-Nov-91
25-Feb-92
28-Apr-92
1-Sep-92
1-Mar-93
1-Apr-93
1-Sep-93
22-Sep-93
1-Mar-94
1-May-94
1-Nov-94
9-Mar-95
10-Jul-95
29-Aug-95
16-Nov-95

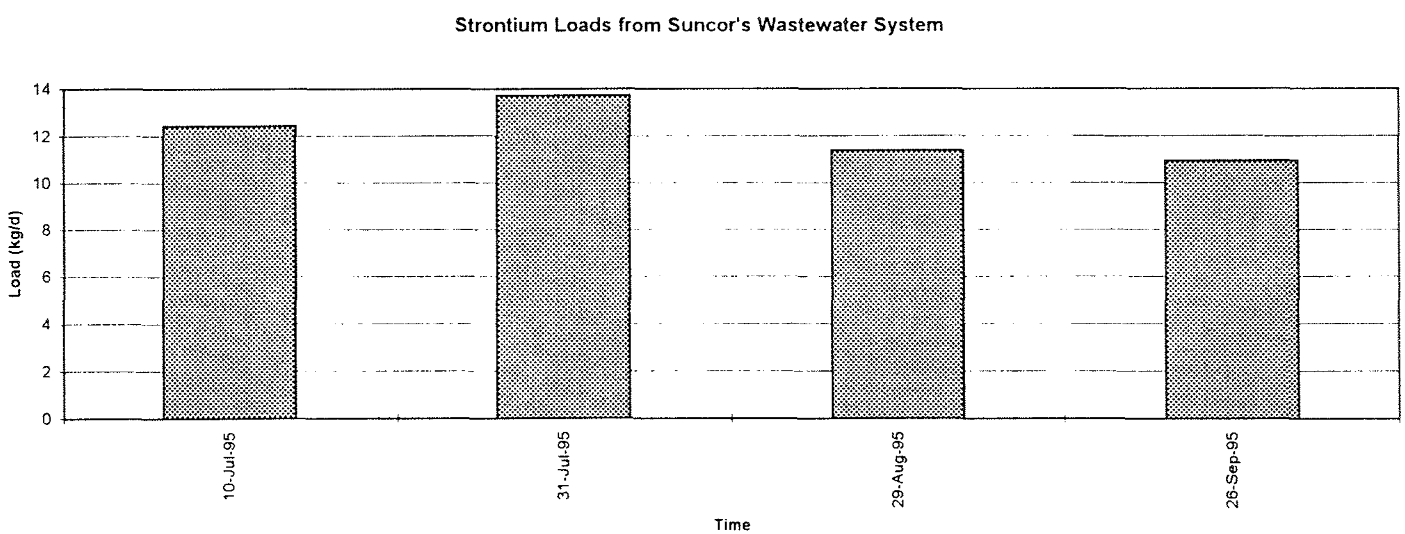


Molybdenum Loads from Suncor's Wastewater System
Load (kg/d)
30
25
20
15
10
5
0
9-Jan-80
8-May-80
24-Jun-80
25-Jun-80
10-Jul-80
29-Sep-81
10-Mar-82
10-Aug-82
11-Aug-82
12-Aug-82
23-Feb-83
30-Aug-83
31-Aug-83
14-May-84
9-Jul-84
24-Oct-84
6-Feb-85
24-Jun-86
10-Jun-87
15-Mar-88
8-Mar-89
6-Dec-89
1-Mar-90
8-May-90
1-Sep-90
1-Mar-91
1-Jun-91
28-Nov-91
25-Feb-92
28-Apr-92
1-Sep-92
1-Mar-93
1-Apr-93
1-Sep-93
22-Sep-93
1-Mar-94
1-May-94
1-Nov-94
9-Mar-95
10-Jul-95
29-Aug-95
16-Nov-95
Time

Figure 5.6-5



Strontium Concentrations in Suncor's Wastewater System
Concentration (mg/L)
0.29
0.28
0.27
0.26
0.25
0.24
0.23
0.22
0.21
10-Jul-95
31-Jul-95
29-Aug-95
26-Sep-95



Strontium Loads from Suncor's Wastewater System
Load (kg/d)
14
12
10
8
6
4
2
0
10-Jul-95
31-Jul-95
29-Aug-95
26-Sep-95
Time

(1994); Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1994 Revisions. Prep. For. U. S. Dept. Of Energy) indicate that acute and chronic toxicity of molybdenum to Daphnia are 207 and 0.24 mg/L, respectively. The cumulative loadings from all of Suncor's wastewater are predicted to result in a molybdenum concentration of only 0.016 mg/L after mixing with 10% 7Q10 flow (Table VI-10 from *Athabasca River Water Releases Impact Assessment*); hence no impacts associated with release of molybdenum are expected.

Q5.8 Provide time series graphs for each of the background river substances that indicated potential to exceed in-stream guidelines, either naturally, or as a result of Suncor's discharges *(Athabasca River Water Releases Impact Assessment, May 1996).*

A5.8 Time series graphs for the following substances are attached: ammonia, chromium, copper, cyanide, aluminum, mercury, phenols and strontium (Figures 5.8-1 to 5.8-8).

Q5.9 Table 4.2–2 could not be located; it appears the reference should be 4.2–1 *(Athabasca River Water Releases Impact Assessment, May 1996, p.26).* Please verify.

A5.9 Table 4.2-2 was incorrectly referenced. The reference should be 4.2-1

Q5.10 Provide an explanation of the information and assumptions made in Tables VI–4, VI–5 and VI–6 *(Athabasca River Water Releases Impact Assessment, May 1996).*

A5.10 These tables provide the results of analysis pertaining to Suncor's refinery and cooling pond effluent and were prepared specifically for the Fixed Plant Expansion Project Application dated March 1996.

The information given in Table VI-4 is described on p.VI-8 of *Athabasca River Water Releases Impact Assessment*. Assumptions are given in pages VI-2 to VI-7 of that report. Also, see below for assumptions related to the conservative nature of the estimates for the combined effluent loadings and concentrations.

Figure 5.8-1

Total Ammonia-N Levels in the Athabasca River Upstream of Suncor

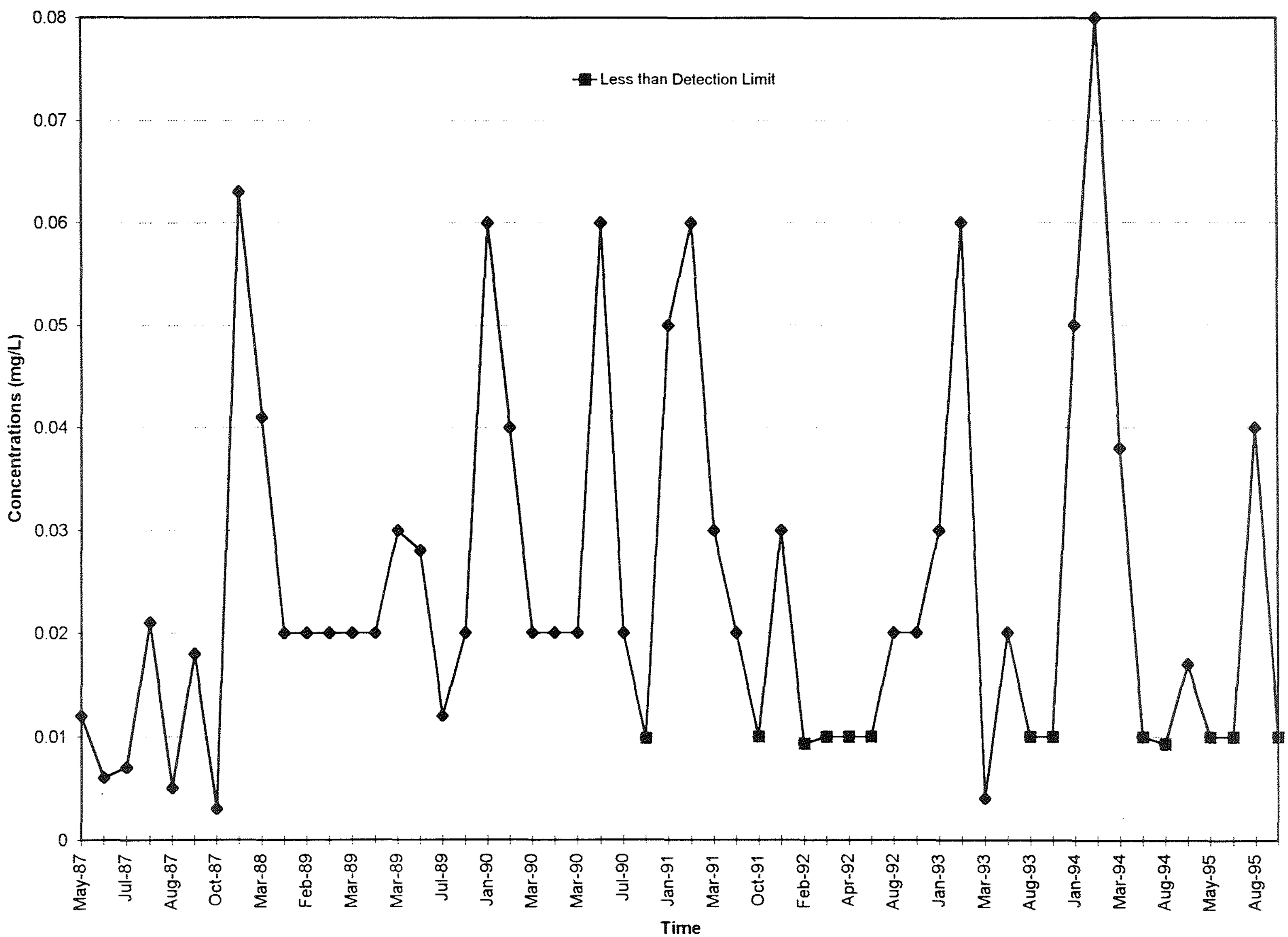
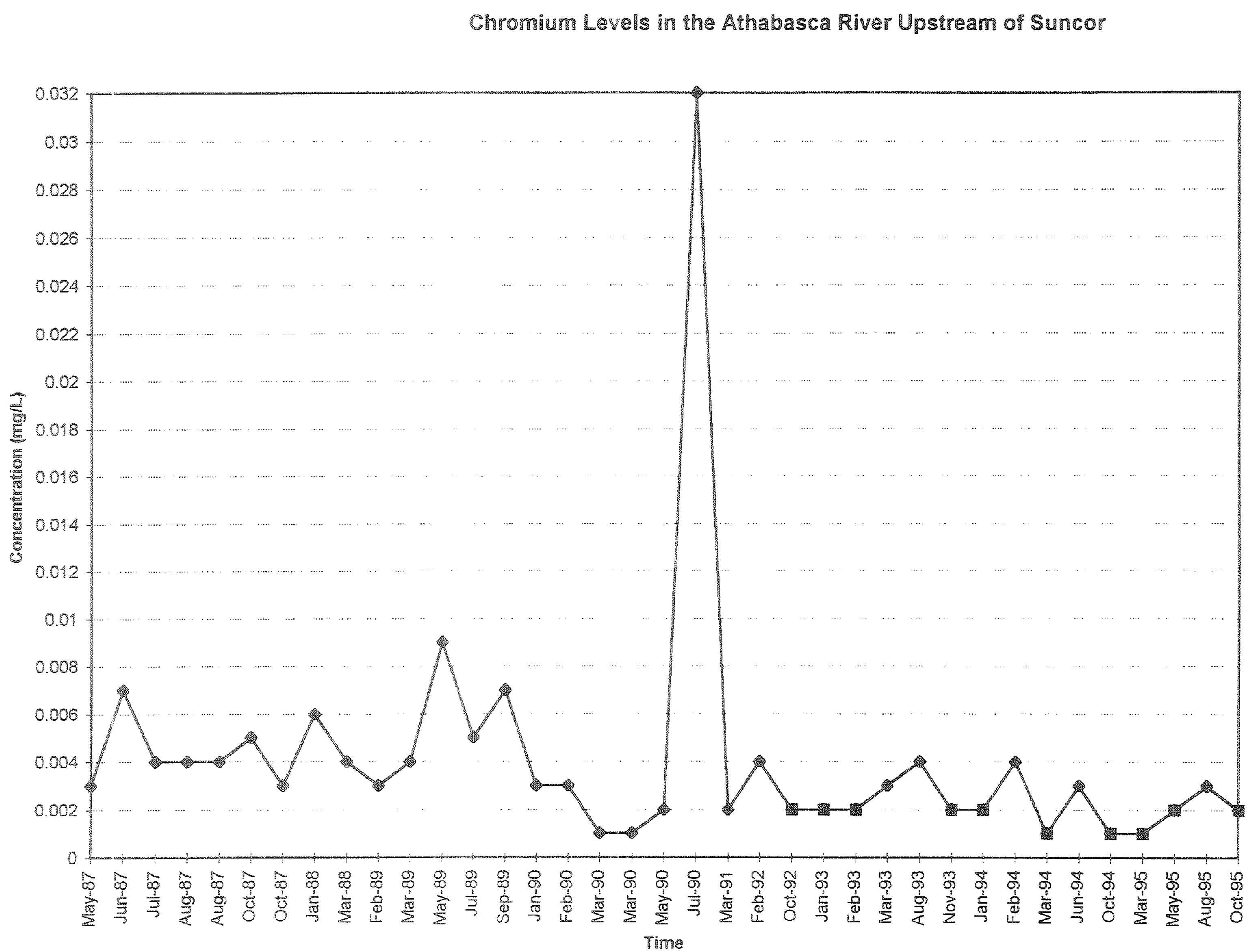


Figure 5.8-2



r:\1995\2307\7000\7200\Chromium Chart 1\Chromium Chart 1

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Figure 5.8-3

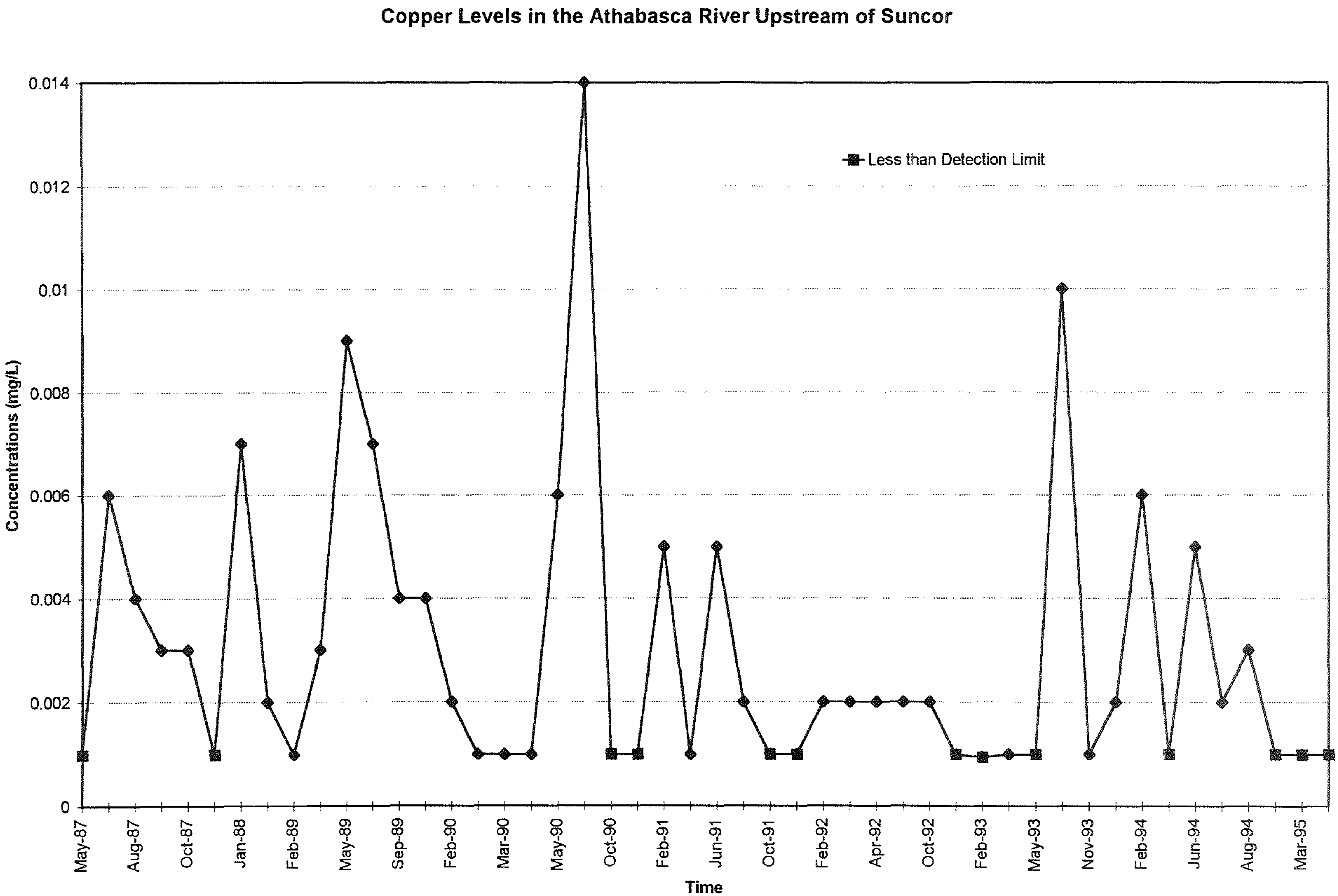
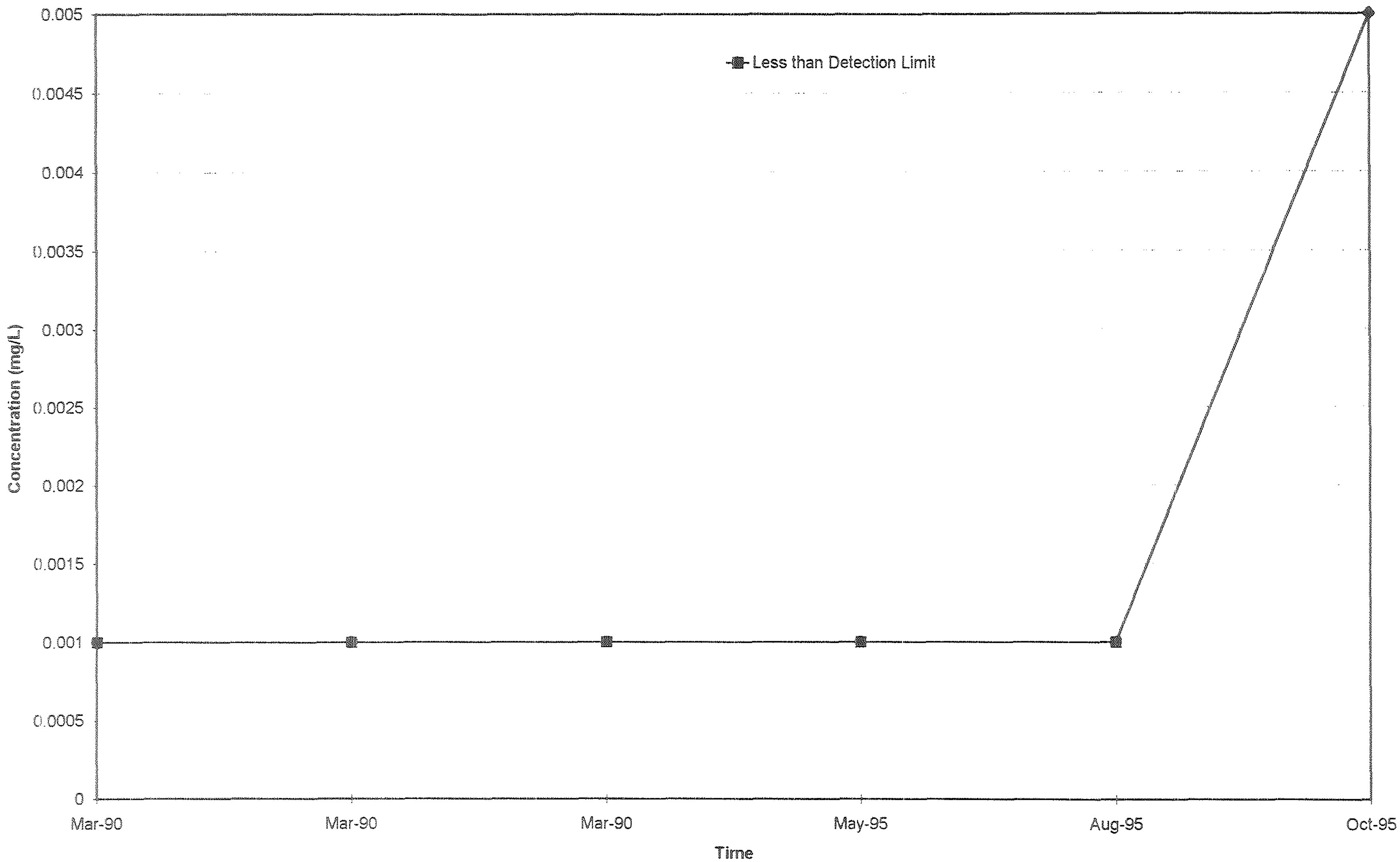

Copper Levels in the Athabasca River Upstream of Suncor
Less than Detection Limit
Concentrations (mg/L)
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
May-87
Aug-87
Oct-87
Jan-88
Feb-89
May-89
Sep-89
Feb-90
Mar-90
May-90
Oct-90
Feb-91
Jun-91
Oct-91
Feb-92
Apr-92
Oct-92
Feb-93
May-93
Nov-93
Feb-94
Jun-94
Aug-94
Mar-95
Time

Figure 5.8-4

Total Cyanide Levels in the Athabasca River Upstream of Suncor

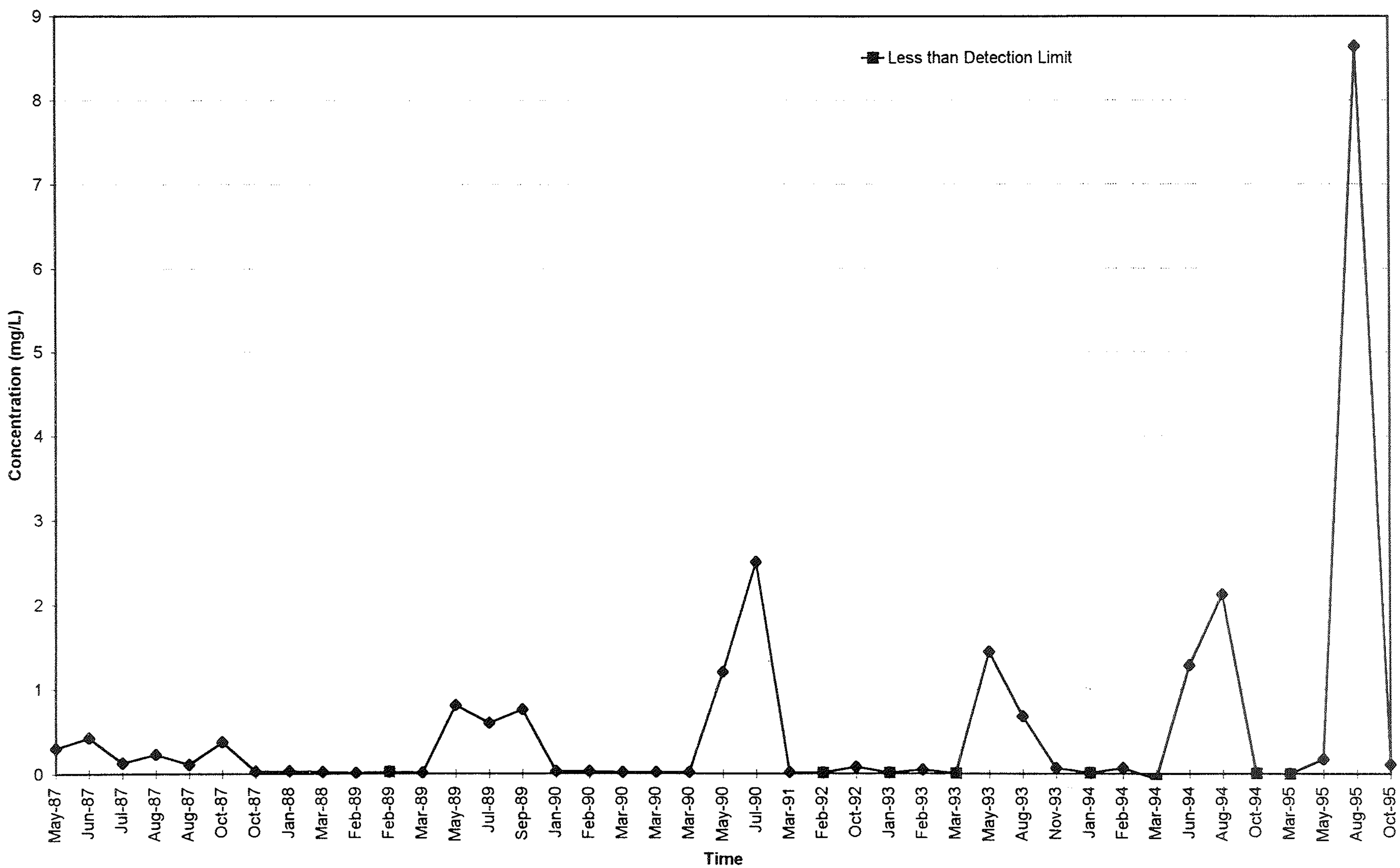


r:\1995\2307\7000\7200\Cyanide Chart 1\Cyanide Chart 1

Golder Associates

Figure 5.8-5

Aluminum Levels in the Athabasca River Upstream of Suncor



r \1995\2307\7000\7200\Aluminum Chart 1\Aluminum Chart 1

Figure 5.8-6

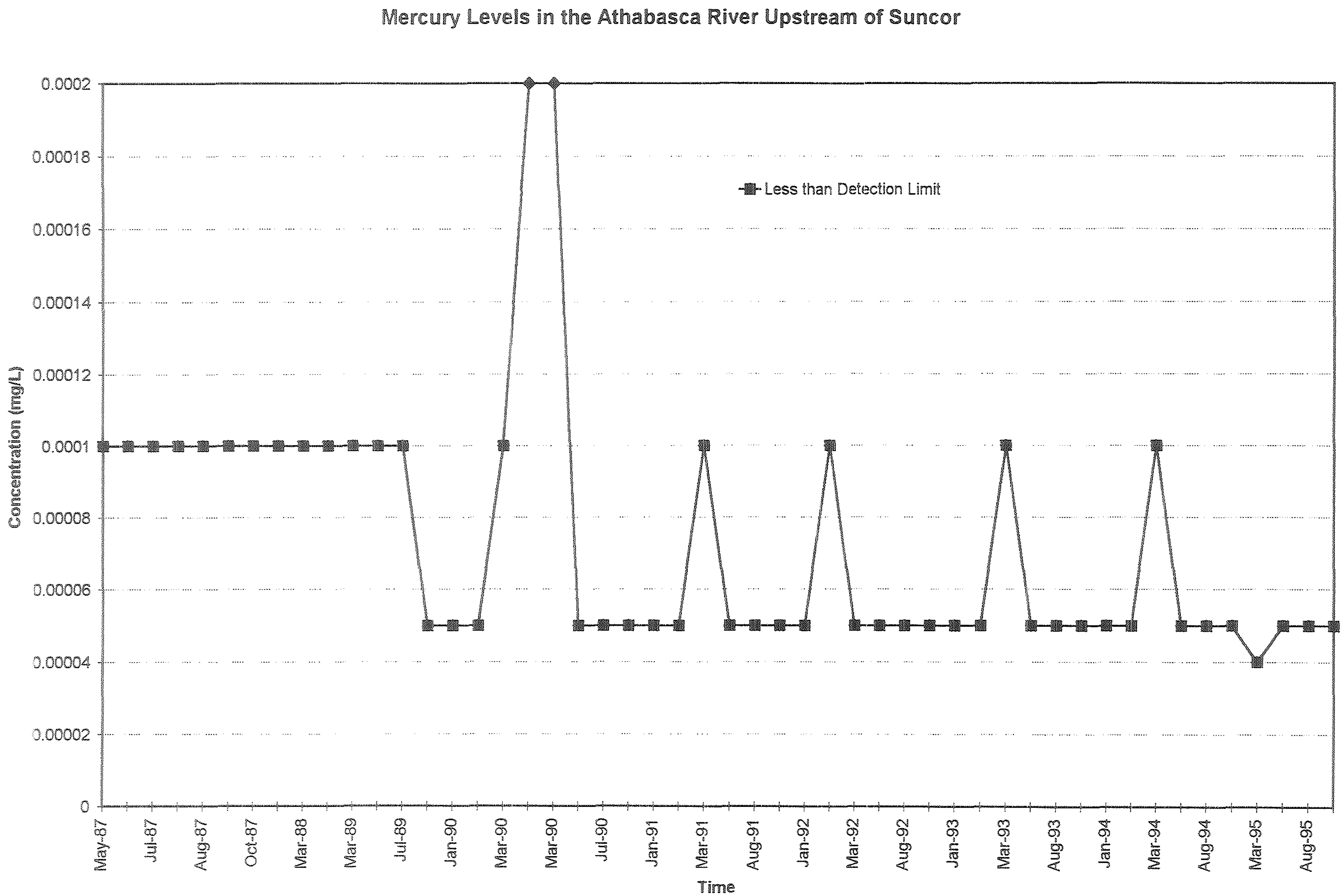

Mercury Levels in the Athabasca River Upstream of Suncor
Less than Detection Limit
Concentration (mg/L)
0.0002
0.00018
0.00016
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
May-87
Jul-87
Aug-87
Oct-87
Mar-88
Mar-89
Jul-89
Jan-90
Mar-90
Mar-90
Jul-90
Jan-91
Mar-91
Aug-91
Jan-92
Mar-92
Aug-92
Jan-93
Mar-93
Aug-93
Jan-94
Mar-94
Aug-94
Mar-95
Aug-95
Time

Figure 5.8-7

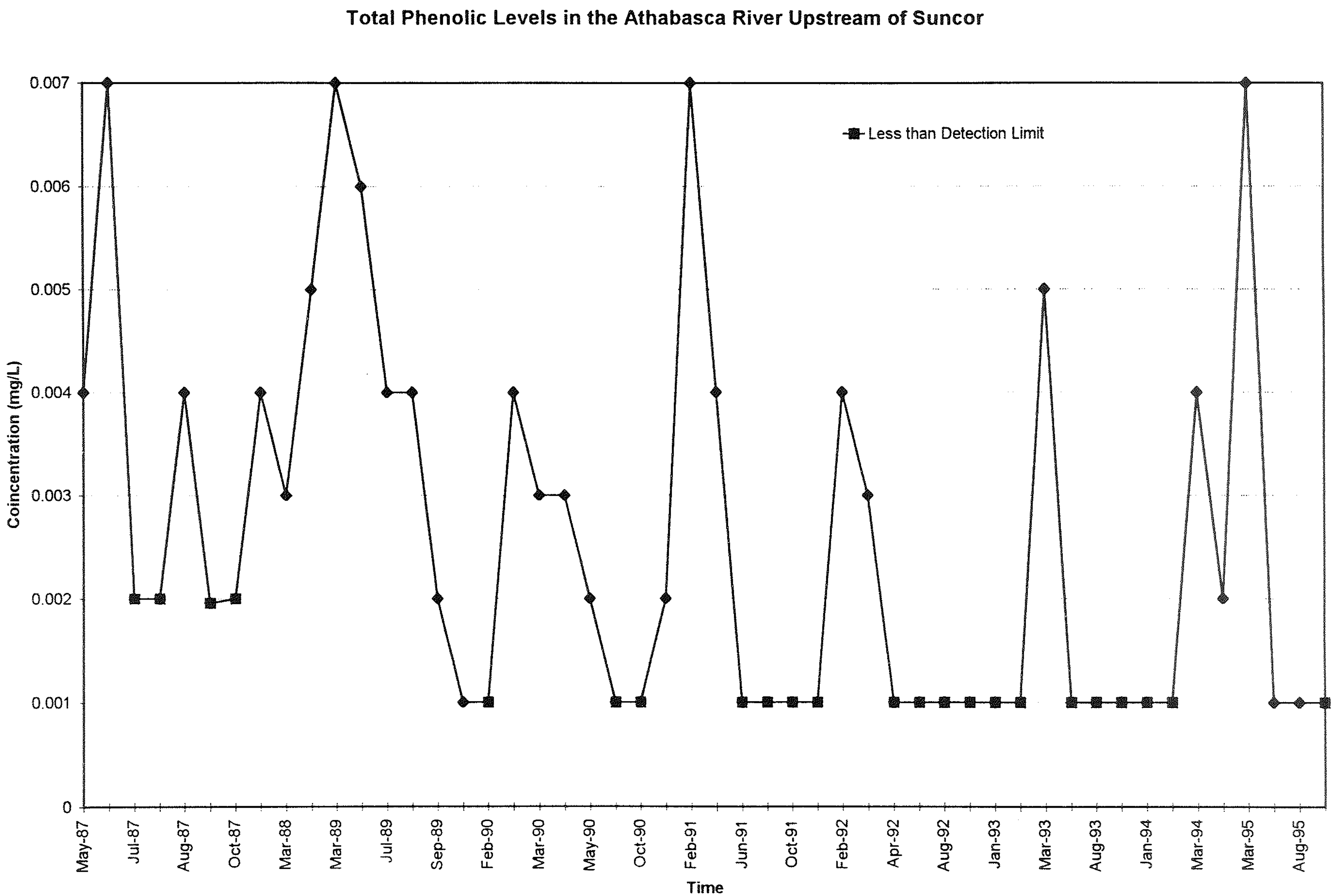
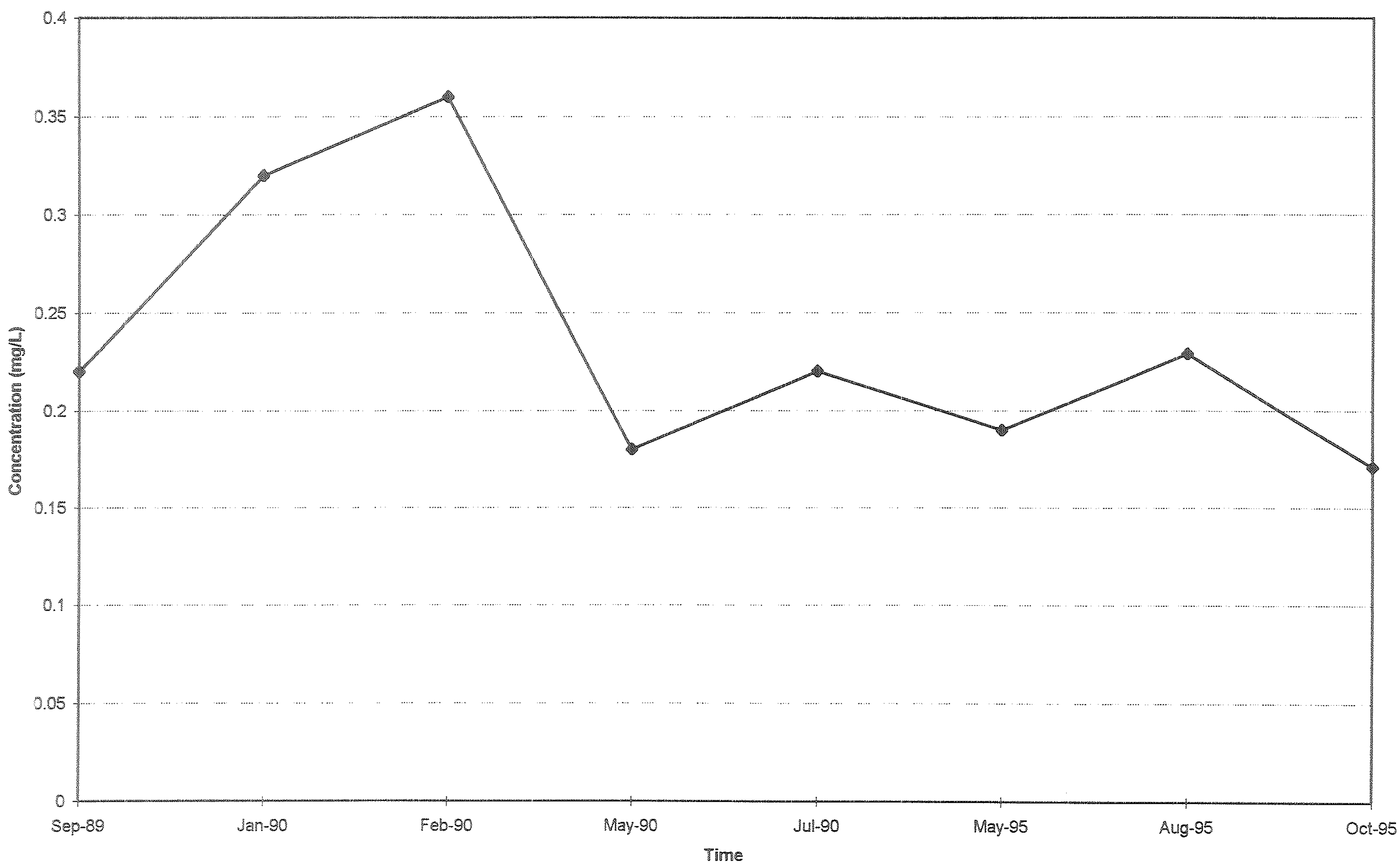

Total Phenolic Levels in the Athabasca River Upstream of Suncor
Less than Detection Limit
Coincentration (mg/L)
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
May-87
Jul-87
Aug-87
Oct-87
Mar-88
Mar-89
Jul-89
Sep-89
Feb-90
Mar-90
May-90
Oct-90
Feb-91
Jun-91
Oct-91
Feb-92
Apr-92
Aug-92
Jan-93
Mar-93
Aug-93
Jan-94
Mar-94
Mar-95
Aug-95
Time

Figure 5.8-8

Strontium Levels in the Athabasca River Upstream of Suncor



r'\1995\2307\7000\7200\Strontium Chart 1\Strontium Chart 1

Golder Associates

Table VI-5 is confusing because all units are not given and footnotes do not provide all necessary information. A revised table is attached.

Table VI-6 is analogous to Table VI-4, except that it directed toward human-health related parameters rather than aquatic-health related parameters. In particular:

Columns 1 to 3 are self-explanatory.

Column 4 lists, along with each parameter, the calculated maximum loads that could be discharged from the wastewater system to maintain concentrations in the Athabasca River below the health guidelines.

Column 5 shows the maximum current (1995) load from the combined effluents. This is computed as the sum of the maximum component loads (columns 6 and 7), where non-detects were set at detection limit values. This is the worst-case condition since future loads will be reduced as a result of decreases in flows and other changes to the wastewater system, we assumed that maximum component loads would occur concurrently, and non-detects assumed to equal detection limit.

Columns 6 and 7 show component (cooling Pond and wastewater) loads.

Column 8 shows the current maximum concentrations for the combined effluents, estimated from flow-weighted concentrations

Columns 9 and 10 show the current maximum concentrations for the cooling Pond and wastewater effluents.

TABLE VI-5

ESTIMATED FREQUENCY OF EXCEEDING THEORETICAL FINAL EFFLUENT LIMIT

	Limit[1]	Unit	Wastewater System			Pond E Cooling		
			Frequency[2] of Exceeding Limit (%)			Frequency[2] of Exceeding Limit (%)		
			79.5K	87.0K	107.0K	79.5K	87.0K	107.0K
Chromium	0.016	(mg/L)	1.3	1.3	1.3	0	0	0
Copper	0.03	(mg/L)	3.8	3.8	3.8	0	0	0
Mercury	0.01	(kg/d)	23.8	8.8	8.8	12.5	6.3	6.3

1 Based upon AEP (1995) water quality based effluent limits. The limits for chromium and copper are end-of-pipe concentrations of acute criteria, whereas the limit for mercury is the maximum allowable load for the wastewater effluent to meet aquatic chronic criteria.

2 Based upon 1980-1995 effluent monitoring data.

Note:
- The 7Q10 flow of 115 cms was used for the Athabasca River flow, and 10% flow mixing zone was applied in the production of in-stream concentrations for evaluating chronic aquatic life criteria.
- Winter season river background concentrations used in the analysis were 0.003 mg/L for chromium, 0.002 mg/L for copper and zero for mercury, respectively.
- Flow rates of the wastewater effluent are 28,875 m^3/d for the 79.5K case, 28,120 m^3/d for the 87.0K case and 21,889 m^3/d for the 107.0K case.

Q5.11 In Figure F3.0–7, why has chronic toxicity increased for the 2020 scenario relative to earlier scenarios? *(Aquatic Issues Associated With the Steepbank Mine, April 1996)?*

A5.11 As noted on page. 90 of 87-91 in *Impact Analysis of Aquatic Issues Associated with the Steepbank Mine* "the year 2020 represent the worst case scenario (i.e., highest concentrations of wastewater in the Athabasca River)." This is a result of the cumulative loadings from all water releases, in particular the potential release of CT water associated with reclamation of Ponds 5 and 6 (see Figures 3.3-1 to 3.3-5 of the *Athabasca River Water Releases Impact Assessment* report for details. Note that these Figures contained errors and revised Figures are atttached).

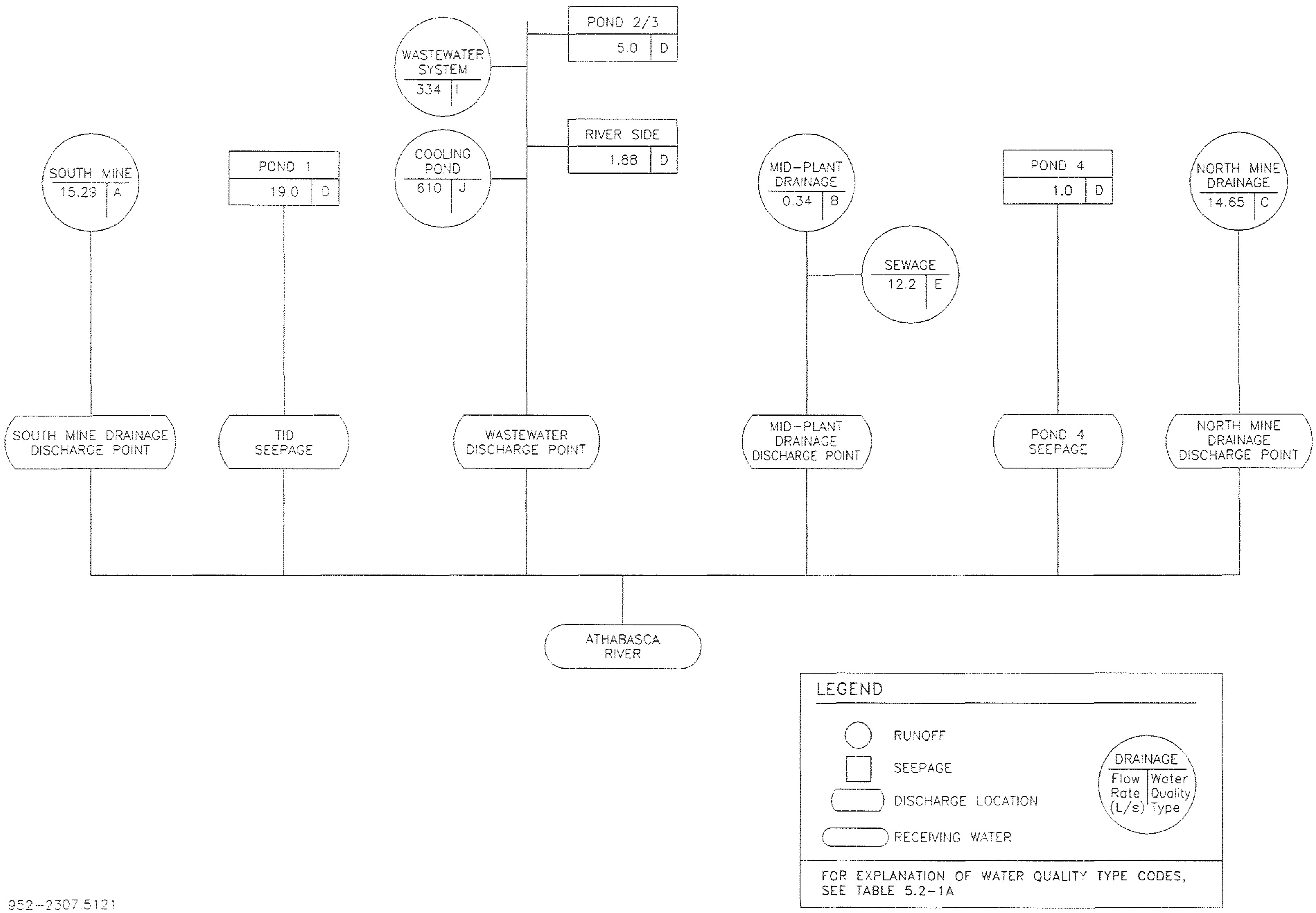
Q5.12 Suncor provides information on reclamation waters in the application *(Steepbank Mine Project Application, April 1996 Section D3.0, pp.70,71)* and in two supporting documents. Suncor states that wetlands provide partial treatment of CT release water, and that further assessment and monitoring is required. The associated water release document presents data to show that CT release waters are unlikely to impact the Athabasca River, but does not assess potential impacts on intermediate surface waters such as Ruth Lake. Provide a management plan and schedule to:

a) predict water quality in the surface waters on the CT deposits/reclaimed tailings ponds at pertinent stages in their evolution (e.g. at completion of infilling with CT, after capping with sand and muskeg, in the long term).

A5.12a A detailed assessment of potential impacts on health of people and wildlife who might use CT reclaimed deposits is provided in the report entitled *Suncor Reclamation Landscape Performance Assessment*. In particular, the potential impacts to wildlife associated with drinking from on-site water bodies was assessed (see Table 5.1-30). A description of the modelling done to predict on-site surface water quality is given on p. 83-84 of that report:

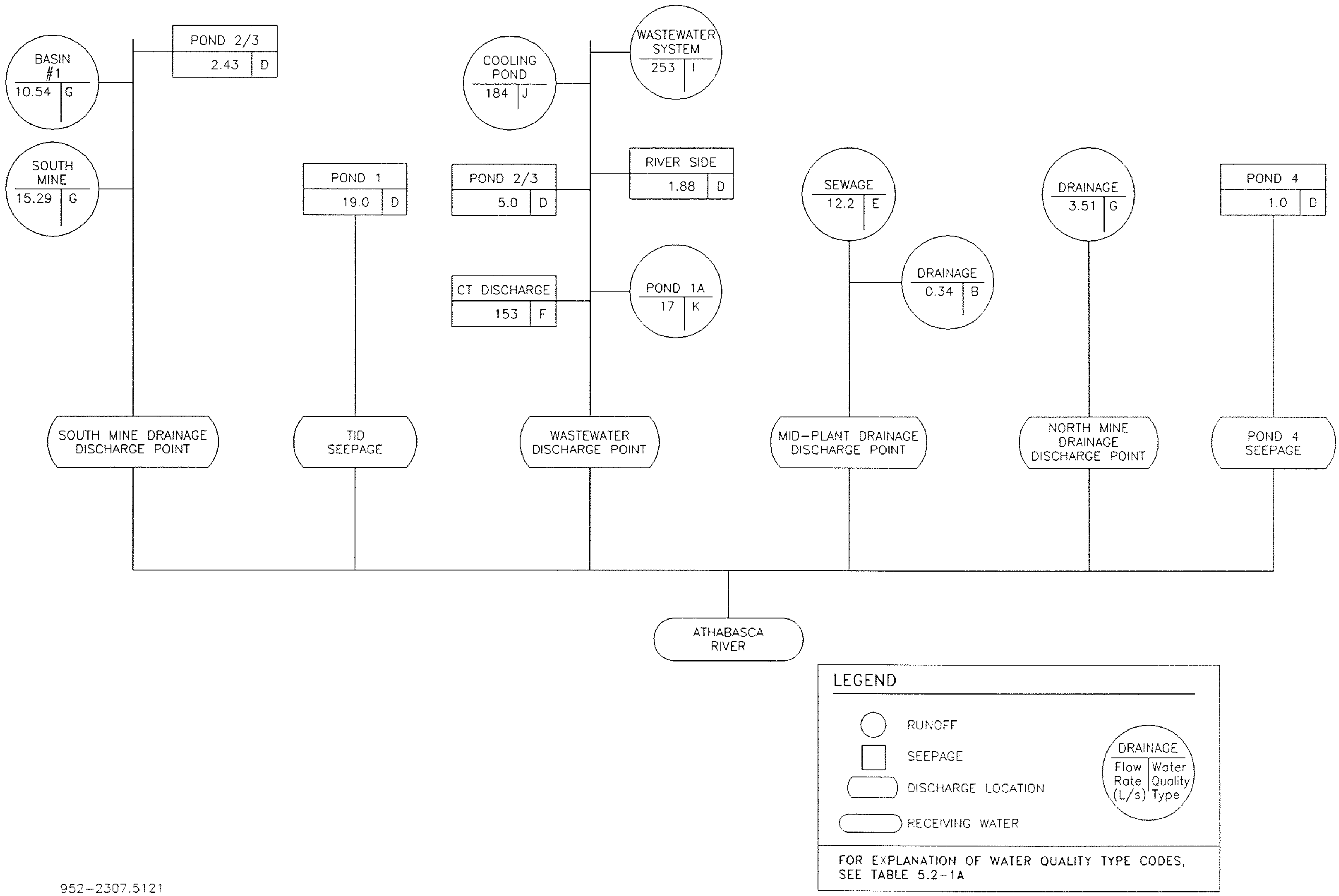
"A chemical fate model was used to predict chemical concentrations in environmental media and biota when measured concentrations were not available. Predicted

Figure 3.3-1
MINESITE DRAINAGE TO ATHABASCA RIVER
SCENARIO: 1995



952-2307.5121
\CH1.R13

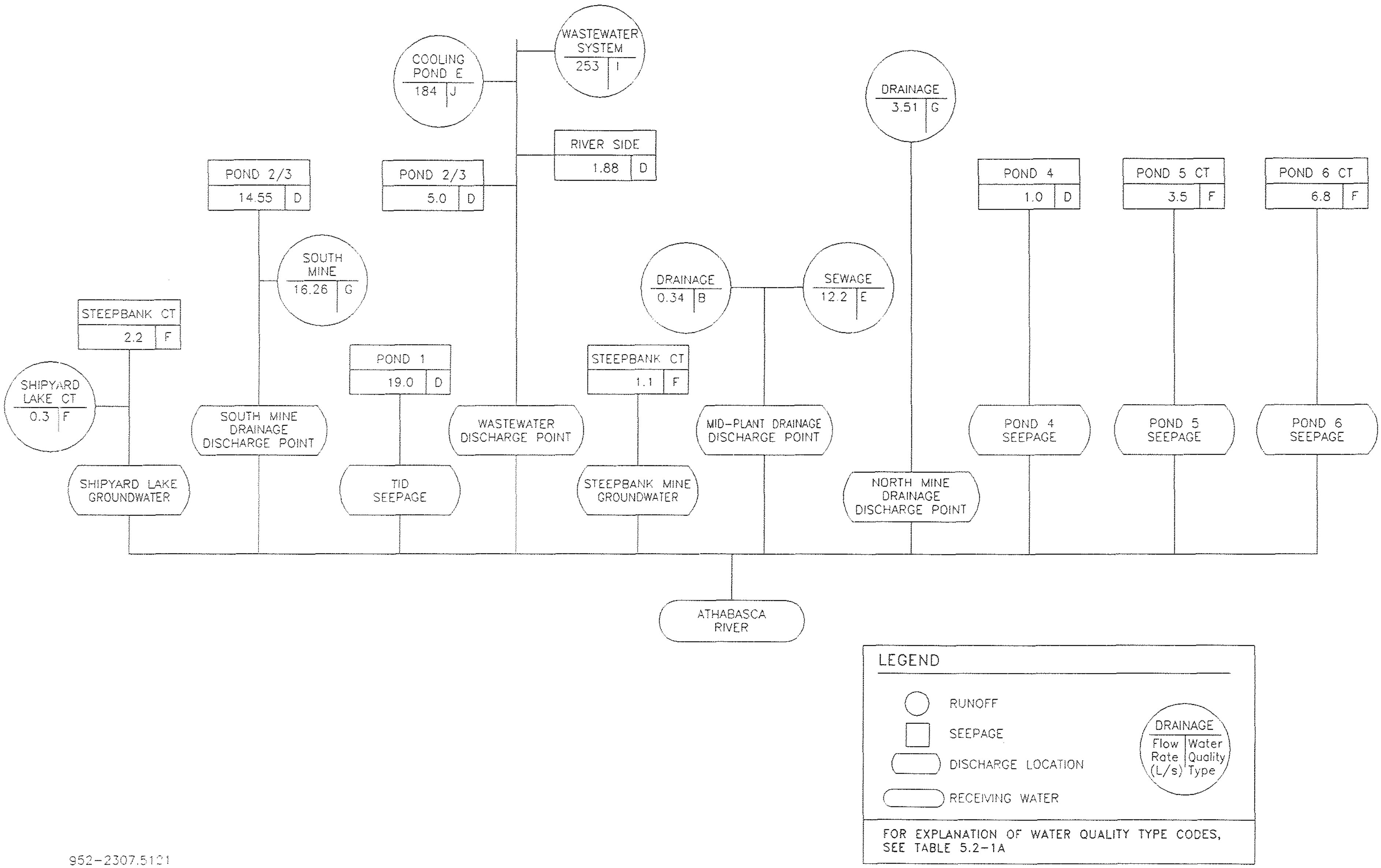
Figure 3.3-2
MINESITE DRAINAGE TO ATHABASCA RIVER
SCENARIO: 2001



952-2307.5121
\CH2.R13

Figure 3.3-3

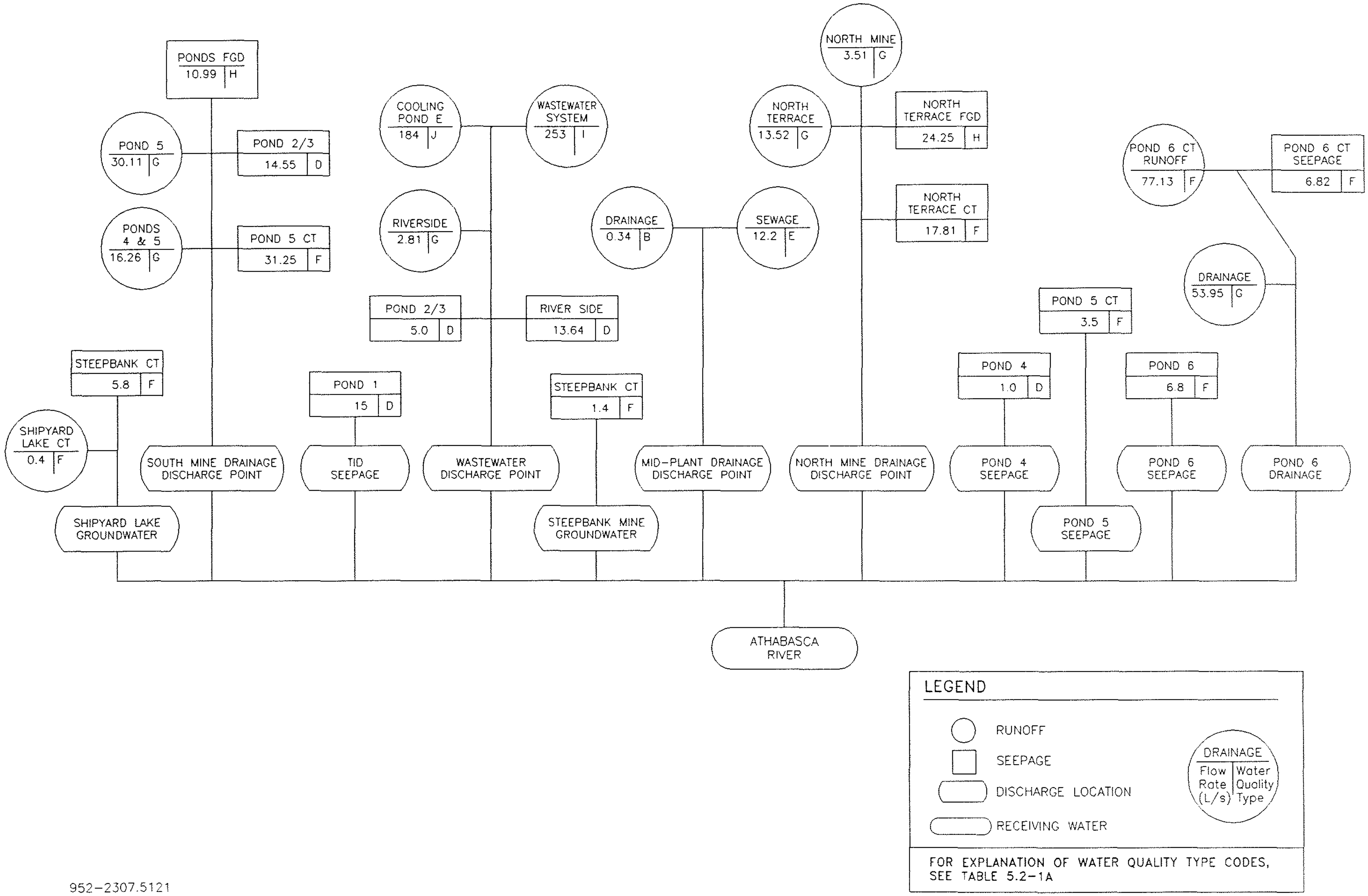
MINESITE DRAINAGE TO ATHABASCA RIVER
SCENARIO: 2010



952-2307.5121
\CH3.R13

Figure 3.3-4

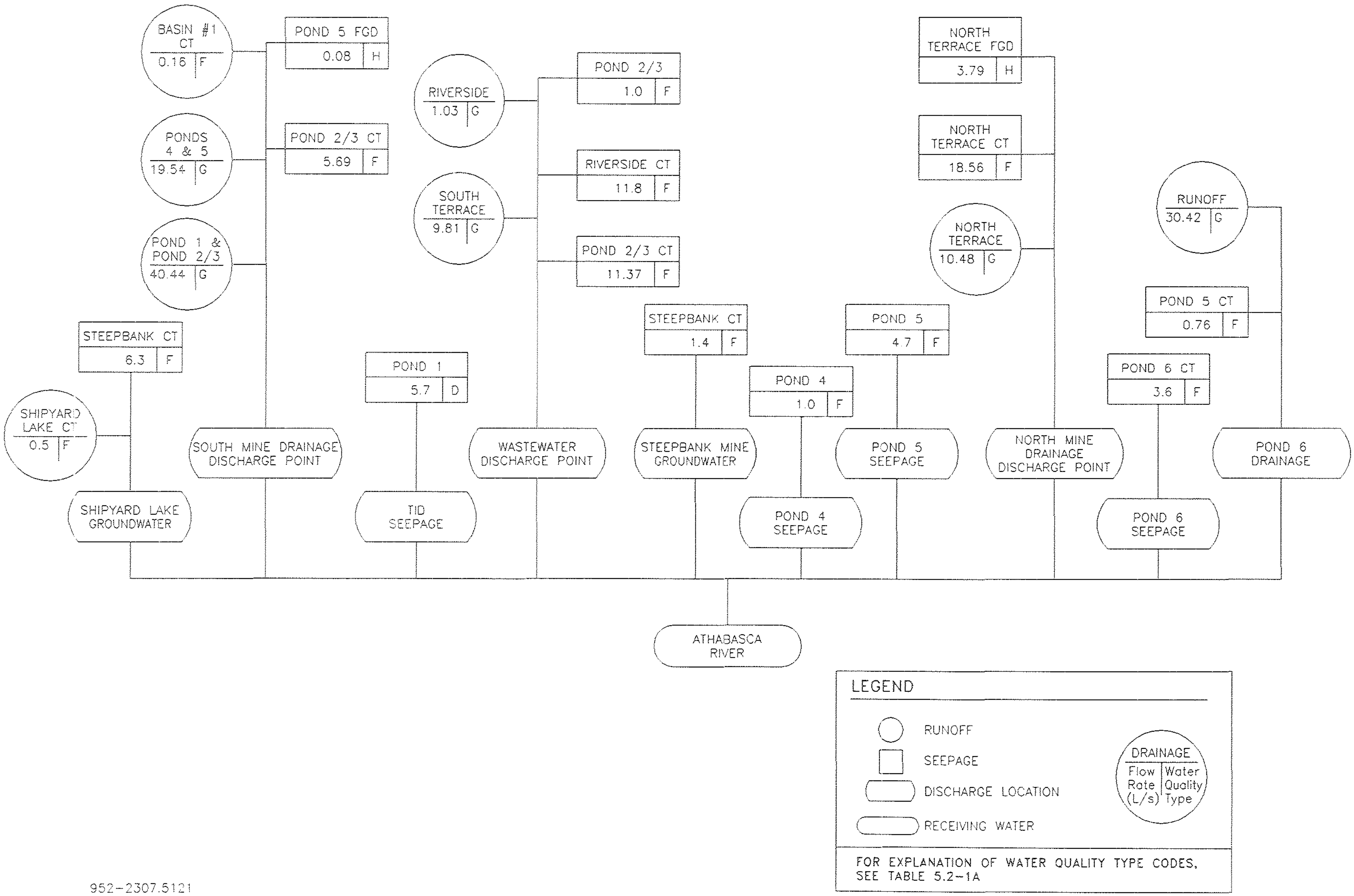
MINESITE DRAINAGE TO ATHABASCA RIVER
SCENARIO: 2020



952-2307.5121
\CH5.R13

Figure 3.3-5

MINESITE DRAINAGE TO ATHABASCA RIVER
SCENARIO: POST-RECLAMATION



952-2307.5121
\CH4.R13

concentrations were then used as input concentrations for the wildlife exposure model. In particular, exposure point concentrations are required for water (Athabasca River and on-site surface water for wildlife), plant, and animal tissues.

The concentrations of the chemicals of potential concern in waters will be highly variable within the reclaimed landscape, given the diversity of sources (CT release water, groundwater seepage and surface runoff from many different reclamation units). Estimates of on-site concentrations were made using a mixing model, where the various on-site waters combine at several nodes prior to discharge to the Athabasca River (see Golder 1996a for a detailed description of this model). These on-site surface waters are assumed to be available to wildlife as a source of drinking water and are composed of water from south mine drainage discharge point, TID seepage, wastewater discharge point, mid-plant drainage discharge point, Pond 4 seepage, north mine drainage point, Pond 5 seepage and Pond 6 seepage. These on-site concentrations represent worst-case conditions since biodegradation processes (e.g., wetlands processing) were not accounted for in the water quality model."

In addition, the sustainability of wetlands receiving CT input is described in detail in Section 4.2.4 of that report.

Suncor will continue to assess surface waters associated with CT landscapes to verify preliminary results. This will be done in conjunction with the CT Reclamation Demonstration described in Question 7.4. Currently, several studies are in place or proposed to develop a design basis for the demonstration (see Question 5.4). The process of predicting water quality through model verification will continue into operational phases of CT deposition.

b) **investigate what will be done with the CT release waters in the earliest stages of evolution of the CT deposit/reclaimed pond when water quality will presumably be the worst.**

A5.12b Suncor plans to maximize the recycling of CT release waters, particularly in the earliest stages of evolution of the CT deposit and reclaimed ponds. Water which cannot be recycled will be treated and released under approved conditions. The timing and discussion of CT release water handling is given in Question 5.1. Investigations will commence in the fall of 1996 when the FGD plant comes on line. Results regarding treatment options would be available by mid-1997.

c) **assess the implications of high sulphate concentrations in the CT release water for sulphate-reducing bacterial metabolism, potential production of hydrogen sulphide, and consequent secondary effects on other aquatic biota in these waters?**

A5.12c The activities of sulphate-reducing bacteria are limited by the availability of other requirements for the bacterial metabolic processes. Most notably, biodegradable organic carbon levels within the CT and CT release waters are at levels such that they act to limit the activities of the sulphate- reducing bacteria. With time, some additional organic carbon may become available in the CT deposits (e.g., through breakdown of organic compounds such as naphthenic acids); however, the rate of breakdown in anaerobic environments, such as would be found within the main body of the CT deposit, is low enough to continue to restrict the activities of the sulphate-reducing bacteria.

Issues related to sulphates will be addressed in the research programs addressed in 5.1(a) and (b).

d) **assess water quality impacts of proposed release waters on local surface water bodies (e.g. Ruth Lake) at pertinent stages in the evolution of the reclaimed landscape.**

A5.12d The reclamation performance assessment framework and models are designed to assess off-site impacts including intermediate systems such as Ruth Lake. As research and monitoring progresses with data output from the on-site programs described in 5.1 (a) and (b), this assessment will be conducted on an iterative basis.

Characterization of Treatment and Discharge Streams

Q5.13 Provide a detailed discussion on why the assumptions made regarding CT wastewater contaminants are considered to be conservative or worst case.

A5.13 As noted on page 12 of *Athabasca River Water Releases Impact Assessment* report:

"Groundwater that originates from CT deposits is expected to be generally comparable to CT release water collected in various lab and field trials (Table 3.2-1). However, it is likely that the CT groundwater will contain lower concentrations of most chemicals than was measured in the laboratory and field experiments because of physical (e.g., mixing with precipitation, dispersion), chemical (sorption of organics to solids) and biological (microbial decay) processes within the groundwater that will reduce levels of certain chemicals. Hence, the use of CT data from the current laboratory and field experiments is expected to serve as a conservative surrogate for CT seepage water."

Further support in provided on page 47 of *Athabasca River Water Releases Impact Assessment* report:

"The limited information on other types of water (CT water, refinery wastewater and other dyke seepages) also indicates a LOEL of 10% and a NOEL of 1% (one endpoint only - EROD). Induction of EROD is a very sensitive endpoint; therefore, although it was the only endpoint used in tests on other types of water releases, it is unlikely that any other endpoint would yield lower LOELs or NOELs. Based on this reasoning, it was assumed that the LOEL and NOEL derived from the existing information could be also applied to Suncor's refinery wastewater, CT release water and seepage waters derived from other existing or future recycle or reclamation ponds and dykes."

In addition, the assessment of potential impacts on people, wildlife and aquatic biota was based on maximum concentrations for chemicals detected in all CT samples. These CT samples included ones that were of extremely poor quality (i.e., only partially non-segregated), which had particular implications with respect to anomalously high PAH levels. See response to Question 3.39 for further discussion of this issue.

Q5.14 Indicate when a thorough characterization of CT wastewater will be available to verify the conservative assumptions employed in the Steepbank Mine application. Indicate the earliest date when this information can be provided, and explain how the information will be used in the evaluations required to support a future application for approval to discharge CT release waters.

A5.14 Detailed analytical and toxicological data are available on CT release waters generated using commercial gypsum, and these data are provided in the EIA impact analysis reports, e.g., see Table I-3 in *Impact Analysis of Aquatic Issues Associated with the Steepbank Mine*.

Figure D3.0-25 of the Steepbank Application shows that it will be several years before chemical equilibrium is reestablished in the tailings system following conversion to the CT process. These forecasts will be updated based on actual operating chemistry data from the FGD and CT processes. It appears that the earliest meaningful period to update these forecasts would be in the second quarter of 1997. This schedule is driven by time for the FGD process to achieve equilibrium with its clarification pond such that its recycle water chemistry is reasonably constant, and for the process to extract gypsum crystals from the FGD gypsum stream for use in CT to be developed, implemented and close to equilibrium.

The remaining portions of this question are answered under question 5.1.

Q5.15 Suncor states that sources of reclamation waters include run-off and seepage from coke piles and gypsum storage (*Steepbank Mine Project Application, April 1996, Section D3.0, p.10*). Summarize the quality and quantity of such waters and the anticipated impacts associated with them.

A5.15 Currently, runoff from coke is diverted to the wastewater treatment system and seepage from coke is monitored as part of Suncor's groundwater monitoring program. There is no evidence that seepage from the existing coke piles is affecting aquatic biota or water quality in the Athabasca River (see *Aquatic Baseline Report for the Athabasca, Steepbank and Muskeg Rivers in the Vicinity of the Steepbank and Aurora Mines* for a discussion of existing impacts).

A recently complete laboratory study conducted by HydroQual has confirmed the lack of toxicity and leaching of inorganic chemicals that might be associated with coke. In particular, extractions of coke were prepared using natural surface water, TID seepage water and Pond 5 CT water and the findings of that study indicates that coke may act to reduce toxicity of process-affected waters. Given that stored coke will be reclaimed with a capping layer and re-vegetated, and the lack of leaching from coke, no impacts on surface runoff or groundwater quality are anticipated.

Potential impacts associated with seepage from the gypsum storage area has been incorporated into the cumulative assessment of water releases, as noted in Figures 3.3-4 and 3.4-5 of *Athabasca River Water Releases Impact Assessment*. As concluded in that report, it is unlikely that Suncor's release waters ware currently affecting or will in the future affect the health of aquatic biota in the Athabasca River. Given that the total loading from gypsum is small relative to other sources, it is reasonable to conclude that gypsum storage will not result in impacts on aquatic biota.

Treatment and Control Processes

Q5.16 What is the probable source of copper, mercury, molybdenum, ammonia, cyanide and chromium in the wastewaters and can it be reduced through source control (elimination or replacement of any process chemicals used)?

A5.16 Ammonia is produced in the hydrotreaters from reactions between nitrogen and hydrogen. Due to its high solubility in water, sour water from the Upgrader is rich in ammonia. Although the bulk of the ammonia is routed to the tailings pond there have been occasions in the past when some of this ammonia rich water has entered the industrial wastewater system. When such a situation does occur the API diversion pumps are activated and the water is routed to the tailings pond. This prevents significant amounts of ammonia from entering the river but small amounts will continue to be discharged. Ammonia is a licensed discharge parameter for the wastewater outfall. All discharges are in compliance with Suncor's current environmental operating approval.

Metals such a molybdenum, chromium, and copper are native to the oil sands and are concentrated through the processing steps involved in producing synthetic crude. Ash generated in the power house from the combustion of coke is high in these metals. As a result, the bulk of the metals found in the wastewater outfall come from the ash pond. Suncor's plan (see Fixed Plant Expansion Application) to send all ash to the tailings pond will eliminate this source of metals from the wastewater system.

There are natural background concentrations of mercury in the Athabasca River. Concentrations of mercury detected in Suncor's wastewater outfall are generally less than natural background concentrations. Suncor uses electrical switches that contain small quantities of mercury. Systems and procedures are in place to properly clean up and dispose of any spills of mercury arising when any of these glass switches are broken. All such spill cleanup material is routed through the hazardous waste storage yard for off-site disposal at approved waste management facilities.

Although Suncor does have a number of chemical products (12) containing cyanide compounds that are approved for use on plant site, most of these products are not stock items (i.e., they are not used in significant quantities) and none are used as process chemicals. Based on limited historical cyanide data in the Athabasca River, it appears that Suncor's wastewater discharge is in the range of background levels.

To the best of Suncor's knowledge there are no process chemicals used that contribute to the concentrations of the six substances mentioned above. That is not to say, however, that Suncor does not use chemical products that contain these substances. For example, many of the lubricants approved for use on plant site do contain molybdenum; however, there is no reason to believe that the molybdenum from such lubricants enter the wastewater system.

Q5.17 The water supply and treatment system and the sewage treatment system *(Steepbank Mine Project Application, April 1996, Section C3.0, pp.59,60 and Section D2.0, p.3)* will not be approved until detailed designs and specifications are submitted for review and approval. Provide either a detail design and specifications for the water supply and treatment system and the sewage treatment system or a time frame for when the information will be provided.

A5.17 The project schedule for the water supply and treatment system, and the sewage treatment system allows for the design base memorandum (DBM) to be completed by the end of 1996, and the detail design to be done by June 1997. Detailed designs will be submitted for approval at this time.

Assessment and Risk Evaluation Methods

Q5.18 Suncor has indicated that it did not screen for aesthetic compounds *(Athabasca River Water Releases Impact Assessment, April 1996)*. What compounds were not screened and why? Clarify whether any streams resulting from the mine

expansion, controlled or otherwise, result in Alberta Surface Water Quality Objectives for aesthetic compounds being exceeded.

A5.18 The wasteload allocation study was done, as noted on p. 4 of *Athabasca River Water Releases Impact Assessment* to help identify chemicals of potential concerns with respect to the health of aquatic biota in the receiving water and as noted on p. 56 of the report to help identify chemicals of potential concern with respect to the human health. Aesthetic objectives were, therefore, not relevant to these investigations.

Even so, certain aesthetic compounds were evaluated. For instance laboratory and field tests were conducted to help assess potential for tainting and these are described in Section F4.0 of *Impact Analysis of Aquatic Issues Associated with the Steepbank Mine, April 1996.* Phosphorus, which is of potential concern because of its role in eutrophication, is discussed below.

The total load of phosphorus from all of the Suncor discharges for Year 2020 (the worst scenario) is 18.7 kg/d (based on maximum recorded effluent total phosphorus concentrations and average flows). The average flow of Athabasca River for the open water season from April to September in 1995 was 885 m^3/s based on Water Survey of Canada flow data.

Q5.19 Confirm that the use of the "maximum" concentration of wastewater substances provided a conservative value to use for the screening assessments *(Athabasca River Water Releases Impact Assessment, April 1996, Appendix VI)*. For example, if there were only two values available, the maximum value of those two would not provide a conservative estimate for screening estimates. Note that the procedures manual recommends the 99^{th} percentile of the substance value (where the predicted percentile is based on an adequate amount of data at least, and preferably greater than 10). If data are not adequate, the reasonable potential multiplier approach should be used. Verify that where substance values were all non detectable, that there were adequate data to follow the assumption that the substance could be excluded from further analysis; or that adequate rationale otherwise exists.

A5.19 The wasteload allocation study was done, as noted on p. 4 of Athabasca River Water Releases Impact Assessment, to help identify chemicals of potential concern with respect to the health of aquatic biota in the receiving water and as noted on p. 56 to help identify chemicals of potential concern with respect to the human health. Suncor is not applying for an approval for discharge of CT water at this stage and does not feel that strict application of the guidance document is required at this point in time.

In any case, for most chemicals and wastewater streams, there are sufficient data to characterize the wastewater streams (see attached Table 5.19-1). For the chemicals/wastewaters in which data are limited we feel that worst-case data have been used (see response to question 3.1.3) and that additional data will likely substantially reduce concentrations used in this screening-level assessment. Table 5.34-1 gives concentrations used in the analysis (see A5.34).

Q5.20 Suncor states that AEP's Procedures Manual protocol was followed to derive a chemical specific wasteload allocation and that median, low-flow background data was used *(Athabasca River Water Releases Impact Assessment, May 1996, p.22)*. The Procedures Manual states that the selection of background contaminant concentrations and river flow conditions is case specific and that median low flow is appropriate in most cases. However, it also indicates that certain substances such as nutrients must be evaluated at appropriate conditions. Suncor should verify (or present arguments) that these compounds were assessed under appropriate conditions.

A5.20 The use of 7Q10 flow provides a conservative evaluation. It represents the worst-case scenario as opposed to summer flows which are much higher than 7Q10 flows. A discussion of phosphorus is provided in response to question 5.18.

Q5.21 It is not clear how the spatial mixing plots in Figures 4.2–x, and VI–x were constructed *(Athabasca River Water Releases Impact Assessment, May 1996)*. Clarify how the calculations were done, including a discussion on how or if the "10% of river width" relates to 10% fraction of flow and spatial zones.

Table 5.19-1 Sample Numbers for Chemical Analyses of Suncor Lease 86 Discharges

		South Mine Drainage	Mid-plant Drainage	North Mine Drainage	TID Seepage	Sewage Effluent	CT Seepage	Future Runoff (max. of South and North)[1]	Gypsum	Wastewater	Cooling Pond E
	Water Quality Code:	A	B	C	D	E	F	G	H	I	J
Para #	Parameter										
1	2,4,6-Trichlorophenol	0	0	0	0	0	0	0	0	3	0
2	2,4-Dichlorophenol	0	0	0	0	0	0	0	0	3	0
3	2,4-Dimethylphenol	4	4	4	1	1	14	0	0	3	3
4	Benzene	4	4	4	3	1	14	0	0	3	3
5	Benzo(a) anthracene	4	4	4	3	1	16	0	0	3	3
6	Biphenyl	4	4	4	3	1	16	0	0	3	3
7	Bis(2-Ethyl-Hexyl)Phthalate	0	0	0	0	0	0	0	0	3	0
8	Butylbenzyl-Phthalate	0	0	0	0	0	0	0	0	3	0
9	Carbon tetrachloride	4	4	4	3	1	14	0	0	3	3
10	Chloroform	4	4	4	3	1	14	0	0	3	3
11	Dibutyl-Phthalate	0	0	0	0	0	0	0	0	3	0
12	Diethyl-Phthalate	0	0	0	0	0	0	0	0	3	0
13	Ethylbenzene	4	4	4	3	1	14	0	0	3	3
14	Fluorene	4	4	4	3	1	16	0	0	3	3
15	Isophorone	0	0	0	0	0	0	0	0	3	0
16	Methylene chloride	4	4	4	3	1	13	0	0	3	3
17	m+p Xylene	4	4	4	3	1	14	0	0	3	3
18	m-cresol	4	4	4	3	1	14	0	0	3	3
19	naphthalene	4	4	4	3	1	16	0	0	3	3
20	o-xylene	4	4	4	3	1	14	0	0	3	3
21	Pyrene	4	4	4	3	1	16	0	0	3	3
22	Toluene	4	4	4	3	1	13	0	0	3	3
23	Total PAH's	0	0	0	3	1	14	0	0	3	0
24	Aluminum - Total	4	4	4	4	1	9	0	0	65	15
25	Ammonia - Total	4	4	4	4	1	17	0	0	60	18
26	Antimony - Total	0	0	0	0	0	0	0	1	1	0
27	Arsenic - Total	4	4	4	4	1	8	0	1	61	16
28	Barium - Total	4	4	4	4	1	9	0	1	26	13
29	Beryllium-Total	4	4	4	4	1	9	0	1	8	1
30	Boron - Total	4	4	4	4	1	9	0	1	5	5
31	Cadmium - Total	4	4	4	4	1	9	0	1	83	16
32	Calcium	4	4	4	4	1	18	0	0	42	18
33	Chloride	4	4	4	4	1	18	0	0	55	18
34	Chromium - Total	4	4	4	4	1	9	0	1	80	16
35	Cobalt - Total	4	4	4	4	1	9	0	1	82	16
36	Copper - Total	4	4	4	4	1	9	0	1	82	16
37	Cyanide -Total	4	4	4	4	1	8	0	1	4	4
38	Iron - Total	4	4	4	4	1	9	0	1	67	18
39	Lead - Total	4	4	4	4	1	9	0	1	70	15
40	Lithium-Total	4	4	4	4	1	9	0	0	4	4
41	Manganese - Total	4	4	4	4	1	9	0	1	75	16
42	Mercury - Total	4	4	4	4	1	7	0	1	79	16
43	Molybdenum - Total	4	4	4	4	1	9	0	1	77	16
44	Nickel - Total	4	4	4	4	1	9	0	1	78	15
45	Phenols - Total	4	4	4	2	1	5	0	0	57	16
46	Phosphorus-Total	4	4	4	4	1	16	0	0	66	17
47	Selenium - Total	4	4	4	4	1	8	0	1	59	13
48	Silver - Total	4	4	4	4	1	9	0	1	30	6
49	Strontium - Total	4	4	4	4	1	9	0	0	4	4
50	Sulphate	4	4	4	4	1	18	0	0	57	17
51	Thallium	0	0	0	0	0	0	0	1	8	1
52	Toxicity (chronic)	4	4	4	4	1	1	0	0	4	4
53	Uranium - Total	4	4	4	4	1	9	0	1	4	4
54	Vanadium - Total	4	4	4	4	1	9	0	1	80	16
55	Zinc - Total	4	4	4	4	1	9	0	1	80	16

[1] No data available for future conditions.

A5.21 Distributions of constituents in the river were modeled using a two-dimensional river mixing model as described in Section 3.3 (p. 14) of *Athabasca River Water Releases Impact Assessment.* Model simulation was conducted for each of the parameters listed in the mixing plots (Figures 4.2-x, and VI-x for different stages of reclamation (Years 1995, 2001, 2010, 2020 and Long-Term), respectively. The output of the mixing model was then processed using a graphing software package, SURFER, to generate the contour plots. The term "10% of river width" refers to the spatial zone and it is equivalent to 10% fraction of flow.

Q5.22 What tracer studies were employed to calibrate the mixing models and are these available?

A5.22 The model was calibrated based on a dye tracer study carried out by Golder in October of 1994. Rhodamine dye tracer was released into the Suncor effluent stream, and its concentration was measured at a number of cross-sections downstream. The field data were then applied for model calibration. Details are provided in Golder. 1994. *Mixing Characteristics of the Suncor Effluent Disharge into the Athabasca River* as referenced in *Athabasca River Water Releases Impact Assessment, May 1996, p93.*

Q5.23 The discussion on human health risk characterization indicates that only the determination of whether the reclaimed landscape poses risk was conducted - inferring that operational phase and wastewater discharges are not being characterized *(Athabasca River Water Releases Impact Assessment, May 1996, p.6)*. Please clarify whether the risk assessment included operational and off-site (receiving water) analyses.

A5.23 The statement on p. 6 is incorrect. As noted on p. 1, the risk assessment addresses potential impacts associated with water releases on the health of people or wildlife that either now or in the future might use the Athabasca River, downstream of Suncor's operations. The release waters consist of all current and future operational and reclamation waters, e.g., CT water, mine drainage waters, seepage from tailings dykes, treated sewage effluent and refinery wastewater and cooling water.

Q5.24 Regarding wasteload allocation, it is stated that predicted concentrations are compared to health-based drinking water criteria. Later discussion indicates that EPA human health based criteria were also considered *(Athabasca River Water Releases Impact Assessment, May 1996, p.56)*. Were only "drinking water criteria" considered?

A5.24 The Wasteload Allocation protocol included U.S. EPA human health-based criteria, which are based on both drinking water and fish ingestion

Q5.25 *Athabasca River Water Releases Impact Assessment, p.64* alludes to the health based drinking water criteria of 0.025 mg/L. Page 57 similarly refers to a drinking water criteria of 0.05 mg/L. Are these different jurisdictional criteria?

A5.25 Two different jurisdictional criteria were inadvertently used here. Page 57 refers to the U.S. EPA drinking water criterion, while page 64 refers to the Health and Welfare Canada criterion. This inconsistency has no bearing on the discussion and findings of this report

Q5.26 If the WLA assessment using EPA human health criteria were used, then it could be stated that an assessment associated with ingesting raw water and aquatic organisms was done according to USEPA human health carcinogen and non-carcinogen wasteload allocation screening procedures *(Athabasca River Water Releases Impact Assessment, May 1996, p.89)*. This should be clarified as the use of these criteria are recommended in the Procedures Manual.

A5.26 Reference to the wasteload allocation study should have been made in Section 6.2. The WLA assessment associated with ingesting raw water and aquatic organisms was completed according to US EPA human health carcinogen and non-carcinogen wasteload allocation screening procedures.

Q5.27 Table VI–12 is mislabelled *(Athabasca River Water Releases Impact Assessment, May 1996)*. The title suggests these EPA criteria are only non-carcinogens, while the column label suggests carcinogens only.

A5.27 A revised Table is attached.

TABLE VI-12
MAXIMUM PREDICTED RIVER CONCENTRATION AFTER COMPLETE MIXING AT 366 m^3/s COMPARED TO HUMAN HEALTH GUIDELINES

	Max. River Concentration (mg/L)	Human Health Guideline (mg/L)	Guideline Source
ORGANIC			
Benzene	0.0000025	0.0012	U.S. EPA
Benzo(a) anthracene	0.0000029	0.0000028	U.S. EPA
Butylbenzyl-Phthalate	0.00000081	5.2	U.S. EPA
Carbon tetrachloride	0.0000075	0.00025	U.S. EPA
Chloroform	0.0000075	0.0057	U.S. EPA
Dibutyl-Phthalate	0.0000024	2.7	U.S. EPA
2,4-Dichlorophenol	0.00000081	0.093	U.S. EPA
Diethyl-Phthalate	0.00000081	23	U.S. EPA
Dis(2-Ethyl-Hexyl)Phthalate	0.000038	15	U.S. EPA
Ethylbenzene	0.00000081	3.1	U.S. EPA
Fluorene	0.000000044	1.3	U.S. EPA
Isophorone	0.00000081	0.0084	U.S. EPA
Methylene chloride	0.000014	0.0047	U.S. EPA
Pyrene	0.000000059	0.96	U.S. EPA
Toluene	0.00000081	6.8	U.S. EPA
Total PAH's	0.000045	0.0000028	U.S. EPA
INORGANIC			
Antimony - Total	0.0000016	0.014	U.S. EPA
Arsenic - Total	0.00064	0.000018	U.S. EPA
Barium - Total	0.080	1	U.S. EPA
Cyanide -Total	0.000033	0.7	U.S. EPA
Iron - Total	0.20	0.3	U.S. EPA
Manganese - Total	0.0074	0.05	U.S. EPA
Mercury - Total	0.0000011	0.00014	U.S. EPA
Nickel - Total	0.0052	0.61	U.S. EPA
Thallium	0.00087	0.0017	U.S. EPA

U.S. EPA (1986).

Q5.28 Most of the sampling was carried out during the summer of 1995 *(Aquatic Issues Associated With the Steepbank Mine)* Large forest fires were raging during sampling. These could have affected some of the sampling results (e.g., high total suspended solids, potential increase in organic substances). Provide discussion of these potential effects. This discussion would facilitate interpretation of future monitoring results.

A5.28 Potential effects of forest fires on surface water quality include increases in suspended solids, nutrients and associated chemicals (e.g., PAHs, dissolved organic carbon). During summer, the Athabasca River was sampled immediately after a fourfold increase in discharge (from 760 to 3000 m^3/s), which greatly increased the suspended sediment load of the river and associated variables. Hence, a change in water quality due to fires would not have been detectable. Also, comparison of data collected in 1995 with historical data for the Athabasca and Steepbank Rivers did not reveal any substantial deviation from previously documented water quality in the river with the exception of high suspended solids loads in the Athabasca River and associated increases in a number of variables in the summer.

Q5.29 A number of laboratory studies were done in relation to tainting potential, such as toxicity testing in the laboratory and exposure of fish to determine tainting *(Athabasca River Water Releases Impact Assessment, May 1996)*. Provide the following information regarding exposure conditions:

a) the source of Athabasca River water used in the lab studies is not described. Was it upstream or downstream of Tar Island Dyke (TID), how far removed.

A5.29a Athabasca River water used in the laboratory studies was collected from upstream of Tar Island Dyke near Fort McMurray (upstream of Sewage Treatment Plant).

b) the dilution water for the TID seepage exposure of various trophic levels is not specifically stated. It is assumed that it was laboratory water (as for the fish tainting studies).

A5.29b Laboratory water was used as the dilution water for the TID seepage exposure to various trophic levels.

c) **the reference to the location of field exposed fish for the tainting study is that it was upstream of the oil sands operations. Was the site upstream from oil sands deposits or was it a site representative of "natural background conditions".**

A5.29c The reference site for the tainting study that was noted as "upstream of oil sands operations" was located a few hundred metres upstream of Tar Island Dyke. Hence, the site was within the oil sands deposits area but outside of the influence of oil sands operations and was representative of "natural background conditions" within the oil sands area.

d) **the effects of control laboratory water and Athabasca River on toxicity/tainting should be compared. This comparison should be used to put the TID seepage tests with laboratory water in context. That is, what is the toxicity/tainting expected to be when TID seepage mixes into the Athabasca River (a condition that was not tested in the laboratory).**

A5.29d The enormous volumes of Athabasca River water required for dilution of TID and other wastewaters for toxicity/tainting testing precludes it use as a dilution water. It is expected that given the higher concentrations of suspended materials in the Athabasca River compared to laboratory control water, that toxicity and possibly tainting compounds will be less available (because of sorption to suspended solids), hence effect levels in the river may be higher than predicted from the laboratory studies. Suncor is currently assessing the feasibility of *in situ* tainting studies.

Q5.30 In Table 3.2–1 *(Athabasca River Water Releases Impact Assessment, May 1996, p.12)*, is the refinery wastewater the treated effluent?

A5.30 The term "refinery wastewater" is equivalent to the term "treated effluent" from the wastewater system.

Q5.31 Clarify the assumed effluent toxicity used to generate the predicted in-river TUc's in Figures 4.2–1 to 4.2–5. *(Athabasca River Water Releases Impact Assessment, May 1996, p.26).*

A5.31 The assumed effluent toxicity was based on the most sensitive chronic endpoint (based on IC25%) and the maximum toxicity reported for that endpoint for each water type. Toxicity data are summarized in Table 4.2-1, and the endpoints included Ceriodaphnia reproduction (TID, CT, cooling pond and sewage lagoon) and algal growth (mine drainage and wastewater system).

Q5.32 Provide the sites and results for benthic sampling of natural substrates discussed in Section 4.3.1.1 Benthic Invertebrates *(Athabasca River Water Releases Impact Assessment, May 1996, pp.28,29)*. Suncor suggests that effects were absent and that this is generally consistent with results of previous benthic surveys. In fact, some previous surveys found localized effects of Suncor wastewaters. Provide discussion on how follow-up studies were designed to verify that the original localized effects are no longer present.

A5.32 Detailed results of the benthic invertebrate survey conducted in 1995 and exact site locations are provided on pages 13-24 (methods) and pages 47-62 (results) of *Aquatic Baseline Report for the Athabasca, Steepbank and Muskeg Rivers in the Vicinity of the Steepbank and Aurora Mines*. Sampling sites along the west bank (where Suncor's current discharges are located) included upstream reference sites, one site below Tar Island Dyke, one site below Suncor's refinery wastewater and sewage discharges and one site approximately 4 km farther downstream. Although benthic community composition varied moderately among sites in both types of samples collected (artificial substrates and Ekman grab), the study did not provide consistent evidence of effluent-related effects on benthic invertebrates. The previous localized effects were found immediately downstream from the refinery wastewater and sewage outfalls. These effects are not relevant to the general ecological health of the Athabasca River, since recovery was found 1 km below the farthest downstream discharge point. The approach used in the 1995 surveys consisted of monitoring one site just below all of Suncor's discharges. Therefore, although the localized effects may persist, the 1995 studies have shown that the general ecological health of the Athabasca River, as reflected by the resident benthic invertebrate communities, has not been compromised by Suncor's operations as also found by the previous studies.

Because the studies conducted in 1995 were aimed to provide baseline information, it was necessary to increase the spatial coverage within the study area instead of focussing on individual discharges. Suncor is currently preparing the long-term monitoring plan for the Athabasca and Steepbank rivers. The long-term monitoring study design will be effects-oriented and will include benthic invertebrate sampling. It is anticipated that the long-term monitoring plan will be available by 30 September 1996.

Q5.33 Table VI–11 *(Athabasca River Water Releases Impact Assessment, May 1996)* should have been referenced. With respect to copper toxicity, a statement on hardness should be included; the recent monitoring near the lease indicate a water hardness of about 110 mg/L calcium carbonate ($CaCO_3$). Discuss this matter.

A5.33 Table VI-11 is referenced on page VI-12 of Appendix VI. A statement on hardness was inadvertently omitted. There should have been a footnote on the table indicating that a hardness value of 192 mg/L based on the winter median value was used. If a hardness value of 110 mg/L is used, the results of the analysis would not change. The maximum release water concentration (0.049 mg/L) would still exceed the acute guideline of 0.019 mg/L calculated with a hardness level of 110 mg/L.

Q5.34 Minesite drainage to the Athabasca River is shown for the present and future scenarios *(Athabasca River Water Releases Impact Assessment, May 1996, Figures 3.3–1 to 5)*. Note that reference to Table 5.2–1 for the water quality type codes cannot be located. Clarify.

A5.34 Table 5.2-1 referred in Figures 3.3-1 to 3.3-5 was not included in the report - *Athabasca River Water Releases Impact Assessment, May 1996.* It is included as Table 5.34-1 of this Supplemental to show the water quality type codes for different water releasess. A total of 11 water quality types were used in model simulation, and they

Table 5.34-1 Maximum Concentrations in Suncor Lease 86 discharges

		Type of drainage	South Mine Drainage	Mid-plant Drainage	North Mine Drainage	TID Seepage	Sewage Effluent	CT Seepage	Future Runoff (max. of South and North)[1]	Gypsum	Wastewater	Cooling Pond E
	Water Quality Code:		A	B	C	D	E	F	G	H	I	J
Para #	Parameter	Units										
1	2,4,6-Trichlorophenol	mg/L	-	-	-	-	-	-	-	-	0.007	-
2	2,4-Dichlorophenol	mg/L	-	-	-	-	-	-	-	-	0.001	-
3	2,4-Dimethylphenol	mg/L	ND	ND	ND	ND	ND	0.001	ND	-	0.001	ND
4	Benzene	mg/L	ND	ND	ND	ND	ND	ND	ND	-	0.001	ND
5	Benzo(a) anthracene	mg/L	ND	ND	ND	ND	ND	0.00027	ND	-	0.001	ND
6	Biphenyl	mg/L	ND	ND	ND	ND	ND	0.00008	ND	-	ND	ND
7	Bis(2-Ethyl-Hexyl)Phthalate	mg/L	-	-	-	-	-	-	-	-	0.015	-
8	Butylbenzyl-Phthalate	mg/L	-	-	-	-	-	-	-	-	0.001	-
9	Carbon tetrachloride	mg/L	ND	ND	ND	ND	ND	ND	ND	-	0.003	ND
10	Chloroform	mg/L	ND	ND	ND	ND	ND	ND	ND	-	0.003	ND
11	Dibutyl-Phthalate	mg/L	-	-	-	-	-	-	-	-	0.003	-
12	Diethyl-Phthalate	mg/L	-	-	-	-	-	-	-	-	0.001	-
13	Ethylbenzene	mg/L	0.0012	ND	ND	0.0015	ND	ND	0.0012	-	ND	ND
14	Fluorene	mg/L	ND	ND	ND	ND	ND	0.00003	ND	-	ND	ND
15	Isophorone	mg/L	-	-	-	-	-	-	-	-	0.001	-
16	Methylene chloride	mg/L	ND	0.004	ND	ND	ND	ND	ND	-	0.0057	ND
17	m+p Xylene	mg/L	0.0041	0.0024	0.0029	ND	0.003	0.015	0.0041	-	ND	ND
18	m-cresol	mg/L	ND	0.0002	ND	ND	ND	0.0005	ND	-	ND	ND
19	naphthalene	mg/L	ND	ND	ND	ND	ND	0.00005	ND	-	ND	ND
20	o-xylene	mg/L	0.0017	0.001	0.0013	0.0027	0.0013	0.015	0.0017	-	0.0022	0.0028
21	Pyrene	mg/L	ND	ND	ND	ND	ND	0.00004	ND	-	ND	ND
22	Toluene	mg/L	ND	ND	ND	ND	ND	ND	ND	-	0.001	ND
23	Total PAH's	mg/L	-	-	-	0.00221	0.00017	0.02326	-	-	ND	-
24	Aluminum - Total	mg/L	0.04	0.1	0.07	1.15	0.51	1.92	0.07	-	5.93	1.15
25	Ammonia - Total	mg/L	0.04	0.05	0.03	6.01	9.26	3.98	0.04	-	25	0.22
26	Antimony - Total	mg/L	-	-	-	-	-	-	-	ND	0.002	-
27	Arsenic - Total	mg/L	0.0005	0.0007	0.0002	0.003	0.0037	0.0058	0.0005	ND	0.17	0.004
28	Barium - Total	mg/L	0.08	0.09	0.12	0.1	0.06	0.18	0.12	0.13	0.101	0.102
29	Beryllium-Total	mg/L	0.003	0.003	0.003	0.002	0.002	ND	0.003	ND	0.002	0.002
30	Boron - Total	mg/L	0.22	0.375	0.19	1.88	0.5	4.26	0.22	1.21	0.15	0.07
31	Cadmium - Total	mg/L	ND	ND	0.003	0.004	ND	0.0066	0.003	ND	0.01	0.003
32	Calcium	mg/L	64	96.3	99	57.1	75.3	118	99	-	69	55
33	Chloride	mg/L	41	190	36	17.3	106	510	41	-	354	ND
34	Chromium - Total	mg/L	ND	0.004	0.002	0.002	ND	0.003	0.002	ND	0.029	0.008
35	Cobalt - Total	mg/L	0.005	ND	0.004	0.005	0.011	0.007	0.005	0.02	0.01	0.004
36	Copper - Total	mg/L	0.004	0.005	0.009	0.006	0.005	0.004	0.009	0.01	0.064	0.029
37	Cyanide -Total	mg/L	0.001	0.001	0.002	0.002	0.004	0.055	0.002	0.07	0.003	0.001
38	Iron - Total	mg/L	0.113	0.45	0.3	2.21	1.05	1.01	0.3	0.35	2.56	2.28
39	Lead - Total	mg/L	ND	ND	ND	ND	ND	0.02	ND	ND	0.05	0.05
40	Lithium-Total	mg/L	0.018	0.035	0.016	0.144	0.01	0.272	0.018	-	0.022	0.006
41	Manganese - Total	mg/L	0.035	0.047	0.111	0.213	0.425	0.058	0.111	1.41	0.121	0.153
42	Mercury - Total	mg/L	0.00052	0.00052	0.00051	0.00026	ND	0.00005	0.00052	ND	0.00062	0.00052
43	Molybdenum - Total	mg/L	ND	0.018	0.0026	0.018	0.045	1.42	0.0026	2.23	0.6	0.002
44	Nickel - Total	mg/L	0.012	0.007	ND	0.005	ND	0.0295	0.012	0.5	0.148	0.02
45	Phenols - Total	mg/L	ND	ND	0.078	0.004	ND	0.016	0.078	-	0.002	0.002
46	Phosphorus-Total	mg/L	0.015	0.046	0.036	0.43	5.05	0.096	0.036	-	0.29	0.171
47	Selenium - Total	mg/L	ND	0.0002	ND	ND	ND	0.04	ND	ND	0.0059	0.0005
48	Silver - Total	mg/L	0.002	0.002	ND	0.0002	ND	0.002	0.002	ND	0.05	0.05
49	Strontium - Total	mg/L	0.171	0.496	0.281	0.337	0.339	2.12	0.281	-	0.287	0.222
50	Sulphate	mg/L	70	211	142	143	56.5	1290	142	-	116	49
51	Thallium	mg/L	-	-	-	-	-	-	-	ND	1	0.1
52	Toxicity (chronic)	TUc	0	10	8.33	6.25	2.78	7.19	8.33	-	8.3	2.9
53	Uranium - Total	mg/L	ND	0.5	ND	ND	ND	0.5	ND	ND	0.5	ND
54	Vanadium - Total	mg/L	0.005	0.003	0.005	0.01	0.003	0.17	0.005	0.13	1.61	0.013
55	Zinc - Total	mg/L	0.036	0.06	0.044	0.058	0.032	0.056	0.044	0.12	0.273	0.047

ND = Not Detected.
- = Not analyzed.
[1] No data available for future conditions. This column based on maximum concentrations from North and South Mine Drainages.

were coded as A to K, respectively. Concentrations of 56 water quality paramters are also shown in Table 5.34-1 for each water quality type.

Q5.35 Clarify why reclamation waters are "not amenable to comparison with ambient water quality criteria" ***(Steepbank Mine Project Application, April 1996, Section D3.0, p.9).***

A5.35 The statement "not amenable to comparison with ambient water quality criteria" is a definition that was based on an early draft of the Oils Sands Technical Working Group (OSWRTWG) report. In the final OSWRTWG report this aspect of reclamation waters has been reworded as follows: "water quality guidelines may not directly apply to all parameters."

Q5.36 Provide a list of groundwater sampling parameters ***(Steepbank Mine Project Application, April 1996, Section D2.0, p.3).***

A5.36 Suncor has been monitoring groundwater conditions on its Lease 86/17 site since the early 1980's. Currently the monitoring network includes 70 dedicated groundwater wells. In addition, 17 wells have been installed on the Steepbank minesite.

The general sampling suite for each well includes:

- Major Ions (Ca, Mg, Na, K, Cl, SO_4, CO_3, HCO_3)
- Conductivity
- Alkalinity
- pH
- TDS
- Hardness
- Nitrate/Nitrite

Other analyses which are carried out on a site specific basis include:

Metals (Al, As, Ba, Be, B, Cd, Cr, Co, Cu, F, Fe, Pb, Li, Mn, Hg. Mo, Ni, P, Si, Ag, Sr, S, Ti, U, V, Zn)

Oil and Grease

Total Organic Carbon

Total Extractable Hydrocarbons

Microtox

Biological Chemical Demand

BTEX plus Total Purgeables

Sulphide

PAH's

alkylated PAH's

Phenolics

PANH's

alkylated PANH's

Volatile Organics

Naphthenic Acids

Q5.37 For the Steepbank Mine, Suncor claims that any seepage water that passes through the dyke can be collected and contained in the mine drainage system *(Steepbank Mine Project Application, April 1996, Section D3.0, p.41)*. Suncor indicates that new impoundment facilities are designed to be constructed of low-permeability overburden materials that will not need engineered seepage control structure for stability. Provide the supporting information for these statements.

A5.37 Suncor constructs two types of tailings impoundment dykes; tailings sand dykes and overburden dykes. Because of their relatively high permeability (10^{-5} cm/s), tailings sand dykes generally require an engineered seepage control structure such as a drain to ensure the phreatic surface does not daylight on the downstream face of the dyke which could lead to local slumping and, potentially, piping. Suncor uses coke from its bitumen upgrader to construct drains in tailings sand dykes as the gradation of the coke makes it a filter to tailings sand. Coke drains generally contain a central perforated collection pipe and a number of lateral offtake pipes to drain the water.

Overburden dykes are constructed primarily of compacted lean tar sand and/or glacial till which has a permeability of between 10^{-6} and 10^{-8} cm/s. No engineered drains are required for stability or phreatic surface control in these structures as the low permeability reduces the volume of seepage. Sand drains (horizontal layers of sand 5-10 feet thick) are included to control construction pore pressures but they contain no pipes to direct seepage flow. Any water which does flow from the sand drains in overburden dykes on the Steepbank mine will be collected in ditches along the toe of the structure and contained.

Q5.38 Suncor has indicated that several water samples have been collected and analyzed to determine background water quality concentrations for various chemicals *(Steepbank Mine Project Application, April 1996, p.42 of Section D3.0)* Provide the complete results of these analyses.

A5.38 The results of these analyses are presented in a number of reports. Background surface water quality is data is located in the following reports:

Impact Analysis of Aquatic Issues Associated with the Steepbank Mine, April 1996.
Text pg. 17, 26, Table E2.0-1, Table E2.0-2, Table E2.0-3, Table I-3

- *Athabasca River Water Release Impact Assessment, May 1996.*
  Text pg. 11, Table 3.2-1
- *Aquatic Baseline Report for the Athabasca, Steepbank and Muskeg Rivers in the Vicinity of the Steepbank and Aurora Mines, Appendices, May 1996.*
  Text pg. 36, Table VII-1, Table VII-2, Table VII-3, Table VII-4, Table VII-5, Table VII-7, Table VII-8,Table VII-9

Background porewater quality is located in the following reports:

- *Impact Analysis of Aquatic Issues Associated with the Steepbank Mine, April 1996.*

  Text pg. 30

  Table E2.0-5
- *Tar Island Dyke Seepage Environmental Risk Assessment, 1994*
- *Tar Island Dyke Porewater Study, 1995*
- *Aquatic Baseline Report for the Athabasca, Steepbank and Muskeg Rivers in the Vicinity of the Steepbank and Aurora Mines, Appendices, May 1996.*

  Table VII-12, Table VII-13, Table VII-14

Groundwater quality information is located in the *Hydrogeology Baseline Steepbank Oil Sands Mine, May 1996.* (Table 6,Table 7).

Q5.39 Suncor states that the level of toxicity of CT release water was found to be lower than that of current recycle water *(Steepbank Mine Project Application, April 1996, Section D3.0, p.48)*, indicating that the creation of CT may be responsible for the reduced toxicity.

a) Provide a review of the detailed mechanisms involved for the reduction of toxicity in the CT process.

A5.39a The source of that statement is from Mikula and Kasperski's (1995) studies on NST, where they reported that toxicity of CT water was reduced relative to fresh tailings. Although they do not provide information on the cause(s) for this reduction in toxicity, there are a number of potential mechanisms:

- Change in surface charge of clays - The addition of gypsum ($CaSO_4$) reduces the highly negative charge associated with sodium-rich clays.

This leads to increased surface activity and increased affinity of PAHS and napthenates to clays. Decreased levels of these constituents, particularly naphthenates leads directly to decreased levels of toxicity.

- Mineral precipitation - The addition of gypsum leads to supersaturated conditions for minerals such as calcite, and may also results in co-precipitation of other compounds, e.g., calcium-naphthenates.
- Increased hardness - The addition of gypsum leads to increased hardness in CT waters relative to recycle waters, and hardness is inversely correlated to toxicity of many inorganic compounds.

The relative contribution of these mechanisms is not known but is a subject of ongoing research by the oil sands industry.

b) Is it possible that toxic materials could be more concentrated in CT, given reduced toxicity of release water? If so, how will these changes influence long term water quality in groundwater systems?

A5.39b If, as discussed above, these changes occur, then water quality in groundwater should be better than originally anticipated since solubility of PAHs and naphthenates is decreased and toxicity of metals and naphthenates reduced.

Q5.40 Results of the 1995 work showed that toxic waters from current dyke seepage and CT release can be treated in wetlands *(Steepbank Mine Project Application, April 1996, Section D3.0, p.49)*. Describe the mechanism involved in this treatment and how long it will take to complete the treatment.

A5.40 Treatment involves the biological breakdown of organic contaminants and ammonia. This is accomplished by natural communities of bacteria (and other microorganisms) which utilize these contaminants as a food source. The period required to achieve a non-acutely toxic water quality will be about one month in a pond/wetlands environment. This timing is under optimum natural conditions (i.e., open water, high oxygen levels and available nutrients). In colder seasons, it is anticipated that much longer retention periods and/or water storage capacities will be required.

Other contaminant fate processes also will occur in addition to natural biodegradation processes described above. These processes include: plant metabolism, volatilization, photolysis, filtration, absorption, sedimentation, precipitation and adsorption.

6 AIR QUALITY

Environmental Effects Monitoring (Biomonitoring)

Q6.1 Suncor currently participates on the Regional Air Quality Coordinating Committee (RAQCC) Environmental Effects Subcommittee, and has been supportive of the Ecological Effects Monitoring working group under the Clean Air Strategic Alliance (CASA). In order to develop successful new monitoring programs, it may be desirable that the results from previous programs that have been completed, or are ongoing, be made available for review by the RAQCC or CASA Committees. Indicate whether Suncor is willing to release pertinent data upon request by either committee.

A6.1 Suncor will provide any pertinent reports or data related to environment effects of air emissions to RAQCC or CASA.

Ground Level Ozone

Q6.2 In the application *(Steepbank Mine Project Application, April 1996, Section E9.0, p.87)*, and the associated impact analysis report *(Impact Analysis of Air Emissions Associated with the Steepbank Mine, April 1996, pp.41,122,128)*, ground level ozone is briefly discussed, and reference is made to ambient air concentrations of ozone in the region which exceed the 24-hour guidelines. Provide further discussion to clarify the proportions of ozone in ambient air attributed to natural sources and activities related to Suncor operations.

A6.2 Ground level ozone arises from two major sources, the first is naturally occurring caused by downward mixing of stratospheric ozone, and the second is due to tropospheric reactions of nitrogen oxides and VOC's in the presence of sunlight.

Using data from Fort McMurray air quality station over the period January 1990 to June 1995, it can be seen that the hourly objective of ozone ground level concentration is exceeded about four times per year. The daily average guideline was exceeded of 135 days of the year.

In order to estimate the relative contributions of anthropogenic and natural ozone to the overall ground level concentrations observed in Fort McMurray, the SMOG computer program (State of California Air Resources Board - Simulation Model of Ozone Generation) was run with the following cases:

- Baseline: Current Syncrude and Suncor Emissions
- Future: Emissions from Suncor, Syncrude and Solv-Ex
- What ozone concentrations would be if the Suncor source was replaced with naturally occurring sources of VOC's

Results from the modelling are as follows:

- The predicted ozone concentrations (first case, above) match the observed concentrations well.
- The modelled ozone concentrations do not show a significant decline even after the Suncor VOC abatement initiatives are implemented.
- Elimination of the Suncor source completely results in a 20% reduction of the

maximum ozone GLC.

In summary, the SMOG model predicts that a) the Suncor VOC reduction program will not have a significant effect on GLC ozone observed in Fort McMurray and b) the Suncor source can contribute up to a 20% of the GLC concentration of ozone.

Total Hydrocarbons (THCs) and Volatile Organic Compounds (VOCs)

Q6.3 In the application, THCs and VOCs are mainly discussed as groupings of compounds. Suncor has stated that the overall emission of these compounds is expected to decline (*Steepbank Mine Project Application, April 1996, Section E9.0, p.84 and Table E9.0–1*). However, we note that individual THC and VOC compounds do not have equal effects on the environment, as some compounds may have effects at very low levels, whereas others are not bioactive. Does Suncor presently have any plans to study and characterize the THC/VOC composition (i.e. presence and amounts of individual compounds) in the main air emission streams from the facility (e.g. tailings ponds, Hydrotransport Cyclofeeder, flares, main stacks)?

A6.3 Suncor has had a program in place to speciate hydrocarbons emitted from plantsite. Work to date has focussed on pond emissions and we have looked at hydrocarbons and sulphur containing hydrocarbons (specifically mercaptans and thiophenes). This year the plan is to expand the study to look for nitrogen containing hydrocarbon compounds.

This type of speciation is done batchwise and is generally handled by contract laboratories off-site. In order to obtain some statistical confidence in the representativeness of the analysis, Suncor plans to repeat and expand this type of work on an annual basis for the next five years on all VOC emission sources. This work is independent of specific analysis that Suncor is co-sponsoring through RAQCC initiatives.

The measurement of flare hydrocarbon combustion efficiency represents some challenges which we need to resolve prior to making any commitments. However based on the flare feed gas analysis containing 20% hydrogen we would expect nearly complete combustion.

The speciation analysis addresses most of the commonly known bio-active hydrocarbons including but not limited to species such as ethylene, TRS and aromatics.

VOCs and Odorous Emissions from Ponds

Q6.4 Table C8.0–2 presents a comparison of current and future VOC emissions *(Steepbank Mine Project Application, April 1996, Section C8.0, p.116)*. Provide a brief discussion on why VOC emissions are predicted to increase from the Tailings Ponds and Upgrading areas.

A6.4 The predictions in table C8.0-2 are based on measurements (for the ponds) and on typical emissions profiles (for the Upgrader) which were then increased in direct proportion to production to account for future increases. At the time, this approach was considered to be a reasonably conservative way to forecast emissions. No VOC abatement projects were therefore included in the estimate. Suncor's strategy has been to reduce significant sources as a priority and address other sources through continuous improvement opportunities. This has resulted in an overall decrease in VOC emissions.

Q6.5 Suncor states *(Steepbank Mine Project Application, April 1996, Section C8.0, p.116)* that "field measurements of pond emissions have indicated that ponds are a much less significant contributor to current VOC emissions from the plant than originally thought". Provide the following additional information:

a) the basis for the original assumption that pond emissions were a significant source of VOC emissions.

b) **the type and amount of field measurements that have been done which now indicate that the pond are a much less significant contributor of emissions, and**

c) **an indication of the likely precision of the Tailings Ponds emission values in Table C8.0–2, as well as the likely precision of the other emission values listed in the table.**

A6.5 The investigation into the relative magnitudes of VOC emissions from plantsite was initiated in the late 1980's, worked extensively on during the odour abatement initiatives and continues today. The original ranking of odour sources was calculated based on the product of "odour threshold" (a semi-qualitative measure of smell expressed in odour units) and flowrate.

This initial ranking of odour sources made assumptions (what are now known to be bad) about the odour threshold intensities of the plant 4 vents and the flowrates out of the South Tank farm vents. These assumptions lead to the identification of ponds 1 and 1A as the largest contributors to offsite odour.

The major odour incidents that occurred in the winter of 1991 (during which time most of pond 1 and 1A were frozen over) required that these assumptions be checked and the revised estimates of flowrates and odour intensity showed that the tank farm and extraction vents ranked considerably higher than originally predicted. This development was to lead to the Vapour Recovery Project.

Three separate experimental measurements of pond emission rates have been performed. All of these results have indicated that pond emissions are significantly lower than what was emitted from the storage tanks and Plant 4 vents prior to the Vapour Recovery Unit installation. For example, the 1995 pond emission data and the 1996 south tank farm tank vapour measurements indicate that the tank farm and Plant 4 vents would have emitted between ten to twenty times more VOC's than the ponds had they been open to atmosphere.

Potential Emissions from Consolidated Tailings (CT)

Q6.6 Suncor states *(Steepbank Mine Project Application, April 1996, Section C8.0, p.116)* that "in the longer term it has been suggested that anaerobic production of noxious vapours or volatilization of hydrocarbons from CT deposits might occur". Has Suncor done any monitoring during its commercial CT trials to establish the type and amount of air emissions that occur during the materials handling operations to produce CT, during the discharge of the CT slurry, and from the CT deposit pond? What type of further monitoring does Suncor anticipate doing in this regard?

A6.6 Consolidated tailings (CT) are a mixture of mature fine tailings (MFT), concentrated coarse mineral separated from the normal Extraction tailings stream, and calcium sulfate. The MFT are retrieved from either tailings Pond 1 or Pond 2 and pumped to the final tailings pumphouse where they are mixed with the concentrated coarse mineral and calcium sulphate. The CT mixture is pumped to its deposition site, where it is discharged and converts over a period of two or three decades to a competent solid. During the consolidation process, water is expressed from the CT mixture and collects on the surface of the site. The bulk of the recovered water is recycled to Extraction. Final reclamation involves removal of the water layer, surcharging the competent CT with sand, and placing overburden and muskeg on the surface to create a soil that is amenable to revegetation.

The immediate potential for odour release from CT operations arises at 2 locations: at the CT mixing tank, and at the deposition site. At the CT mixing tank the cyclone underflow tailings at 60°C are mixed with MFT at about 15°C. Any odour would be related to the presence of organics in both streams. During the CT Commercial Trial, there have been infrequent and irregular occasions when staff have noted odours different from the normal plant environment. Spot checks for vapours containing hydrocarbons, H_2S or SO_2 were completed shortly after the odours had been noted, but no noxious vapours were detected. It is suspected that the source of the odour was from the MFT, although it is unclear why the MFT would have discrete periods of abnormal odour.

Odours have been detected at the CT discharge location in Pond 5. Except for rare and isolated events, the odour levels are not different from normal tailings operations. It should be noted that the temperature of the CT discharge is around 35°C which is below the normal tailings discharge temperature of around 55°C. Therefore the potential for odour emission is reduced. In the current tailings system there are 5 hot tailings streams discharging to the ponds (one from the centrifuge plant and 4 from the primary extraction plant). When CT is in full operation in August, 1996, 2 of the primary extraction tailings streams will operate at the reduced CT temperature of around 35°C. Therefore, there is a potential for a net reduction of tailings odours.

Recent observation at the CT deposit in Pond 5 indicate that the odour normally associated with tailings water is not present. In addition, the water does not have the characteristic tailings odour. This is to be correlated with non-detectable levels of total extractable hydrocarbons determined from laboratory analyses of the top water.

Suncor will survey the odours from both emission locations once CT is in full operation. In the unlikely event that odour emissions related to the CT process warrant special mitigation, the following actions could be considered:

- the CT mixing tank can be connected into the site-wide vapour collection system
- sub-aqueous deposition of CT could be implemented, although there appear to be substantial long term dewatering and reclamation benefits from subareal CT deposition.

In the longer term, there is a remote possibility that the high levels of sulfate in the pond water system (relative to current operations) will result in anaerobic production of H2S from CT deposits. Although there has not been a specific investigation of this issue, there have been no reports indicating that H_2S generation will become a problem based on hundreds of laboratory tests, many of which last for months. It is the opinion of Suncor's biochemical consultants that the conditions required for H_2S generation will not be present. Even if the phenomenon occur, it is unlikely to be of significant environmental concern because of anticipated low release rates.

Q6.7 Two major consolidated tailings disposal ponds (Ponds 7 and 8) will be established at the Steepbank Mine *(Steepbank Mine Project Application, April 1996, Section C3.0, p.41)*. Comment on the potential of hydrocarbon and odorous emissions from the ponds. With regard to the topographic location of the ponds, under poor atmospheric dispersion conditions (valley trapping), could emissions from these ponds affect the ambient air quality in Fort McMurray or Fort McKay?

A6.7 Ponds 7 and 8 will be receiving CT tailings which is the product of cycloned (or densified) Plant 3 tailings mixed with mature fine tailings and gypsum. The nature of potential emissions is discussed in Question 6.6. With process changes, the net effect on emission potential is predicted to be lower than normal Plant 3 tailings discharge.

Ponds 7 and 8 are located on the east side of the river valley with final elevation similar to current ponds on Lease 86/17. These ponds are also in the same proximity to the river valley axis. Therefore, the dispersion of fugitive emissions associated with these ponds will be similar to that of current ponds. Given the nature of the discharge (CT tailings) and their location relative to the valley, contributions to THC concentrations in Fort McMurray and Fort McKay are not expected to be significant.

Integrated Mines Tailings Plan - Effect on Air Emissions

Q6.8 The effect that the tailings management plan will likely have on air emissions is discussed by Suncor *(Impact Analysis of Air Emissions Associated with the*

***Steepbank Mine, April 1996, p.74*). Please clarify the following:**

a) **the effect on total hydrocarbon (THC) and total reduced sulphur (TRS) emissions that is expected to occur due to the Extraction Plant 4 effluent being directed to Pond 2/3, rather than Pond 1, and**

A6.8a Plant 4 tailings contain fine sand, water, trace amounts of diluent (naphtha), and bitumen. These hydrocarbon losses are the source for THC and TRS. Estimates of THC emissions from Plant 1 with Plant 4 discharge are an order of magnitude greater than for Ponds 2/3 with Plant 3 discharge. (Table A.17, *Sources of Atmospheric Emissions in the Athabasca Oil Sand Region - Report 1*). Upstream process upsets significantly increase emissions of THC's and TRS.

This discharge will be relocated to Pond 2/3 from Pond 1. The influence of valley topography on meteorology and dispersion of this emission from the new location is difficult to quantify. However, directionally the source is further from the river valley axis and therefore, directionally should be less influenced by valley air flow and entrapment.

Moreover, initiatives to reduce and control THC and TRS have been discussed in the Application and in this Supplemental, which should further reduce these emission potentials in ambient air.

b) **the point in time when a decision will be made whether to connect the CT mixing tank to the site vapour collection system and whether to carry out CT deposition under the water surface, and why these decisions cannot be made now.**

A6.8b There was one instance over the six month CT commercial demonstration run when observations of unusually odourous vapours were made. A follow-up quantitative survey showed hydrocarbon vapours were below the detection limit. Therefore, we do not intend to connect the CT mixing tank to the site vapour collection system.

An analysis of the data from the CT commercial demonstration indicated that better CT performance is achieved if the CT are deposited sub-aerially. Suncor intends to maximize sub-aerial deposition of CT in the future.

Naphtha Losses to the Tailings Ponds

Q6.9 In a number of places in the application (*e.g. Steepbank Mine Project Application, April 1996., Section A4.0, p.34*), Suncor states that the Naphtha Recovery Unit (NRU) will be modified so that diluent losses to ponds will be no more at 107 thousand barrels per calendar day than at 79.5 thousand barrels per calendar day. However, it is not specifically stated how this will be accomplished. Describe the modifications to the facility that are proposed to achieve this commitment. If a number of options are presently being evaluated, please advise us when the evaluation will be completed, and provide a base case scenario for achieving the commitment (e.g. installation of a second NRU).

A6.9 We are taking an incremental approach to improved recovery in the NRU as production increases. In September 1996 we will install a new feedbox, install new internals to enhance contact between the tailings and the stripping steam, and relocate the point where steam is injected into the column. The first change is not anticipated to affect hydrocarbon recovery. The last two have the potential to improve recovery. Their effect will be determined in a post-modification audit on the column.

In parallel with the foregoing, Suncor is conducting a laboratory program to characterize the hydrocarbons present in NRU feed, in particular the extent of hydrocarbon adsorption on the mineral in NRU feed, and the vapour pressure for pure NRU hydrocarbon and for successively deeper cuts of NRU hydrocarbon.

These data will enable an assessment of the following:

- the sensitivity of hydrocarbon recovery to NRU vacuum level,
- the benefits of adding incremental hot water to the NRU feed as a means of adding heat, and

- the relative significance for hydrocarbon recovery of the initial flash of NRU feed vs the rate-limited mass transfer in the stripping section of the column.

Analysis of this information and an audit of the retrofitted NRU should be completed by November 1996.

Our base case assumption is that a second NRU will be constructed to achieve the target diluent recovery. Alternatives under consideration include the following:

- a carbon copy of the existing facility and operating mode,
- separation of NRU feed into mineral-rich and fluid-rich streams, and processing the former in the existing NRU and the latter in a new stripping column, and
- a spray drier-type vessel that maximizes the effectiveness of the flashing feed for hydrocarbon recovery.

The preferred option will have been selected by November 1996.

Emissions from Hydrotransport Cyclofeeder

Q6.10 The Hydrotransport Cyclofeeder will be a new source of air emissions associated with the Steepbank Mine *(Steepbank Mine Project Application, April 1996, Section D2.0, p.2)*. Does Suncor have any monitoring data on Cyclofeeder air emissions, based on either the pilot scale work that Suncor has done, or based on the work that other oil sands operators (Syncrude) have done? Provide a discussion on the feasibility of installing an emissions control system to reduce VOC emissions from the Cyclofeeder. If an emissions control system is not included in the initial installation, will it be feasible to retrofit a control system at a later date, if concerns about emissions are identified during actual operation?

A6.10 Suncor has no monitoring data on hydrocarbon emissions from a cyclofeeder. Suncor does have data on hydrocarbon emissions from conditioning drums in our existing plant, and they are below the threshold level that poses a hazard to human health.

Suncor anticipates that hydrocarbon emissions from the cyclofeeders will be lower than from the existing drums for two reasons:

- The exposed surface area in one cyclofeeder, which processes 5000 tonnes oil sand per hour, is about the same as the exposed surface area in one drum, which processes 1400 tonnes oil sand per hour. Hence when Steepbank is in full operation, the exposed surface area in the cyclofeeders will be less than currently occurs in the drums. The rate of hydrocarbon emissions is directly proportional to exposed surface area.
- The slurry temperature in the cyclofeeders will be in the range 50 to 55°C. The slurry temperature in the drums is about 75°C. The rate of hydrocarbon emissions increases with temperature of the liquid phase.

Both these reasons point to lower hydrocarbon emission rates from the Steepbank cyclofeeders than from the existing conditioning drums.

Suncor does not intend to install an emissions control system on the cyclofeeders. If conditions warrant, a retrofit will be installed at a later date.

Air Emissions from Mine Operations

Q6.11 Explain with respect to Section 8.1, whether emissions of VOCs, total reduced sulphur compounds, or odours are expected to occur directly from the open mine or from any aquifer depressurization waters. Also indicate whether particulate emissions (dusting) are expected to occur during the oil sand ore crushing and handling that is described on p.74 of Section C5.0, and whether any control measures will be necessary.

A6.11 With regard to the mine, hydrocarbon volatilization occurs from the surface of exposed oil sand. This is a minor and localized effect and is more prevalent on warm days.

Suncor has no quantitative data on these sources and because of the minor observed levels no studies are planned.

The basal aquifer located at the east side of the Steepbank Mine may need to be depressurized before Pit 2 mining commences. This stream has been characterized in the EIA program and results presented in the report *Impact Analysis Steepbank Mine EIA Surface Water and Groundwater*. The water quality analysis indicates that the potential for VOC's, TRS's, or odours is very low. Based on experience with basal aquifers on Lease 86/17 emissions are expected to be insignificant.

Dusting from the oil sand crushing and handling operation is localized, based on existing experience. Workers in the vicinity of this equipment are provided with the appropriate protective equipment if dust becomes a problem.

Suncor does not anticipate any control measures for any of the above emission sources.

Opportunities To Reduce Naphtha Losses

Q6.12 Suncor has stated in the application that diluent (naphtha) losses to ponds will be no more at 107 thousand barrels per calendar day than at 79.5 thousand barrels per calendar day. Has Suncor considered the feasibility of any plant modifications that could reduce the absolute amount of naphtha losses, and thereby reduce air emissions associated with the ponds? Specifically, has Suncor considered whether the absolute volume of naphtha losses could be reduced by either:

- **the installation of a second NRU, or**
- **the use of any other equipment/procedures in addition to, or instead of, the existing NRU system in order to recover naphtha?**

A6.12 As discussed in the response to Question 4.9, Suncor is considering the installation of a second NRU. The other equipment/procedures under consideration are intended to better exploit the physical phenomena upon which NRU operation is based.

At this time we are not considering a dramatic change from current practice.

Diluent Quality - Odour Abatement

Q6.13 Diluent losses (quantity) to the tailings ponds are discussed in the application, but the effect of diluent quality on the potential for off-site odours does not appear to have been discussed. As part of the Steepbank Mine Project, will any mitigative activities be necessary to ensure that recent improvements to control diluent quality are not compromised? Has Suncor considered any alternatives to the present diluent (sour naphtha) which might reduce or eliminate the diluent as a potential source of odours?

A6.13 Diluent quality could be affected by the quality of bitumen recovered from oil sand mined. Testing of bitumen composited from core samples retrieved from the Steepbank site indicated that bitumen recovered would be of equivalent quality to current product.

Measures Suncor has in place to control diluent quality are part of the Fixed Plant operation. The operating set points for the Gas Recovery Unit have been changed such that the unit operates in a tighter range. Monitoring guidelines are in place for monitoring diluent quality, and the response to off-spec diluent is directed by internal operating procedures. These procedures will not be effected by the Steepbank operation.

As part of the odour abatement studies, a number of alternative diluent sources were examined and a report presented to Alberta Environmental Protection. These ranged from using Syncrude diluent to various distillations of Suncor diluent. The decision was to change the operating parameters of the GRU to limit the quantity of light mercaptans and other hydrocarbons in the makeup diluent. These compounds correlated with odour episodes. Suncor is continuing to modify the Gas Recovery Unit operation to minimize the quantity of odorous compounds in the diluent, as part of our ongoing commitment to improve the diluent quality.

7 HUMAN HEALTH

Q7.1 Suncor is designing an experimental study of toxicity arising from low level exposure to napthenic acids (*Impact of Human Health Issues Associated with the Steepbank Mine, April 1996, p.74*). Describe the proposed study design and explain how the results will be used to reduce uncertainty about the potential for toxicity.

A7.1 A study plan is currently under design and should be available by September 30. The results of this study will provide the information required to derive a reference dose for naphthenates. This is turn provides the missing information required to quantify risks associated with exposure to this group of chemicals.

Q7.2 Discuss Suncor's plans to monitor fish tissue for potentially toxic organic and inorganic chemicals representative of surface water releases during the proposed approval period. How will Suncor use and communicate the results?

A7.2 Suncor is currently developing a long-term monitoring program which is anticipated to include sampling of fish tissue for concentrations of organic and inorganic chemicals. The monitoring program will be available by September 30, 1996. Suncor will provide regular monitoring reports to stakeholders.

Q7.3 Suncor has conducted fish tainting studies. What related studies are planned for the future to verify current findings and hypotheses? Describe how they will be conducted to:

a) further assess the potential for fish tainting from Suncor's surface water releases;

A7.3a A laboratory fish health study is currently underway to determine the Lowest Observable Effect Level (LOEL) and No Observable Effect Level (NOEL). In the study, rainbow trout have been exposed for 10 days to Wastewater Treatment System discharge waters diluted to concentrations of 0.01%, 0.1% and 1%. A second set of fish were similarly exposed and then removed from the test tank and placed for 10 days in a clean water tank to evaluate the depuration of tainting compounds. The exposure component of the study has been completed and the fish are presently being tested for tainting. Results are expected by the end of July 1996.

In combination with this laboratory fish health study, samples of the major input streams to the Wastewater Treatment System have been sampled for identification of suspected tainting compounds.

Depending on the results of the laboratory fish health study, a field tainting study may be carried out. Exact timing will depend on river conditions. If conducted, fish will be placed in cages at locations both upstream and downstream of Suncor's Wastewater Treatment System discharge, as well as directly in the mixing zone of the discharge. Following a ten day exposure, the test fish would be evaluated for tainting.

b) enable measures to be taken to prevent increases of fish tainting as a result of Suncor's surface water releases; and

A7.3b Fish tainting resulting from the discharge of Suncor's surface water releases has not been demonstrated conclusively. Suncor will complete a 1996 fish health and tainting study in association with its Wastewater Treatment System discharge in September. If this study indicates a fish health or tainting issue, then Suncor will undertake a study to identify the specific wastewater stream(s) responsible for the tainting and initiate a program to mitigate the impact of that stream.

c) involve stakeholders in the design and execution of programs related to the above studies.

A7.3c Suncor participates in the scientific community through the Canadian Oil Sands Network for Research and Development. Aquatic research projects are vetted through this network which reflects the concerns of many stakeholders.

From Suncor's on-going stakeholder consultation program issues or concerns regarding aquatics would be indirectly incorporated. Currently, Suncor does not directly consult public stakeholders for direct input to these studies. A Northern River Basin Study recommendation is to develop such a process for river basin monitoring and research. Suncor will participate in such an initiative.

Q7.4 Suncor intends to construct a CT reclamation demonstration site and may be planning to study bioaccumulation in edible plants at that site (*Impact Analysis of Human health Issues Associated with the Steepbank Mine, April 1996, p.75*). Clarify Suncor's intentions regarding the "small scale experimental platform to quantify bioaccumulation of metals", including which potentially toxic organic and inorganic chemicals will be monitored and the associated milestones.

A7.4 It is Suncor's intention to construct a CT reclamation test site to develop and validate the technologies required to reclaim CT deposits and to demonstrate that CT reclamation will produce healthy and sustainable ecosystems up to 15 years before commercial reclamation can be attempted. The activities at the site will include:

1) Infilling with CT materials
2) Stabilization of the surface of the CT deposit
3) Construction of "hummocks' on the stabilized surface of CT deposits in order to establish a surface drainage system
4) Reconstruction of top soil materials using muskeg
5) Revegatation of the surface materials using different thicknesses of capping materials
6) Asessment of the ecosystem health and sustainability of reclaimed ecosystems.

A test site will be constructed on the east end of Pond 2 adjacent to the previous CT test sites. As early as practical following resumption and commissioning of CT operations in 1996 (probably in October) the CT stream can be diverted to infill the test area. As much release water as possible will be removed from the surface of the deposit prior to freeze up. Initial profile sampling will be conducted. It is recognized that the chemistry of this first layer may not fully reflect equilibrium FGD gypsum chemistry.

In 1997, additional release water will be removed and a second layer of CT will be placed. This layer may reflect FGD equilibrium conditions. Release water will be removed in preparation for the 1997-1998 winter freeze/thaw period.

Strength testing in 1998 will establish whether capping with tailings sand can be attempted or whether and additional freeze/thaw cycle will be required.

Final construction of the hummock surface and revegetation is anticipated in 1999. Subsequent years will involve monitoring of the reclaimed demonstration site.

Coincident with construction and stabilization of the site, supporting test programs consisting of laboratory and field plot tests, will be conducted to identify revegetation issues and requirements. These programs are discussed in answer to Question 5.4.

Q7.5 Reductions in emissions of odorous chemicals such as VOC's are proposed as part of the Suncor fixed plant expansion *(Impact Analysis of Air Emissions Associated with the Steepbank Mine, April 1996, pp.75-81)*. What is Suncor's view regarding provisions for the enhancement of the odour response protocol during the proposed approval period, to address odorous sulphur chemicals (e.g. hydrogen sulphide, carbonyl and dimethyl sulphide, dimethyl and carbon disulphide and mercaptans)? Discuss the need for monitoring of odorous sulphur chemicals in the communities of Fort McMurray and Fort McKay.

A7.5 The odour response protocol was developed through the RAQCC (Regional Air Quality Coordinating Committee). With RAQCC stakeholders, the methods and procedures have continuously been improved which has resulted in better resolution of source and cause of off-site odour episodes. Enhancements to the existing protocol will be determined by need, and Suncor is committed to any such initiative through RAQCC.

The need for monitoring of odourous sulphur compounds in the communities of Fort McMurray and Fort McKay is currently under review by RAQCC. Suncor will participate in any changes to the existing level of monitoring and any new initiatives.

Q7.6 Discuss the evaluation of lead, hexane, benzene, toluene, and trimethyl benzene for inhalation pathways in relation to the USEPA risk based concentrations (RBC) *(Athabasca River Water Releases Impact Assessment, May 1996, p.77)*. Does Suncor presently have any plans to monitor concentrations of specific volatile organic compounds, polycyclic aromatic compounds, sulphur compounds and metals near the proposed mine?

A7.6 A discussion of benzene, toluene and trimethyl benzene is provided on p. 76 (paragraph 1) of *Athabasca River Water Releases Impact Assessment*

Predicted concentrations of lead slightly exceeded RBCs (Table 5.1-15; however as noted on p. 77 of *Athabasca River Water Releases Impact Assessment*: "Considering the multiple protective assumptions built into this analysis, it is reasonable to conclude that dust generated from Suncor's operations does not pose an off-site health hazard".

Suncor has a program in place to monitor various areas of plantsite for specific hydrocarbons, including PAH's. The new mine area will also be subject to this monitoring program and the tailings ponds, cyclofeeder and other possible sites of VOC emissions will be sampled.

Sampling and analysis for metals will be done in conjunction with members of RAQCC, and will likely focus initially on areas closer to the local communities. As issues are identified (or discounted) during these RAQCC initiatives, follow up actions may be required.

For worker safety reasons, Suncor will sample particulates from the new mine and these results will be made known to the members of RAQCC for information.

8 MINE/WORKER SAFETY

Q8.1 Submit a detailed plan (certified by a professional engineer) outlining procedures for the safe control of the angles on benches, berms and general slopes in the pit, overburden dumps, and impoundment dykes.

A8.1 A plan, certified by a professional engineer, outlining procedures for the control of walls in accordance with section 23 of the Occupational Health and Safety Act will be submitted prior to the commencement of mining operations at the Steepbank Mine. All impoundment dykes are approved by regulatory agencies.

Q8.2 Provide plan showing the location of the haul roads and associated emergency escape roads. If, in Suncor's opinion, emergency escape roads are not necessary, provide the procedures for safely stopping out-of-control vehicles.

A8.2 The haulroad layout for the Steepbank Mine is currently at a level of detail sufficient for equipment requirement determination and long range mine planning. Detailed haulroad design will meet the requirements of section 21 of the Occupational Health and Safety Act. The placement of emergency escape roads will be designed for any continuous ramp, exceeding 5% grade, where a controlled stop on a bench is not possible.

Q8.3 Provide details of the arrangement of loading, hauling and drilling equipment on the working bench. Indicate the maximum height shovels excavating overburden and oil sands can reach.

A8.3 The standard bench height planned for the Steepbank Mine is 15 metres. The bench height may vary due to the nature of selective mining, however, the working face working will be maintained at a safe working height. The height of the working face is maintained at the standard safe working height for the specific shovel by design or dozer assistance. The current standards for working face height are 15 metres for electric cable shovels and 12.5 metres for hydraulic shovels. This is consistent with requirements under the Mines Safety Regulation Section 23(2) which limits the working face height to no more than 1.5 metres above the maximum heights that the excavation equipment can reach.

Q8.4 Provide an analysis which demonstrates that the integrity of impoundment dykes will not be affected by the blasting of ore and overburden.

A8.4 Suncor does not blast oil sand or overburden as a routine unit operation of the mining process. Blasting of limestone is performed on a limited basis (approximately 500 k tonnes/year) to provide road construction material and calcium carbonate for the Flue Gas Desulphurization process. Blasting of frost layers to maintain a safe working face and prevent frost lumps that cannot be handled by the ore sizers is performed on an as required basis during winter operations. Suncor did not have any frost blasts during the 1995-1996 winter.

Blast design procedures to ensure the integrity of impoundment dykes, overburden dumps, and pit walls is not affected by blasting have been developed to maintain the maximum peak particle velocities below prescribed values. Minimum scales distance factors for the various structures have been defined based on empirical measurements of blast vibration. Blasts are designed to maintain the maximum weight of explosives charge per delay below the value determined using the appropriate scales distance factors.

Q8.5 Provide the location of explosives magazines.

A8.5 Suncor's blasting magazine is currently located at the north end of the operating mine on Lease 86/17. There are no plans , at this time, to locate a blasting magazine on the Steepbank minesite. If a decision is made to have a blasting magazine at the Steepbank site a suitable location that meets the requirements of the Alberta Mines Safety Regulations and the Canada Explosives Act will be selected.

Q8.6 Provide Suncor's safety procedures for workers crossing the Athabasca River on the ice bridge or by barge (drowning and hypothermia hazards must be addressed).

A8.6 Suncor has developed and has already utilized a safe work procedure for working on or around a barge. This procedure was utilized during the 1995 Athabasca River Drilling Program. One of the main controls in this work procedure (to prevent the possibility of drowning) is that all personal who are working outside on the deck of the barge must at all times wear a personal floatation device. As far as hypothermia is concerned, this procedure has been written to mitigate the possibility of an employee falling into the water. If for some reason someone does enter the water, the employee when rescued will be treated for his/her medical condition by highly trained and competent personnel. This procedure will be updated (as required) to reflect any type of changing condition in the operation of the barge, or employees working on or around the Athabasca River.

Suncor’s ice bridge is designed by a professional engineer who specializes in this type of construction. The bridge is constructed according to specifications and is tested by the professional engineer prior to commissioning. After commissioning, the ice bridge is tested for competency on a monthly basis. At the end of the season the bridge is decommissioned (by blasting) to prevent anyone from crossing it in an unsafe state. Access to the ice bridge is restricted and set safety rules have been put in place to mitigate the possibility of a loss.

9 PIPELINE APPROVAL REQUIREMENTS

Q9.1 In order to meet EUB application requirements for the requested pipeline and related surface facilities approvals, a completed schedule 1, 3, and 3.1 (as outlined in EUB Guide G-56) must be submitted (including fees). In support of these completed schedules, the information outlined in Audit Requirements (Unit 3, page 28 of Guide G-56) must also be available to the EUB upon request.

A9.1 Schedules 1, 3, and 3.1 will be submitted separately to EUB.

Q9.2. The following information is required to address safety issues and environmental matters related to the pipelines and surface facilities, including the river crossing:

a) Consideration of installing leak detection system (for the diesel line) as per the CAPP guidelines to detect leaks and initiate prompt shutdowns of the facilities.

A9.2a The diesel line will be installed in the bridge trough eliminating risk of spillage in the event of pipeline failure. Also it should be noted that the trough is being designed to slope from the middle to holding tanks at each abutment. Final design will be accomplished using CAPP guidelines.

b) Consideration of installing automatic isolation valves and/or check valves at the river crossing prevent backflow and minimize spill in case of a pipeline failure.

A9.2b Design parameters for all lines will include instrumentation controls that in the event of line failure the pumps will cycle down. In the case of the hydrotransport line installation of automatic valves and/or check valves have already been considered but they would cause line sanding which would impede operations and cause major maintenance problems.

c) Comment on the possibility of external coating damage as a result of pipe movement, and consideration of external corrosion control measures for any bare pipe.

A9.2c Hydrotransport and hot pipe lines will be insulated, therefore eliminating the possibility of external coating damage. The existing tailing lines which are exposed, are not effected by external corrosion because they have an operating life which is shorter than the time required for corrosion to affect the pipe performances.

d) Comment on the effects of thermal expansion or contraction of the pipelines, and consideration of appropriate measures to allow for adequate thermal expansion or contraction.

A9.2d Design of the pipe lines call for them to sit on free moving wooden sleepers which will allow thermal expansion or contraction to occur. Use of expansion barrel and joints will be a consideration in final design.

e) Comment on the possibility of overpressure on the system as a result of a line plug or a change in ambient air temperature, and consideration of installing appropriate shutdown or pressure relieving devices for overpressure protection.

A9.2e Design will include instrument controls that will cycle and shut down the systems in the event of either an overpressure or underpressure situation.

f) Comment on the possibility of third party damage on the pipelines and consideration of placing warnings signs at appropriate locations.

A9.2f All pipelines in the vicinity of access roads will be protected by an earth berm, where they cross the bridge they are protected by the concrete trough. Third party access is controlled by Suncor Security.

g) Where the pipelines are in proximity to electrical transmission lines, comment on the effects of fault currents, induced potentials or interference, and consideration of appropriate measures to reduce such effects.

A9.2g Except where the pipelines cross at the bridge they will not be in proximity of transmission lines. Where the pipelines and transmission lines cross on the bridge they are separated by the concrete deck, and each have their own isolated support systems as well as the fact the bridge itself is grounded. Gas and diesel lines are the pipelines of main concerns. Cathodic protection and distance from power lines will be addressed in detail design.

10 QUESTIONS AND COMMENTS FROM FEDERAL AUTHORITIES

Q10.1 The Canadian Coast Guard (responsible Federal Authority) has, for the purposes of its review, defined the project scope as the construction and maintenance of the bridge across the Athabasca River and any construction related works, accesses, storage areas or other undertakings directly associated with the bridge. Suncor is asked to respond to the following concerns and questions that have been identified through the Canadian Coast Guard's referral of the application to appropriate Federal Authorities:

a) "The proposed barge loading area, bridge structure, as well as the infrastructure directly south of the bridge appears to present an impediment to wildlife trying to negotiate the bridge wildlife underpass. In addition, the road from the hydrotransport area to the service area will increase disturbance to habitat immediately adjacent to the Athabasca River proper. Environment Canada recommends that important wildlife travel corridors be protected in the proponents mining strategy and that movement of wildlife along the Athabasca River corridor continue unabated. Environment Canada recommends that a continuously forested zone of undisturbed habitat (not less than 100 m in width; no sections less than 200 m and more than 400 m in length) should be maintained."

A10.1a As part of the Steepbank EIA, Suncor conducted wildlife baseline surveys in 1995 and 1996 and reviewed the literature related to the Athabasca River area. The literature shows that generally the river corridor is important for wildlife movement between seasonal ranges and for dispersing individuals. From the winter track count surveys there was no well defined pattern of movement along the valley for moose and forest carnivores. There was evidence of east-west corridor movement between upland and valley areas.

The Steepbank Mine will completely disrupt some areas east of the escarpment, as well as some of the escarpment areas. Therefore, the use of the east-west corridor on the

Steepbank Mine area will be eliminated. The removal of the east-west corridor will further reduce the usage of the Athabasca River valley corridor because animals which use the Athabasca River valley may gain access to this corridor via the east-west corridor. The net result is that the expected demand for use of the Athabasca River valley corridor will decrease from the already low levels recorded during the EIA field investigations.

Moreover, the bridge access will continue to be an impediment to wildlife movement indefinitely and irrespective of other activities in the valley. Beyond 2020, this impact will continue even with the envisioned relocation of facilities to the upland areas. Suncor has proposed the river-bank bypass as the most practical solution, given the baseline assessment.

For other river corridor facilities, Suncor is proposing a modified corridor varying from no buffer at the barge landing to less than 100m buffers at the hydrotransport pipeline and drainage basin. The barge area will be landscaped immediately after the bridge is constructed with mature vegetation. The other areas will be revegetated as soon as practical. In the vicinity of the shop access road, further refinement of the mine plan has resulted in an increased corridor to 100m.

Therefore, Suncor cannot entirely meet the specific corridor guidelines suggested by Environment Canada. However, based on the importance as assessed above, the proposed re-design and plan is a reasonable level of mitigation.

b) "The initiatives that the proponent intends to incorporate into the bridge design to mitigate environmental impacts (page 70-71, Steepbank Mine Project Application) appear appropriate for countering potential adverse environmental effects. Ongoing refinement of the mitigation is expected to resolve current residual concerns related to sedimentation and erosion during the bridge construction."

10.1b Suncor is continually refining the bridge and new mine design to mitigate environmental impacts. Regarding the bridge, a final selection of the bridge contractor was based on a design build concept. The new design features an innovative approach to construction of the piers which is significantly different from the original proposal. This involves the installation of two (2) steel pilings (approx. 2.5m diameter) into river bedrock at each pier site and filling with concrete. The piles are installed by vibra-hammering and bedrock drilling from a barge which minimizes suspension of sediment. The excavated material is then, disposed in a controlled fashion. This method eliminates the need for earth coffer dams and may eliminate the need for access berms as well. The abutment construction procedures will also minimize sedimentation by use of coarse aggregate fill and controlled placement outside of fish spawning periods. This activity will be controlled to a suspended solids standard.

The above details have been provided to the Department of Fisheries and Oceans (DFO).

c) **"C4.2 - Athabasca River Bridge - Dialogue is continuing between DFO-HMD and Suncor regarding the proposed bridge. Outstanding issues consist of: rationalization of the west abutment in the Athabasca River, potential effects of river construction and river works on downstream hydraulic conditions, potential increases in downstream erosion, provision of a sediment control plan and suspended solids monitoring program. Some specific comments regarding the bridge proposal follow:**

- **The current plans for the bridge indicate that the west abutment will extend approximately 75 m into the channel of the Athabasca River. This is an issue of concern as the abutment will constrict the river channel, increase local water velocities, may increase local erosion on Tar Island Dyke or on opposing bank of the river, and will entail a significant amount of infilling and instream construction with the potential attendant release of significant amounts of suspended solids into the river. Given these potentially adverse conditions, Suncor is requested to further rationalize the proposed design of the west abutment.**

- **Dealing further with the current bridge design, Suncor has not provided a comprehensive mitigation plan for construction of the abutments and coffer dams particularly with regard to sediment control. Suncor has indicated that construction of the west abutment and pier #1 may proceed as early as the late fall/early winter of 1996. this is a time when the Athabasca River runs relatively clear, when spawning migrations are underway and when fish have evacuated the tributaries to overwinter in the Athabasca River. A comprehensive sediment control plan, including appropriate monitoring, will be required before construction can proceed in the Athabasca River."**

A10.1c • West Abutment Rationalization

The original design and the new design build proposal were based on a river hydraulics study by AGRA Earth and Environmental. This report has been provided to DFO. The overall constriction, with abutments, of 357m is not considered a hydraulic issue because the bridge is located immediately downstream of a natural constriction of narrower width (300m).

With respect to Tar Island Dyke, erosion potential upstream of the bridge would not increase. Suncor is planning to riprap the river bank independent of the bridge.

There is a natural process of sediment deposition downstream of the bridge site. The west abutment could increase this deposition. This is not a significant fish habitat impact. Suncor's fresh water intake may be impacted and planning is underway for relocation.

Localized velocities around the abutment will increase but this has been assessed as a marginal impact for fish.

The location of the bridge abutments are determined by a number of factors. In general the shortest bridge is preferred although cost savings must be weighed against environmental, hydraulic and other issues. The original concept was based on an hydraulic opening of approximately 400m and was completed prior to any specific hydraulic studies for the bridge. In January 1996 AGRA completed their study which recommended a minimum opening width from a hydraulic and ice jam perspective of 350m at elevation 234m. This can be compared with a hydraulic width upstream of the bridge site of 300m. The environmental impacts of the proposed abutment arrangement of a 357m opening was assessed and considered to be minor in nature and magnitude. These assessments, based on the Steepbank EIA, have been provided to DFO.

Other factors which influenced the overall bridge arrangement included:

- Presence of either a solution cavity (sink hole) or buried stream channel west of pier 1. This geotechnical anomaly prevents pier 1 from being located any further west and hence constrains practical bridge arrangements.

- Space constraints on the west bank for pipeline transitions, electrical and other utility facilities.

- The east abutment is located in a depositional area with relatively shallow water and hence it is more practical and cost effective to riprap a fill rather than construct a longer bridge.

- Construction Monitoring and Control Plan

With the change and refinement to the bridge design, Suncor has finalized construction procedures and proposed a sediment monitoring and control program with the contractor. This has been provided to DFO.

The need for coffer dams has been eliminated and there is a high probability that access berms would not be required. The latter is dependent on early start-up of pier construction. Access berms would be required if the piers are not completed by winter freeze-up later in 1996.

The abutments would be constructed outside of the fish spawning period specified as September 15 to October 15. Mitigative measures that have been incorporated into the operation to minimize sediment introduction include the use of a large bulldozer to move material into the river, as opposed to an end-dump operation, as we believe less material will be exposed to scour if the aggregate is moved into the river in larger blocks. The initial loading surface will be maintained near water level (i.e. 0.3m above water level), to reduce momentum and associated mixing of aggregate and water as the aggregate is introduced to the water column. In addition, the leading edge of the abutments and working berms will be constructed first, such that the majority of the aggregate is placed in the river behind the leading edge of these structures, in slower-moving water.

During construction, monitoring of TSS (total suspended solids) would occur. Non-compliance with a TSS standard of 10 mg/l above background would initiate further control measures. The first step would be the installation of a riprap berm upstream of the abutment or working berm. If additional mitigation is required, a silt fence will be installed downstream of the berm. Although the use of a silt fence may be desirable, we have concerns that upon removal, a considerable sediment plume may be created. Therefore, removal of the silt fence would have to occur in the spring, when TSS levels are increasing in the river. The possibility would exist that the silt fence would be destroyed during break-up.

Excavated material from the inside of the pier pilings is proposed for controlled discharge to the river. River bed and bedrock materials contain small amounts of fines and therefore suspended solids in the river column should be minimal. Monitoring and control to the TSS standard is proposed. Exceedance of the standard will result in the transfer of this material to shore for alternate disposal.

The monitoring program has been designed on the basis of water quality model predictions of concentration of TSS downstream of above activities. The details have been provided to DFO.

d) **"E2.2.2 - p.18 - It is noted that the current cumulative effects analysis includes Syncrude, Suncor, Solv-Ex, ALPAC and Northern Forest Products. What about the other pulp mills operating on the system? Can a cumulative effect assessment be done on a regional basis particularly when dealing with watershed issues?"**

A10.1d In design and implementation of the Steepbank EIA, Suncor considered cumulative effects within the bounds of what can reasonably be known outside of the project impacts.

Please refer to the supporting EIA report entitled "*Impact Analysis of Human Impact Issues Associated with the Steepbank Mine*" for elaboration of predictions of present and future water quality in the Athabasca River (Pages 37 and 38):

"Upstream developments are accounted for directly by measuring water quality in the Athabasca River immediately upstream of Suncor. Both Solv-ex and Syncrude's proposed Aurora Mine are located on the opposite side of the river from most of Suncor's discharges, so they will not contribute to increased concentrations within Suncor's mixing zone (where maximum in-stream concentrations are expected). Release water associated with reclamation from Syncrude's existing leases may contribute an additional load to the Athabasca River from the old Beaver River channel, and this extra load was accounted for in the simulation of post-reclamation conditions."

The same modelling assumptions were used for evaluating both human health and aquatic impacts, so the above statement holds for the Aquatics assessment. We have assumed that future water quality conditions in the Athabasca River would not decrease from historical conditions.

The analysis accounts for future releases from oil sand development and inputs from Syncrude are described on page 93 of the report entitled *Impact Analysis of Aquatics Issues Associated with the Steepbank Mine:*

"Syncrude's reclamation of existing mines involves construction of end-pit lakes. The water quality of these lakes is expected to develop over time to moderately productive lakes comparable to natural lakes in the region. Water quality in the lakes will be suitable for sensitive aquatic biota within a few years following capping, and prior to any release from the lake to the Athabasca River. Hence discharge is not expected to add a significant source of load to the Athabasca River; even so this source of water was incorporated into the future water quality projections. Presently, no information is available on water releases from Syncrude's proposed Aurora Mine. Thus, potential contributions to cumulative impacts from the Aurora Mine are not included in the assessment. They will, however be assessed as part of the Aurora Mine EIA."

These assumptions are further defined on pages 25-26 of *Impact Analysis of Human Health Impact Issues Associated with the Steepbank Mine.*

Section 10 of this Supplemental has already been provided to the EUB, AEP and the federal DFO. This information is required for the Canadian Coast Guard in order to issue the bridge construction permit under the NWPA.

If you have any questions concerning the above items please contact myself at (403) 743-6892 or

Yours truly,

SUNCOR INC., OIL SANDS GROUP

Terrance J. Bachynski
Director, Project Approvals

TB/mc

APPENDIX 1

ENVIRONMENTAL SCREENING UPDATE REVISIONS TO THE SUNCOR STEEPBANK AEUB APPLICATION

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REPORT ON

ENVIRONMENTAL SCREENING UPDATE FOR REVISIONS TO THE SUNCOR STEEPBANK MINE AEUB APPLICATION

JULY 26, 1996

DISTRIBUTION:

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1.0 INTRODUCTION

Suncor Inc., Oil Sands Group (Suncor) submitted an application to the Alberta Energy Utilities Board on April 30, 1996 for the construction of the Steepbank Mine, an oil sands mine and processing facility north of Fort McMurray, Alberta (Suncor 1996). A component of that application was an environmental impact assessment which reported and assessed the potential impacts associated with the project.

The planning process for the Steepbank Mine has continued since the Application was submitted to the regulatory agencies. The purpose of this environmental assessment update is to review the Impact Hypotheses upon which the original EIA was based, to determine which of those hypotheses may have outcomes affected by the subsequent mine plan changes, and to what extent.

2.0 PROJECT CHANGES

Since original project definition (Suncor 1996), continuing development of Steepbank Mine plans have resulted in a number of refinements to the original plans. Key elements of those revisions are described below.

2.1 North Overburden Waste Dump

Overburden waste dumps are constructed landforms where overburden, lean oil sands and oversize material are deposited. Original mine plans called for mining of the northern peninsula of the mine site, in the elbow of the Steepbank and Athabasca River confluence. Subsequently, it has been decided not to mine the area but to leave the overburden dump in that location. The

North Overburden Waste Dump will be situated 200 metres from the Athabasca River and 100 metres from the Steepbank Valley break. The crest elevation will be higher than the existing plateau, but will be contoured to provide a natural landform appearance, with an overall slope of 3:1. The dump height is expected to be 300 m asl, the same height as planned for the West Overburden Waste Dump. The dyke toe will be above the 1:100 ice flood contour. The design of the North Overburden Waste Dump, as shown on Figure 1, has been modified to incorporate changes to allow a more natural landscape design. Further details on design modifications for the overburden waste dumps is provided in Golder (1996a).

2.2 West Overburden Waste Dump and Shipyard Lake

The West Overburden Waste Dump, in the original plan, was to be situated in the area between Pit 1 and Pit 2, west of the truck dump, and extending into a portion of Shipyard Lake. The waste dump plan has been reconfigured south of its original location and outside of the wetland area. The waste dump will have the same storage volume as previously proposed (600,000 m^3). The toe of the dump will be 200 metres from the Athabasca River and, similar to the north dump, will be contoured to resemble a natural landform. The design will include erosion protection from a 1:100 year ice flood event. Figure 1 shows the footprint of the West Overburden Waste Dump under the new configuration.

Inflows to Shipyard Lake will be managed to assure the water quality and quantity required to maintain the wetlands. As part of the measures to protect Shipyard Lake, the drainage plan has been redesigned to include a system allowing discharge of required volumes of the water into Shipyard Lake. This system allows discharge of excess volumes of water via an outfall to the Athabasca River.

2.3 Barge Landing

Barge landings are constructed to facilitate the movement of materials into and out of the Steepbank Mine area during the course of bridge construction. Originally proposed north of the bridge, the barge landing site, and an adjoining roadway to the mine infrastructure is now located south of the bridge (Figure 1).

2.4 Bridge Design Changes

Initial design of the bridge across the Athabasca River was based on feasibility-level engineering. More detailed engineering and a design-build contract selection process has resulted in changes to the original design and construction methods.

2.5 Setback from the Athabasca River

Relocation of the barge landing and revisions to drainage areas will reduce the setback of mine facilities and infrastructure from the Athabasca River. Figure 1 shows the differences in the footprints of the overburden waste dumps in the valley between the original application and the currently planned configuration. The changes to the setback from the river are discussed and detailed in Section 4.5 of the detailed Conservation and Reclamation Report (Golder 1996a).

2.6 Project Schedule

An earlier mine startup is anticipated than in the original proposal (January 1, 1999 compared to 3rd quarter 2000). The implications will be accelerated manpower requirements, which will overlap with the workforce requirements of Suncor's Fixed Plant Expansion project. Therefore, an additional camp facility will be required. The Steepbank Mine construction camp will be located on the east side of the Athabasca River, on a site which will subsequently become part of the Steepbank Mine.

3.0 METHODS AND ANALYSIS

The approach of this EIA update is consistent with that in the original Suncor Steepbank Mine Application (Suncor 1996). Each of the hypotheses in the original EIA is reviewed, with those hypotheses whose outcome may be affected by the plan refinements identified for further investigation. For those hypotheses where the revisions may affect a change, the impacts are examined, applying the criteria used in the original EIA.

Key information sources and analytical tools used in the assessment included:

- Project Information: Plans and specifications provided by Suncor, both in the original Application (Suncor 1996), as well as in update information based on additional planning and planning refinements.

- Analytical tools: The areal extent of proposed facilities was digitized into a GIS/ARCInfo software program, and compared with facility extent and vegetation/landform impact as presented in the original Application EIA (Suncor 1996).

4.0 SELECTION OF AFFECTED HYPOTHESES

Table 1 lists each environmental impact assessment hypothesis addressed in the original Application (Suncor 1996), with identification of those hypotheses with outcomes that may potentially change as a result of further development of Steepbank Mine plans.

TABLE 1
STEEPBANK MINE EIA IMPACT HYPOTHESES SUMMARY LIST

	HYPOTHESIS	**Potential Change from EIA results?**	**Remarks**
SOCIO-ECONOMIC			
1	The Steepbank Mine Project will contribute additional local, provincial and national benefits through additional employment, the procurement of goods and services required for the project and the payment of local, provincial and national taxes and royalties.	no	
2	Construction-related activities and employment and the associated temporary increase in population will result in increased demands on services and infrastructure within the Regional Municipality of Wood Buffalo.	yes	see hypothesis # 6
3	Operations-related employment and the associated increase in population will result in increased demands on services and infrastructure within communities in the Regional Municipality of Wood Buffalo.	no	
4	The social stability and quality of life of communities within Regional Municipality of Wood Buffalo will be maintained as a result of the continued operation of the Suncor project, through development of the Steepbank Mine.	no	
5	The Steepbank Mine project will contribute to a loss in the traditional resource base of the Fort MacKay community and displace some traditional activities.	no	
6	The cumulative demands from the Suncor, Solv-Ex and Syncrude projects combined with the expected demands from existing populations within the Regional Municipality of Wood Buffalo will result in increased demands on local communities and affect the quality of life of those communities.	yes	Changing construction scheduling will accelerated demand for construction workforce. See section 5.1 of this report
HUMAN HEALTH			
7	The health and well being of people who live, work or engage in recreational activities within the study area may be affected by changes to Athabasca and Steepbank River water quality caused by water releases resulting from extraction, processing and reclamation of oil sands from Suncor's existing and proposed mines.	no	
8	The health and well being of people who live, work or engage in recreational activities within the study area may be affected by air emissions resulting from extraction, processing and reclamation of oils sands from Suncor's existing or proposed mines.	no	

9	The health and well being of people who live, work or engage in recreational activities within the study area may be affected by cumulative exposure to chemicals associated with water and air emissions from Suncor's activities and other developments within the Regional Study Area.	no	
10	The health of people who in the future may occupy and/or use the land reclaimed from Suncor's Lease 86/17 and Steepbank Mine may be affected by release of chemicals from the reclaimed landscapes.	no	
11	The health and safety of on-site workers may be affected by development and operations of the Steepbank Mine and related facilities.	no	
TERRESTRIAL			
12	Valued Ecosystem Components in the Athabasca River valley could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.	yes	Revisions to infrastructure siting and reconfiguration of West Overburden Waste Dump will affect project's impacts to river valley VECs; see Section 4.4 of Golder 1996a
13	Existing and future use of the area's landscapes could be limited by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.	no	
14	Visual integrity of the Athabasca River Valley could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.	yes	Reconfiguration of the West Overburden Dump and North overburden dump may affect landscape profile; see to Section 4.1 in Golder 1996a
15	Biodiversity could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.	yes	Refinements to C & R practices and alterations to footprint of the west overburden dump may affect biodiversity; see Section 4.0 in Golder 1996a
16	Wetlands could be affected by Lease 86/17 and Steepbank Mine development and operation, including mine dewatering, changes to subsurface drainage, and reclamation release water.	yes	Reconfiguration of West Overburden Dump will alter effects to Shipyard Lake and associated wetlands; refer to Section 4.2 and 5.0 in Golder 1996a

17	Air emissions from the Suncor operation could have an impact on vegetation and soils, as well as aquatic environments.	no	
WILDLIFE			
18	Mine development will result in changes in the availability and quality of wildlife habitat which will bring about a reduction in wildlife populations	no	
19	Disturbance associated with mechanical noise and human activity may result in reduced abundance of wildlife.	no	
20	Direct mortality of wildlife caused by mine development could result in reduced abundance of wildlife.	no	
21	Mine development will disrupt the movement patterns of wildlife in the vicinity of the Steepbank Mine, thereby reducing access to important habitat or interfering with population mechanisms, resulting in decreased abundance of wildlife.	yes	Changes to mine infrastructure and operations in the river valley will change the width of vegetated wildlife corridor between the facilities and the river; see Section 4.5 in Golder 1996a
22	Mine development could cause a reduction in wildlife resource use (hunting, trapping, non-consumption recreational use).	no	
23	Development of the Steepbank Mine could contribute to a loss of natural biodiversity.	no	
SURFACE AND GROUNDWATER RESOURCES			
24	Flows in the Athabasca and Steepbank Rivers could be significantly changed by mine development withdrawals for extraction, upgrading and/or reclamation.	no	
25	Ice jams, floods or other hydrological events could cause structure damage and flooding of facilities that will result in subsequent impacts to hydrological/aquatic systems and downstream uses.	no	
26	Navigation along the Athabasca River could be affected by bridge construction.	no	
27	Groundwater quality could be affected by contaminant migration from processing and extraction activities.	no	
AQUATIC RESOURCES			
28	Construction, operational or reclamation activities might adversely affect aquatic habitat in the Steepbank River.	no	

29	Construction, operational or reclamation activities might adversely affect aquatic habitat in the Athabasca River.	yes	Revisions to bridge design and construction practices could affect aquatic habitats; refer to Section 5.4 of this report
30	Water releases associated with construction, operational or reclamation activities might adversely affect aquatic ecosystem health in the Athabasca or Steepbank Rivers.	no	
31	Water releases associated with construction, operational or reclamation activities might adversely affect the quality of fish flesh.	no	
32	Construction, operational or reclamation activities might lead to changes in aquatic habitat and/or aquatic health which might result in a decline in fish abundance in the Athabasca or Steepbank Rivers.	yes	See hypothesis # 29.
33	Construction, operational or reclamation activities might lead to changes in fish abundance or quality of fish flesh which might result in a decreased use of the fish resource.	no	
34	Construction, operational or reclamation activities might cause changes in Athabasca River water quality which limit downstream use of the water.	no	
AIR QUALITY			
35	Global climate change could be affected by increased release of greenhouse gases associated with production expansion related to the Steepbank Mine.	no	
HISTORICAL RESOURCES			
36	Significant archaeological, paleontological or historical resources could be affected by the development and operation of the Steepbank Mine.	no	

5.0 ANALYSIS OF AFFECTED HYPOTHESES

Of the 36 hypotheses addressed in the Application EIA (Suncor 1996), the analysis results of nine hypotheses could potentially be affected by the mine plan refinements. Each is addressed below.

5.1 Potential Socio-Economic Effects

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

AND

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

Revising the project construction scheduling to provide for mine startup in January 1999 instead of mid-2000 will result in accelerated manpower requirements for operations. This will overlap with the fixed plant expansion workforce and require additional camp facilities, which will be operated on the east side of the river. The Steepbank Mine camp will be located within the footprint of the area to be mined in the future, and therefore it will not result in terrain or vegetation disturbance beyond that resulting from planned mine development. Figure 2 shows the cumulative workforce requirements for the major developments in the area, as presented in the Application (Suncor 1996). Figure 2 also provides the revised cumulative workforce demand projections, accounting for changes from Steepbank acceleration and updated figures for Syncrude's Aurora Mine project (Syncrude 1996).

The acceleration of work on the Steepbank Mine results in an increased cumulative workforce during 1997, but a decreased cumulative workforce in 1999 and 2000. By shifting the construction workforce, this would reduce the need for workforce recruitment beyond local and provincial resources as well as provide sustained employment. The economic spin-off from construction employment and procurement will also be accelerated.

5.2 Potential Effects to Terrestrial Resources

Hypothesis 12: *Valued Ecosystem Components in the Athabasca River valley could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.*

Key changes to the Steepbank Mine's potential effects to terrestrial resources will result from the reconfiguration of the West Overburden Waste Dump and the North Overburden Waste Dump. Because of the status of the Athabasca River valley and escarpment slopes within the Fort McMurray-Athabasca Oil Sands planning area (Alberta Environmental Protection 1995), landforms and some vegetation types within the valley were identified as Valued Ecosystem Components. The relocation of the West Overburden Waste Dump to avoid Shipyard Lake has reduced the extent of mature balsam poplar forest and riparian wetlands that were to have been disturbed in the original plan.

Overall, the impact of the Steepbank Mine project to Valued Ecosystem Components within the Athabasca River valley will be reduced as a result of implementation of the plan revisions, particularly as a result of relocation of the West Overburden Waste Dump. The Dump will not be encroaching into the Shipyard Lake wetlands complex. As such this riparian wetland complex, identified as a Valued Ecosystem Component (VEC), will be left intact.

Hypothesis *14: Visual integrity of the Athabasca River Valley could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.*

In the Application EIA, visual effects of the planned development were considered to be moderate within the Local Study Area. Mitigations to reduce the visual effects of dykes and earthworks included contouring earthworks and avoiding a single profile and straight line. The revised configuration of the North and West Overburden Waste Dumps incorporates swales and curved slopes which will increase the overburden dump's integration into the natural landscape. Revegetation and the addition of small hills and swales on the top and along the slopes of the dump will also visually integrate the earthwork into the landscape. The visual impact of sighting the west dump nearer to the river as compared to the original location could be off-set by the re-design of contours. The visual impacts of the proposed changes will not be increased from the previous assessment of local, moderate effects.

Hypothesis 15: *Biodiversity could be affected by the development, operation and reclamation of the Steepbank Mine and Lease 86/17.*

Impacts to biodiversity at the landscape level remain relatively constant between the original mine plan and proposed revisions, with continuing moderate impacts. Fragmentation will continue to remain at a moderate level due to the mine extent in the Upland section and the bridge and mining infrastructure within the valley. At the community and species level of biodiversity, biodiversity impacts will be reduced because of the relocation of the West Overburden Waste Dump away from Shipyard Lake, with its high potential for diverse and unique vegetation communities, and rare species. Also, the surface reclamation plan has been further refined with embankments to enhancements to ensure biodiversity potential.

Hypothesis 16: *Wetlands could be affected by Lease 86/17 and Steepbank Mine development and operation, including mine dewatering, changes to subsurface drainage, and reclamation release water.*

The original mine plan (Suncor 1996b) proposed that the West Overburden Waste Dump would partially intrude on the open water area (4.3 ha) of Shipyard Lake and adjacent closed shrub communities (37.9 ha). Mine plan revisions have subsequently incorporated mitigations proposed in the environmental assessment to reduce those impacts by avoiding Shipyard Lake and leaving the adjacent wetlands complex intact.

5.3 Potential Effects to Wildlife Resources

Hypothesis 21: *Mine development will disrupt the movement patterns of wildlife in the vicinity of the Steepbank Mine, thereby reducing access to important habitat or interfering with population mechanisms, resulting in decreased abundance of wildlife.*

The Athabasca River valley appears to support limited north-south wildlife movement along the river valley, with east-west movement to and from the river valley of greater consequence. Relocation of the barge landing and the increased length of the area where there will be an undisturbed buffer of less than 100m width along the river will further discourage wildlife movement parallel to the river, particularly for the larger terrestrial species. However, this may be partially off-set by the re-design of the buffer at the shop access corridor from 70 metres to 100 metres. These species are highly mobile, however, and are not limited to travel along the river valley.

5.4 Potential Effects to Aquatic Resources

Hypothesis 29: *Construction, operational or reclamation activities might adversely affect aquatic habitat in the Athabasca River;*

AND

Hypothesis 32: *Construction, operational or reclamation activities might lead to changes in aquatic habitat and/or aquatic health which might result in a decline in fish abundance in the Athabasca or Steepbank Rivers.*

Revisions to bridge design and construction methods will not adversely affect aquatic habitats or fish abundance in the Athabasca River (Golder 1996b). There will be a reduced impact during construction because of elimination of earth coffer dams and access berms.

6.0 CONCLUSION

The revisions to the mine plan presented in the original Suncor Oil Sands Group Steepbank Mine Application (Suncor 1996) will result in limited, but positive changes to the environmental impacts reported in the Application. Accelerated mine operations will result in levelling out of workforce requirements and reducing the peaks and valleys of employment within the region that were previously expected to occur (Figure 2).

Mine plan revisions have reduced the impacts previously expected to terrestrial resources within the Athabasca River valley. Impacts to Shipyard Lake and adjacent wetland shrub complex will be avoided because the West Overburden Waste Dump will be relocated. In addition, greater landform complexity from more flexible contouring of the overburden waste dumps will result in increased community and species biodiversity in the long term.

Although the Athabasca River Valley does not appear to be an important north-south corridor for wildlife movement, its effectiveness will be further reduced because of a decrease in the length where a natural vegetated buffer of more than 100m width occurs.

Changes to bridge design and work methods will not result in adverse effects to aquatic habitats or fish abundance. Construction methods due to new pier design will further reduce impacts due to river solids loading.

7.0 REFERENCES

Golder Associates Ltd. 1996a. Detailed Conservation and Reclamation Plan for Suncor's Integrated Mine Plan. Lease 86/17, Steepbank Mine and Athabasca River Valley.

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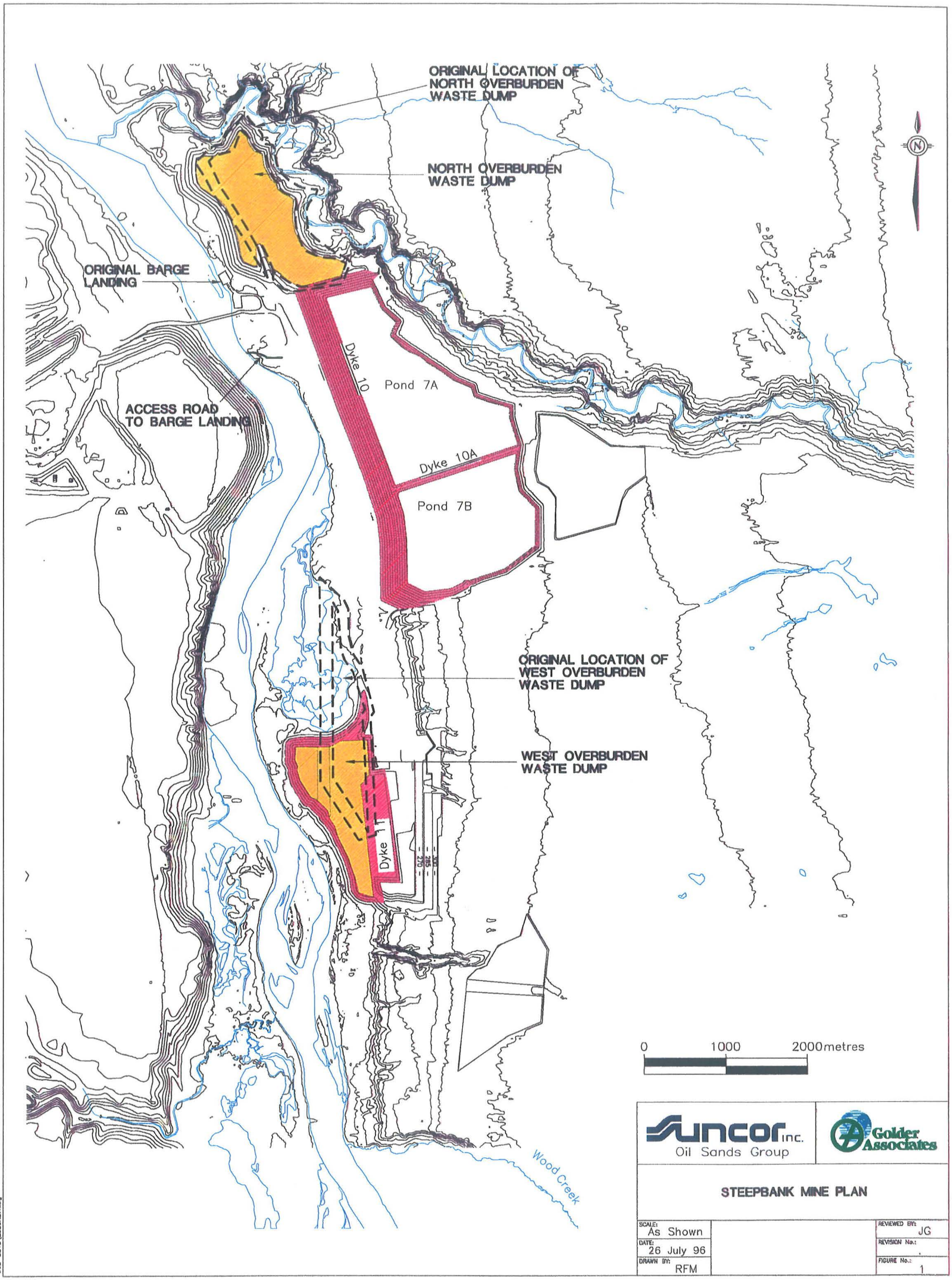
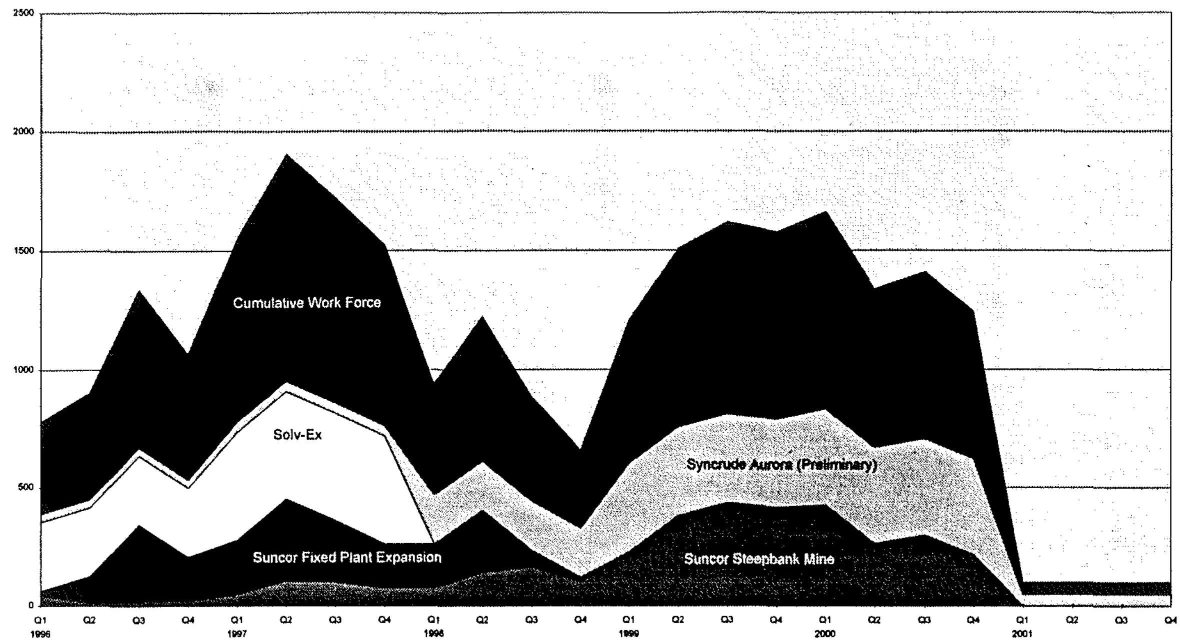
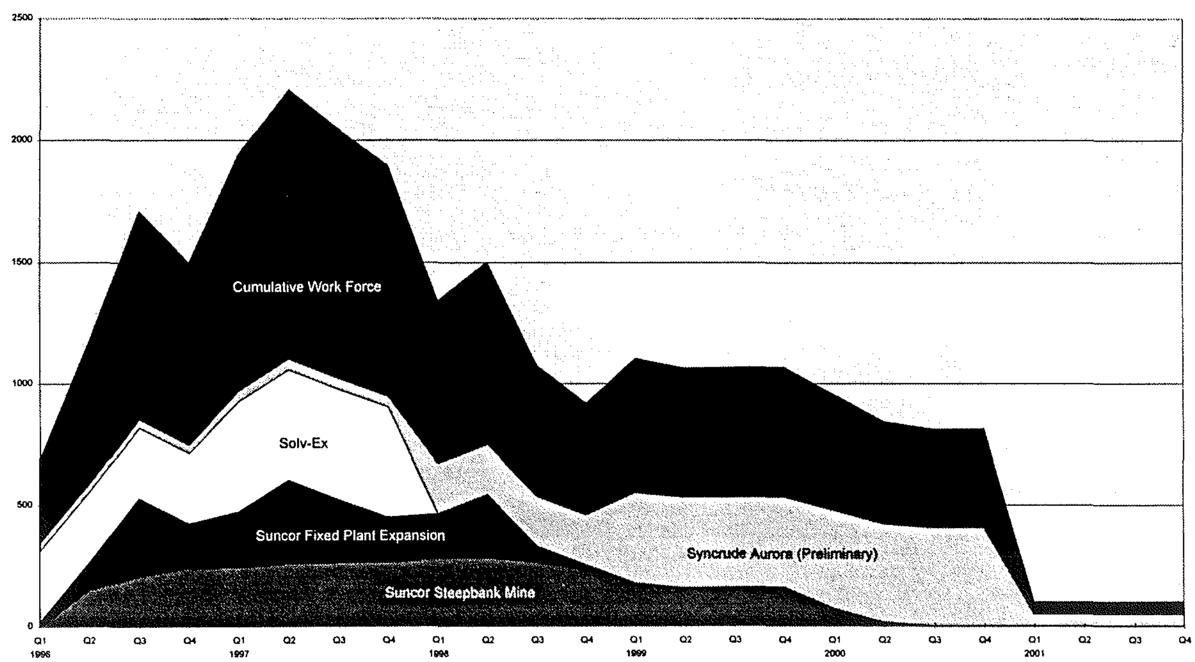

ORIGINAL LOCATION OF NORTH OVERBURDEN WASTE DUMP
NORTH OVERBURDEN WASTE DUMP
ORIGINAL BARGE LANDING
ACCESS ROAD TO BARGE LANDING
Dyke 10
Pond 7A
Dyke 10A
Pond 7B
ORIGINAL LOCATION OF WEST OVERBURDEN WASTE DUMP
WEST OVERBURDEN WASTE DUMP
Dyke 11
Wood Creek
N
0
1000
2000metres
Suncor inc.
Oil Sands Group
Golder Associates
STEEPBANK MINE PLAN
SCALE: As Shown
DATE: 26 July 96
DRAWN BY: RFM
REVIEWED BY: JG
REVISION No.:
FIGURE No.: 1

Figure 2: Work Force Projections

Cumulative Peak Construction Work Force:
Original Steepbank Mine Work Force Projections



Cumulative Peak Construction Work Force:
Revised Steepbank Mine Work Force Projections



APPENDIX 2

ORE GRADE CUT-OFF EVALUATION

ORE GRADE CUT-OFF EVALUATION
STEEPBANK MINE

INTRODUCTION

Suncor Inc. Oil Sands Group acknowledges the responsibility of maximizing resource recovery, consistent with the Oil Sands Conservation Act and sound economic and engineering principles.

A review of previous work suggests that considerable effort has been expended on cut-off grade and associated recovery relationships. The focus of this project is to consolidate findings and document results. In particular, the economic implication of cut-off grade with respect to the reserves of the existing mine (Leases 86 / 17) and the Steepbank Mine is being investigated.

SCOPE / OBJECTIVES

At the completion of this project a cut-off grade and economic pit limit ratio for the oil sand resource on Leases 86 / 17 and Steepbank will be rationalized and applied to finalize ultimate mining limits and the subsequent reserve base for planning and scheduling. In attaining this goal, the following objectives are met:

- Define the relationships between cut-off grade, economic pit limit ratio, and mineable reserves in terms of Net Present Value (NPV), average grade, tonnage-grade distribution, recovered bitumen, and average unit bitumen costs.

- Select a rational and defensible cut-off grade and economic pit limit ratio based on these relationships.

- Apply the cut-off grade and economic pit limit ratio to finalize mining limits (pit designs), mineable reserve, and mining schedule on Leases 86 / 17 and Steepbank.

- Provide regulatory agencies with a summary report, following internal review, in September, 1996. Discussions regarding the conclusions would follow.

ASSUMPTIONS

The following assumptions are made to allow project completion within a reasonable time frame. In some cases, the need for follow-up work, beyond the scope of the current project is defined.

- Existing grade / recovery relationship(s) are utilized in the analysis. Although future work in the form of discrete plant test runs and detailed reconciliations is warranted, the existing formulae are considered to provide acceptable results. This assumption will be tested through a sensitivity analysis within the scope of the current project.

- Minimum mineable ore and waste thickness is 3 metres. This is consistent with past practice and takes into consideration the mining selectivity and economics of large equipment applied since the introduction of truck / shovel mining.

- The extraction plant and upgrader facilities' production capability will be complemented by mine capacity (ie. the cut-off grade will not limit oil production capacity).

DESCRIPTION

A flow sheet has been developed to represent the process that will be applied in reviewing the relationship of cut-off grade, economic pit limit ratio, and economic reserves (see Figure 1). Cut-off grade will be expressed as recovered bitumen barrels per tonne. Economic pit limit ratio will be expressed as total tonnes mined per recovered barrel. This process commences with a simplified economic model of the Suncor operations to determine the unit basis "dollars available for mining" or the balance left over after all other costs of production are subtracted from the revenue stream. The dollars available are stated in "dollars per barrel bitumen." The dollars available along with average ore and waste mining costs are used as an input to a procedure which checks each ore block (approx. 15m x 15m x 15m) to determine if the revenue generated will support the costs to mine and process the block including the associated blocks above it. This three-dimensional economic optimization is referred to as a floating cone analysis. A more sophisticated "Lerchs - Grossman" analysis may be applied.

The final pit limits are established at the boundary of blocks which:

1. Generate sufficient revenue to support their own mining costs and the costs of the waste immediately above it.
2. Maintain a positive value when all costs and revenues of the ore and waste zones above the elevation are compared.

Cut-off grade, which defines ore / waste zones within the ore body, is introduced as a variable within the analysis. The output is a series of relationships between cut-off grade and NPV, average grade, grade distribution, recovered bitumen, and average unit bitumen costs. These relationships are investigated to determine the optimum case consistent with maximum return, minimum risk, and maximized resource recovery.

The cut-off grade and economic pit limit ratio selection must address the following risks:

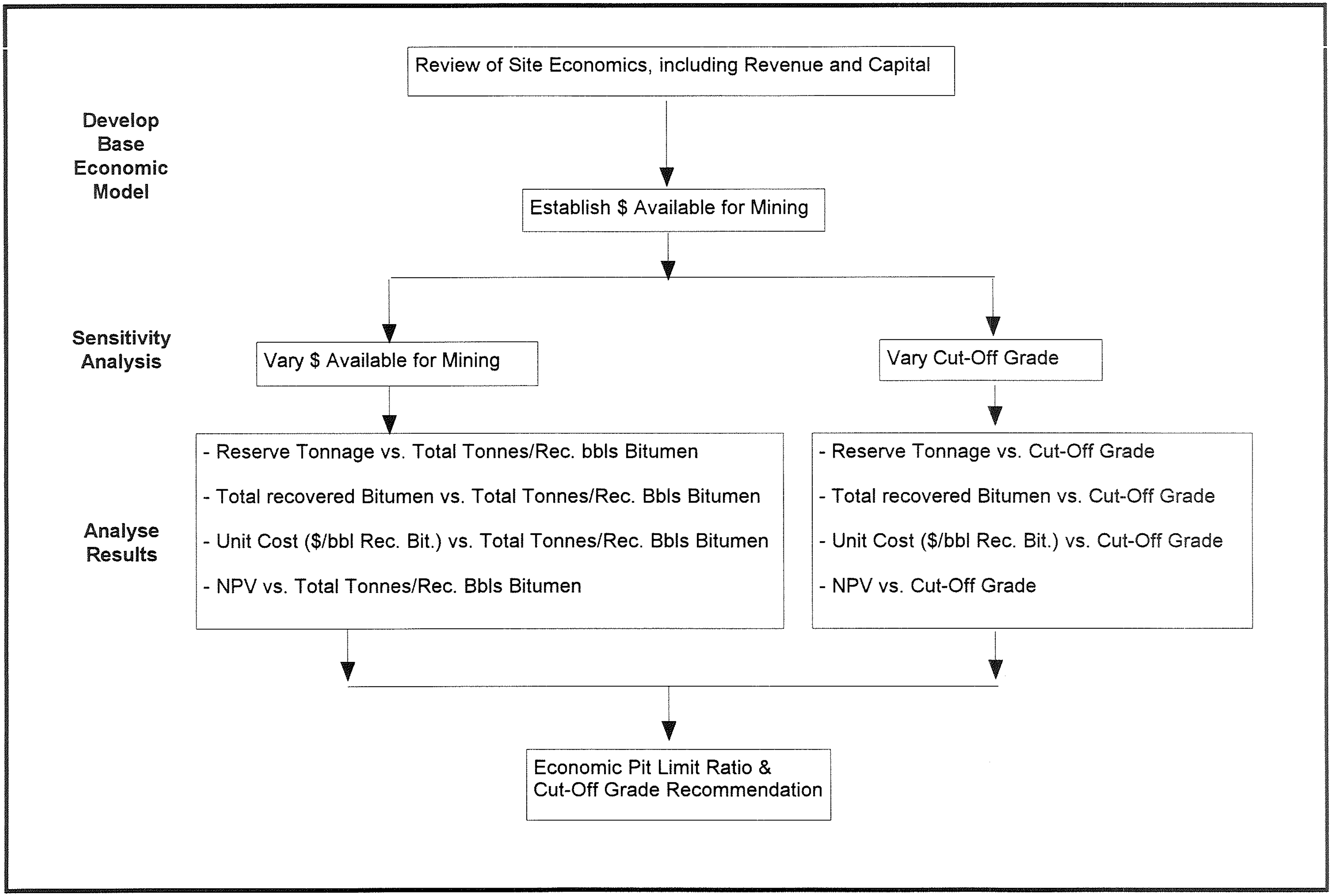
1. The average reserve grade must not limit the ability to supply the required bitumen to meet production goals.
2. The bitumen production costs for the resultant reserves must be able to withstand minor negative grade variances (i.e., small grade decreases cannot result in large cost increases).

3. The bitumen production costs for the resultant reserves must be able to withstand reasonable market variations.
4. Profit margins must meet the needs and expectations of Suncor Inc. and the stockholders.

PROJECT SCHEDULE

Consistent with the project objectives, it is anticipated that the project can be completed in September, 1996.

Figure 1


Review of Site Economics, including Revenue and Capital
Develop Base Economic Model
Establish $ Available for Mining
Sensitivity Analysis
Vary $ Available for Mining
Vary Cut-Off Grade
Analyse Results
- Reserve Tonnage vs. Total Tonnes/Rec. bbls Bitumen
- Total recovered Bitumen vs. Total Tonnes/Rec. Bbls Bitumen
- Unit Cost ($/bbl Rec. Bit.) vs. Total Tonnes/Rec. Bbls Bitumen
- NPV vs. Total Tonnes/Rec. Bbls Bitumen
- Reserve Tonnage vs. Cut-Off Grade
- Total recovered Bitumen vs. Cut-Off Grade
- Unit Cost ($/bbl Rec. Bit.) vs. Cut-Off Grade
- NPV vs. Cut-Off Grade
Economic Pit Limit Ratio & Cut-Off Grade Recommendation