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**REPORT ON**

# 1997 SYNTHESIS OF ENVIRONMENTAL INFORMATION ON CONSOLIDATED / COMPOSITE TAILINGS (CT)

**Submitted to:**

**Suncor Energy Inc. Oil Sands**

**April 1998** **972-2205.6045**

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April 23, 1998

Proj. No. 972-2205

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Sustainable Development
Suncor Energy Inc., Oil Sands
P.O. Box 4001
Fort McMurray, AB
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RE: Final Report on "Synthesis of Environmental Information on Consolidated Tailings"

Dear Martin

Attached are five copies of the "Synthesis of Environmental Information on Consolidated Tailings". This report summarizes the available chemistry and toxicology data for CT materials. Data sources have included Suncor, Syncrude, consultants, government agencies and universities.

If you have any additional questions about the report, please contact either Farida Bishay (299-4656), Munir Jivraj at 299-4624 or me at 299-5640.

Yours very truly

**GOLDER ASSOCIATES LTD.**

Shaun McKeon

for John R. Gulley, M.Sc., P. Biol.
Oil Sands Project Director

attachments (5)

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# EXECUTIVE SUMMARY


This document provides a summary of the chemical and toxicological information available as of October 1997 from laboratory (bench scale), prototype (field scale) and commercial scale CT operations at both Suncor and Syncrude. It focuses on CT materials produced with 800 to 1,600 mg/L of added gypsum. This information can be used as baseline data to address the environmental issues related to the large-scale deposition of this material.

Consolidated (a term used by Suncor) / Composite (a terms used by Syncrude) Tailings, or CT, is a new technology that increases the rate of settling of fine particles to reduce the amount of fines segregation (i.e., the formation of non-segregating tailings). This process increases the rate of dewatering. CT is a mixture of of fresh tailings, MFT, sands and a coagulant (currently gypsum or calcium sulphate [$CaSO_4$]). The gypsum acts to reduce the separation of the fines from the larger sand particles, resulting in a deposit with more solids than conventional MFT. This process provides a relatively "rapid" conversion from the fluid tailings to a trafficable landscape.

Implementation of the CT technology on a commercial scale was initiated by Suncor in 1996. Commissioning of this process required detailed monitoring of operating conditions. Of primary concern were inorganic chemistry balances coupled with sands and fine ratios dynamics. Therefore, the majority of available chemistry is for inorganics. The available organic chemistry and toxicological data for CT waters and solids are limited and cover a wide range of "process recipes", which include different sources of tailings materials, different sources of calcium sulphate coagulant, and varying coagulant concentrations.

Physical and chemical characteristics of CT materials discussed herein include: a) the physical characteristics including low dissolved oxygen and fine grain size that may restrict plant root growth; and b) the chemical characteristics including inorganic constituents such as salts, ammonia and metals, and organic constituents such as naphthenic acids, polycyclic aromatic hydrocarbons and volatile organic compounds. The data described in this report are relevant primarily to the leaching release mechanism and groundwater, surface water and sediment quality issues.

Although CT technology is a relatively new, various iterations of the process have been implemented since its derivation. Some of the precursor studies began as early as 1980; and focused on obtaining tailings that were suitable for vacuum or pressure filtration, or for building slopes and beaches (FTFC 1995). Since 1990, research topics included segregation boundaries, sedimentation and consolidation characteristics and chemical properties of the release water from non-segregating tailings (FTFC 1995). The most recent research has been directed at assessing the toxicity of CT release waters.

Some of the data presented reflect that chemical equilibrium has not yet been established. With continued recycling (i.e., the reuse of CT release water in the extraction process) conservative ions, such as chloride, sodium and sulphate will increase. However, it is expected that metals and organics (e.g., naphthenic acids) will reach equilibrium quickly and will not increase beyond levels recorded in current active tailings ponds.

On the other hand, time (i.e., aged compared with fresh CT release water) is expected to decrease the chemical concentration of ammonia and organic parameters and toxicity via biological processes (e.g., nitrification/denitrification, bacterial mineralization), photo-oxidation and volatilization. For example in Suncor and Syncrude field trials, naphthenic acids decreased with time, although at different rates. Any coincident effect on major ions or metals is not expected.

Regardless, CT release water quality is expected to be variable depending on operational processes and storage/treatment options. However, the same directional trends have been observed with both Suncor and Syncrude CT materials.

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# 1 INTRODUCTION

The major waste product from the Clark Hot Water Extraction (CHWE) process is a slurry consisting of water, unprocessed bitumen, sand and a fines fraction which is approximately 10% of the waste stream. This waste slurry is deposited in tailings ponds on both Suncor Energy Inc. (Suncor) and Syncrude Canada Ltd. (Syncrude) leases. The majority of the sand particles in the oil sands tailings stream segregate from the slurry. The remaining materials slowly settle to a semi-fluid deposit called "fine tailings". Over time (approximately five years), the fine tailings densifies slightly to form mature fine tails or MFT. This large volume of stored fine tailings provides both economic (i.e., operational costs) and environmental (i.e., reclamation) challenges, particularly related to dewatering (i.e., separating the water from the solids) of the produced fine tailings (Fine Tailings Fundamentals Consortium [FTFC] 1995).

Consolidated (a term used by Suncor) / Composite (a terms used by Syncrude) Tailings, hereafter referred to as CT, is a new technology that increases the rate of settling of fine particles and reduces the amount of fines segregation (i.e., the formation of non-segregating tailings). CT is a mixture of fresh tailings, MFT, sands and a coagulant (currently gypsum or calcium sulphate[$CaSO_4$]).

Although the CT process has the potential to decrease the economic and environmental challenges, it is a relatively new technology that is still under development and commercial trial. The available chemistry and toxicological data for CT waters and solids are limited and cover a wide range of "process recipes", which include different sources of tailings materials, different sources of calcium sulphate coagulant, and varying coagulant concentrations. Information about the chemical and toxicological properties of CT was previously summarized in the FTFC, 1995.

This document provides a summary of the chemical and toxicological information available as of October 1997 from laboratory (bench scale), prototype (field scale) and commercial scale CT operations at both Suncor and Syncrude. It focuses on CT materials produced with 800 to 1,600 mg/L of added gypsum. This information can be used as baseline data to address the environmental issues related to the large-scale deposition of this material.

## 1.1 OBJECTIVES

The purpose of this document is to summarize the available chemical and toxicological data of gypsum CT. The report includes:

- a review of the available gypsum CT data;

- an annotated bibliography of the available CT reports (Appendix I); and
- a compilation of the available chemistry and toxicological data for CT materials made with gypsum as a coagulant (Appendices II and III).

## 1.2 CHARACTERISTICS AND CONSTITUENTS OF CT MATERIALS

Potential characteristics of CT materials that are presented herein include:

- Inorganic Constituents - may act as stressors or toxicants
    - salts
    - ammonia
    - metals
    - hydrogen sulphide
- Organic Constituents - may act as toxicants or carcinogens
    - naphthenic acids (NA)
    - polycyclic aromatic hydrocarbons (PAH)
    - volatile organic compounds (VOC)
    - methane

These characteristics and constituents may impact the biological receptors in aquatic, wetlands and terrestrial ecosystems. Within these systems, various types of biota/receptors may be exposed to the chemicals of concern including: microbes, plants, invertebrates, vertebrates and humans.

# 2 HISTORY OF CT

Although CT technology is relatively new, various iterations of the process have been tested since its derivation. Non-segregating tailings studies began as early as 1980; and focused on obtaining tailings that were suitable for vacuum or pressure filtration, or for building slopes and beaches (FTFC 1995). Since 1990, research has focused on segregation boundaries, sedimentation and consolidation characteristics, and chemical properties of the release water from non-segregating tailings (FTFC 1995). The most recent research has been directed at assessing the toxicity of CT water.

The term, non-segregating tailings (NST), was used in studies prior to 1994, during which lime or acid and lime were generally used to reduce segregation. More recently, different forms of gypsum have been used as the coagulant, and the terminology has changed to CT. Some of the non-gypsum studies are included in the annotated bibliography (Appendix I) for completeness.

The initial NST bench-scale research was conducted by:

- Caughill (1992; summarized in FTFC 1995), to determine sedimentation and consolidation rates and hydraulic conductivity of tailings treated with the optimum lime concentration for Syncrude tailings;
- University of Alberta (1992-93; summarized in FTFC 1995), to determine the segregation and sedimentation characteristics, consolidation rates and in-line mixing and initial pumpability for nine categories of solids and fines content for Syncrude tailings; and
- University of Alberta (1993-95; summarized in FTFC 1995), to determine various segregation and sedimentation characteristics and consolidation rates for three types of tailings using a series of coagulant chemicals for Suncor tailings.

The 1993-95 work conducted by the University of Alberta initiated the use of calcium-rich flyash as a coagulant. This led to the concept of using the calcium sulphate-rich by-product from the Suncor flue gas desulphization plant. The initial NST field-scale research was conducted by:

- Suncor (1993-94; summarized in FTFC 1995), to determine geotechnical behaviour, deposit characteristics, deposition procedures, material management and cyclone operation, additive mixing procedures, pumpability, and release water chemistry for Suncor and Syncrude tailings; and
- Syncrude (1994-95; summarized in FTFC 1995), to test three combinations of tailings with differing sands:fines ratios under two coagulant treatments (i.e., acid lime and $CaSO_4$) for Syncrude tailings.

Studies on acid/lime NST and gypsum CT are summarized in Figure 1. These recent studies, as well as some earlier studies are noted in the annotated bibliography in Appendix I. The research switched focus from acid/lime NST to gypsum CT due to improved operations efficiency, decreased costs and improved release water quality. These studies provide the most information on CT deposit and release water chemistry and toxicity, and make up the majority of the data summarized in Sections 3 and 4.

Chemistry and toxicity data summarized herein were obtained from the available literature including sources such as Suncor, Syncrude, CANMET and various consultants and universities. The data sources are limited to those discussed in the September 8, 1997 CT Workshop (documented in the minutes that are provided in Appendix IV). Only data from gypsum CT and NST research are included (see Appendix II for chemistry data and Appendix III for toxicity data). In general, solid and water chemistry and toxicology are discussed separately with regard to the operator (i.e., Suncor or Syncrude) and scale (i.e., bench, field, commercial).

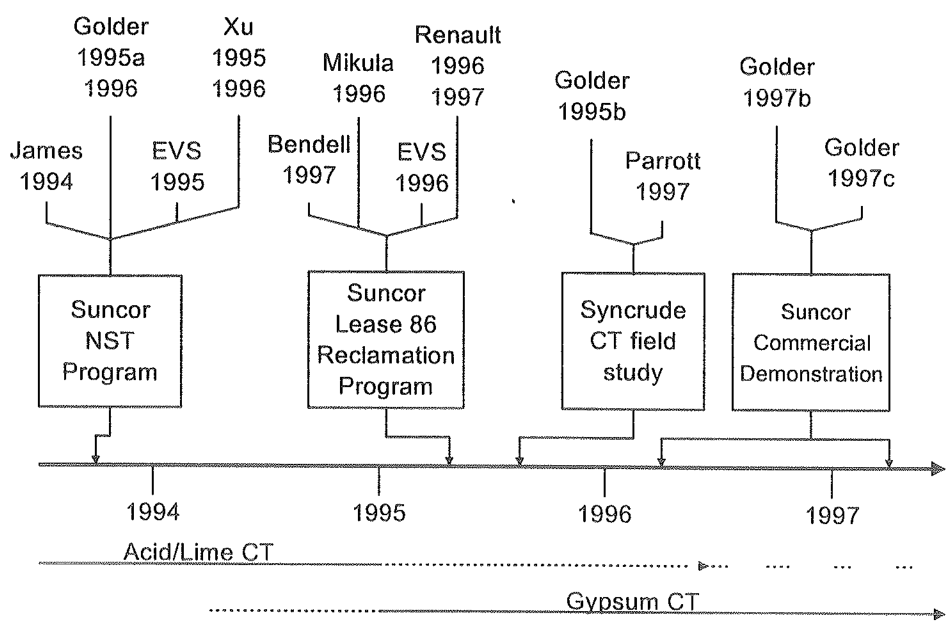


**Figure 1** **Recent NST and CT Research**

# 3 CHEMICAL PROPERTIES OF CT

Many different types of chemical analyses have been conducted on both CT solids and produced water. These include: conventional parameters (e.g., pH, conductivity, total suspended solids, alkalinity), major ions (e.g., sodium, chloride, sulphate), total and dissolved metals (e.g., boron, cadmium, molybdenum, zinc), organic parameters (e.g., total organic carbon, naphthenic acids, polycyclic aromatic hydrocarbons, volatile organic compounds, phenolics). The available data are provided in Appendix II and are summarized below.

## 3.1 CHEMISTRY OF THE SOLIDS ASSOCIATED WITH GYPSUM CT

There are limited solids chemistry data from field and commercial scale trials at Suncor and bench scale trials at Syncrude. Four (total) sets of CT solids chemistry data are available (Appendix II - Table II-A). At the time of this report, Suncor is the only plant operating at a commercial scale, and one set of CT solid sample results was available from the process (Appendix II - Table II-A).

### 3.1.1 Inorganic Constituents

A summary of selected inorganic constituents, divided into conventional parameters and metals, is provided in Table 1. Complete results of all parameters analysed are provided in Table II-A of Appendix II.

#### 3.1.1.1 Conventional Parameters

Conventional parameters were generally not measured during the Syncrude testing; and hence, a detailed comparison of the two processes is not possible. Conductivity was comparable among the limited samples, though Suncor samples tended to be lower than Syncrude's bench scale results. This difference may be due to the differences between Suncor and Syncrude ore deposits, although the study scale or gypsum source or concentration may also contribute to the differences observed.

#### 3.1.1.2 Metals

Metal levels in the Suncor field-scale solid deposits were generally lower than those in the Syncrude bench and Suncor commercial scale trials (Table 1). However, metal concentrations in Syncrude bench and Suncor commercial trials were very similar. These differences may be due to the different tailings (e.g., scavenger tails were used in the Suncor field trial rather than conventional plant 3 whole tailings) and different ore deposits used in each trial.

### Table 1 Summary of CT Solids Inorganic Chemistry

| Parameter | Units | Syncrude | | Suncor | |
|---|---|---|---|---|---|
| | | Bench Scale | | Field Scale | Commercial Scale |
| | | NST Deposit in Flume Test | Low Gypsum CT | RW160-1[a] | CT0108-2 |
| ***Conventional Parameters and Nutrients*** | | | | | |
| Bicarbonate | ppm | - | - | 683 | - |
| Calcium | ppm | - | - | 67 | - |
| Chloride | ppm | - | - | 57 | - |
| Conductivity | µS/cm | - | 2,440 | 1,536 | 1,750 |
| pH | units | - | 7.3 | - | 8.7 |
| Sodium | ppm | - | - | 352 | - |
| Sulphate | ppm | - | - | 127 | - |
| Total Suspended Solids | ppm | - | - | 12,700 | - |
| Nitrogen - Ammonia | ppm | - | - | 4.3 | - |
| *Total Metals* | | | | | |
| Arsenic | ppm | - | <20 | 0.04 | <0.2 |
| Boron | ppm | - | - | 4.4 | 9 |
| Cadmium | ppm | - | <0.3 | 0.01 | <0.3 |
| Chromium | ppm | - | 15.4 | 0.5 | 6.2 |
| Copper | ppm | - | 2.7 | 0.2 | 3.8 |
| Lead | ppm | - | 4.4 | 0.3 | 4 |
| Mercury | ppm | - | <20 | 0.05 | <20 |
| Molybdenum | ppm | - | 1.1 | 1.1 | 1.2 |
| Nickel | ppm | - | 14.4 | 1.2 | 10.8 |
| Selenium | ppm | - | <4 | 0.01 | <0.2 |
| Zinc | ppm | - | 13.6 | 0.9 | 11.9 |

[a] analysis based on leachate sample.
\- no data.

### 3.1.2 Organic Constituents

A summary of test results for selected organic constituents is provided in Table 2. Complete results of all parameters analysed are provided in Table II-A of Appendix II.

Naphthenic acids were only analysed in the Suncor field trial (107 mg/L). Polycyclic aromatic hydrocarbons (PAH) were at, or near, the detection limit in the Syncrude bench-scale trials and slightly higher in the Suncor field trials. These differences may be due to the different tailings (e.g., scavenger tails were used in the Suncor field trial) and different ore deposits used in each trial.

**Table 2 Summary of CT Solids Prganic Chemistry**

| Parameter | Units | Syncrude | | Suncor | |
|---|---|---|---|---|---|
| | | Bench Scale | | Field Scale | Commercial Scale |
| | | NST Deposit in Flume Test | Low Gypsum CT | RW160-1[a] | CT0108-2 |
| ***Organics*** | | | | | |
| Total Organic Carbon | ppm | - | - | 395.0 | - |
| Naphthenic Acids | mg/L | - | - | 107.0 | - |
| Naphthelene (PAH) | ppb | <0.01 | <0.04 | 0.02 | - |
| Benzo(a)pyrene (PAH) | ppb | 0.02 | 0.05 | 0.45 | - |
| Phenanthrene (PAH) | ppb | 0.46 | <0.04 | 0.17 | - |
| Total Detectable PAHs | ppb | 8.6 | 15.3 | 116.5 | - |
| Phenol | ppb | - | <0.02 | 1.3 | - |

[a] analysis based on leachate sample.
\- no data.

## 3.2 CHEMISTRY OF THE RELEASE WATER FROM GYPSUM CT

There are release water chemistry data from bench, field and commercial scale trials at Suncor and bench and field scale trials at Syncrude. The available chemistry data are provided in Appendix II and include:

- Suncor bench scale tests which include conventional parameters, major ions, metals and general organics (Table II-B.1).
- Syncrude bench scale tests which include conventional parameters, major ions, metals, general organics, PAHs, polycyclic aromatic nitrogen heterocycles (PANH) (Table II-B.2).
- Suncor field and commercial scale tests which include analyses from all parameter groups (Tables II-C.1 and II-D.1).
- Syncrude field scale tests which include conventional parameters, major ions, metals and general organics (Table II-C.2).

However, the constituents analyzed within each parameter group were not necessarily the same for the different test programs. The available data are summarized below (Tables 3 to 5).

## 3.2.1 Inorganic Constituents

### 3.2.1.1 Conventional Parameters

#### *Bench Scale Trials*

Samples for bench scale trials from both Suncor (Table II-B.1 in Appendix II) and Syncrude (Table II-B.2 in Appendix II) were taken from May 1994 to June 1995. The Suncor bench scale data set consists of a large sample size (i.e., 1 to 44 samples) of inorganic analyses, while the Syncrude data set was smaller (i.e., 1 to 5 samples) (Table 3 and 4). There were some differences between Suncor and Syncrude CT release water; for example, chloride and sodium were higher and ammonia and calcium were lower in Syncrude release water compared with Suncor release water. These differences may be due to different ore deposits or the source of gypsum. Ammonia is typically higher in oil sands process-affected waters at Suncor than Syncrude. Syncrude ore is typically higher in sodium than Suncor ore (MacKinnon and Sethi 1993). Suncor used gypsum from the Flue Gas Desulphurization Plant (FGD) or DOMTAR's Commercial Grade Gypsum (CGG); while Syncrude used Sherritt's Agricultural Grade Gypsum (AGG) in their bench-scale trials. Some differences in these coagulant sources have been observed (e.g., more metals were found to be of potential concern in FGD compared with AGG; Golder 1997).

Kaperski and Mikula (1994) monitored CT release water chemistry in various Suncor streams mixed with FGD over the period of release water generation (i.e., sampled with a frequency of 1, 2, 4, 9, 10 and 28 days). During this generation period, sulphate often doubled after 28 day generation period (Table 5; Appendix II - Table II-B.1). This increase was due to continued exchange of ions that allows the generation of release water. However, if the release water is separated from the solids and then assessed, ions such as sulphate remain comparable (e.g., for about 5 month old CT release water only ±10% variation over a 10 week period was observed; EVS 1995a).

#### *Field Scale Trials*

CT generation for Suncor field scale trial began in summer of 1994 and continued in summer of 1995 as part of Lease 86 reclamation study (Appendix II - Table II-C.1). Syncrude on the other hand set up its NST field trials in summer of 1995 (Appendix II - Table II-C.2). Chloride, sodium and sulphate were much higher in the Syncrude samples compared with those from Suncor (Table 3 and 4). Again, these differences may be due to:

## Table 3 Summary of Inorganic Chemistry for CT Release Water From Suncor Trials

| Parameter[b] | Bench Scale | | | | Field Scale | | | | Commercial Scale | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All Data | | | Fresh[a] | All Data | | | Fresh[a] | Pond 5 Composite | | | Fresh[a] | | |
| | Mean | # of Analyses | Range | | Mean | # of Analyses | Range | | Mean | # of Analyses | Range | Mean | # of Analyses | Range |
| ***Conventional Parameters*** | | | | | | | | | | | | | | |
| Bicarbonate | 425 | (38) | 162 - 754 | - | 422 | (23) | 239 - 2787 | - | 673 | (84) | 383 - 1046 | 786 | (6) | 685 - 1046 |
| Carbonate | 1.3 | (38) | 0 - 32 | - | 4.4 | (23) | <DL - 34 | - | 0.78 | (83) | <DL - 28 | 7 | (6) | 0 - 28 |
| Conductivity (µS/cm) | 3160 | (2) | 3090 - 3230 | 3090 | 2133 | (6) | 1891 - 2880 | 2100 | 2346 | (34) | 1380 - 2810 | - | - | |
| Chemical Oxygen Demand | 254 | (2) | 216 - 292 | - | 230 | (1) | | - | | - | | - | - | |
| pH (units) | 8 | (26) | 7.6 - 8.8 | 8.2 | 8.3 | (20) | 7.9 - 9.1 | 7.8 | 7.8 | (84) | 6.8 - 8.8 | 8.2 | (6) | 7.7 - 8.8 |
| Sulphur (total) | 627 | (24) | 158 - 1204 | - | 220 | (6) | 186 - 387 | - | | - | | - | - | |
| ***Major Ions*** | | | | | | | | | | | | | | |
| Calcium | 394 | (44) | 20 - 776 | 129 | 116 | (23) | 33 - 542 | 100 | 82 | (80) | 8 - 157 | 32 | (6) | 8 - 53 |
| Chloride | 154 | (40) | 50 - 366 | 54 | 54 | (23) | 42 - 72 | - | 60.9 | (99) | 27 - 163 | 56 | (6) | 42 - 94 |
| Magnesium | 132 | (42) | 12 - 379 | 44 | 20 | (23) | 7 - 80 | - | 24.7 | (80) | 26 - 46 | 14 | (6) | 6 - 17 |
| Sodium | 484 | (42) | 298 - 746 | 520 | 455 | (23) | 332 - 982 | - | 446 | (81) | 354 - 514 | 439 | (6) | 354 - 514 |
| Sulphide | <0.02 | (1) | | - | - | | | - | | - | | - | - | |
| Sulphate | 1546 | (44) | 487 - 3555 | 1270 | 868 | (23) | 555 - 2530 | 640 | 691 | (99) | 140 - 980 | 373 | (6) | 140 - 519 |
| ***Nutrients*** | | | | | | | | | | | | | | |
| Nitrogen - Nitrate + Nitrite | 0.5 | (2) | | 0.05 | 0.01 | (15) | 0.003 - 0.08 | - | 0.06 | (32) | 0.003 - 0.84 | - | - | - |
| Nitrogen - Ammonia | 7 | (2) | 5.7 - 8.4 | 5.7 | 0.89 | (15) | 0.1 - 2.41 | - | 6.37 | (3) | 6.31 - 8.20 | - | - | - |
| Phophorus (Total) | 0.002 | (1) | | | <DL | (5) | | | 0.01 | (3) | 0.01 - 0.02 | | | |
| ***Total Metals*** | | | | | | | | | | | | | | |
| Boron | 6.0 | (26) | 2.8 - 11 | 3 | 3.26 | (6) | 2.7 - 4.51 | - | 3.44 | (4) | 2.63 - 3.62 | - | - | - |
| Copper | 0.03 | (11) | 0.01 - 0.24 | 0.02 | 0.00 | (6) | <DL - 0.03 | - | | (2) | <DL - 0.004 | - | - | - |
| Iron | 0.24 | (25) | <DL - 1.7 | 0.1 | 0.24 | (6) | <DL - 1.01 | - | 0.41 | (4) | <0.001 - 1.17 | - | - | - |
| Molybdenum | 0.43 | (5) | 0.15 - 0.84 | 0.84 | 1.23 | (6) | 1.08 - 1.42 | - | 1.07 | (4) | 0.99 - 1.14 | - | - | - |
| Zinc | 0.12 | (11) | 0.01 - 0.24 | 0.08 | 0.04 | (6) | <DL - 0.16 | - | 0.026 | (3) | 0.021 - 0.028 | - | - | - |

(a) Fresh refers to CT release water analysed as it was generated.
- Data sets that were clearly identified as such:
  - Suncor bench scale - EVS (1995),
  - Suncor field scale - EVS (1996),
  - Suncor commercial scale - Kot et al. (1997).

(b) Units are mg/L except where noted otherwise.

Notes: - = no data available.
DL = Detection Limit.

## Table 4 Summary of Inorganic Chemistry for CT Release Water From Syncrude Trials

| Parameter[a] | Bench Scale | | | | Field Scale | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | All Data | | | Fresh[b] | All Data | | | Fresh[b] | | |
| | Mean | n | Range | | Mean | n | Range | Mean | n | Range |
| ***Conventional Parameters*** | | | | | | | | | | |
| Bicarbonate | 932 | | 800 - 1093 | 800 | 859 | 3 | 671-1133 | 759 | | 554-834 |
| Carbonate | 59 | | 20 - 112 | 20 | - | | - | - | | - |
| Chemical Oxygen Demand | 280 | | 260 - 300 | 260 | - | | - | - | | - |
| Conductivity (µS/cm) | 3575 | | 3550 - 3600 | 3600 | 4603 | 3 | 3970-5180 | 4370 | | 4270-4590 |
| pH | 8.8 | | 8.4 - 9.2 | 8.4 | 8.3 | 3 | 8-8.6 | 8 | | 8.3-8.5 |
| Sulphur (total) | 329 | | 316-352 | - | - | | - | - | | - |
| ***Major Ions*** | | | | | | | | | | |
| Calcium | 18.3 | | 7.6 - 36 | 36 | 56 | 3 | 36.2-78.6 | 63 | | 52.9-76.6 |
| Chloride | 367 | | 52 - 523 | 365 | 535 | 3 | 471-624 | 499 | | 484-509 |
| Magnesium | 10.7 | | 5.5 - 19 | 19 | - | | - | - | | - |
| Sodium | 1091 | | 910 - 1221 | 910 | 1118 | 3 | 998-1230 | 981 | | 945-1050 |
| Sulphate | 1017 | | 897 - 1114 | 1040 | 1182 | 3 | 1043-1322 | 1099 | | 1043-1172 |
| Sulphide | <0.01 | | | <0.01 | - | | - | - | | - |
| ***Nutrients*** | | | | | | | | | | |
| Nitrogen - Nitrate + Nitrite | 0.06 | | 0.05 - 0.06 | 0.05 | - | | - | - | | - |
| Nitrogen - Ammonia | 0.42 | | 0.35 - 0.49 | 0.49 | - | | - | - | | - |
| Phosphorus (Total) | 0.2 | | - | - | - | | - | - | | - |
| ***Total Metals*** | | | | | | | | | | |
| Boron | 3.06 | | 2.26-3.6 | 2.26 | 3.5 | 5 | 2.91-4.2 | 4 | | 3.16-4.18 |
| Copper | 0.09 | | 0.001-0.27 | 0.004 | - | | - | - | | - |
| Iron | 0.04 | | <DL-0.04 | 0.04 | - | | - | - | | - |
| Molybdenum | 0.18 | | 0.134-0.240 | 0.15 | 0.2 | 3 | <0.01-0.3 | - | | - |
| Zinc | 0.05 | | <DL-0.16 | 0.003 | - | | - | - | | - |

[a] Fresh refers to CT release water analysed as it was generated.
- Data sets that were clearly identified as such:
  Syncrude bench scale - Golder (1995b)
  Syncrude field scale - Syncrude (1995) - no data available.

[b] mg/L except where noted otherwise.

Notes: DL = detection limit.
n number of analysis.

**Table 5 Suncor CT Release Water Chemistry During Generation[a]**

| Parameter | Unit | Day 2 | Day 10 | Day 28 |
|---|---|---|---|---|
| *Conventional Parameters and Major Ions* | | | | |
| Bicarbonate | mg/L | 516 | 306 | 269 |
| Calcium | mg/L | 553 | 541 | 533 |
| Chloride | mg/L | 90 | 109 | 112 |
| Fluoride | mg/L | 1.2 | 1.5 | 10.8 |
| Magnesium | mg/L | 94 | 109 | 132. |
| pH | | 7.62 | 7.86 | 7.82 |
| Potassium | mg/L | 28 | 36 | 41 |
| Sodium | mg/L | 538 | 640 | 714 |
| Sulphate | mg/L | 1203 | 1331 | 2457 |
| Sulphur | mg/L | 676 | 898 | 940 |
| *Total Metals* | | | | |
| Aluminum | mg/L | 1.3 | 1.3 | 1.2 |
| Arsenic | mg/L | <DL | 0.02 | - |
| Barium | mg/L | 0.055 | 0.036 | 0.043 |
| Boron | mg/L | 4.6 | 5 | 7.4 |
| Copper | mg/L | 0.006 | <DL | - |
| Iron | mg/L | 0.14 | 0.049 | 0.016 |
| Lithium | mg/L | 0.25 | 0.34 | 0.38 |
| Magnesium | mg/L | 94 | 109 | 132 |
| Manganese | mg/L | 0.5 | 0.22 | - |
| Silicon | mg/L | 2.9 | 2.4 | 3.6 |
| Strontium | mg/L | 2.5 | 2.8 | 3.1 |
| Vanadium | mg/L | - | 0.001 | - |
| Zinc | mg/L | 0.082 | 0.1 | - |

[a] Scavenger Tails/FGDS trial; Kasperski and Mikula, 1994*a*; data set available in Appendix II.

- gypsum grade (FGD vs. CGG).
- gypsum source (DOMTAR vs. Sherritt);
- gypsum dosage (~900-1200 mg/L by Suncor vs. 1400 mg/L by Syncrude); and
- differences in ore deposits mined.

Porewater was also assessed in Syncrude's field scale trial (Appendix II - Table II-E.1). Porewater collected about 1 week after discharge ceased was comparable (for the major ions analysed) with porewater collected one month after active discharge.

### *Commercial Scale Trial*

The commercial scale trial for CT production to Pond 5 was initiated by Suncor in November 1995 and continues to operate (Appendix II - Table II-D.1). The sample size for conventional parameters range from 3 to 113 samples (Table 3). Although these data have been collected since the Pond's inception, they are not applicable to assess any changes over time since fresh CT was continually added to Pond 5. The levels of major ions in fresh CT release water to Pond 5 were comparable with composite samples collected from Pond 5, being except for sulphate which was much lower in the composite samples.

Although generally comparable, there were some differences across scale for Suncor, most notably calcium and sulphate. This may be due to different dosages of gypsum among the different trials. Syncrude was generally similar among trials.

### 3.2.1.2 Metals

Metals analysed in Suncor and Syncrude CT release water samples were comparable regardless of field scale (Table 3 and 4; Appendix II).

## 3.2.2 Organic Constituents

Many organic constituents were not consistently analysed at either Suncor or Syncrude or across scales. When these constituents were measured (e.g., Suncor field and commercial scales and Syncrude bench scale) they were low (i.e., less or near detection limits; see Appendix II), with the exception of parameters that are a measurement of a group of constituents (e.g., naphthenic acids; see Tables 6 and 7).

**Table 6 Summary of CT Release Water Organic Chemistry From Suncor Trials**

| Parameter (mg/L) | Bench Scale | Field Scale | | Commercial Scale |
|---|---|---|---|---|
| | All Data<br>Mean (# of analyses)<br>Range | All Data<br>Mean (# of analyses)<br>Range | Fresh[a] | Pond 5 Composite<br>Mean (# of analyses)<br>Range |
| *General Organics* | | | | |
| Dissolved Organic Carbon | 60 (1)<br>- | - | - | 50 (3) 48.5-51.7<br>- |
| Naphthenic Acids | 66 (1)<br>- | 78 (27) 62-100 | 76 | 69 (19) 50-87<br>- |
| Total Inorganic Carbon | 99 (3) 69 - 129<br>- | 64 95) 42-139 | - | -<br>- |
| Total Organic Carbon | 95 (3) 62 - 116<br>- | 76 (11) 56-236 | - | -<br>- |

(a) Fresh refers to CT release water analysed as it was generated.
- Data sets that were clearly identified as such:
Suncor bench scale - EVS (1995)
Suncor field scale - EVS (1996)
Suncor commercial scale - Kot et al. (1997).
- no data available.

**Table 7 Summary of CT Release Water Organic Chemistry for Syncrude Trials**

| | Bench Scale | | Field Scale | |
|---|---|---|---|---|
| **Parameter (mg/L)** | **All Data Mean (# of analyses) Range** | **Fresh[a]** | **All Data Mean (# of analyses) Range** | **Fresh[a]** |
| | ***General Organics*** | | | |
| Dissolved Organic Carbon | 61 (2) 55 - 66.9 | 55 | - | - |
| Naphthenic Acids | 76 (1) | 76 | 82 (17) 68-99 | 75 (1) |
| Total Inorganic Carbon | 160 (3) 113 - 187 | - | - | - |
| Total Organic Carbon | 212 (3) 191 - 252 | - | - | - |

(a) Fresh refers to CT release water analysed as it was generated.
- Data sets that were clearly identified as such:
Syncrude bench scale - Golder (1995b)
Syncrude field scale - Syncrude (1995) .
\- no data available.

Naphthenic acids were comparable (Table 6 and 7). The Suncor field scale trial illustrates the decrease in naphthenic acids over time (Table 8). A similar trend was observed in Syncrude field scale trial, although the decay rate was lower. This difference may be due to the length of the studies and the season in which they were conducted, rather than ore or process differences.

**Table 8 Naphthenic Acids (mg/L) in Suncor and Syncrude Field Scale Trials Over Time**

| Time (days) | Suncor[a] | | Syncrude[b] | |
|---|---|---|---|---|
| | Pit 1 | Pit 2 | Pond 2 | Pond 5 |
| 0 | 95 | 95 | 81 | 84 |
| 21 | 89 | 94 | - | - |
| 35 | 83 | 87 | - | - |
| 50 | 78 | 79 | - | - |
| 56 | 70 | 73 | - | - |
| 63 | 62 | 62 | - | - |
| 78 | 63 | 63 | - | - |
| 91 | 68 | 69 | - | - |
| 92 | - | - | 86 | - |
| 327 | - | - | 50 | 63 |
| 381 | - | - | 48 | 58 |

(a) CT Wetlands study in 1995; June 17 to September 18, 1995; EVS 1996.
(b) November 23, 1995 to December 8 1996; Syncrude 1995.
\- no data collected.

# 4 TOXICOLOGICAL PROPERTIES OF CT

A variety of toxicity tests have been conducted on CT release waters from laboratory and field studies. Some toxicity testing is also being initiated on different mixtures of CT solids.

Aquatic toxicity tests are used to detect and evaluate the potential toxicological effects of substances on aquatic organisms. Since these effects are not necessarily harmful, a principal function of these tests is to identify chemicals or whole effluents that can have adverse effects at low exposure concentrations. These tests can provide information that can be used to assess the risk associated with exposure of an organism to a known concentration of a substance.

Aquatic toxicity tests consist of exposure of test organisms to a number of dilutions of the test water for a specified period. At the end of the exposure period, survival (acute tests) or other, non-lethal endpoints (e.g., growth, reproduction; chronic tests) are quantified and a dose-response relationship is developed. Standard statistics are calculated based on the dose-response curve.

The standard statistic used to describe acute toxicity is the median lethal concentration (LC50), which is the concentration of test water that causes 50% mortality. Statistics used to describe sublethal toxicity are the IC50 and the IC25 (for "inhibition concentration"). The inhibition concentration is the concentration causing a given percent reduction in growth or reproduction.

Toxicity tests were conducted with CT water at both the acute and chronic levels. Acute toxicity tests were conducted with the following organisms:

- bacteria (Microtox);
- two water flea species (crustaceans): *Daphnia magna* and *Ceriodaphnia dubia*; and
- two fish species: rainbow trout (*Oncorhynchus mykiss*) and fathead minnow (*Pimephales promelas*).

Chronic toxicity tests were conducted with the following organisms:

- the freshwater alga *Selenastrum capricornutum* (endpoint is growth);
- the water flea *Ceriodaphnia dubia* (endpoint is reproduction); and
- the fathead minnow (*Pimephales promelas*) (endpoint is growth).

Toxicity tests were first conducted with laboratory produced CT water (bench scale trials). Next, tests were conducted with water from field scale experiments and commercial scale trials. The available data are provided in Appendix III and summarized below. Definitions for toxicological terms are provided in Appendix V.

## 4.1 SOLID TOXICITY OF GYPSUM CT

Acute and chronic toxicity data for CT solids were not available, although some research using CT solids as a soil (i.e., amended with various materials such as muskeg or tailings sand) for growing various plants has been conducted. The results from bench scale trials (Renault and Zwiazek 1996) and field scale trials (Xu 1997) indicated that different plants have different tolerances to the CT deposits. Further work is being conducted to assess the cause of the effects observed and mode of plant tolerance.

## 4.2 RELEASE WATER TOXICITY OF GYPSUM CT

The toxicity data available for CT release water (Table 9 and 10; Appendix III). Although much of the data were comparable between Suncor and Syncrude and across test scales, there were some differences (see below). These differences may be attributed to various characteristics of the test material (e.g., ore, gypsum source, gypsum concentration); however, there is insufficient data to support any conclusions at this time.

### 4.2.1 Bench Scale Trials

Microtox, rainbow trout and alevin survival and *Ceriodaphnia dubia* survival were conducted for bench scale trials (Table 9; Appendix III - Table III-A). There is no clear relationship between test organisms that can be derived as yet; responses vary greatly from one organism to the next. However, a decrease in toxicity has been observed over time. For example, rainbow trout survival was assessed for Suncor gypsum CT under different treatments in the laboratory in 1994-95, and found to vary from 0% to 100% for fresh to older CT, respectively (EVS 1995a). Similarly, *C. dubia* 7 day survival ranged from 13% (~5 months after CT production) to 100% (older CT) for 8 different test samples (EVS 1995a).

### 4.2.2 Field Scale Trials

Toxicity tests were conducted at the field level (Table 9 and 10; Appendix III - Tables III-A and III-B). Also, toxicity tests were conducted with different types of CT water, originating from enclosures, pits and trenches, and produced at different times. These release waters were treated with various substances (e.g., nutrients) which can probably account for some of the variability in the results. For example, rainbow trout LC50 varied from 10% to >100% for 12 different samples showing the wide range of responses in the field scale trials (EVS 1996).

A decrease in toxicity has been observed over time for certain test species. For example, rainbow trout survival improved from an LC50 of 60% to 100% (n=6) (Syncrude 1995). At the chronic level, *C. dubia* reproduction improved from an IC50 of 32% to 83% over 11 months (Syncrude 1995). Acute toxicity to other organisms (e.g., *C. dubia*, *D. magna*) was variable and the number of samples were insufficient to allow for an analysis of trends. Chronic testing with *S. capricornutum* (n=4) indicated that toxicity increased over time, from an IC50 of 93% to 56% (Syncrude 1995).

### 4.2.3 Commercial Scale Trial

Toxicity test results from Suncor's commercial scale trial tended to be comparable with those from field scale trials (Table 9 and 10; Appendix III, Tables III-A and III-B). A decrease of the acute toxicity over time was observed for all test species (i.e., rainbow trout, fathead minnow, *D. magna* and *C. dubia*) (Table 9).

Chronic toxicity testing for reproduction and growth inhibition of *C. dubia* and fathead minnow, respectively, seemed to show a similar decrease in toxicity over time (i.e, from fresh to older CT samples) as observed with the acute tests. A decrease of toxicity over time was observed, except for *S. capricornutum* where values increased over time (Table 10). However, it is important to note that the number of samples ranged from 3 to 5 for all test species.

## Table 9 CT Release Water Acute Toxicity

| Toxicity Test | Endpoint | Suncor[a] Range | Suncor[a] n | Syncrude[b] Range | Syncrude[b] n |
|---|---|---|---|---|---|
| ***Bench Scale*** | | | | | |
| Microtox | IC50 | - | - | 58 - 72<br>[58][c] | 2<br>[1] |
| | IC20 | 53 | 1 | 12-13 | 2 |
| Rainbow Trout | LT50 | 4 - >96<br>[4 -9] | 8<br>[2] | - | - |
| | % Survival | 0 - 100 | 9 | - | - |
| Alevin | % Survival | 0 - 100 | 7 | - | - |
| *Ceriodaphnia dubia* (7 day) | % Survival | 13-100 | 8 | - | - |
| ***Field Scale*** | | | | | |
| Microtox | IC50 | 59 - >100 | 25 | 54 - >100<br>[>100] | 39 |
| | IC40 | 36 - 95 | 19 | - | - |
| | IC30 | 22 - 45 | 19 | - | - |
| | IC20 | 12->100 | 25 | | |
| Rainbow Trout | LC25 | 31 | 1 | - | - |
| | LC50 | <10 - >100 | 15 | 60-100<br>[60] | 6<br>[1] |
| | NOEC | 25 | 1 | - | - |
| | LOEC | 50 | 1 | - | - |
| | % Survival | 0 - 100 | 12 | 0-100 | 5 |
| Fathead Minnow | LC50 | - | - | 75->100<br>[75] | 4<br>[1] |
| | Survival | - | - | 0-100 | 4 |
| *Daphnia magna* (48 h) | LC25 | >100 | 1 | - | - |
| | LC50 | >100 | 5 | 100->100 | 4 |
| | NOEC | >100 | 1 | - | - |
| | LOEC | >100 | 1 | - | 1 |
| | % Survival | - | - | 100->100 | 4 |
| *Ceriodaphnia dubia* (7 days) | LC25 | 44 | 1 | - | - |
| | LC50 | 64 | 1 | 50-100 | 4 |
| | NOEC | 50 | 1 | - | - |
| | LOEC | 100 | 1 | 50-100 | 4 |
| | % Survival | 0 - 63 | 6 | - | - |
| ***Commercial Scale Trial*** | | | | | |
| Microtox | IC50 | 90->100<br>[>91] | 18<br>[1] | - | - |
| | IC20 | 18->9<br>[32] | 18<br>[1] | - | - |
| Rainbow Trout | LC50 | 50 - 100 | 4 | - | - |
| | % Survival | 0 | 1 | - | - |
| Fathead Minnow | LC25 | 33-62<br>[33] | 3<br>[1] | - | - |
| | LC50 | 41-74<br>[41] | 3<br>[1] | - | - |
| | NOEC | 13-100<br>[13] | 3<br>[1] | - | - |
| | LOEC | 25-50<br>[25] | 3<br>[1] | - | - |
| *Daphnia magna* Survival (48 h) | LC25 | >100<br>[>100] | 3<br>[1] | - | - |
| | LC50 | >100<br>[>100] | 3<br>[1] | - | - |
| | NOEC | 100<br>[100] | 3<br>[1] | - | - |
| | LOEC | >100<br>[>100] | 3<br>[1] | | |

| Toxicity Test | Endpoint | Suncor[a] Range | n | Syncrude[b] Range | n |
|---|---|---|---|---|---|
| *Ceriodaphnia dubia* (7 days) | LC25 | 27-95 [27] | 5 [1] | - | - |
| | LC50 | 35->100 [35] | 5 [1] | - | - |
| | NOEC | 25-100 [25] | 5 [1] | - | - |
| | LOEC | 50->100 [50] | 5 [1] | - | - |

(a) Suncor data from Suncor EVS Report 1995a, Suncor, Lease 86 (EVS-Wetlands 1996 Report), Suncor Pond 5 East Studies and data from Suncor Project Millennium EIA.
(b) Syncrude data from 1995 bench and field tests.
(c) Data in [square brackets] are for fresh CT release water samples only.
\- no data available.

## Table 10 CT Release Water Chronic Toxicity

| Toxicity Test | Endpoint | Suncor[a] range | n | Syncrude[b] range | n |
|---|---|---|---|---|---|
| **Field Scale** | | | | | |
| Ceriodaphnia dubia Reproduction (7 day) | IC25 | 14 | 1 | - | - |
| | IC50 | 20 | 1 | 32-83 [32][c] | 4 [1] |
| | NOEC | 13 | 1 | 13-60 [13] | 4 [1] |
| | LOEC | 25 | 1 | - | - |
| Selanastrum Growth (72 hrs) | IC25 | 45 | 1 | 10 - 72 [72] | 2 [1] |
| | IC50 | 78 | 1 | 56 - 93 [93] | 4 [1] |
| | NOEC | 25 | 1 | 6 - 50 [50] | 2 [1] |
| | LOEC | 50 | 1 | 13 - 100 [100] | 4 [1] |
| **Commercial Scale Trials** | | | | | |
| Ceriodaphnia dubia Reproduction (7 day) | IC25 | 16-63 [63] | 5 [1] | - | - |
| | IC50 | 22-75 [75] | 5 [1] | | |
| | NOEC | 13-50 [50] | 5 [1] | | |
| | LOEC | 25-100 [100] | 5 [1] | | |
| Selanastrum Growth (72 hrs) | IC25 | 25-74 [25] | 3 [1] | - | - |
| | IC50 | 41-50 [41] | 3 [1] | - | - |
| | NOEC | 25 [25] | 3 [1] | - | - |
| | LOEC | 50 [50] | 3 [1] | - | - |
| Fathead Minnow Growth (7 days) | IC25 | 26->50 [26] | 3 [1] | | |
| | IC50 | 36->50 [36] | 3 [1] | | |
| | NOEC | 13-50 [25] | 3 [1] | | |
| | LOEC | 25->50 [50] | 3 [1] | | |

(a) Suncor data from Suncor, Lease 86 data, Suncor Pond 5 East and from Suncor Project Millennium EIA.
(b) Syncrude data from Syncrude 1995 field tests.
(c) Data in [square brackets] are for fresh CT release water samples only.
\- no data available

# 5 OPERATIONAL AND ENVIRONMENTAL CONTEXT - SUMMARY

Process options and treatment techniques may act positively or negatively to affect water quality as defined in terms of chemistry and toxicity (Table 11). Process options include sand:fines ratio and recycling of CT release water. Treatment techniques affect the CT release water once generated and include decay over time once isolated from operations(i.e., retention of CT water) and treatment by wetlands.

**Table 11 Trends Matrix of Factors Affecting CT Release Water Quality**

| | Parameter | | | | | |
|---|---|---|---|---|---|---|
| Variable | Major Ions | Ammonia | Metals | Naphthenic Acids | Polycyclic Aromatic Hydrocarbons | Toxicity |
| Increasing Sand:Fines Ratio | ⇔ | short term: ⇧<br>long term: ⇔ | short term: ⇧;<br>long term: ⇔ | short term: ⇧;<br>long term: ⇔ | short term: ⇧<br>long term: ⇔ | short term: ⇧;<br>long term: ⇔ |
| Recycling of CT release water | ⇧ | ⇧⇔ | ⇧⇔ | ⇧⇔ | ⇧⇔ | ⇧? |
| Time (Decay) | ⇔ | ⇩ | ⇔ | ⇩ | ⇩ | ⇩ |
| Wetlands | ⇔ | ⇩ | ⇩ | ⇩ | ⇩ | ⇩ |

⇧ increase
⇩ decrease
⇔ stable; no change; equilibrium

In general, the higher the sand and lower the fines content (to a maximum ratio) the faster the CT deposit will consolidate. Assuming the majority of the chemical constituents are associated with the fines (rather than the sands), then the higher the sands:fines ratio the fewer chemical constituents are present to be released. However, release water from acid/lime treatment of 6:1 and 4:1 sand:fine ratio materials was comparable with respect to major ions, naphthenic acid and microtox (Syncrude 1995). The ratio affects the rate at which water is released and consequently the release rate/concentration of a chemical constituent. However, the total load of a given chemical to the reclamation landscape (and ambient environment) will likely be the same in the end because this release is dependent on the total fines volume to be handled.

Recycling (i.e., the reuse of CT release water in the extraction process) will increase conservative ions, such as chloride, sodium and sulphate. However, it is expected that metals and organics (e.g., naphthenic acids) will reach equilibrium quickly and will not increase beyond certain levels (Syncrude 1995).

Time (i.e., aged compared with fresh CT release water) is expected to decrease the chemical concentration of ammonia and organic parameters and toxicity via biological processes (e.g., nitrification/denitrification, bacterial mineralization), photo-oxidation and volatilization. For example, in Suncor and Syncrude field trials naphthenic acids decreased with time, although at different rates. In contrast, a 70 day bench-scale experiment using Suncor CT, which was about 5 months old did not show any significant decrease (Figure 2). Although there are limited PAH data, similar decreasing trends over time are expected. Decreases are expected to be slower due to the higher complexity of PAHs compared with naphthenic acids. Any coincident effect on major ions or metals is not expected.

Similarly, toxicity tended to decrease with time in these same studies, although not for all organisms or trials. *Ceriodaphnia dubia* survival increased from 0% to 60% in the Suncor bench-scale trials and the LC50 increased from 50% to >100% in the Syncrude field-scale trials. Although there were differences between organisms and trials with respect to changes in CT toxicity with time, the overall trend is a decrease in toxicity with time. This is expected since most of the toxicity is associated with naphthenic acids and ammonia, which tended to decrease with time during these same studies.

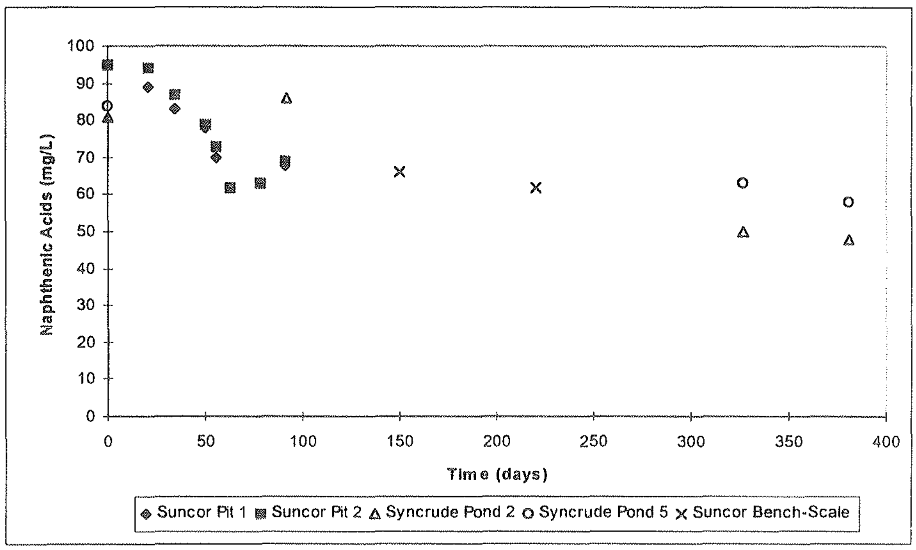


**Figure 2 Decay of Naphthenic Acids Over Time**

Regardless, CT release water quality is expected to be variable depending on operational processes and storage/treatment options. However, directional trends have been observed with both Suncor and Syncrude CT materials (Table 11) and with further research should become better defined.

# 6 CLOSURE

We trust this report presents the information you require. Should any portion of the report require clarification, please contact the undersigned.

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# APPENDIX I

# ANNOTATED BIBLIOGRAPHY

## ANNOTATED BIBLIOGRAPHY OF AVAILABLE CT REPORTS

### NOTE TO THE READERS:

Concurrent with bench and field scale studies (i.e., 1993 - 1994) the term non-segregating tails (NST) was used. Subsequently, the term "Consolidated Tailings" (CT) was adopted by Suncor, while Syncrude adopted the term "Composite Tailings" (CT) to refer to NST. Both terms are synonymous and widely accepted to replace the term NST. The term NST or CT is used below to reflect the term used in the original reference material.

*1982*

**San, R.H.C. 1982. Mutagenicity Potential of Syncrude Wastewaters. Prepared for Syncrude Canada Ltd. Prepared by B. C. Cancer Research Centre. 18 pp. plus figures and tables.**

| | |
|---|---|
| Source of CT: | Does not deal with CT samples |
| Methodology: | *In vitro* short-term bioassays were used on Syncrude's recycle water, coke storage and tailings water to assess mutagenicity on Syncrude wastewaters. |
| Chemistry: | not assessed |
| Toxicity: | *Salmonella* Mutagenicity Test, Chromosome Aberration Test, DNA Repair and Inhibition Test |
| Bioaccumulation: | Not assessed |
| Data used: | None |

*1993*

**EMA. 1993. Oil Sands Dry Landscape Reclamation: Phase 1 Study Report. Prepared for Suncor Inc., Oil Sands Group and Syncrude Canada Ltd. Prepared by EMA. 72 pp. plus figures and diagrams.**

| | |
|---|---|
| Source of CT: | Suncor, acid/lime NST |
| Methodology: | Generated NST leachate by mixing NST solids with reagent grade water/ or acetic acid. Leachate and solids were examined for toxicity and general chemistry. |
| Chemistry: | Unleached solids - pH, conductivity, major ions and other conventional, as well as nutrients<br>leachate - metals, nutrients and conventional |
| Toxicity: | unleached and leached solids - seedling emergence using *Latuca sativa*<br>unleached solids - earthworm survival<br>leachate - algal growth, seed germination and root elongation using *Latuca sativa*, nematode survival and growth, SOS-Chromotest using *E.coli* and Microtox® |
| Bioaccumulation: | Not assessed |
| Data use: | None used |

**Suncor 1993 NST Program**

| | |
|---|---|
| Source of CT: | Suncor, acid/lime NST; and Syncrude, gypsum and acid/lime NST |
| Methodology: | NST collected from Suncor's test pits and tanks, as well as bench-scale experiments at U of A were analyzed for various chemical parameters. |
| Chemistry: | Solids and water - metals, conventional, nutrients and limited organics (test results appended to James 1994) |
| Toxicity: | Microtox® |
| Bioaccumulation: | Not assessed |
| Data use: | Some for field scale |

*1994*

**James, W. 1994. Water Quality Review and Treatment Recommendations for Water Released from Suncor's Tailings: Interim Draft. Prepared for Suncor. Published by Alberta Environmental Centre.**

| | |
|---|---|
| Source of CT: | Suncor, acid/lime NST; and Syncrude, gypsum and acid/lime NST |
| Methodology: | Using data describing various wastewater flows from Suncor's mine site, James examined in-stream concentrations for various individual chemical parameters. |
| Chemistry: | Solids and water - metals, conventional, nutrients and limited organics |
| Toxicity: | Microtox® |
| Bioaccumulation: | Not assessed |
| Data used: | Some for field scale |

**Kasperski, K.L. and R.J. Mikula. 1994*a*. Effects of Addition of Flue Gas Desulphurization Slurry on Tailings Water Chemistry. CANMET WRC 94-40(CF). Prepared for Suncor Inc. Prepared by CANMET. 42 PP. plus appendices.**

| | |
|---|---|
| Source of CT: | Suncor Flue Gas Desulphurization Slurry(FGDS) (18.6 wt%) |
| Methodology: | Lab-scale suspensions of tailings (scavenger, pond 2/3, recycle water) and FGDS were made to assess tailings release water chemistry and impact on extraction process |
| Chemistry: | conventional, metals |
| Toxicity: | N/A |
| Bioaccumulation: | N/A |
| Date used: | Metals at different sampling period |

**Kasperski, K.L. and R.J. Mikula. 1994*b*. Modelling the Effects of Gypsum Addition on Suncor Plant Water Chemistry: Interim Report. CANMET WRC 95-13(CF). Prepared for Suncor Inc. Prepared by CANMET. 20 pp.**

Source of CT: Suncor's FGDS (250 mg/L and 850 mg/L $CaSO_4$-$2H_2O$)
Methodology: Modelling was performed on Stream 12 tailings going to dyke 8 with 250 and 850 ppm gypsum for summer and winter conditions.
Chemistry: Conventional, metals
Toxicity: Not assessed
Bioaccumulation: Not assessed
Data use: None

*1995*

**EVS. 1995. Biological Treatment Options for Consolidated Tailings Release Waters. Project number 3/144-30. Prepared for Suncor Inc., Oil Sands Group. Prepared by EVS Environment Consultants. 69 pp. plus tables and figures.**

Source of CT: Suncor, acid/lime and gypsum CT
Methodology: Examined treatability of CT release waters using different scenarios over 10 week period:

- basic - water in tank containing trickling filter media + Suncor wetland sediments
- enhanced - basic + $PO_4$ + aeration
- inoculated - enhanced + nitrifying bacteria
- open - inoculated without trickling filter media
- recirculated - water moving between open and wetland tanks

Chemistry: Conventional, metals, nutrients and limited organics (pre-treatment only) naphthenic acids and DOC (pre & post-treatment)
Toxicity: Microtox®, *Daphnia magna* and rainbow trout survival (juveniles, eggs and alevins)
Bioaccumulation: Not assessed
Data use: Some for bench and field scale trials

**Golder. 1995*a*. Oil Sands Dry Landscape Reclamation: Phase 2: Toxicity and Chemistry of Leachates from various reclamation materials. Project number 932-7196. Prepared for Suncor Inc. Prepared by Golder Associates Ltd. 43 pp. plus tables and figures.**

Source of CT: Suncor, acid/lime NST

Methodology: Bench-scale experiments examining toxicity and chemistry of leachates generated by rinsing NST with Suncor mine water (note: other oil sands materials were rinsed with de-ionized water). A total of 10 porewater volumes were put through each sample, and sample columns were kept anaerobic throughout the experiment.

Chemistry:

- Solids - nutrients, pH conductivity, major ions and other conventional
- Leachate - metals and conventional

Toxicity:

- Solids - 5 day seedling emergence using lettuce, and 14 day earthworm survival
- Leachate - algal growth, SOS-Chromotest using *E.coli*, Microtox®, and nematode survival and growth

Bioaccumulation: Not assessed

Data use: Some for bench scale studies

**Golder. 1995*b*. Lab Flume Tests Result. Data provided by Mike MacKinnon of Syncrude on August 1996.**

Source of CT: Syncrude, gypsum CT, 900 $g/m^3$ gypsum

Methodology: Samples collected from bench scale u-shaped design.

Chemistry: Conventional, metals and organics

Toxicity: Microtox®

Bioaccumulation: Not assessed

Data use: Data used for solids

**Kasperski, K.L. and R.J. Mikula. 1995. Tailings Release Water Chemistry and Toxicity: Comparison of Tailings Treatments. CANMET WRC 95-11(CF). Prepared for Suncor Inc. and Fine Tails Fundamentals Consortium. Prepared by CANMET. 30 pp. plus appendices.**

| | |
|---|---|
| Source of CT: | Syncrude/ Suncor - OSLO Hot Water Extraction (OWHE)/Clark Hot Water Extraction (CHWE) Drum Test |
| Methodology: | Study the chemical composition and toxicity of water produced in lab by University of Alberta and CANMET; and field tests for various mature fine tails (MFT) and beach runoffs. Samples collected were representative from NST, Freeze-thaw, NST and Fine Tails Test Pits. These samples went back to 1993/1994 field and bench scale studies. |
| Chemistry: | Conventional, metals |
| Toxicity: | Microtox®, 96 h trout (*Oncorhynchus mykiss*), 48 h *Daphnia magna* mortality |
| Bioaccumulation: | Not assessed |
| Data use: | $CaSO_4$ related NST samples were used |

**Mikula, R.J. and K.L. Kasperski. 1995. Nonsegregating Tailings Release Water Chemistry: Preliminary Report. CANMET WRC 95-26(CF). Prepared for Suncor Inc. Prepared by CANMET. 31pp. plus appendix.**

| | |
|---|---|
| Source of CT: | Suncor's FGDS, 600 mg/L agricultural grade gypsum (AGG) |
| Methodology: | Studies on the effect of added cations and anions on bitumen recovery, tailings settling and recycle water chemistry for the Clark Hot Water Extraction Process. |
| Chemistry: | some metals |
| Toxicity: | Not assessed |
| Bioaccumulation: | Not assessed |
| Data use: | Chemistry for NST release water |

**Suncor, Inc., Oil Sands Group. 1995. CT field pilot study (continued in 1996 and 1997 as Commercial Demonstration Project). Various lab reports held in-house at Golder.**

| | |
|---|---|
| Source of CT: | Suncor, 1000 mg/kg gypsum CT (1995) |
| Methodology: | Samples collected from the production line and the pond at different times from Dec. 19, 1995 to Jan. 8, 1996. |
| Chemistry: | Mix of conventional, metals and organics |
| Toxicity: | see Golder 1997 Pond 5 Study |
| Bioaccumulation: | Not assessed |
| Data use: | Pond 5 and other $CaSO_4$ related data |

**Syncrude. 1995. Field NST Field Demonstration. Appendix Q. Presentation Material provided by Mike MacKinnon. Vol 4/4.**

Source of CT: Syncrude, different doses of acid/lime and gypsum samples
Methodology: Presentation summary of different NST experiments including acid/lime and gypsum; standpipe tests and field studies.
Chemistry: Metals and conventional chemical parameters, naphthenic acid
Toxicity: Microtox®
Bioaccumulation: Not assessed
Data use: For Syncrude's field scale experiments

**Shaw, B., G. Cuddy, G. McKenna, M. MacKinnon. 1995. Non-segregating Tailings: 1995 NST Field Demonstration Summary Report. Prepared by Syncrude Canada Ltd. 200 pp. plus figures and tables.**

Source of CT: Syncrude, plant 5 tails plus Mildred Lake Settling Basin (MLSB) MFT with 1400 $g/m^3$ AGG gypsum from DOMTAR
Methodology: CT placed in U-shaped pit; release water placed in 5 NST holding test pits.
Chemistry: Major ions and cations of release and porewater, naphthenic acid
Toxicity: Microtox®
Bioaccumulation: Not assessed
Data use: Release water and porewater chemistry for field scale comparison

**Wastewater Technology Centre. 1995. Preliminary Evaluation of Options for Treatment of Tailings Pond Effluents for Discharge to the Northern Rivers Basin.**

Source of CT: Suncor, acid/lime NST; and Syncrude, gypsum and acid/lime NST
Methodology: Review of treatment technologies available to treat CT and other oil sands wastewaters.
Chemistry: Solids and water - metals, conventional, nutrients and limited organics (test results appended to James 1994)
Toxicity: Microtox®
Bioaccumulation: Not assessed
Data use: Some for field scale

**Xu, J.G., R.L. Johnson, P.Y.P. Yeung and S. Wu. 1995. Plant growth and metal uptake by plants from two oil sand fine tailings. Prepared for Suncor Inc., Oil Sands Group. Prepared by Alberta Environmental Centre.**

| | |
|---|---|
| Source of CT: | Suncor, acid/lime CT |
| Methodology: | Examined 1) plant growth on CT solids, CT + nitrogen (N), phosphorus (P) and potassium (K), CT + N, P and K + micro-nutrients and CT + N, P and K + peat, 2) plant metal uptake, and 3) microbial activity within CT deposits. These experiments were done in greenhouses using reed canary grass and willow seedlings. |
| Chemistry: | Solids - metals, conventional and nutrients |
| Toxicity: | Plant growth, and microbial activity |
| Bioaccumulation: | Metal uptake in plants |
| Data use: | None |

*1996*

**EVS. 1996. Constructed Wetlands for the Treatment of Oil Sands Wastewater, Technical Report #5. Project number 3/144-31. Prepared for Suncor Inc., Oil Sands Group by EVS Environment Consultants. 12 chapters + appendices.**

| | |
|---|---|
| Source of CT: | Plant 3 MFT plus gypsum (900 to 1000 $g/m^3$) |
| Methodology: | Three part study.<br>• Part 1, Wetland treatability - water from the different CT pits was pumped into 4 constructed wetlands to examine ability of wetlands to treat CT release waters<br>• Part 2, Biofilters - CT water was poured into 200L barrels to assess effectiveness of biofilm reactors.<br>• Part 3, Bioaccumulation - exposed mallard ducklings to CT waters for 4 weeks to examine bioaccumulation potential of CT toxins. |
| Chemistry: | Part 1 - metals, conventional, organics, nutrients and naphthenic acids (pre & post-treatment)<br>Part 2 - nutrients and naphthenic acids (pre & post-treatment) |
| Toxicity: | Part 1 - phytoplankton and zooplankton abundance within the wetlands, Microtox®, and survival of *Daphnia magna*, fathead minnows, sticklebacks and trout (pre & post-treatment)<br>Part 2 - rainbow trout survival rates |
| Bioaccumulation: | Measured survival, growth and gross pathology of ducklings, as well as, metal and PAH levels in various body tissues |
| Data use: | Toxicity data for field scale |

**Golder. 1996. Toxicity and Bioaccumulation Potential of Fine Tails and Tailings Water from Oil Sands Extraction. Project number 942-2287. Prepared for Syncrude Canada Ltd. and Suncor Inc. Prepared by Golder Associated Ltd. 24pp.**

| | |
|---|---|
| Source of CT: | Suncor, acid/lime CT from pilot test |
| Methodology: | Part 1 focused on CT toxicity using, undiluted CT solids, CT solids mixed with Mildred Lake Sediments (MLS) and aged CT solids.<br>Part 2 was a bioaccumulation study using CT solids diluted with MLS and covered with Mildred Lake water. Lipid sacs were used as substitutes for living subjects due to toxicity problems associated with the CT samples. |
| Chemistry: | Not assessed |
| Toxicity: | Microtox®, monitored survival rates for midge larva, mayfly nymph, bristle worm, leech, snail and amphipod<br>limited testing of CT release water toxicity to amphipods |
| Bioaccumulation: | Measured PAH levels in lipid sacs |
| Data use: | None |

**Kasperski, K.L. and R.J. Mikula. 1996. Modelling Suncor Recycle Water Chemistry: Impact of Consolidated Tails. CANMET WRC 96-16(CF). Prepared for Suncor Inc. Prepared by CANMET. 30 pp.**

| | |
|---|---|
| Source of CT: | Suncor FGDS (to give 900 mg/L CT) |
| Methodology: | River water and CT water chemistry are simulated via model to predict several water management scenarios at the Suncor Operation |
| Chemistry: | conventional |
| Toxicity: | Not assessed |
| Bioaccumulation: | Not assessed |
| Data use: | Conventional parameters |

**Li, X., J. Storey, P. Yeung, M. Fung. 1996. Plant Growth on Aggregated Oil Sands Processing Wastes. Prepared for Syncrude. Presented in 21st Annual Meeting, Canadian Land Reclamation Association, Calgary. Sept. 18 - 20, 1996.**

| | |
|---|---|
| Source of CT: | Syncrude, Domatar AGG |
| Methodology: | Aggregates were made with mixtures of MFT, CT and Tailing Sands to assess seedling. |
| Chemistry: | Not assessed |
| Toxicity: | Not assessed |
| Bioaccumulation: | Not assessed |
| Data use: | None |

**Li, X., M. Fung. 1996. Creating a Soil-like Profile for Plant Growth Using Tailings Sand and Fine Tails. Prepared for Syncrude. Prepared by Alberta Environmental Centre. Presented Petroleum Society of CIM's 47th Annual Technical Meeting, Calgary. June 10 - 12, 1996.**

| | |
|---|---|
| Source of CT: | Syncrude, Domtar AGG |
| Methodology: | Different reclamation materials like MFT, TS, CT and Tailing sands were used to make aggregates. The test looked at different soil-like properties. |
| Chemistry: | Soil chemical parameters |
| Toxicity: | Not assessed |
| Bioaccumulation: | Not assessed |
| Data use: | None |

**Mikula, R.J. 1996. Suncor Pond Survey 1995. CANMET WRC 96-24(CF). Prepared for Suncor Inc. Prepared by CANMET. 35 pp.**

| | |
|---|---|
| Source of CT: | Suncor FGDS |
| Methodology: | Suncor Pond 1, Pond 1A, Pond 2, Pond 3 and Pond 4 were characterized by several methods including sieve analysis, methylene blue, BSW (bitumen, solids and water), viscosity and gel strength. The reason for characterization was to accurately reflect the consolidation behavior of the clays as function of depth. |
| Chemistry: | Not assessed |
| Toxicity: | Not assessed |
| Bioaccumulation: | Not assessed |
| Data use: | None |

**Mikula, R.J., K.L. Kasperski and R.D. Burns. 1996. Consolidated Tailings Release Water Chemistry. In Conservation and Reclamation Issues, 1995-1996. Prepared for Suncor Inc. Prepared by CANMET.**

Source of CT: 600 ppm gypsum, source is unclear - assume Suncor
Methodology: Not mentioned
Chemistry: Major ions in release waters
Toxicity: Microtox®, *Daphnia magna* and trout survival
Bioaccumulation: Not assessed
Data use: None

**Renault, S. and J.J. Zwiazek. 1996. Phytotoxicity of Reclaimed Fine Tails and Tailings Sands. Prepared for Suncor Inc. and Syncrude Canada Ltd. Prepared by Dept. of Renewable Resources, University of Alberta. 63 pp.**

Source of CT: Suncor, gypsum CT
Methodology: Part 1 - CT solids were placed on top of dry capping material and mixed with capping material to depth of 20 cm. Mixture was then planted with aspen, dogwood and poplar cutting, as well as conifer, raspberry, rose and blueberry seedlings.
Part 2 - monitored willow, aspen, poplar and white spruce in Suncor's Hummoch-wetlands, which was fed CT release water.
Chemistry: Not assessed
Toxicity: Measured survival, water potentials and transpiration rates
Bioaccumulation: Not assessed
Data use: Phytotoxicity for CT mix

**Xu, J.G. and R.L. Johnson. 1996. Plant growth, dewatering and contaminant uptake from oil sands fine tails and tailings. Alberta Environmental Centre, Vegreville, Alberta. Prepared for Suncor Inc., Oil Sands Group.**

Source of CT: Suncor, acid/lime CT
Methodology: Examined 1) plant growth on CT solids, CT + muskeg and CT + muskeg + tailings sand, 2) the ability of plants to dewatering CT, 3) changes in CT moisture and nutrient content with plant growth, 4) plant metal uptake, and 5) microbial activity within CT deposits. These experiments were done using reed canary grass, poplar, willow and cattail.
Chemistry: Solids - metals, conventional, nutrients and PAHs
Toxicity: Plant growth and microbial activity
Bioaccumulation: Metal uptake in plants
Data use: None

*1997*

**Bendell-Young, L.I., A.P. Farrell, C.J. Kennedy, A. Kermode, M.M. Moore and A.L. Plant. 1997. Ecological viability of wetlands receiving oil sands effluent. *Abstract in* Proceedings of the 23rd Annual Aquatic Toxicity Workshop: Oct. 7-9, 1996, Calgary, Alta. Goudey, J.S., S.M. Swanson, M.D. Treissman and A.J. Miimi (eds.). Canadian Technical Report of Fisheries and Aquatics Sciences No. 2144.**

| | |
|---|---|
| Source of CT: | Suncor, gypsum CT |
| Methodology: | examined community health in wetlands receiving CT release water and dyke drainage water. |
| Chemistry: | Non assessed |
| Toxicity: | benthic community structure, chironomid density and biomass, plant growth, fish stress and mutagenic potential of bottom-dwelling chironomids |
| Bioaccumulation: | Not assessed |
| Data use: | None |

**Golder. 1997*a*. Environmental Implications of Different Sources of Gypsum. Project number 962-2522 Produced for Syncrude Canada Ltd.**

| | |
|---|---|
| Source of CT: | No CT assessed, just gypsum sources such as 1000 g/m$^3$ Domtar, Agrium, Westrock, Suncor's FGDS |
| Methodology: | Preliminary screening on envrionmental concerns and health impacts of various CT deposits. Contribution of metals from each source was also calculated. |
| Chemistry: | Metal chemistry |
| Toxicity: | Not assessed |
| Bioaccumulation: | Not assessed |
| Data use: | None |

**Golder. 1997*b*. Field-scale Trials to Assess Effects of Consolidated Tails Release Water on Plants and Wetlands Ecology. Project number 962-1881. Prepared for Suncor Inc. Prepared by Golder Associates Ltd.**

| | |
|---|---|
| Source of CT: | Suncor Pond 5, gypsum CT |
| Methodology: | Part 1, Hummock - Wetland Study - surface waters from Pond 5 were pumped into a hummock-wetland area to assess release water treatability. Part 2, Sulphate effects on plant growth - potted plants were placed in trenches, which were then filled with CT water; sulphate was added where needed to produce levels of 350, 1600 and 3500 ppm sulphate Part 3, Sulphate effects con't - plants in a greenhouse were exposed to 1 of 5 treatments: control, CT water, post-wetland treatment CT water, and CT water with sulphate levels of 1250 and 2500 ppm. |
| Chemistry: | Parts 1 and 2 - metals, nutrients, naphthenic acids, PAHs (Part 1 only) and conventional in water, sediments and porewater |
| Toxicity: | Part 1 - diversity and biomass of phytoplankton, zooplankton and benthic invertebrates, general plant biomass, fathead minnow survival, percent cover, species distribution and abundance Part 2 - diversity and biomass of zooplankton and benthic invertebrates, and survival and growth using beaked willow, sandbar willow, balsam poplar and reed canary grass Part 3 - seed viability and germination rates in barley and reed canary grass |
| Bioaccumulation: | Not assessed |
| Data use: | Some Pond 5 data |

**Golder. 1997*c*. A Limnological Survey of Suncor's Pond 5 East. Project number 962-2341. Prepared for Suncor Inc. Prepared by Golder Associates.**

| | |
|---|---|
| Source of CT: | Suncor, gypsum CT from Suncor Commercial Trials |
| Methodology: | Pond 5 water was collected from 1 m depth and near pond bottom. |
| Chemistry: | PAHs, metals, conventional, naphthenic acids and nutrients |
| Toxicity: | Diversity of phytoplankton, zooplankton and benthic invertebrates, identification of surrounding vegetation, and survival of trout and *Ceriodaphnia dubia* |
| Bioaccumulation: | Metal content in surrounding cattails |
| Data use: | Pond 5 water quality and toxicity data |

**Kasperski, K.L., R. J. Mikula. 1997. Modelling Suncor Recycle Water Chemistry: Impact of Consolidated Tails, Part 2. CANMET WRC 97-14 (CF). Prepared for Suncor Inc. Prepared by CANMET. 19 pp.**

Source of CT: Simulation on FGDS 900 to 1400 $g/m^3$
Methodology: Computer simulations of several scenarios (i.e., year 2021) at Suncor with CT production with FGDS. Assessment of CT release water chemistry and effect on extraction and plant process was also assessed.
Chemistry: Conventional parameters
Toxicity: Not assessed
Bioaccumulation: Not assessed
Data use: None

**Kot, J.J., R.J. Mikula, K.L. Kasperski. 1997. Suncor CT Trial: Water Chemistry Monitoring Program (1995-1996). CANMET WRC 97-05(CF). Prepared for Suncor Inc. Prepared by CANMET. 26 pp.**

Source of CT: Suncor, FGDS
Methodology: Pond 5 CT release water chemistry was monitored from November 1995 to September 1996.
Chemistry: Conventional parameters
Toxicity: Not assessed
Bioaccumulation: Not assessed
Data use:

**Mikula, R.J., V.A. Munoz, K.L. Kasperski and D. Omotoso. 1997. Consolidated Tailings: Technical Support For the Suncor Commercial Trial. CANMET WRC 97-13(CF). Prepared for Suncor Inc. Prepared by CANMET. 41 pp.**

Source of CT: FGDS 900 ppm gypsum (or 1400 ppm wt/CT vol)
Methodology: A rapid test methods were developed by CANMET to assess segregation behavior during CT production at field and commercial scale.
Chemistry: Not assessed
Toxicity: Not assessed
Bioaccumulation: Not assessed
Data use: None

**Parrott, J.L., M.D. MacKinnon, T. Van Meer and D.A. Birkholz. 1997. Assessment of (sub)lethal toxicity of oil sands reclamation waters using standard and biochemical indicator bioassays on waters and SPMD extracts. *Abstract in* Proceedings of the 23rd Annual Aquatic Toxicity Workshop: Oct. 7-9, 1996, Calgary, Alta. Goudey, J.S., S.M. Swanson, M.D. Treissman and A.J. Miimi (eds.). Canadian Technical Report of Fisheries and Aquatics Sciences No. 2144.**

| | |
|---|---|
| Source of CT: | Syncrude, AGG Domatar |
| Methodology: | examined chronic and acute toxicity of various release oil sands release waters to host of indicator species; semi-permeable membrane devices (SPMDs), exposed for 7 weeks, were also used to examine toxicological responses in fish cells |
| Chemistry: | SPMDs - PAHs |
| Toxicity: | rainbow trout, fathead minnow, *Daphnia magna* and *Ceriodaphnia dubia* survival, Microtox®, and algal growth |
| Bioaccumulation: | partially assessed with SPMDs; examined the influence of SPMD extracts on mixed function oxygenase activity in fish cells |
| Data use: | None |

**Renault, S. and J.J. Zwiazek. 1997. Phytotoxicity of Reclaimed Fine Tails and Tailing Sands. Prepared for Suncor Inc., OSG and Syncrude Canada Ltd.**

| | |
|---|---|
| Source of CT: | Syncrude and Suncor's 1995 CT (dose 900 - 1400 $g/m^3$) |
| Methodology: | Greenhouse study on effects of CT and fine tails on plants found in boreal forest of the Athabasca region. Different kinds of CT and FT mixtures were used as soil treatments. |
| Chemistry: | Plant physiological parameters, hydrocarbon uptake |
| Toxicity: | Seed survival, plant growth |
| Bioaccumulation: | Not assessed |
| Data use: | None |

# APPENDIX II

# AVAILABLE CHEMISTRY DATA

# Table II-A
# Summary of CT Solids Chemistry



| Parameter | Units | Suncor Commercial[1] CT0108-2 18-Jan-96 | Suncor Field[2] RW160-1 16-Jun-95 | Syncrude Bench NST DEPOSIT IN FLUME TEST[3] May-95 | Syncrude Bench LOW GYPSUM CT[4] 30-Oct-95 | MIN | MAX | MEAN | N |
|---|---|---|---|---|---|---|---|---|---|
| **Conventional Parameters** | | | | | | | | | |
| Biochemical Oxygen Demand | µg/g | | 16.7 | | | | 16.7 | | 1 |
| Chlorophyll "a" | µg/g | | 0.001 | | | | 0.001 | | 1 |
| Conductance | µS/cm | 1750 | 1536 | | 2440 | 1536 | 2440 | 1909 | 3 |
| pH | units | 8.7 | | | 7.3 | 7.3 | 8.7 | 8 | 2 |
| Sulphide | µg/g | | 0.01 | | | | 0.01 | | 1 |
| Total Alkalinity | µg/g | | 560 | | | | 560 | | 1 |
| Total Dissolved Solids | µg/g | | 894 | | | | 894 | | 1 |
| Total Suspended Solids | µg/g | | 12700 | | | | 12700 | | 1 |
| **Major Ions** | | | | | | | | | |
| Bicarbonate (HCO3) | µg/g | | 682.6 | | | | 682.6 | | 1 |
| Calcium | µg/g | | 67.1 | | | | 67.1 | | 1 |
| Carbonate (CO3) | µg/g | | 0.5 | | | | 0.5 | | 1 |
| Chloride | µg/g | | 57 | | | | 57 | | 1 |
| Magnesium | µg/g | | 1.9 | | | | 1.9 | | 1 |
| Potassium | µg/g | | 46.5 | | | | 46.5 | | 1 |
| Sodium | µg/g | | 352 | | | | 352 | | 1 |
| Sulphate | µg/g | | 127 | | | | 127 | | 1 |
| **Nutrients** | | | | | | | | | |
| Nitrate + Nitrite | µg/g | | 0.112 | | | | 0.112 | | 1 |
| Nitrogen - Ammonia | µg/g | | 4.26 | | | | 4.26 | | 1 |
| Nitrogen - Kjeldahl | µg/g | | 26 | | | | 26 | | 1 |
| Phosphorus, Total | µg/g | 50 | 4.7 | | | 4.7 | 50 | 27.35 | 2 |
| **Total Metals** | | | | | | | | | |
| Aluminum (Al) | µg/g | | 149 | | | | 149 | | 1 |
| Arsenic (As) | µg/g | <0.2 | 0.036 | | <20 | <0.2 | 0.036 | | 3 |
| Barium (Ba) | µg/g | 17 | 1.27 | | 19.1 | 1.27 | 19.1 | 12.46 | 3 |
| Beryllium (Be) | µg/g | 0.3 | 0.028 | | 0.3 | 0.028 | 0.3 | 0.21 | 3 |
| Boron (B) | µg/g | 9 | 4.43 | | | 4.43 | 9 | 6.7 | 2 |
| Cadmium (Cd) | µg/g | <0.3 | 0.01 | | <0.3 | <0.3 | 0.01 | | 3 |
| Calcium (Ca) | µg/g | 1140 | | | | | 1140 | | 1 |
| Chromium (Cr) | µg/g | 6.2 | 0.5 | | 15.4 | 0.5 | 15.4 | 7.37 | 3 |
| Cobalt (Co) | µg/g | 3.7 | 0.307 | | 2.0 | 0.307 | 3.7 | 2.00 | 3 |
| Copper (Cu) | µg/g | 3.8 | 0.164 | | 2.7 | 0.164 | 3.8 | 2.22 | 3 |
| Iron (Fe) | µg/g | 4240 | 235 | | | 235 | 4240 | 2238 | 2 |
| Lead (Pb) | µg/g | 4 | 0.32 | | 4.4 | 0.32 | 4.4 | 2.91 | 3 |
| Lithium (Li) | µg/g | 3.6 | 0.426 | | | 0.426 | 3.6 | 2.013 | 2 |
| Magnesium (Mg) | µg/g | 530 | | | | | 530 | | 1 |
| Manganese (Mn) | µg/g | 123 | 8.1 | | | 8.1 | 123 | 65.6 | 2 |
| Mercury (Hg) | µg/g | <20 | 0.05 | | <20 | <20 | 0.05 | | 3 |
| Molybdenum (Mo) | µg/g | 1.2 | 1.05 | | 1.1 | 1.05 | 1.2 | 1.12 | 3 |
| Nickel (Ni) | µg/g | 10.8 | 1.2 | | 14.4 | 1.2 | 14.4 | 8.8 | 3 |
| Potassium (K) | µg/g | 390 | | | | | 390 | | 1 |
| Selenium (Se) | µg/g | <0.2 | 0.012 | | <4 | <0.2 | 0.012 | | 3 |
| Silicon (Si) | µg/g | 1360 | 157 | | | 157 | 1360 | 759 | 2 |
| Silver (Ag) | µg/g | <0.2 | 0.002 | | | <0.2 | 0.002 | | 2 |
| Sodium (Na) | µg/g | 450 | | | | | 450 | | 1 |
| Strontium (Sr) | µg/g | 14.9 | 1.52 | | | 1.52 | 14.9 | 8.2 | 2 |
| Sulphur (S) | µg/g | | 61.2 | | | | 61.2 | | 1 |
| Titanium (Ti) | µg/g | 41.6 | 0.64 | | | 0.64 | 41.6 | 21.1 | 2 |
| Uranium (U) | µg/g | <50 | 0.5 | | | <50 | 0.5 | | 2 |
| Vanadium (V) | µg/g | 19.6 | 4.43 | | 23.7 | 4.43 | 23.7 | 15.9 | 3 |
| Zinc (Zn) | µg/g | 11.9 | 0.933 | | 13.6 | 0.933 | 13.6 | 8.8 | 3 |
| **General Organics** | | | | | | | | | |
| Dissolved Organic Carbon | µg/g | | 372 | | | | 372 | | 1 |
| Total Organic Carbon | µg/g | | 395 | | | | 395 | | 1 |
| Naphthenic acids | µg/g | | 107 | | | | 107 | | 1 |
| Total Petroleum Hydrocarbons | µg/g | | 18. | | 2480 | 18 | 2480 | 1249 | 2 |
| **Target PAHs and Alkylated PAHs** | | | | | | | | | |
| Naphthalene | ppb | | 0.02 | <0.01 | <0.04 | <0.01 | 0.02 | | 2 |
| Methyl naphthalenes | ppb | | 0.02 | | <0.04 | <0.04 | 0.02 | | 2 |
| C2 Subst'd naphthalenes | ppb | | 0.78 | 0.02 | <0.08 | <0.08 | 0.78 | | 3 |
| C3 Subst'd naphthalenes | ppb | | 1.8 | 0.22 | <0.08 | <0.08 | 1.8 | | 3 |
| C4 Subst'd naphthalenes | ppb | | 5.5 | 0.4 | <0.08 | <0.08 | 5.5 | | 3 |
| Acenaphthene | ppb | | 0.69 | 0.05 | <0.04 | <0.04 | 0.69 | | 3 |
| Methyl acenaphthene | ppb | | 1.6 | <0.01 | <0.08 | <0.01 | 1.6 | | 2 |
| Acenaphthylene | ppb | | 0.02 | <0.01 | <0.04 | <0.01 | 0.02 | | 2 |
| Anthracene | ppb | | 0.02 | <0.01 | <0.04 | <0.01 | 0.02 | | 2 |
| Dibenzo(a,h)anthracene | ppb | | 0.02 | <0.01 | <0.04 | <0.01 | 0.02 | | 2 |
| Benzo(a)Anthracene/Chrysene | ppb | | 4.3 | | 0.32 | 0.32 | 4.3 | 2.31 | 2 |
| Benz(a)Anthracene | ppb | | | 0.02 | | | 0.02 | | 1 |
| Chrysene | ppb | | | 0.02 | | | 0.02 | | 1 |
| Methyl Chrysene/Benz(a)Anthra. | ppb | | | 0.12 | | | 0.12 | | 1 |
| C2-Subst'd Chrysene/Benz(a)Anthra. | ppb | | | 0.12 | | | 0.12 | | 1 |
| Methyl benzo(a)anthracene/chrysene | ppb | | 7.8 | | 0.42 | 0.42 | 7.8 | 4.11 | 2 |
| C2 Subst'd benzo(a)anthracene/chrysene | ppb | | 9.6 | | 0.46 | 0.46 | 9.6 | 5.03 | 2 |
| Benzo(a)pyrene | ppb | | 0.45 | 0.02 | 0.05 | 0.02 | 0.45 | 0.17 | 3 |
| Methyl Benzo(a) Pyrene/Benzo (b&k) Flu | ppb | | | <0.02 | | | <0.02 | | 0 |
| C2 Subst'd Benzo(a) Pyrene/Benzo (b&k) | ppb | | | <0.02 | | | <0.02 | | 0 |
| Methyl benzo(b&k) fluoranthene/methyl b | ppb | | 3.1 | | 0.29 | 0.29 | 3.1 | 1.70 | 2 |
| C2 Subst'd benzo(b& k) fluoranthene/ben: | ppb | | 1.3 | | 0.12 | 0.12 | 1.3 | 0.71 | 2 |
| Benzo(b&k)fluoranthene | ppb | | 0.51 | 0.02 | 0.12 | 0.02 | 0.51 | 0.22 | 3 |
| Benzo(g,h,i)perylene | ppb | | 0.02 | <0.01 | <0.04 | <0.01 | 0.02 | | 2 |
| Biphenyl | ppb | | 0.05 | <0.02 | <0.08 | <0.02 | 0.05 | | 2 |
| Methyl biphenyl | ppb | | 0.21 | <0.02 | <0.08 | <0.02 | 0.21 | | 2 |
| C2 Substituted biphenyl | ppb | | 1.2 | 0.19 | <0.08 | <0.08 | 0.19 | | 3 |
| Dibenzothiophene | ppb | | 0.02 | 0.02 | <0.04 | <0.04 | 0.02 | | 3 |
| Methyl dibenzothiophene | ppb | | 3 | 0.28 | <0.08 | <0.08 | 3 | | 3 |
| C2 Substituted dibenzothiophene | ppb | | 11 | 0.51 | 0.27 | 0.27 | 11 | 3.93 | 3 |
| C3 Subst'd dibenzothiophene | ppb | | 14 | 0.53 | 1.7 | 0.53 | 14 | 5.41 | 3 |
| C4 Subst'd dibenzothiophene | ppb | | 10 | 0.83 | 4.5 | 0.83 | 10 | 5.11 | 3 |
| Fluoranthene | ppb | | 0.32 | 0.04 | <0.04 | <0.04 | 0.32 | | 3 |
| Methyl fluoranthene/pyrene | ppb | | 2.5 | | 0.53 | 0.53 | 2.5 | 1.5 | 2 |
| Fluorene | ppb | | 0.04 | 0.06 | <0.04 | <0.04 | 0.06 | | 3 |
| Methyl fluorene | ppb | | 0.56 | 0.28 | <0.08 | <0.08 | 0.56 | | 3 |
| C2 Substituted fluorene | ppb | | 4.6 | 0.25 | <0.08 | <0.08 | 4.6 | | 3 |

| Parameter | Units | Suncor | | Syncrude | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Commercial[1] | Field[2] | Bench | | | | | |
| | | CT0108-2 | RW160-1 | NST DEPOSIT IN FLUME TEST[3] | LOW GYPSUM CT[4] | MIN | MAX | MEAN | N |
| | | 18-Jan-96 | 16-Jun-95 | May-95 | 30-Oct-95 | | | | |
| Indeno(c,d-123)pyrene | ppb | | 0.02 | <0.01 | <0.04 | <0.01 | 0.02 | | 2 |
| Phenanthrene | ppb | | 0.17 | 0.46 | <0.04 | <0.04 | 0.46 | | 3 |
| Methyl phenanthrene/anthracene | ppb | | 4.3 | 0.75 | 0.15 | 0.15 | 4.3 | 1.7 | 3 |
| C2 Subst'd phenanthrene/anthracene | ppb | | 8.2 | 1 | 0.29 | 0.29 | 8.2 | 3.2 | 3 |
| C3 Subst'd phenanthrene/anthracene | ppb | | 12 | 1.4 | 1.6 | 1.4 | 12 | 5 | 3 |
| C4 Subst'd phenanthrene/anthracene | ppb | | 6.3 | 1.1 | 4.3 | 1.1 | 6.3 | 3.9 | 3 |
| 1-Methyl-7-isopropyl-phenanthrene (Rete | ppb | | 0.04 | | <0.08 | <0.08 | 0.04 | | 2 |
| Pyrene | ppb | | 0.46 | <0.1 | 0.16 | <0.01 | 0.46 | | 2 |
| **Target PANHs** | | | | | | | | | |
| quinoline | ppb | | 0.02 | | <0.04 | <0.04 | 0.02 | | 2 |
| 7-Methyl quinoline | ppb | | 0.02 | | <0.04 | <0.04 | 0.02 | | 2 |
| C2 Subst'd quinoline | ppb | | 0.02 | | <0.04 | <0.04 | 0.02 | | 2 |
| C3 Subst'd quinoline | ppb | | 0.02 | | <0.04 | <0.04 | 0.02 | | 2 |
| Acridine | ppb | | 0.02 | | <0.04 | <0.04 | 0.02 | | 2 |
| Methyl acridine | ppb | | 0.02 | | <0.04 | <0.04 | 0.02 | | 2 |
| Phenanthridine | ppb | | 0.02 | | <0.04 | <0.04 | 0.02 | | 2 |
| Carbazole | ppb | | 0.02 | | <0.04 | <0.04 | 0.02 | | 2 |
| Methyl carbazole | ppb | | 0.02 | | <0.04 | <0.04 | 0.02 | | 2 |
| C2 Subst'd carbazole | ppb | | 0.02 | | <0.04 | <0.04 | 0.02 | | 2 |
| **Phenolics** | | | | | | | | | |
| Phenol | ppb | | 1.3 | | <0.02 | <0.02 | 1.3 | 0.66 | 2 |
| o-Cresol | ppb | | 0.1 | | <0.02 | <0.02 | 0.1 | 0.06 | 2 |
| m-Cresol | ppb | | 0.4 | | <0.02 | <0.02 | 0.4 | 0.21 | 2 |
| p-Cresol | ppb | | 0.1 | | <0.02 | <0.02 | 0.1 | 0.06 | 2 |
| 2,4-Dimethylphenol | ppb | | 0.1 | | <0.02 | <0.02 | 0.1 | 0.06 | 2 |
| 2-Nitrophenol | ppb | | 2 | | <0.04 | <0.04 | 2 | 1.02 | 2 |
| 4-Nitrophenol | ppb | | 20 | | <1 | <1 | 20 | 10.5 | 2 |
| 2,4-Dinitrophenol | ppb | | 20 | | <1 | <1 | 20 | 10.5 | 2 |
| 4,6-Dinitro-2-methyl phenol | ppb | | 20 | | <1 | <1 | 20 | 10.5 | 2 |
| **Volatile organics** | | | | | | | | | |
| Acetone | ppb | | 100 | | | | 100 | | 1 |
| Acrolein | ppb | | 100 | | | | 100 | | 1 |
| Acrylonitrile | ppb | | 100 | | | | 100 | | 1 |
| Benzene | ppb | | 1 | | | | 1 | | 1 |
| Bromodichloromethane | ppb | | 1 | | | | 1 | | 1 |
| Bromoform | ppb | | 1 | | | | 1 | | 1 |
| Bromomethane | ppb | | 10 | | | | 10 | | 1 |
| 2-Butanone (MEK) | ppb | | 100 | | | | 100 | | 1 |
| Carbon disulfide | ppb | | 1 | | | | 1 | | 1 |
| Carbon tetrachloride | ppb | | 1 | | | | 1 | | 1 |
| Chlorobenzene | ppb | | 1 | | | | 1 | | 1 |
| Chloroethane | ppb | | 10 | | | | 10 | | 1 |
| 2-Chloroethyl vinyl ether | ppb | | 5 | | | | 5 | | 1 |
| Chloroform | ppb | | 1 | | | | 1 | | 1 |
| Chloromethane | ppb | | 10 | | | | 10 | | 1 |
| Dibromochloromethane | ppb | | 1 | | | | 1 | | 1 |
| Dibromomethane | ppb | | 1 | | | | 1 | | 1 |
| 1,2-Dichlorobenzene | ppb | | 1 | | | | 1 | | 1 |
| 1,3-Dichlorobenzene | ppb | | 1 | | | | 1 | | 1 |
| 1,4-Dichlorobenzene | ppb | | 1 | | | | 1 | | 1 |
| cis-1,4-Dichloro-2-butene | ppb | | 2 | | | | 2 | | 1 |
| trans-1,4-Dichloro-2-butene | ppb | | 5 | | | | 5 | | 1 |
| Dichlorodifluoromethane | ppb | | 1 | | | | 1 | | 1 |
| 1,1-Dichloroethane | ppb | | 1 | | | | 1 | | 1 |
| 1,2-Dichloroethane | ppb | | 1 | | | | 1 | | 1 |
| 1,1-Dichloroethene | ppb | | 1 | | | | 1 | | 1 |
| trans-1,2-Dichloroethene | ppb | | 1 | | | | 1 | | 1 |
| 1,2-Dichloropropane | ppb | | 1 | | | | 1 | | 1 |
| cis-1,3-Dichloropropene | ppb | | 1 | | | | 1 | | 1 |
| trans-1,3-Dichloropropene | ppb | | 1 | | | | 1 | | 1 |
| Ethanol | ppb | | 100 | | | | 100 | | 1 |
| Ethylbenzene | ppb | | 1 | | | | 1 | | 1 |
| Ethylene dibromide | ppb | | 1 | | | | 1 | | 1 |
| Ethyl methacrylate | ppb | | 200 | | | | 200 | | 1 |
| 2-Hexanone | ppb | | 200 | | | | 200 | | 1 |
| Iodomethane | ppb | | 1 | | | | 1 | | 1 |
| 4-Methyl-2-pentanone (MIBK) | ppb | | 200 | | | | 200 | | 1 |
| Methylene chloride | ppb | | 1 | | | | 1 | | 1 |
| Styrene | ppb | | 1 | | | | 1 | | 1 |
| Tetrachloroethylene | ppb | | 1 | | | | 1 | | 1 |
| 1,1,2,2-Tetrachloroethane | ppb | | 5 | | | | 5 | | 1 |
| Toluene | ppb | | 1 | | | | 1 | | 1 |
| 1,1,1-Trichloroethane | ppb | | 1 | | | | 1 | | 1 |
| 1,1,2-Trichloroethane | ppb | | 1 | | | | 1 | | 1 |
| 1,2,3-Trichloropropane | ppb | | 2 | | | | 2 | | 1 |
| Trichloroethene | ppb | | 1 | | | | 1 | | 1 |
| Trichlorofluoromethane | ppb | | 1 | | | | 1 | | 1 |
| Vinyl acetate | ppb | | 100 | | | | 100 | | 1 |
| Vinyl chloride | ppb | | 20 | | | | 20 | | 1 |
| Xylenes | ppb | | 1 | | | | 1 | | 1 |

Note:
Mean, maximum and standard deviations are based on detectable results
[1]Commercial CT data obtained from Suncor's Pond 5 survey (Golder 1997c).
[2]Field data obtained from Suncor's Lease 86 Wetland studies (EVS 1996); leachate.
[3]Syncrude solids data was obtained from Golder's flume tests (Golder 1995b).
[4]Low gypsum CT data received from Mike MacKinnon (Syncrude 1995).

## Summary of Suncor CT Release Water Chemistry From Bench Scale Trials

| SAMPLE ID/Date | | Consol.Su CPW+Ca[1] | 2M Su PW+C[2] | Scavenger tails CT Day 2[3] | Scavenger tails CT Day 10 | Scavenger tails CT Day 28 | Pond 2/3 tails CT Day 2 | Pond 2/3 tails CT Day 10 | Pond 2/3 CT Day 28 | Recycle water suspension CT Day 2 | Recycle water suspension CT Day 10 | Recycle water suspension CT Day 28 | Recycle water suspension CT Day 2 | Recycle water suspension CT Day 10 | Recycle water suspension CT Day 28 | Recycle water suspension CT Day 1 | Recycle water suspension CT Day 4 | Recycle water suspension CT Day 9 | Pond 2/3 CT suspension Day 1 | Pond 2/3 CT suspension Day4 | Pond 2/3 Ct suspension Day 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unit | May-94 | Jun-94 | Oct-94 | Oct-94 | Oct-94 | Oct-94 | Oct-94 | Oct-94 | Oct-94 | Oct-94 | Oct-94 | Oct-94 | Oct-94 | Oct-94 | Oct-94 | Oct-94 | Oct-94 | Oct-94 | Oct-94 | Oct-94 |
| **Conventional Parameters** | | | | | | | | | | | | | | | | | | | | | |
| Conductance | µS/cm | | | | | | | | | | | | | | | | | | | | |
| Hardness | mg/L | 99.3 | 183.5 | | | | | | | | | | | | | | | | | | |
| pH | units | 8.7 | 8.1 | 7.62 | 7.86 | 7.82 | 7.64 | 7.78 | 7.68 | 7.6 | 7.8 | 7.85 | 7.68 | 7.85 | 7.89 | 7.91 | 7.77 | 8.04 | 8.3 | 8.23 | 8.26 |
| Sulphide | mg/L | | | | | | | | | | | | | | | | | | | | |
| Total Alkalinity | mg/L | | | | | | | | | | | | | | | | | | | | |
| Total Inorganic Carbon | mg/L | 69.4 | 129.4 | | | | | | | | | | | | | | | | | | |
| Turbidity | mg/L | | | | | | | | | | | | | | | | | | | | |
| Biochemical Oxygen Demand | mg/L | | | | | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L | | | | | | | | | | | | | | | | | | | | |
| **Major Ions** | | | | | | | | | | | | | | | | | | | | | |
| Bicarbonate (HCO3) | mg/L | 437 | 623 | 516 | 306 | 269 | 372 | 314 | 286 | 474 | 202 | 162 | 417 | 173 | 171 | 540 | 364 | 189 | 754 | 727 | 717 |
| Calcium | mg/L | 20.3 | 48.4 | 553 | 541 | 533 | 536 | 692 | 776 | 556 | 741 | 651 | 644 | 751 | 616 | 701 | 622 | 595 | 23 | 36 | 35 |
| Carbonate (CO3) | mg/L | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Chloride | mg/L | 318 | 305 | 90 | 109 | 112 | 101 | 157 | 197 | 106 | 120 | 153 | 163 | 222 | 310 | 255 | 301 | 289 | 66 | 50 | 63 |
| Fluoride | mg/L | 29.7 | <DL | 1.2 | 1.5 | 10.8 | 2.4 | 3.3 | 0 | 2.4 | 3.3 | 12 | 3.9 | 3.7 | 0 | 48 | 0 | 0 | 0 | 18 | 0 |
| Magnesium | mg/L | 11.8 | 15.2 | 94 | 109 | 132 | 104 | 146 | 223 | 108 | 128 | 182 | 176 | 223 | 360 | 379 | 356 | 353 | 19 | 18 | 19 |
| Potassium | mg/L | 13.1 | 15.1 | 28 | 36 | 41 | 26 | 37 | 41 | 11 | 14 | 18 | 12 | 16 | 24 | 18 | 19 | 19 | 20 | 21 | 20 |
| Sodium | mg/L | 728.6 | 745.9 | 538 | 640 | 714 | 443 | 614 | 690 | 298 | 408 | 500 | 300 | 418 | 598 | 360 | 341 | 341 | 457 | 438 | 438 |
| Sulphate | mg/L | 887 | 822 | 1203 | 1331 | 2457 | 1205 | 1514 | 3555 | 1055 | 1063 | 2211 | 1227 | 1524 | 3183 | 2594 | 3289 | 2746 | 608 | 487 | 496 |
| $Fe^{2+/3+}$ | mg/L | | | | | | | | | | | | | | | | | | | | |
| $H_2CO_3$ | mg/L | | | | | | | | | | | | | | | | | | | | |
| **Nutrients** | | | | | | | | | | | | | | | | | | | | | |
| Nitrate + Nitrite | mg/L | | | | | | | | | | | | | | | | | | | | |
| Nitrogen - Ammonia | mg/L | | | | | | | | | | | | | | | | | | | | |
| Nitrogen - Kjeldahl | mg/L | | | | | | | | | | | | | | | | | | | | |
| Phosphorus, Total | mg/L | | | | | | | | | | | | | | | | | | | | |
| **Total Metals** | | | | | | | | | | | | | | | | | | | | | |
| Aluminum (Al) | mg/L | 1.7 | 0.52 | 1.3 | 1.3 | 1.2 | 1.3 | 1.3 | 1.8 | 1.4 | 1.5 | 1.5 | 1.4 | 1.5 | 1.6 | 1.4 | 1.4 | 1.2 | 0.49 | 10.3 | 8.8 |
| Antimony (Sb) | mg/L | | | | | | | | | | | | | | | | | | | | |
| Arsenic (As) | mg/L | | | 0 | 0.02 | na | 0.017 | 0.02 | na | 0.02 | 0.029 | na | 0.025 | 0 | na | | | | | | |
| Barium (Ba) | mg/L | 0.03 | 0.064 | 0.055 | 0.036 | 0.043 | 0.053 | 0.04 | 0.049 | 0.029 | 0.03 | 0.043 | 0.024 | 0.029 | 0.042 | 0.034 | 0.034 | 0.033 | 0.17 | 0.27 | 0.2 |
| Beryllium (Be) | mg/L | | | | | | | | | | | | | | | | | | | | |
| Bismuth | mg/L | | | | | | | | | | | | | | | | | | | | |
| Boron (B) | mg/L | 3.4 | 3.1 | 4.6 | 5 | 7.4 | 4.9 | 5 | 10.4 | 4.6 | 5.2 | 7.03 | 6.5 | 7 | 14 | 11 | 11 | 11 | 3.8 | 3.9 | 3.9 |
| Cadmium (Cd) | mg/L | | | | | | | | | | | | | | | | | | | | |
| Calcium (Ca) | mg/L | 20.3 | 48.4 | | | | | | | | | | | | | | | | | | |
| Chromium (Cr) | mg/L | | | | | | | | | | | | | | | | | | | | |
| Cobalt (Co) | mg/L | | | | | | | | | | | | | | | | | | | | |
| Copper (Cu) | mg/L | <DL | <DL | 0.006 | 0 | na | 0.002 | 0 | na | 0.0032 | 0.0017 | na | 0.0031 | 0.00028 | na | | | | | | |
| Iron (Fe) | mg/L | <0.34 | <0.08 | 0.14 | 0.049 | 0.016 | 0.19 | 0.049 | 0.12 | 0.07 | 0.009 | 0.32 | 0.009 | 0.0008 | 0.27 | 0.05 | 0.16 | 0.45 | 0.11 | 1.73 | 1.5 |
| Lead (Pb) | mg/L | | | | | | 0 | 0.02 | na | 0.016 | 0 | na | 0 | 0.06 | na | | | | | | |
| Lithium (Li) | mg/L | 0.22 | 0.26 | 0.25 | 0.34 | 0.38 | 0.19 | 0.35 | 0.41 | 0.13 | 0.22 | 0.24 | 0.138 | 0.24 | 0.32 | 0.23 | 0.25 | 0.23 | 0.21 | 0.23 | 0.2 |
| Magnesium (Mg) | mg/L | 11.8 | 15.2 | 94 | 109 | 132 | 104 | 146 | 223 | 108 | 128 | 182 | 176 | 223 | 360 | 379 | 356 | 353 | 19 | 18 | 19 |
| Manganese (Mn) | mg/L | 0.017 | 0.019 | 0.5 | 0.22 | na | 0.23 | 0.22 | na | 0.17 | 0.22 | na | 0.18 | 0.26 | na | | | | | | |
| Mercury (Hg) | mg/L | | | | | | | | | | | | | | | | | | | | |
| Molybdenum (Mo) | mg/L | 0.18 | 0.15 | | | | | | | | | | | | | | | | | | |
| Nickel (Ni) | mg/L | | | | | | | | | | | | | | | | | | | | |
| Potassium (K) | mg/L | 13.1 | 15.1 | | | | | | | | | | | | | | | | | | |
| Selenium (Se) | mg/L | | | | | | | | | | | | | | | | | | | | |
| Silicon (Si) | mg/L | 4.3 | 3 | 2.9 | 2.4 | 3.6 | 5.9 | 5.4 | 8.9 | 3.2 | 2.8 | 5.6 | 3 | 2.6 | 5.8 | 3.1 | 3.9 | 4.5 | 3.7 | 21 | 19 |
| Silver (Ag) | mg/L | | | | | | | | | | | | | | | | | | | | |
| Sodium (Na) | mg/L | | | | | | | | | | | | | | | | | | | | |
| Strontium (Sr) | mg/L | 0.6 | 0.9 | 2.5 | 2.8 | 3.1 | 2.9 | 2.8 | 4.9 | 0.83 | 1 | 1.2 | 0.9 | 1.2 | 1.5 | 1.3 | 1.3 | 1.2 | 0.87 | 0.95 | 0.95 |
| Sulphur (S) | mg/L | 268.1 | 254.4 | 676 | 898 | 940 | 682 | 898 | 1204 | 636 | 845 | 945 | 709 | 995 | 1107 | 885 | 895 | 924 | 167 | 158 | 165 |
| Thallium | mg/L | <DL | <DL | | | | | | | | | | | | | | | | | | |
| Titanium (Ti) | mg/L | | | | | | | | | | | | | | | | | | | | |
| Tungsten | mg/L | | | | | | | | | | | | | | | | | | | | |
| Vanadium (V) | mg/L | | | | 0.001 | na | na | 0.029 | na | na | 0.006 | na | na | 0.005 | na | | | | | | |
| Zinc (Zn) | mg/L | <DL | <DL | 0.082 | 0.1 | na | 0.081 | 0.13 | na | 0.084 | 0.12 | na | 0.13 | 0.23 | na | | | | | | |
| **General Organics** | | | | | | | | | | | | | | | | | | | | | |
| Dissolved Organic Carbon | mg/L | | | | | | | | | | | | | | | | | | | | |
| Total Organic Carbon | mg/L | 116.3 | 62.2 | | | | | | | | | | | | | | | | | | |
| Total Phenolics | mg/L | | | | | | | | | | | | | | | | | | | | |

note: Mean and standard deviations are calculated for detectable results (with n>2).

[1]Data obtained from CANMET Report (WRC 95-11), sample 53

[2]Data obtained from CANMET Report (WRC 95-11), sample 52

[3] Day 1 to 28 CT data were obtained from CANMET Division Report WRC 94-40 (CF).
Seven sets of CT suspensions were made using Suncor Pond 2/3, Scavenger tails and plant release water with FGDS.

[4]Data obained from 1994 EVS Lab study

[5]Data obtained from April 1995 CANMET report.

# Table II-B.1



## Summary of Suncor CT Release Water Chemistry From Bench Scale Trials

| SAMPLE ID/Date | Unit | Recycle water CT suspension Day 1 Oct-94 | Recycle water CT suspension Day 4 Oct-94 | Recycle water CT suspension Day 9 Oct-94 | Scavenger tails Ct suspension Day 2 Oct-94 | Scavenger tails CT suspension Day 28 Oct-94 | Pond 2/3 CT suspension Day 2 Oct-94 | Pond 2/3 CT suspension Day 28 Oct-94 | Recycle water CT suspension Day 2 Oct-94 | Recycle water CT suspension Day 28 Oct-94 | Recycle water CT suspension Day 2 Oct-94 | Recycle water CT suspension Day 28 Oct-94 | Recycle water CT suspension Day 2 Oct-94 | Recycle water CT suspension Day 28 Oct-94 | Pond 2/3 CT suspension Day 2 Oct-94 | Pond 2/3 CT suspension Day 28 Oct-94 | Recycle water suspension Day 2 Oct-94 | Recycle water suspension Day 28 Oct-94 | 1994 EVS[4] Oct-94 | 1994 EVS[4] Nov-94 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conventional Parameters | | | | | | | | | | | | | | | | | | | | |
| Conductance | µS/cm | | | | | | | | | | | | | | | | | | 3090 | 3230 |
| Hardness | mg/L | | | | | | | | | | | | | | | | | | | |
| pH | units | 7.86 | 7.94 | 8.12 | | | | | | | | | | | | | | | 8.2 | 8.22 |
| Sulphide | mg/L | | | | | | | | | | | | | | | | | | | <0.02 |
| Total Alkalinity | mg/L | | | | | | | | | | | | | | | | | | 354 | 387 |
| Total Inorganic Carbon | mg/L | | | | | | | | | | | | | | | | | | | |
| Turbidity | mg/L | | | | | | | | | | | | | | | | | | 12 | 3.24 |
| Biochemical Oxygen Demand | mg/L | | | | | | | | | | | | | | | | | | 8 | <5 |
| Chemical Oxygen Demand | mg/L | | | | | | | | | | | | | | | | | | 216 | <292 |
| Major Ions | | | | | | | | | | | | | | | | | | | | |
| Bicarbonate (HCO3) | mg/L | 639 | 569 | 438 | 516 | 269 | 372 | 286 | 474 | 162 | 417 | 171 | 540 | 189 | 754 | 717 | 639 | 438 | | |
| Calcium | mg/L | 180 | 140 | 82 | 553 | 533 | 536 | 776 | 556 | 651 | 644 | 616 | 701 | 595 | 23 | 35 | 180 | 82 | 129 | 139 |
| Carbonate (CO3) | mg/L | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Chloride | mg/L | 58 | 60 | 62 | 90 | 112 | 101 | 197 | 106 | 153 | 163 | 310 | 255 | 289 | 66 | 63 | 58 | 62 | 54 | 52.1 |
| Fluoride | mg/L | 0 | 0 | 0 | | | | | | | | | | | | | | | | |
| Magnesium | mg/L | 19 | 18 | 18 | 94 | 132 | 104 | 223 | 108 | 182 | 176 | 360 | 379 | 353 | 19 | 19 | 19 | 18 | | |
| Potassium | mg/L | 10 | 10 | 10 | 28 | 41 | 26 | 41 | 11 | 18 | 12 | 24 | 18 | 19 | 20 | 20 | 10 | 10 | 27.6 | 28.7 |
| Sodium | mg/L | 351 | 346 | 346 | 538 | 714 | 443 | 690 | 298 | 500 | 300 | 598 | 360 | 341 | 457 | 438 | 351 | 346 | | |
| Sulphate | mg/L | 644 | 677 | 543 | 1203 | 2457 | 1205 | 3555 | 1055 | 2211 | 1227 | 3183 | 2594 | 2746 | 608 | 496 | 644 | 543 | 1270 | 1320 |
| $Fe^{2+/3+}$ | mg/L | | | | 0.14 | 0.016 | 0.19 | 0.12 | 0.07 | 0.32 | 0.009 | 0.27 | 0.05 | 0.45 | 0.11 | 1.5 | 0.13 | 0.13 | | |
| $H_2CO_3$ | mg/L | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Nutrients | | | | | | | | | | | | | | | | | | | | |
| Nitrate + Nitrite | mg/L | | | | | | | | | | | | | | | | | | 0.05 | 0.05 |
| Nitrogen - Ammonia | mg/L | | | | | | | | | | | | | | | | | | 5.72 | 8.4 |
| Nitrogen - Kjeldahl | mg/L | | | | | | | | | | | | | | | | | | | 10.2 |
| Phosphorus, Total | mg/L | | | | | | | | | | | | | | | | | | | 0.002 |
| Total Metals | | | | | | | | | | | | | | | | | | | | |
| Aluminum (Al) | mg/L | 0.69 | 0.41 | 0.24 | 0.13 | 1.2 | 1.3 | 1.8 | 1.4 | 1.5 | 1.4 | 1.6 | 1.4 | 1.2 | 0.49 | 8.8 | 0.69 | 0.24 | 0.33 | <0.20 |
| Antimony (Sb) | mg/L | | | | | | | | | | | | | | | | | | 0.0018 | <0.20 |
| Arsenic (As) | mg/L | | | | | | | | | | | | | | | | | | 0.003 | <0.20 |
| Barium (Ba) | mg/L | 0.064 | 0.051 | 0.039 | | | | | | | | | | | | | | | 0.03 | 0.037 |
| Beryllium (Be) | mg/L | | | | | | | | | | | | | | | | | | <0.001 | <0.005 |
| Bismuth | mg/L | | | | | | | | | | | | | | | | | | | <0.10 |
| Boron (B) | mg/L | 3 | 3.1 | 3.1 | | | | | | | | | | | | | | | 2.8 | 3.2 |
| Cadmium (Cd) | mg/L | | | | | | | | | | | | | | | | | | <0.003 | <0.010 |
| Calcium (Ca) | mg/L | | | | | | | | | | | | | | | | | | | |
| Chromium (Cr) | mg/L | | | | | | | | | | | | | | | | | | 0.009 | <0.015 |
| Cobalt (Co) | mg/L | | | | | | | | | | | | | | | | | | 0.009 | <0.015 |
| Copper (Cu) | mg/L | | | | | | | | | | | | | | | | | | 0.022 | <0.010 |
| Iron (Fe) | mg/L | 0.13 | 0.017 | 0.013 | | | | | | | | | | | | | | | 0.11 | 0.04 |
| Lead (Pb) | mg/L | | | | | | | | | | | | | | | | | | <0.02 | <0.050 |
| Lithium (Li) | mg/L | 0.18 | 0.17 | 0.17 | | | | | | | | | | | | | | | 0.165 | 0.268 |
| Magnesium (Mg) | mg/L | 19 | 18 | 18 | | | | | | | | | | | | | | | 44 | 44.8 |
| Manganese (Mn) | mg/L | | | | | | | | | | | | | | | | | | 0.05 | 0.008 |
| Mercury (Hg) | mg/L | | | | | | | | | | | | | | | | | | <0.05 | <0.00005 |
| Molybdenum (Mo) | mg/L | | | | | | | | | | | | | | | | | | 0.84 | 0.823 |
| Nickel (Ni) | mg/L | | | | | | | | | | | | | | | | | | 0.01 | 0.021 |
| Potassium (K) | mg/L | | | | | | | | | | | | | | | | | | | |
| Selenium (Se) | mg/L | | | | | | | | | | | | | | | | | | 0.0006 | <0.20 |
| Silicon (Si) | mg/L | 4.2 | 3.3 | 3.3 | | | | | | | | | | | | | | | 4.5 | 3.69 |
| Silver (Ag) | mg/L | | | | | | | | | | | | | | | | | | <0.01 | <0.015 |
| Sodium (Na) | mg/L | | | | | | | | | | | | | | | | | | 520 | 525 |
| Strontium (Sr) | mg/L | 0.4 | 0.37 | 0.31 | | | | | | | | | | | | | | | 2.09 | 2.47 |
| Sulphur (S) | mg/L | 175 | 185 | 176 | | | | | | | | | | | | | | | | |
| Thallium | mg/L | | | | | | | | | | | | | | | | | | | <0.10 |
| Titanium (Ti) | mg/L | | | | | | | | | | | | | | | | | | 0.017 | <0.01 |
| Tungsten | mg/L | | | | | | | | | | | | | | | | | | | <0.10 |
| Vanadium (V) | mg/L | | | | | | | | | | | | | | | | | | 0.02 | <0.030 |
| Zinc (Zn) | mg/L | | | | | | | | | | | | | | | | | | 0.08 | 0.014 |
| General Organics | | | | | | | | | | | | | | | | | | | | |
| Dissolved Organic Carbon | mg/L | | | | | | | | | | | | | | | | | | | 60 |
| Total Organic Carbon | mg/L | | | | | | | | | | | | | | | | | | | |
| Total Phenolics | mg/L | | | | | | | | | | | | | | | | | | 0.015 | 0.023 |

note: Mean and standard deviations are calculated for detectable results (with n>2).

[1] Data obtained from CANMET Report (WRC 95-11), sample 53

[2] Data obtained from CANMET Report (WRC 95-11), sample 52

[3] Day 1 to 28 CT data were obtained from CANMET Division Report WRC 94-40 (CF).
Seven sets of CT suspensions were made using Suncor Pond 2/3, Scavenger tails and plant release water with FGDS.

[4] Data obained from 1994 EVS Lab study

[5] Data obtained from April 1995 CANMET report

## Summary of Suncor CT Release Water Chemistry From Bench Scale Trials

| SAMPLE ID/Date | Unit | Suncor (CANMET1995)[5] Apr-95 | Suncor (CANMET1995)[5] Apr-95 | Suncor (CANMET1995)[5] Apr-95 | Suncor (CANMET1995)[5] Apr-95 | Consol.Sn PW+Ca[1] JUL 94. | MIN | MAX | MEAN | STD. DEV | N |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Conventional Parameters** | | | | | | | | | | | |
| Conductance | µS/cm | | | | | | 3090 | 3230 | 3160 | | 2 |
| Hardness | mg/L | | | | | 149 | 99 | 184 | 144 | 42.4 | 3 |
| pH | units | | | | | 8.8 | 8 | 9 | 8 | 0.3 | 26 |
| Sulphide | mg/L | | | | | | | | <0.02 | | 1 |
| Total Alkalinity | mg/L | | | | | | 354 | 387 | 371 | | 2 |
| Total Inorganic Carbon | mg/L | | | | | 98.9 | 69 | 129 | 99 | | 3 |
| Turbidity | mg/L | | | | | | 3 | 12 | 8 | | 2 |
| Biochemical Oxygen Demand | mg/L | | | | | | <5 | 8 | | | 2 |
| Chemical Oxygen Demand | mg/L | | | | | | 216 | 292 | 254 | | 2 |
| **Major Ions** | | | | | | | | | | | |
| Bicarbonate (HCO3) | mg/L | | | | | 529 | 162 | 754 | 425 | 187.7 | 38 |
| Calcium | mg/L | 150 | 129.5 | 113.4 | 81.43 | 33.6 | 20 | 776 | 394 | 279.2 | 44 |
| Carbonate (CO3) | mg/L | | | | | 32 | 0 | 32 | 1 | 5.8 | 38 |
| Chloride | mg/L | | | | | 366 | 50 | 366 | 154 | 96.5 | 40 |
| Fluoride | mg/L | | | | | 2.7 | 0 | 48 | 6 | 11.6 | 23 |
| Magnesium | mg/L | 33.42 | 28.59 | 33.8 | 28.8 | 15.9 | 12 | 379 | 132 | 123.4 | 42 |
| Potassium | mg/L | | | | | 15 | 10 | 41 | 21 | 9.6 | 40 |
| Sodium | mg/L | 579.8 | 496.1 | 568.8 | 523.7 | 722.2 | 298 | 746 | 484 | 140.6 | 42 |
| Sulphate | mg/L | 1526 | 1192 | 1531 | 1123 | 1016 | 487 | 3555 | 1546 | 923.6 | 44 |
| $Fe^{2+/3+}$ | mg/L | | | | | | 0.009 | 2 | 0.25 | 0.4 | 14 |
| $H_2CO_3$ | mg/L | | | | | | 0 | 0 | 0 | | 14 |
| **Nutrients** | | | | | | | | | | | |
| Nitrate + Nitrite | mg/L | | | | | | 0.05 | 0.05 | 0.1 | | 2 |
| Nitrogen - Ammonia | mg/L | | | | | | 6 | 8 | 7 | | 2 |
| Nitrogen - Kjeldahl | mg/L | | | | | | | | 10 | | 1 |
| Phosphorus, Total | mg/L | | | | | | | | 0.002 | | 1 |
| **Total Metals** | | | | | | | | | | | |
| Aluminum (Al) | mg/L | | | | | 0.12 | 0.1 | 10 | 2 | 2.3 | 40 |
| Antimony (Sb) | mg/L | | | | | | 0.002 | 0.2 | 0.101 | | 2 |
| Arsenic (As) | mg/L | | | | | | 0 | 0.2 | 0.03 | 0.1 | 10 |
| Barium (Ba) | mg/L | | | | | 0.07 | 0.02 | 0.27 | 0.06 | 0.1 | 26 |
| Beryllium (Be) | mg/L | | | | | | 0.001 | 0.005 | 0.003 | | 2 |
| Bismuth | mg/L | | | | | | | | <0.1 | | 1 |
| Boron (B) | mg/L | | | | | 3.5 | 3 | 14 | 6 | 3.2 | 26 |
| Cadmium (Cd) | mg/L | | | | | | 0.003 | 0.01 | 0.007 | | 2 |
| Calcium (Ca) | mg/L | | | | | 33.6 | 20 | 48 | 34 | 14.1 | 3 |
| Chromium (Cr) | mg/L | | | | | | 0.01 | 0.02 | 0.01 | | 2 |
| Cobalt (Co) | mg/L | | | | | | 0.01 | 0.02 | 0.01 | | 2 |
| Copper (Cu) | mg/L | | | | | 0.24 | 0 | 0.24 | 0.03 | 0.1 | 11 |
| Iron (Fe) | mg/L | | | | | <DL | <DL | 1.7 | 0.239 | 0.4 | 25 |
| Lead (Pb) | mg/L | | | | | | 0 | 0.06 | 0.02 | 0.02 | 8 |
| Lithium (Li) | mg/L | | | | | 0.24 | 0.1 | 0.4 | 0.2 | 0.1 | 26 |
| Magnesium (Mg) | mg/L | | | | | 15.9 | 12 | 379 | 128 | 121.7 | 26 |
| Manganese (Mn) | mg/L | | | | | 0.074 | 0.01 | 0.5 | 0.2 | 0.1 | 13 |
| Mercury (Hg) | mg/L | | | | | | <0.00005 | <0.05 | | | 2 |
| Molybdenum (Mo) | mg/L | | | | | 0.16 | 0.2 | 0.8 | 0.4 | 0.4 | 5 |
| Nickel (Ni) | mg/L | | | | | | 0.01 | 0.02 | 0.02 | | 2 |
| Potassium (K) | mg/L | | | | | 15 | 13 | 15 | 14 | 1.1 | 3 |
| Selenium (Se) | mg/L | | | | | | 0.0006 | 0.2 | 0.1 | | 2 |
| Silicon (Si) | mg/L | | | | | 3.2 | 2 | 21 | 5 | 4.6 | 26 |
| Silver (Ag) | mg/L | | | | | | <0.01 | <0.02 | 0.01 | | 2 |
| Sodium (Na) | mg/L | | | | | | 520 | 525 | 523 | | 2 |
| Strontium (Sr) | mg/L | | | | | 0.99 | 0.3 | 5 | 2 | 1.1 | 26 |
| Sulphur (S) | mg/L | | | | | 259.6 | 158 | 1204 | 627 | 360.1 | 24 |
| Thallium | mg/L | | | | | 0.2 | <0.1 | 0.2 | | | 3 |
| Titanium (Ti) | mg/L | | | | | | <0.01 | 0.02 | 0.01 | | 2 |
| Tungsten | mg/L | | | | | | | | 0.1 | | 1 |
| Vanadium (V) | mg/L | | | | | | 0.001 | 0.03 | 0.02 | 0.01 | 6 |
| Zinc (Zn) | mg/L | | | | | 0.24 | 0.01 | 0.24 | 0.12 | 0.07 | 11 |
| **General Organics** | | | | | | | | | | | |
| Dissolved Organic Carbon | mg/L | | | | | | | | 60 | | 1 |
| Total Organic Carbon | mg/L | | | | | 105.3 | 62.2 | 116.3 | 94.6 | 28.6 | 3 |
| Total Phenolics | mg/L | | | | | | 0.015 | 0.023 | 0.019 | | 2 |

note: Mean and standard deviations are calculated for detectable results (with n>2).

[1] Data obtained from CANMET Report (WRC 95-11), sample 53

[2] Data obtained from CANMET Report (WRC 95-11), sample 52

[3] Day 1 to 28 CT data were obtained from CANMET Division Report WRC 94-40 (CF).
Seven sets of CT suspensions were made using Suncor Pond 2/3, Scavenger tails and plant release water with FGDS.

[4] Data obained from 1994 EVS Lab study

[5] Data obtained from April 1995 CANMET report.

# Table II-B.2



## Summary of Syncrude CT Release Water Chemistry from Bench Scale Trials

| | | Syncrude | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **SAMPLE ID** | | **Consol.Sy C PW+Ca[1]** | **Consol Sy C PW+Ca[1]** | **2M Sy PW+Ca[1]** | **Flume Test Sample[2]** | **NST Bench Test[2]** | **MIN** | **MAX** | **MEAN** | **N** |
| **DATE** | **Units** | **May-94** | **Jun-94** | **Jun-94** | **May-95** | **Jun-95** | | | | |
| **Conventional Parameters** | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L | | | | 260 | 300 | 260 | 300 | 280 | 2 |
| Conductance | µS/cm | | | | 3600 | 3550 | 3550 | 3600 | 3575 | 2 |
| Hardness | mg/L | 41.6 | 62.1 | 64.2 | | | 41.6 | 64.2 | 56 | 3 |
| pH | units | 9 | 9.2 | 8.5 | 8.4 | 8.81 | 8.4 | 9.2 | 8.8 | 5 |
| Sulphide | mg/L | | | | <0.01 | <0.01 | | <0.01 | | 2 |
| Total Alkalinity | mg/L | | | | 688 | 567 | 567 | 688 | 628 | 2 |
| Total Inorganic Carbon | mg/L | 113.1 | 180.8 | 187.1 | | | 113.1 | 187.1 | 160.3 | 3 |
| **Major Ions** | | | | | | | | | | |
| Bicarbonate (HCO3) | mg/L | 925 | 908 | 1093 | 800 | | 800 | 1093 | 932 | 4 |
| Calcium | mg/L | 7.6 | 14 | 15 | 36 | 19.1 | 7.6 | 36 | 18.3 | 5 |
| Carbonate (CO3) | mg/L | 80 | 112 | 24 | 20 | | 20 | 112 | 59 | 4 |
| Chloride | mg/L | 523 | 51.5 | 455 | 365 | 442 | 51.5 | 523 | 367.3 | 5 |
| Cyanide | mg/L | | | | 0.055 | <0.001 | <0.001 | 0.055 | | 2 |
| Fluoride | mg/L | 29.8 | 24.6 | <DL | | | <DL | 29.8 | 27.2 | 3 |
| Magnesium | mg/L | 5.5 | 6.6 | 6.5 | 19 | 15.8 | 5.5 | 19 | 10.7 | 5 |
| Potassium | mg/L | 11.7 | 12.8 | 12.3 | 22 | 21.3 | 11.7 | 22 | 16 | 5 |
| Sodium | mg/L | 1221 | 1202 | 1197 | 910 | 925 | 910 | 1221 | 1091 | 5 |
| Sulphate | mg/L | 1114 | 1080 | 953 | 1040 | 897 | 897 | 1114 | 1017 | 5 |
| **Nutrients** | | | | | | | | | | |
| Nitrate + Nitrite | mg/L | | | | 0.050 | 0.060 | 0.05 | 0.06 | 0.06 | 2 |
| Nitrogen - Ammonia | mg/L | | | | 0.49 | 0.35 | 0.35 | 0.49 | 0.42 | 2 |
| Phosphorus, Total | mg/L | | | | | 0.2 | | 0.2 | | 1 |
| Phosphorus,Total Dissolved | mg/L | <DL | <DL | <DL | 0.033 | 0.19 | <DL | 0.19 | 0.11 | 5 |
| **General Organics and Toxicity** | | | | | | | | | | |
| Dissolved Organic Carbon | mg/L | | | | 55 | 66.9 | 55 | 66.9 | 61 | 2 |
| Microtox IC20 | % | | | | 13 | 12 | 12 | 13 | 13 | 2 |
| Microtox IC50 | % | | | | 58 | 72 | 58 | 72 | 65 | 2 |
| Naphthenic acids | mg/L | | | | 76 | | | 76 | | 1 |
| Oil and Grease | mg/L | | | | 15 | 14.4 | 14.4 | 15 | 14.7 | 2 |
| Surfactants (MBAS) | mg/L | | | | 1.9 | 2 | 1.9 | 2 | 2.0 | 2 |
| Total Organic Carbon | mg/L | 251.7 | 192.6 | 190.6 | | | 190.6 | 251.7 | 211.6 | 3 |
| Total Phenolics | mg/L | | | | 0.016 | 0.017 | 0.016 | 0.017 | 0.0165 | 2 |
| **Total Metals** | | | | | | | | | | |
| Aluminum (Al) | mg/L | 1.1 | 0.04 | 0.22 | 0.52 | 0.12 | 0.04 | 1.1 | 0.4 | 5 |
| Barium (Ba) | mg/L | 0.09 | 0.1 | 0.16 | 0.1 | 0.1 | 0.09 | 0.16 | 0.11 | 5 |
| Beryllium (Be) | mg/L | | | | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 2 |
| Boron (B) | mg/L | 3.6 | 3.6 | 3.1 | 2.26 | 2.75 | 2.26 | 3.6 | 3.06 | 5 |
| Cadmium (Cd) | mg/L | | | | <0.003 | <0.003 | | <0.003 | | 2 |
| Calcium (Ca) | mg/L | 7.6 | 14 | 15 | | | 7.6 | 15 | 12.2 | 3 |
| Chromium (Cr) | mg/L | | | | 0.002 | 0.004 | 0.002 | 0.004 | 0.003 | 2 |
| Cobalt (Co) | mg/L | | | | <0.003 | 0.003 | <0.003 | 0.003 | | 2 |
| Copper (Cu) | mg/L | <DL | 0.27 | <DL | 0.004 | <0.001 | <DL | 0.27 | 0.09 | 5 |
| Iron (Fe) | mg/L | <0.21 | <DL | <0.09 | 0.04 | <0.01 | <DL | 0.04 | | 5 |
| Lead (Pb) | mg/L | | | | <0.02 | <0.02 | | <0.02 | | 2 |
| Lithium (Li) | mg/L | 0.19 | 0.21 | 0.24 | 0.205 | 0.214 | 0.19 | 0.24 | 0.21 | 5 |
| Magnesium (Mg) | mg/L | 5.5 | 6.6 | 6.5 | | 0.001 | 0.001 | 6.6 | 4.65 | 4 |
| Manganese (Mn) | mg/L | <DL | 0.016 | <DL | <0.001 | | <0.001 | 0.016 | | 4 |
| Molybdenum (Mo) | mg/L | 0.24 | 0.21 | 0.18 | 0.150 | 0.134 | 0.134 | 0.24 | 0.183 | 5 |
| Nickel (Ni) | mg/L | | | | 0.014 | 0.015 | 0.014 | 0.015 | 0.015 | 2 |
| Potassium (K) | mg/L | 11.7 | 12.8 | 12.3 | | | 11.7 | 12.8 | 12.3 | 3 |
| Silicon (Si) | mg/L | 3.8 | 3.4 | 4.9 | | | 3.4 | 4.9 | 4.0 | 3 |
| Silver (Ag) | mg/L | | | | <0.002 | <0.002 | | <0.002 | | 2 |
| Strontium (Sr) | mg/L | 0.33 | 0.43 | 0.4 | 1.09 | 0.94 | 0.33 | 1.09 | 0.64 | 5 |
| Sulphur (S) | mg/L | 351.8 | 318.5 | 316.1 | | | 316.1 | 351.8 | 328.8 | 3 |
| Titanium (Ti) | mg/L | | | | 0.016 | <0.003 | <0.003 | 0.016 | | 2 |
| Uranium (U) | mg/L | | | | <0.5 | <0.5 | | <0.5 | | 2 |
| Vanadium (V) | mg/L | | | | 0.006 | <0.002 | <0.002 | 0.006 | 0.004 | 2 |
| Zinc (Zn) | mg/L | <DL | 0.16 | <DL | 0.003 | 0.001 | <DL | 0.16 | 0.055 | 5 |

# Summary of Syncrude CT Release Water Chemistry from Bench Scale Trials

| | | Syncrude | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE ID | | Consol.Sy C PW+Ca[1] | Consol Sy C PW+Ca[1] | 2M Sy PW+Ca[1] | Flume Test Sample[2] | NST Bench Test[2] | MIN | MAX | MEAN | N |
| DATE | Units | May-94 | Jun-94 | Jun-94 | May-95 | Jun-95 | | | | |
| Target PAHs and Alkylated PAHs | | | | | | | | | | |
| Naphthalene | ppb | | | | <0.02 | <0.02 | | <0.02 | | 2 |
| C1 Subst'd napthalenes | ppb | | | | <0.02 | | | <0.02 | | 1 |
| C2 Subst'd naphthalenes | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| C3 Subst'd naphthalenes | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| C4 Subst'd naphthalenes | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| Acenaphthene | ppb | | | | <0.02 | <0.02 | | <0.02 | | 2 |
| Methyl acenaphthene | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| Acenaphthylene | ppb | | | | <0.02 | <0.02 | | <0.02 | | 2 |
| Anthracene | ppb | | | | <0.02 | <0.02 | | <0.02 | | 2 |
| Dibenzo(a,h)anthracene | ppb | | | | <0.02 | <0.02 | | <0.02 | | 2 |
| Benz(a)Anthracene | ppb | | | | <0.02 | | | <0.02 | | 1 |
| Chrysene | ppb | | | | <0.02 | | | <0.02 | | 1 |
| Methyl Chrysene/Benz(a)Anthra. | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| C2 Subst'd Chrysene/Benz(a)Anthr | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| Benzo(a)pyrene | ppb | | | | <0.02 | <0.02 | | <0.02 | | 2 |
| Methyl Benzo(a)Pyrene/Benzo(b&k | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| C2 Subst'd Benzo(a)Pyrene/Benzo( | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| Benzo(b&k)fluoranthene | ppb | | | | <0.02 | | | <0.02 | | 1 |
| Benzo(g,h,i)perylene | ppb | | | | <0.02 | <0.02 | | <0.02 | | 2 |
| Biphenyl | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| Methyl biphenyl | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| C2 Substituted biphenyl | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| Dibenzothiophene | ppb | | | | <0.02 | <0.02 | | <0.02 | | 2 |
| Methyl dibenzothiophene | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| C2 Substituted dibenzothiophene | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| C3 Subst'd dibenzothiophene | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| C4 Subst'd dibenzothiophene | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| Fluoranthene | ppb | | | | <0.02 | <0.02 | | <0.02 | | 2 |
| Methyl fluoranthene/pyrene | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| Fluorene | ppb | | | | <0.02 | <0.02 | | <0.02 | | 2 |
| Methyl fluorene | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| C2 Substituted fluorene | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| Indeno(c,d-123)pyrene | ppb | | | | <0.02 | <0.02 | | <0.02 | | 2 |
| Phenanthrene | ppb | | | | <0.02 | <0.02 | | <0.02 | | 2 |
| Methyl phenanthrene/anthracene | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| C2 Subst'd phenanthrene/anthracen | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| C3 Subst'd phenanthrene/anthracen | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| C4 Subst'd phenanthrene/anthracen | ppb | | | | <0.04 | <0.04 | | <0.04 | | 2 |
| Pyrene | ppb | | | | <0.02 | <0.02 | | <0.02 | | 2 |
| Target PANHs | | | | | | | | | | |
| Quinoline | ppb | | | | <0.02 | | | <0.02 | | 1 |
| 7-Methyl quinoline | ppb | | | | <0.02 | | | <0.02 | | 1 |
| C2 Subst'd quinoline | ppb | | | | <0.02 | | | <0.02 | | 1 |
| C3 Subst'd quinoline | ppb | | | | <0.02 | | | <0.02 | | 1 |
| Acridine | ppb | | | | <0.02 | | | <0.02 | | 1 |
| Methyl acridine | ppb | | | | <0.02 | | | <0.02 | | 1 |
| Phenanthridine | ppb | | | | <0.02 | | | <0.02 | | 1 |
| Carbazole | ppb | | | | <0.02 | | | <0.02 | | 1 |
| Methyl carbazole | ppb | | | | <0.02 | | | <0.02 | | 1 |
| C2 Subst'd carbazole | ppb | | | | <0.02 | | | <0.02 | | 1 |

[1]Data obtained from 1995 CANMET DIVISION REPORT WRC 95-11 (CF)

[2]Data obtained from Syncrude's Mike MacKinnon.

# Table II - C.1

Page 1 of 4

## Summary of Suncor CT Release Water Chemistry From Field Scale Trials

| SAMPLE ID and Date | Units | NST -1 pool low Ca Nov-94 | NST 2-pool high Ca Oct-94 | NST swimpool Oct-94 | NST-2 pool high Ca Nov-94 | NST1-pool low Ca Oct-94 | RW161-1 Jul-95 | RW161-2 Jul-95 | RW161-5 Jul-95 | RW161-T002 Jul-95 | RW161-T002( Jul-95 | RW162(W054 ,56) Sep-95 | RW162T0018 Jul-95 | RW162T0033 Aug-95 | RW162T0065 Sep-95 | RW162W002- Jul-95 | RW162W028, Aug-95 | RW162W036 | RW162W0404 7 Aug-95 | RW162W061 Sep-95 | RW163(W005 4,5,6) Sep-95 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Conventional Parameters** | | | | | | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L | | | | | | | | | | | | | | | 0.001 | | | | | |
| Chlorophyll "a" | mg/L | | | | | | | | | | | | | | | | | | 0.008 | | |
| Conductance | µS/cm | | | | | | | | | | | | | | | 2337 | | | 2154 | | |
| Hardness | mg/L | 505.6 | 1411 | 306 | 1681.3 | 503 | | | | | | | | | | | | | | | |
| pH | units | 8.2 | 8 | 8.4 | 7.9 | 8.2 | | | | | | 8.37 | | | | 8.1 | 8.2 | | 8.34 | 8.43 | 8.37 |
| Sulphide | mg/L | | | | | | | | | | | 0.01 | | | | 0.01 | 0.01 | | 0.01 | 0.01 | 0.01 |
| Total Alkalinity | mg/L | | | | | | 410 | 504 | 524 | | | 356 | | | | 496 | 387 | | 363 | 351 | 308 |
| Total Dissolved Solids | mg/L | | | | | | 1380 | 1613 | 1650 | | | 1404 | | | | 1595 | 1506 | | 1435 | 1512 | 1288 |
| Total Inorganic Carbon | mg/L | 82.5 | 42.4 | 64.3 | 50.7 | 80.3 | | | | | | | | | | | | | | | |
| Total Suspended Solids | mg/L | | | | | | | | | | | | | | | 3 | | | 9 | | |
| **Major Ions** | | | | | | | | | | | | | | | | | | | | | |
| Bicarbonate (HCO3) | mg/L | 375 | 239 | 362 | 283 | 432 | 499.8 | 614.4 | 638.8 | | | 412.7 | | | | 604.6 | 471.8 | | 430.2 | 406.2 | 360.7 |
| Calcium | mg/L | 123.8 | 453 | 57.4 | 542 | 129 | 105 | 122 | 127 | | | 51.2 | | | | 100 | 57.5 | | 46.3 | 55.8 | 42.6 |
| Carbonate (CO3) | mg/L | 0 | <DL | 8 | 0 | <DL | 0.5 | 0.5 | 0.5 | | | 10.5 | | | | 0.5 | 0.5 | | 6.1 | 10.7 | 7.2 |
| Chloride | mg/L | 55 | 53 | 47 | 42 | 54 | 48.1 | 55.7 | 57.2 | | | 55 | | | | 55.2 | 59 | | 57.6 | 53.5 | 55 |
| Fluoride | mg/L | 12.5 | 1.6 | 14.5 | 13 | 2.1 | | | | | | | | | | | | | | | |
| Magnesium | mg/L | 47.7 | 68 | 39.4 | 79.6 | 44 | 6.9 | 11 | 11.4 | | | 12 | | | | 12.8 | 12.6 | | 12 | 13.6 | 10.1 |
| Potassium | mg/L | 29 | 33.5 | 26.5 | 38.4 | 27.6 | 13.1 | 19 | 18.6 | | | 16.1 | | | | 18.8 | 18 | | 17 | 19.3 | 14.1 |
| Sodium | mg/L | 498.9 | 600 | 643.2 | 630.5 | 520 | 332 | 456 | 437 | | | 417 | | | | 471 | 449 | | 441 | 460 | 392 |
| Sulphate | mg/L | 1191 | 2530 | 1044 | 2376 | 1270 | 625 | 642 | 679 | | | 636 | | | | 635 | 674 | | 640 | 696 | 586 |
| **Nutrients** | | | | | | | | | | | | | | | | | | | | | |
| Nitrate + Nitrite | mg/L | | | | | | | | | | | 0.012 | | | | 0.006 | 0.006 | | 0.006 | 0.009 | 0.021 |
| Nitrogen - Ammonia | mg/L | | | | | | | | | | | 0.33 | | | | 2.38 | 0.725 | | 0.71 | 0.16 | 0.24 |
| Nitrogen - Kjeldahl | mg/L | | | | | | | | | | | 1.92 | | | | 4.6 | 2.75 | | 2 | 1.72 | 1.2 |
| Phosphorus, Total | mg/L | | | | | | | | | | | 0.05 | | | | 0.019 | 0.096 | | 0.076 | 0.035 | 0.053 |
| Phosphorus,Total Dissolved | mg/L | <DL | <DL | <DL | <DL | <DL | | | | | | | | | | | | | | | |
| **General Organics and Toxicity** | | | | | | | | | | | | | | | | | | | | | |
| Biochemical Oxygen Demand | mg/L | | | | | | | | | | | | | | | 2.8 | | | 6.9 | | |
| Daphnia LC50 | % | >100 | NM | NM | >100 | NM | | | | | | | | | | | | | | | |
| Dissolved Organic Carbon | mg/L | | | | | | | | | | | | | | | 53.6 | | | 65 | | |
| Microtox (%light output) | % | 84 | | | 67 | | | | | | | | | | | | | | | | |
| Naphthenic acids | mg/L | | | | | | 98 | | | 86 | 100 | 77 | 85 | 87 | 69 | 76 | 76 | 87 | 68 | 69 | 63 |
| Rainbow Trout LC50 | % | 71 | NM | NM | 71 | NM | | | | | | | | | | | | | | | |
| Total Organic Carbon | mg/L | 86.6 | 91.9 | 90.9 | 92.5 | 96.7 | | | | | | | | | | 56.1 | | | 65 | | |

Note:
NM = not measured
Mean and standard deviation calculation is based on detectable results

# Table II - C.1



## Summary of Suncor CT Release Water Chemistry From Field Scale Trials

| SAMPLE ID and Date | Units | RW163T0017 Jul-95 | RW163T0032 Aug-95 | RW163W001-W014 Jul-95 | RW163W028, 29,30 Aug-95 | RW163W039-46 Aug-95 | RW163W060 Sep-95 | RW164 (W054,5,6) Sep-95 | RW164T0018 Jul-95 | RW164T0033 Aug-95 | RW164W002 Jul-95 | RW164W028, Aug-95 | RW164W040-47 Aug-95 | RW164W062 Sep-95 | MIN | MAX | MEAN | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Conventional Parameters** | | | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L | | | | | | | | | | | | | | | **0.001** | | **1** |
| Chlorophyll "a" | mg/L | | | 0.001 | | 0.0024 | | | | | 0.001 | | 0.0032 | | **0.001** | **0.008** | **0.003** | **5** |
| Conductance | µS/cm | | | 2402 | | 1891 | | | | | 2109 | | 1902 | | **1891.000** | **2402.000** | **2132.5** | **6** |
| Hardness | mg/L | | | | | | | | | | | | | | **306.0** | **1681.3** | **881.4** | **5** |
| pH | units | | | 8.16 | 8.54 | 8.49 | 8.38 | 8.27 | | | 8.17 | 8.22 | 8.35 | 8.34 | **7.9** | **8.5** | **8.3** | **20** |
| Sulphide | mg/L | | | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | | | 0.01 | 0.01 | 0.01 | 0.01 | **0.0** | **0.0** | **0.0** | **15** |
| Total Alkalinity | mg/L | | | 472 | 325 | 289 | 343 | 277 | | | 407 | 318 | 284 | 295 | **277.0** | **524.0** | **372.7** | **18** |
| Total Dissolved Solids | mg/L | | | 1670 | 1486 | 1254 | 1513 | 1229 | | | 1600 | 1376 | 1245 | 1433 | **1229.0** | **1670.0** | **1454.9** | **18** |
| Total Inorganic Carbon | mg/L | | | | | | | | | | | | | | **42.4** | **82.5** | **64.0** | **5** |
| Total Suspended Solids | mg/L | | | 10 | | 17 | | | | | 0.4 | | 3 | | **0.4** | **17.0** | **7.1** | **6** |
| **Major Ions** | | | | | | | | | | | | | | | | | | |
| Bicarbonate (HCO3) | mg/L | | | 575.4 | 367.9 | 330.8 | 401.6 | 337.7 | | | 496.1 | 387.6 | 333 | 347.7 | **239.0** | **638.8** | **422.1** | **23** |
| Calcium | mg/L | | | 82.1 | 33.3 | 35.8 | 58.6 | 72.3 | | | 118 | 84.5 | 76.1 | 88.1 | **33.3** | **542.0** | **115.7** | **23** |
| Carbonate (CO3) | mg/L | | | 0.5 | 13.9 | 10.6 | 8.1 | 0.5 | | | 0.5 | 0.5 | 6.5 | 5.9 | **0.0** | **13.9** | **4.4** | **21** |
| Chloride | mg/L | | | 67 | 66.5 | 54.4 | 55 | 46.5 | | | 51.7 | 50.5 | 48.9 | 45.4 | **42.0** | **67.0** | **53.6** | **23** |
| Fluoride | mg/L | | | | | | | | | | | | | | **1.6** | **14.5** | **8.7** | **5** |
| Magnesium | mg/L | | | 12.5 | 11.7 | 9.9 | 12 | 7.9 | | | 8.5 | 8.4 | 7.2 | 9.5 | **6.9** | **79.6** | **20.4** | **23** |
| Potassium | mg/L | | | 20.2 | 18.3 | 14.8 | 16.1 | 13.1 | | | 15.4 | 15.1 | 11.5 | 15.5 | **11.5** | **38.4** | **19.5** | **23** |
| Sodium | mg/L | | | 500 | 468 | 408 | 457 | 347 | | | 399 | 380 | 353 | 405 | **332.0** | **643.2** | **455.0** | **23** |
| Sulphate | mg/L | | | 700 | 690 | 555 | 705 | 573 | | | 614 | 644 | 575 | 690 | **555** | **2530** | **868.3** | **23** |
| **Nutrients** | | | | | | | | | | | | | | | | | | |
| Nitrate + Nitrite | mg/L | | | 0.004 | 0.004 | 0.003 | 0.01 | 0.025 | | | 0.038 | 0.02 | 0.019 | 0.019 | **0.00** | **0.04** | **0.0** | **15** |
| Nitrogen - Ammonia | mg/L | | | 2.41 | 0.098 | 0.12 | 0.36 | 0.7 | | | 2.28 | 1.362 | 1.05 | 0.41 | **0.10** | **2.41** | **0.9** | **15** |
| Nitrogen - Kjeldahl | mg/L | | | 4.15 | 1.16 | 0.95 | 1.28 | 1.46 | | | 4.05 | 2.75 | 1.5 | 1.43 | **0.95** | **4.60** | **2.2** | **15** |
| Phosphorus, Total | mg/L | | | 0.024 | 0.073 | 0.05 | 0.023 | 0.039 | | | 0.021 | 0.06 | 0.025 | 0.006 | **0.01** | **0.10** | **0.0** | **15** |
| Phosphorus,Total Dissolved | mg/L | | | | | | | | | | | | | | | **<DL** | | **5** |
| **General Organics and Toxicity** | | | | | | | | | | | | | | | | | | |
| Biochemical Oxygen Demand | mg/L | | | 2.5 | | 3 | | | | | 1.6 | | 4.1 | | **1.6** | **6.9** | **3.5** | **6** |
| Daphnia LC50 | % | | | | | | | | | | | | | | | | **>100** | **2** |
| Dissolved Organic Carbon | mg/L | | | 65.3 | | 65 | | | | | 57.1 | | 64 | | **53.6** | **65.3** | **61.7** | **6** |
| Microtox (%light output) | % | | | | | | | | | | | | | | **67** | **84** | **75.5** | **2** |
| Naphthenic acids | mg/L | 87 | 73 | 94 | 79 | 62 | 69 | 63 | 83 | 70 | 89 | 78 | 62 | 68 | **62** | **100** | **77.6** | **26** |
| Rainbow Trout LC50 | % | | | | | | | | | | | | | | **71** | **71** | **71.0** | **2** |
| Total Organic Carbon | mg/L | | | 65.7 | | 68 | | | | | 57.7 | | 64 | | **56.1** | **96.7** | **75.9** | **11** |

Note:

NM = not measured

Mean and standard deviation calculation is based on detectable results

# Table II - C.1



## Summary of Suncor CT Release Water Chemistry From Field Scale Trials

| SAMPLE ID and Date | | NST -1 pool low Ca | NST 2-pool high Ca | NST swimpool | NST-2 pool high Ca | NST1-pool low Ca | RW162W002- | RW162W0404 7 | W163W001-W0 | RW163W039-4 | RW164W002 | RW164W040-4 | MIN | MAX | MEAN | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Metals** | | | | | | | | | | | | | | | | |
| Aluminum (Al) | mg/L | | | | | | 0.14 | 0.03 | 0.1 | 1.92 | 0.01 | 0.05 | **0.01** | **1.92** | **0.38** | **6** |
| Arsenic (As) | mg/L | | | | | | 0.003 | 0.0008 | 0.0028 | 0.0007 | 0.0058 | 0.0025 | **0.001** | **0.01** | **0.003** | **6** |
| Barium (Ba) | mg/L | | | | | | 0.18 | 0.11 | 0.14 | 0.05 | 0.13 | 0.09 | **0.05** | **0.18** | **0.12** | **6** |
| Beryllium (Be) | mg/L | | | | | | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | | **0.001** | | **6** |
| Boron (B) | mg/L | | | | | | 3.5 | 3.37 | 3.74 | 3.19 | 3.06 | 2.7 | **2.70** | **3.74** | **3.26** | **6** |
| Cadmium (Cd) | mg/L | | | | | | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | | **0.003** | | **6** |
| Chromium (Cr) | mg/L | | | | | | 0.002 | 0.002 | 0.002 | 0.002 | 0.003 | 0.002 | **0.002** | **0.003** | **0.002** | **6** |
| Cobalt (Co) | mg/L | | | | | | 0.003 | 0.003 | 0.007 | 0.003 | 0.006 | 0.003 | **0.003** | **0.01** | **0.004** | **6** |
| Copper (Cu) | mg/L | | | | | | 0.002 | 0.001 | 0.001 | 0.002 | 0.001 | 0.003 | **0.001** | **0.003** | **0.002** | **6** |
| Iron (Fe) | mg/L | | | | | | 0.12 | 0.04 | 0.15 | 1.01 | 0.04 | 0.06 | **0.04** | **1.01** | **0.24** | **6** |
| Lead (Pb) | mg/L | | | | | | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | **0.02** | **0.02** | **0.02** | **6** |
| Lithium (Li) | mg/L | | | | | | 0.173 | 0.198 | 0.189 | 0.188 | 0.156 | 0.156 | **0.16** | **0.20** | **0.18** | **6** |
| Manganese (Mn) | mg/L | | | | | | 0.032 | 0.016 | 0.015 | 0.058 | 0.035 | 0.027 | **0.02** | **0.06** | **0.03** | **6** |
| Mercury (Hg) | mg/L | | | | | | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | **0.05** | **0.05** | **0.05** | **6** |
| Molybdenum (Mo) | mg/L | | | | | | 1.19 | 1.15 | 1.37 | 1.08 | 1.42 | 1.19 | **1.08** | **1.42** | **1.23** | **6** |
| Nickel (Ni) | mg/L | | | | | | 0.009 | 0.005 | 0.023 | 0.007 | 0.019 | 0.018 | **0.01** | **0.02** | **0.01** | **6** |
| Selenium (Se) | mg/L | | | | | | 0.0007 | 0.0028 | 0.0016 | 0.0014 | 0.0005 | 0.0036 | **0.001** | **0.004** | **0.002** | **6** |
| Silicon (Si) | mg/L | | | | | | 2.96 | 2.32 | 2.82 | 5.58 | 2.85 | 3.01 | **2.32** | **5.58** | **3.26** | **6** |
| Silver (Ag) | mg/L | | | | | | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | **0.002** | **0.002** | **0.002** | **6** |
| Strontium (Sr) | mg/L | | | | | | 1.02 | 0.934 | 1.09 | 0.752 | 0.996 | 0.865 | **0.75** | **1.09** | **0.94** | **6** |
| Sulphur (S) | mg/L | | | | | | 236 | 229 | 249 | 207 | 215 | 186 | **186** | **249** | **220** | **6** |
| Titanium (Ti) | mg/L | | | | | | 0.003 | 0.003 | 0.003 | 0.009 | 0.003 | 0.003 | **0.003** | **0.01** | **0.004** | **6** |
| Uranium (U) | mg/L | | | | | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | **0.50** | **0.50** | **0.50** | **6** |
| Vanadium (V) | mg/L | | | | | | 0.007 | 0.002 | 0.002 | 0.002 | 0.17 | 0.131 | **0.002** | **0.17** | **0.05** | **6** |
| Zinc (Zn) | mg/L | | | | | | 0.043 | 0.044 | 0.056 | 0.043 | 0.051 | 0.025 | **0.03** | **0.06** | **0.04** | **6** |
| **Dissolved Metals** | | | | | | | | | | | | | | | | |
| Aluminum (Al) | mg/L | <DL | 0.1 | <DL | <DL | 0.33 | | | | | | | **<DL** | **0.33** | **0.22** | **5** |
| Barium (Ba) | mg/L | 0.02 | 0.02 | 0.03 | 0.02 | 0.03 | | | | | | | **0.02** | **0.03** | **0.03** | **5** |
| Boron (B) | mg/L | 3.19 | 3 | 4 | 3.6 | 2.8 | | | | | | | **2.80** | **4.00** | **3.35** | **5** |
| Calcium (Ca) | mg/L | 123.8 | 453 | 57.4 | 542 | 129 | | | | | | | **57** | **542** | **295.35** | **5** |
| Copper (Cu) | mg/L | <DL | 0.023 | <DL | <DL | 0.022 | | | | | | | **<DL** | **0.02** | **0.02** | **5** |
| Iron (Fe) | mg/L | <DL | 0.06 | <DL | <DL | 0.11 | | | | | | | **<DL** | **0.11** | **0.09** | **5** |
| Lithium (Li) | mg/L | 0.32 | 0.185 | 0.34 | 0.37 | 0.165 | | | | | | | **0.17** | **0.37** | **0.27** | **5** |
| Magnesium (Mg) | mg/L | 47.7 | 68 | 39.4 | 79.6 | 44 | | | | | | | **39.40** | **79.60** | **57.75** | **5** |
| Manganese (Mn) | mg/L | <DL | 0.21 | <DL | 0.06 | 0.05 | | | | | | | **<DL** | **0.21** | **0.11** | **5** |
| Molybdenum (Mo) | mg/L | 0.8 | 0.892 | 0.3 | 0.8 | 0.84 | | | | | | | **0.30** | **0.89** | **0.71** | **5** |
| Potassium (K) | mg/L | 29 | 33.5 | 26.5 | 38.4 | 27.6 | | | | | | | **26.50** | **38.40** | **31.50** | **5** |
| Silicon (Si) | mg/L | 5.82 | 3.9 | 2.3 | 5 | 4.5 | | | | | | | **2.30** | **5.00** | **3.93** | **5** |
| Sodium (Na) | mg/L | 498.9 | 600 | 643.2 | 630.5 | 520 | | | | | | | **520** | **643** | **598.4** | **5** |
| Strontium (Sr) | mg/L | 2.35 | 4.3 | 1.6 | 4.92 | 2.09 | | | | | | | **1.60** | **4.92** | **3.23** | **5** |
| Sulphur (S) | mg/L | 479.8 | 875 | 394.4 | 1012 | 411 | | | | | | | **394** | **1012** | **673** | **5** |
| Zinc (Zn) | mg/L | | 0.093 | <DL | 0.17 | 0.08 | | | | | | | **<DL** | **0.17** | **0.11** | **5** |

Note:

<DL = less than detection limit

Mean and standard deviation calculation is based on detectable results

## Summary of Suncor CT Release Water Chemistry From Field Scale Trials

| SAMPLE ID and Date | | RW161-1 | RW162W036 | RW163W010 | RW163W035 | RW164W011 | RW164W036 | MIN | MAX | MEAN | N |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Target PAHs and Alkylated PAHs** | | | | | | | | | | | |
| Naphthalene | ppb | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | <0.02 | | 5 |
| Methyl naphthalenes | ppb | <0.01 | 0.05 | <0.02 | 0.04 | <0.02 | 0.05 | <0.01 | 0.05 | 0.04 | 6 |
| C2 Subst'd naphthalenes | ppb | | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | | <0.04 | | 5 |
| C3 Subst'd naphthalenes | ppb | 0.02 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | 0.02 | 0.02 | 6 |
| C4 Subst'd naphthalenes | ppb | 0.22 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | 0.22 | 0.22 | 6 |
| Acenaphthene | ppb | 0.4 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | 0.40 | 0.40 | 6 |
| Methyl acenaphthene | ppb | 0.05 | <0.04 | <0.04 | 0.04 | <0.04 | <0.04 | <0.04 | 0.05 | 0.05 | 6 |
| Acenaphthylene | ppb | <0.01 | 0.08 | <0.02 | 0.06 | <0.02 | 0.07 | <0.01 | 0.08 | 0.06 | 6 |
| Anthracene | ppb | <0.01 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.01 | <0.02 | 0.01 | 6 |
| Dibenzo(a,h)anthracene | ppb | <0.01 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.01 | <0.02 | 0.01 | 6 |
| Benzo(a)Anthracene/Chrysene | ppb | <0.01 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.01 | <0.02 | 0.01 | 6 |
| Benz(a)Anthracene | ppb | | <0.04 | | | | | | <0.04 | | 1 |
| C2 Subst'd Chrysene/Benz(a)Anthr | ppb | | <0.04 | | | | | | <0.04 | | 1 |
| Methyl benzo(a)anthracene/chrysen | ppb | | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | | <0.04 | | 5 |
| C2 Subst'd benzo(a)anthracene/chr | ppb | | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | | <0.04 | | 5 |
| Benzo(a)pyrene | ppb | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | <0.02 | | 5 |
| Methyl benzo(b&k) fluoranthene/m | ppb | | <0.02 | <0.04 | <0.04 | <0.04 | <0.04 | <0.02 | <0.04 | | 5 |
| C2 Subst'd benzo(b& k) fluoranthe | ppb | | <0.02 | <0.04 | <0.04 | <0.04 | <0.04 | <0.02 | <0.04 | | 5 |
| Benzo(b&k)fluoranthene | ppb | | 0.08 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | 0.08 | 0.08 | 5 |
| Benzo(g,h,i)perylene | ppb | 0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | 0.02 | 0.02 | 6 |
| Biphenyl | ppb | <0.01 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | <0.01 | <0.04 | 0.01 | 6 |
| Methyl biphenyl | ppb | <0.02 | <0.02 | <0.04 | <0.04 | <0.04 | <0.04 | <0.02 | <0.04 | 0.02 | 6 |
| C2 Substituted biphenyl | ppb | <0.02 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | <0.02 | <0.04 | 0.02 | 6 |
| Dibenzothiophene | ppb | 0.19 | <0.04 | <0.02 | <0.02 | <0.02 | <0.02 | <0.04 | 0.19 | 0.19 | 6 |
| Methyl dibenzothiophene | ppb | 0.02 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | 0.02 | 0.02 | 6 |
| C2 Substituted dibenzothiophene | ppb | 0.28 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | 0.28 | 0.28 | 6 |
| C3 Subst'd dibenzothiophene | ppb | 0.51 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | 0.51 | 0.51 | 6 |
| C4 Subst'd dibenzothiophene | ppb | 0.53 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | 0.53 | 0.53 | 6 |
| Fluoranthene | ppb | 0.83 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | 0.83 | 0.83 | 6 |
| Methyl fluoranthene/pyrene | ppb | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | | <0.04 | | 6 |
| Fluorene | ppb | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | <0.02 | | 5 |
| Methyl fluorene | ppb | 0.06 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | 0.06 | 0.06 | 6 |
| C2 Substituted fluorene | ppb | 0.28 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | 0.28 | 0.28 | 6 |
| Indeno(c,d-123)pyrene | ppb | 0.25 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | 0.25 | 0.25 | 6 |
| Phenanthrene | ppb | <0.01 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.01 | <0.02 | 0.01 | 6 |
| Methyl phenanthrene/anthracene | ppb | 0.46 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | 0.46 | 0.46 | 6 |
| C2 Subst'd phenanthrene/anthracen | ppb | 0.75 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | 0.75 | 0.75 | 6 |
| C3 Subst'd phenanthrene/anthracen | ppb | 1 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | 1 | 1.00 | 6 |
| C4 Subst'd phenanthrene/anthracen | ppb | 1.4 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | 1.4 | 1.40 | 6 |
| 1-Methyl-7-isopropyl-phenanthrene | ppb | 1.1 | | <0.04 | <0.04 | <0.04 | <0.04 | <0.04 | 1.1 | 1.10 | 6 |
| Pyrene | ppb | <0.01 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.01 | <0.02 | 0.01 | 6 |
| **Target PANHs** | | | | | | | | | | | |
| quinoline | ppb | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | <0.02 | | 5 |
| 7-Methyl quinoline | ppb | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | <0.02 | | 5 |
| C2 Subst'd quinoline | ppb | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | <0.02 | | 5 |
| C3 Subst'd quinoline | ppb | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | <0.02 | | 5 |
| Acridine | ppb | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | <0.02 | | 5 |
| Methyl acridine | ppb | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | <0.02 | | 5 |
| Phenanthridine | ppb | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | <0.02 | | 5 |
| Carbazole | ppb | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | <0.02 | | 5 |
| Methyl carbazole | ppb | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | <0.02 | | 5 |
| C2 Subst'd carbazole | ppb | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | <0.02 | | 5 |
| **Phenolics** | | | | | | | | | | | |
| Phenol | ppb | | <0.4 | 1 | <0.4 | 0.2 | <0.4 | <0.4 | 1 | | 5 |
| o-Cresol | ppb | | <0.4 | 1 | <0.4 | 0.1 | <0.4 | <0.4 | 1 | | 5 |
| m-Cresol | ppb | | <0.4 | 1 | <0.4 | 0.3 | <0.4 | <0.4 | 1 | | 5 |
| p-Cresol | ppb | | <0.4 | 1 | <0.4 | 0.1 | <0.4 | <0.4 | 1 | | 5 |
| 2,4-Dimethylphenol | ppb | | <0.4 | 1 | <0.4 | 0.2 | <0.4 | <0.4 | 1 | | 5 |
| 2-Nitrophenol | ppb | | <2 | <2 | <2 | <2 | <2 | | <2 | | 5 |
| 4-Nitrophenol | ppb | | <20 | <20 | <20 | <20 | <20 | | <20 | | 5 |
| 2,4-Dinitrophenol | ppb | | <20 | <20 | <20 | <20 | <20 | | <20 | | 5 |
| 4,6-Dinitro-2-methyl phenol | ppb | | <20 | <20 | <20 | <20 | <20 | | <20 | | 5 |
| **Volatile organics** | | | | | | | | | | | |
| Acetone | ppb | | <100 | <100 | <100 | <100 | <100 | | <100 | | 5 |
| Acrolein | ppb | | <100 | <100 | <100 | <100 | <100 | | <100 | | 5 |
| Acrylonitrile | ppb | | <100 | <100 | <100 | <100 | <100 | | <100 | | 5 |
| Benzene | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| Bromodichloromethane | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| Bromoform | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| Bromomethane | ppb | | <10 | <10 | <10 | <10 | <10 | | <10 | | 5 |
| 2-Butanone (MEK) | ppb | | <100 | <100 | <100 | <100 | <100 | | <100 | | 5 |
| Carbon disulfide | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| Carbon tetrachloride | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| Chlorobenzene | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| Chloroethane | ppb | | <10 | <10 | <10 | <10 | <10 | | <10 | | 5 |
| 2-Chloroethyl vinyl ether | ppb | | <5 | <5 | <5 | <5 | <5 | | <5 | | 5 |
| Chloroform | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| Chloromethane | ppb | | <10 | <10 | <10 | <10 | <10 | | <10 | | 5 |
| Dibromochloromethane | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| Dibromomethane | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| 1,2-Dichlorobenzene | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| 1,3-Dichlorobenzene | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| 1,4-Dichlorobenzene | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| cis-1,4-Dichloro-2-butene | ppb | | <2 | <2 | <2 | <2 | <2 | | <2 | | 5 |
| trans-1,4-Dichloro-2-butene | ppb | | <5 | <5 | <5 | <5 | <5 | | <5 | | 5 |
| Dichlorodifluoromethane | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| 1,1-Dichloroethane | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| 1,2-Dichloroethane | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| 1,1-Dichloroethene | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| trans-1,2-Dichloroethene | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| 1,2-Dichloropropane | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| cis-1,3-Dichloropropene | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| trans-1,3-Dichloropropene | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| Ethanol | ppb | | <100 | <100 | <100 | <100 | <100 | | <100 | | 5 |
| Ethylbenzene | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| Ethylene dibromide | ppb | | <1 | <1 | <1 | <1 | <1 | | <1 | | 5 |
| [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | | | | [illegible] | | [illegible] |

# Table II-C.2



## Summary of Syncrude NST Release Chemistry From 1995 NST Field Trials

| | | NST RELEASE WATER | | | | | COMPOSITION OF POREWATERS IN THE NST DEPOSITED IN THE NST CELL | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Water released from the NST mix deposited in the MFT cell | | | | | Grab sample taken during operations (Surface Water) | | | | | Grab sample of upper substrate after active discharge had ceased (Porewater) | | | | Profiles of Porewater quality one month after active discharge | | | |
| | | MIN | MAX | MEAN | Standard Deviation | N | MIN | MAX | MEAN | Standard Deviation | N | MIN | MAX | MEAN | N | MIN | MAX | MEAN | N |
| **Conventional Parameters** | | | | | | | | | | | | | | | | | | | |
| pH | | 8 | 8.6 | 8.3 | 0.2 | 39 | 8.34 | 8.54 | 8 | | 4 | 8.33 | 8.38 | 8 | 3 | 8.25 | 8.61 | 8 | 8 |
| Conductivity | µS/cm | 3970 | 5180 | 4603 | 264 | 39 | 4270 | 4590 | 4370 | 148 | 4 | 4560 | 4780 | 4640 | 3 | 3850 | 6060 | 4553 | 8 |
| **Major Ions** | | | | | | | | | | | | | | | | | | | |
| Bicarbonate | (mg/L) | 671 | 1133 | 859 | 84 | 39 | 554 | 834 | 759 | 170 | 4 | 535 | 746 | 625 | 3 | 500 | 1162 | 689 | 7 |
| Calcium | (mg/L) | 36.2 | 78.6 | 56 | 8 | 39 | 52.9 | 76.6 | 63 | 10 | 4 | 62.4 | 73.4 | 67 | 3 | 32.1 | 109 | 61 | 8 |
| Chloride | (mg/L) | 471 | 624 | 535 | 29 | 39 | 484 | 509 | 499 | 12 | 4 | 509 | 535 | 519 | 3 | 485 | 719 | 584 | 8 |
| Magnesium | (mg/L) | 16.6 | 26.2 | 20 | 2.1 | 39 | 18.2 | 25.4 | 20 | 3 | 4 | 21.7 | 23.3 | 22 | 3 | 11.5 | 30.1 | 19 | 8 |
| Potassium | (mg/L) | 19.7 | 31.7 | 26 | 2.5 | 39 | 22.2 | 30.9 | 25 | 4 | 4 | 26.1 | 28.9 | 27 | 3 | 15.7 | 26.1 | 20 | 8 |
| Sodium | (mg/L) | 998 | 1230 | 1118 | 58 | 39 | 945 | 1050 | 981 | 48 | 4 | 1010 | 1110 | 1057 | 3 | 914 | 1330 | 1039 | 8 |
| Sulphate | (mg/L) | 1043 | 1322 | 1182 | 63 | 39 | 1043 | 1172 | 1099 | 58 | 4 | 1285 | 1312 | 1295 | 3 | 406 | 2076 | 943 | 8 |
| **Total Metals** | | | | | | | | | | | | | | | | | | | |
| Aluminum | (mg/L) | <0.01 | 0.12 | <0.01 | | 39 | <0.01 | 0.357 | <0.01 | | 4 | 0.389 | 0.697 | 0.5 | 3 | 0.237 | 11.8 | 3 | 8 |
| Boron | (mg/L) | 2.91 | 4.24 | 3.5 | 0.3 | 39 | 3.16 | 4.18 | 4 | | 4 | 3.72 | 4.01 | 4 | 3 | 2.85 | 3.74 | 3 | 8 |
| Iron | (mg/L) | | | <0.01 | | 39 | <0.01 | 0.042 | <0.01 | | 4 | 0.052 | 0.113 | 0.074 | 3 | 0.192 | 2.46 | 1 | 8 |
| Manganese | (mg/L) | <0.01 | 0.32 | 0.1 | 0.1 | 39 | | | | | | | | | | | | | |
| Molybdenum | (mg/L) | <0.01 | 0.38 | 0.2 | 0.1 | 39 | | | | | | | | | | | | | |
| Nickel | (mg/L) | <0.01 | 0.31 | 0.1 | 0.1 | 39 | | | | | | | | | | | | | |
| Silicon | (mg/L) | 2 | 4.2 | 2.5 | 0.03 | 39 | 1.97 | 2.94 | 2 | 0 | 4 | 2.61 | 3.06 | 3 | 3 | 5 | 24 | 10 | 8 |
| Titanium | (mg/L) | <0.01 | 0.24 | 0.1 | 0.1 | 39 | | | | | | | | | | | | | |
| Vanadium | (mg/L) | <0.01 | 0.25 | 0.1 | 0.1 | 39 | | | | | | | | | | | | | |
| **General Organics and Toxicity** | | | | | | | | | | | | | | | | | | | |
| IC50 | % | 54 | 100 | 81 | 15 | 39 | 100 | 100 | 100 | | 4 | 82 | 100 | 91 | 2 | 73 | 100 | 94 | 8 |
| IC20 | % | 10 | 19 | 13 | 2 | 39 | 18 | 23 | 21 | 2 | 4 | 15 | 20 | 18 | 2 | 13 | 26 | 20 | 8 |
| Toxic Units | | 1 | 1.9 | 1.2 | | 39 | | | | | | | | | | | | | |
| Naphthenic Acid | (mg/L) | 68 | 99 | 82 | 7 | 17 | | | 75 | | 1 | | | 94 | 1 | | | | |

Data summarized from Syncrude Canada Ltd. (1995).

# Table II - D.1



## Summary of Suncor CT Release Water Chemistry From Commercial Scale Trials

| SAMPLE ID | | CT0108-1 | CT1219 | Fresh CT mix POND 5 | Fresh CT mix POND 5 | Fresh CT mix POND 5 | Fresh CT mix POND 5 | Fresh CT mix POND 5 | Fresh CT mix POND 5 | POND 5 | POND 5 | POND 5 | POND 5 | POND 5 | POND 5 | POND 5 | POND 5 | POND 5 | POND 5 | POND 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | | Jan-96 | Jan-96 | Jan-96 | Jan-96 | Mar-96 | Jul-96 | Jul-96 | Sep-96 | Aug-95 | Dec-95 | Jun-96 | Sep-96 | Mar-97 | Mar-97 | May-97 | Jul-97 | Sep-97 | Sep-97 | Oct-97 |
| **Conventional Parameters** | | | | | | | | | | | | | | | | | | | | |
| Biochemical Oxygen Demand | mg/L | | | | | | | | | | | | | | | | | | | |
| Conductance | µS/cm | 2370 | 2580 | | | | | | | 2220 | | 2810 | 2408 | 2306 | 2364 | 2424 | 2281 | 2338 | 2381 | 2375 |
| Hardness | mg/L | 401 | 362 | | | | | | | 311 | | | 434 | 323 | 326 | 438 | 323 | 356 | 411 | 391 |
| pH | units | 7.83 | 7.91 | 7.7 | 8.2 | 7.9 | 8.5 | 8.8 | 8.1 | 8.3 | | | 8.19 | 8.07 | 8.03 | 8.01 | 8.1 | 7.97 | 8.19 | 8.14 |
| PP Alkalinity | mg/L | | | | | | | | | | | | 0.1 | 0.01 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Total Alkalinity | mg/L | 622 | 550 | | | | | | | 438 | | | 521 | 485 | 507 | 539 | 451 | 464 | 520 | 518 |
| Total Dissolved Solids | mg/L | 1700 | 1780 | | | | | | | 1610 | | | 1575 | 1459 | 1503 | 1626 | 1468 | 1638 | 1548 | 1509 |
| Total Suspended Solids | mg/L | | | | | | | | | 6 | | | | | | | | | | |
| **Major Ions** | | | | | | | | | | | | | | | | | | | | |
| Bicarbonate (HCO3) | mg/L | 758 | 670 | 708 | 750 | 1046 | 685 | 750 | 774 | 535 | | | 635 | 591 | 618 | 657 | 550 | 566 | 634 | 631 |
| Calcium | mg/L | | | 41 | 28 | 53 | 23 | 8 | 41 | 74.6 | | 157 | | | | | | | | |
| Carbonate (CO3) | mg/L | 0.5 | 0.5 | 0 | 0 | 0 | 14 | 28 | 0 | <5 | | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Chloride | mg/L | 44.4 | 57.4 | 52 | 42 | 58 | 94 | 46 | 45 | 57.8 | | | 58 | 55.8 | 56 | 54.1 | 63.4 | 58 | 57.2 | 56.2 |
| Fluoride | | 5.84 | 5.16 | | | | | | | | | | | | 3.3 | 2.96 | | | | |
| Hydroxide | mg/L | | | | | | | | | | | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Magnesium | mg/L | | | 17 | 17 | 17 | 11 | 6 | 17 | 30.4 | | | | | | | | | | |
| Potassium | mg/L | | | 17 | 18 | 23 | 20 | 15 | 21 | 18.5 | | | | | | | | | | |
| Sodium | mg/L | | | 402 | 390 | 514 | 504 | 354 | 467 | 471 | | 510 | | | | | | | | |
| Sulphate | mg/L | 658 | 745 | 360 | 292 | 429 | 500 | 140 | 519 | 772 | | 980 | 615 | 555 | 594 | 665 | 592 | 694 | 600 | 570 |
| **Nutrients** | | | | | | | | | | | | | | | | | | | | |
| Nitrate + Nitrite | mg/L | 0.043 | 0.030 | | | | | | | <0.05 | | | 0.07 | 0.84 | 0.036 | 0.013 | 0.15 | 0.025 | 0.05 | 0.05 |
| Nitrogen - Ammonia | mg/L | | | | | | | | | 8.20 | | | | | | | | | | |
| Phosphorus, Total | mg/L | | | | | | | | | 0.015 | | | | | | | | | | |
| Phosphorus,Total Dissolved | mg/L | <0.1 | <0.1 | | | | | | | 0.004 | | | | | 0.1 | 0.1 | | | | |
| **General Organics and Toxicity** | | | | | | | | | | | | | | | | | | | | |
| Dissolved Organic Carbon | mg/L | | | | | | | | | 48 | | | | | | | | | | |
| Microtox IC50 @ 15 min | % | | | | | | | | | | | 100 | | | | | | | | |
| Naphthenic acids | mg/L | | | | | | | | | 78 | 83 | 50 | | | | | | | | |
| Total Recoverable Hydrocarbons | mg/L | | | | | | | | | 0.9 | | | | | | | | | | |

| SAMPLE ID | | Pond 5 10 feet | Pond 5 10 feet | Pond 5 10 feet | Pond 5 10 feet | Pond 5 10 feet | Pond 5 10 feet | Pond 5 10 feet | Pond 5 10 feet | Pond 5 10 feet | Pond 5 10 feet | Pond 5 10 feet | Pond 5 10 feet | Pond 5 10 feet |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | | Jan-96 | Jan-96 | May-96 | May-96 | Jul-96 | Jul-96 | Jul-96 | Jul-96 | Aug-96 | Aug-96 | Sep-96 | Sep-96 | Sep-96 |
| **Conventional Parameters** | | | | | | | | | | | | | | |
| Biochemical Oxygen Demand | mg/L | | | | | | | | | | | | | |
| Conductance | µS/cm | | | | | | | | | | | | | |
| Hardness | mg/L | | | | | | | | | | | | | |
| pH | units | 7.8 | | | | | | 8.1 | | | | | | |
| PP Alkalinity | mg/L | | | | | | | | | | | | | |
| Total Alkalinity | mg/L | | | | | | | | | | | | | |
| Total Dissolved Solids | mg/L | | | | | | | | | | | | | |
| Total Suspended Solids | mg/L | | | | | | | | | | | | | |
| **Major Ions** | | | | | | | | | | | | | | |
| Bicarbonate (HCO3) | mg/L | 639 | | | | | | 651 | | | | | | |
| Calcium | mg/L | 62 | 60 | 72 | 71 | 71 | 66 | 52 | 56 | 59 | 64 | 62 | 70 | 64 |
| Carbonate (CO3) | mg/L | <DL | | | | | | <DL | | | | | | |
| Chloride | mg/L | 56 | 57 | 50 | 50 | | | 54 | | 56 | 56 | 58 | | |
| Fluoride | | | | | | | | | | | | | | |
| Hydroxide | mg/L | | | | | | | | | | | | | |
| Magnesium | mg/L | 25 | 26 | 27 | 27 | 26 | 25 | 22 | 23 | 24 | 23 | 25 | 26 | 23 |
| Potassium | mg/L | | | 26 | 26 | 24 | 23 | | | 26 | 26 | 25 | 26 | 23 |
| Sodium | mg/L | 374 | 374 | 501 | 497 | 464 | 443 | 383 | 418 | 455 | 442 | 459 | 486 | 443 |
| Sulphate | mg/L | 791 | | 685 | 683 | | | 766 | | 701 | 707 | 804 | | |
| **Nutrients** | | | | | | | | | | | | | | |
| Nitrate + Nitrite | mg/L | | | | | | | | | | | | | |
| Nitrogen - Ammonia | mg/L | | | | | | | | | | | | | |
| Phosphorus, Total | mg/L | | | | | | | | | | | | | |
| Phosphorus,Total Dissolved | mg/L | | | | | | | | | | | | | |
| **General Organics and Toxicity** | | | | | | | | | | | | | | |
| Dissolved Organic Carbon | mg/L | | | | | | | | | | | | | |
| Microtox IC50 @ 15 min | % | | | | | | | | | | | | | |
| Naphthenic acids | mg/L | | | | | | | | | | | | | |
| Total Recoverable Hydrocarbons | mg/L | | | | | | | | | | | | | |

Notes:
Mean and standard deviations were calculated based on detectable results

# Table II - D.1



## Summary of Suncor CT Release Water Chemistry From Commercial Scale Trials

| SAMPLE ID | | Pond 5 average of depths | Pond 5 water (Jul-Sept.) | Pond 5 water 10' | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | | Jul-96 | Aug-96 | Mar-96 | Nov-95 | Jan-96 | Jan-96 | Jan-96 | Mar-96 | Mar-96 | Mar-96 | Mar-96 | Mar-96 | Apr-96 | May-96 | May-96 | May-96 |
| **Conventional Parameters** | | | | | | | | | | | | | | | | | |
| Biochemical Oxygen Demand | mg/L | | | | | | | | | | | | | | | | |
| Conductance | µS/cm | | | | | | | | | | | | | | | | |
| Hardness | mg/L | | | | | | | | | | | | | | | | |
| pH | units | 7.94 | 7.8 | 7.7 | 8.5 | 7.9 | | 7.2 | 7.7 | 7.7 | 7.6 | 8 | 7.6 | 7.8 | | | 7.9 |
| PP Alkalinity | mg/L | | | | | | | | | | | | | | | | |
| Total Alkalinity | mg/L | | | | | | | | | | | | | | | | |
| Total Dissolved Solids | mg/L | | | | | | | | | | | | | | | | |
| Total Suspended Solids | mg/L | | | | | | | | | | | | | | | | |
| **Major Ions** | | | | | | | | | | | | | | | | | |
| Bicarbonate (HCO3) | mg/L | 600 | 640 | 838 | 436 | 635 | | 509 | 838 | 874 | 727 | 745 | 813 | 820 | | | 835 |
| Calcium | mg/L | 71.5 | 62 | 118 | 45 | 47 | 51 | 143 | 118 | 119 | 92 | 97 | 125 | 116 | 69 | 73 | 119 |
| Carbonate (CO3) | mg/L | <DL | <DL | 0 | 3 | <DL | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 |
| Chloride | mg/L | 68.2 | 57 | 81 | 120 | 57 | 43 | 163 | 81 | 83 | 58 | 46 | 62 | 62 | 50 | 51 | 83 |
| Fluoride | | | | | | | | | | | | | | | | | |
| Hydroxide | mg/L | | | | | | | | | | | | | | | | |
| Magnesium | mg/L | 24.5 | 24 | 25 | 46 | 21 | 23 | 29 | 25 | 25 | 25 | 25 | 25 | 25 | 26 | 27 | 26 |
| Potassium | mg/L | 22.75 | 24 | 27 | 19 | | | 24 | 27 | 28 | 27 | 27 | 24 | 26 | 25 | 26 | 28 |
| Sodium | mg/L | 430 | 438 | 453 | 510 | 375 | 356 | 463 | 453 | 435 | 437 | 452 | 463 | 434 | 489 | 498 | 442 |
| Sulphate | mg/L | 690.6 | 737 | 776 | 818 | 799 | 597 | 704 | 776 | 792 | 779 | 608 | 666 | 753 | 693 | 713 | 802 |
| **Nutrients** | | | | | | | | | | | | | | | | | |
| Nitrate + Nitrite | mg/L | | | | | | | | | | | | | | | | |
| Nitrogen - Ammonia | mg/L | | | | | | | | | | | | | | | | |
| Phosphorus, Total | mg/L | | | | | | | | | | | | | | | | |
| Phosphorus, Total Dissolved | mg/L | | | | | | | | | | | | | | | | |
| **General Organics and Toxicity** | | | | | | | | | | | | | | | | | |
| Dissolved Organic Carbon | mg/L | | | | | | | | | | | | | | | | |
| Microtox IC50 @ 15 min | % | | | | | | | | | | | | | | | | |
| Naphthenic acids | mg/L | | | | | | | | | | | | | | | | |
| Total Recoverable Hydrocarbons | mg/L | | | | | | | | | | | | | | | | |

| SAMPLE ID | | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | | May-96 | May-96 | May-96 | May-96 | May-96 | May-96 | May-96 | May-96 | May-96 | Jun-96 | Jun-96 | Jun-96 | Jun-96 | Jun-96 | Jun-96 | Jun-96 | Jun-96 |
| **Conventional Parameters** | | | | | | | | | | | | | | | | | | |
| Biochemical Oxygen Demand | mg/L | | | | | | | | | | | | | | | | | |
| Conductance | µS/cm | | | | | | | | | | | | | | | | | |
| Hardness | mg/L | | | | | | | | | | | | | | | | | |
| pH | units | 7.8 | 6.8 | 6.9 | 7.3 | 7.5 | 7.5 | 7.4 | 7.5 | 7.6 | 7.9 | 7.8 | 7.8 | 7.7 | 7.7 | 7.7 | 7.3 | 7.6 |
| PP Alkalinity | mg/L | | | | | | | | | | | | | | | | | |
| Total Alkalinity | mg/L | | | | | | | | | | | | | | | | | |
| Total Dissolved Solids | mg/L | | | | | | | | | | | | | | | | | |
| Total Suspended Solids | mg/L | | | | | | | | | | | | | | | | | |
| **Major Ions** | | | | | | | | | | | | | | | | | | |
| Bicarbonate (HCO3) | mg/L | 715 | 692 | 752 | 685 | 761 | 722 | 740 | 747 | 747 | 691 | 722 | 731 | 692 | 716 | 792 | 610 | 619 |
| Calcium | mg/L | 94 | 120 | 119 | 113 | 107 | 105 | 106 | 105 | 101 | 121 | 101 | 100 | 79 | 87 | 104 | 97 | 69 |
| Carbonate (CO3) | mg/L | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Chloride | mg/L | 56 | 83 | 57 | 56 | 56 | 57 | 56 | 55 | 56 | 83 | 55 | 55 | 75 | 75 | 78 | | 69 |
| Fluoride | | | | | | | | | | | | | | | | | | |
| Hydroxide | mg/L | | | | | | | | | | | | | | | | | |
| Magnesium | mg/L | 29 | 26 | 26 | 25 | 25 | 26 | 25 | 25 | 25 | 26 | 28 | 28 | 25 | 25 | 25 | 24 | 23 |
| Potassium | mg/L | 32 | 30 | 30 | 29 | 29 | 28 | 28 | 27 | 27 | 28 | 32 | 32 | 29 | 27 | 27 | 25 | 22 |
| Sodium | mg/L | 492 | 461 | 433 | 415 | 435 | 430 | 430 | 431 | 437 | 447 | 481 | 483 | 437 | 422 | 431 | 432 | 438 |
| Sulphate | mg/L | 762 | 795 | 782 | 771 | 767 | 787 | 768 | 751 | 765 | 779 | 753 | 757 | 842 | 869 | 903 | | 746 |
| **Nutrients** | | | | | | | | | | | | | | | | | | |
| Nitrate + Nitrite | mg/L | | | | | | | | | | | | | | | | | |
| Nitrogen - Ammonia | mg/L | | | | | | | | | | | | | | | | | |
| Phosphorus, Total | mg/L | | | | | | | | | | | | | | | | | |
| Phosphorus, Total Dissolved | mg/L | | | | | | | | | | | | | | | | | |
| **General Organics and Toxicity** | | | | | | | | | | | | | | | | | | |
| Dissolved Organic Carbon | mg/L | | | | | | | | | | | | | | | | | |
| Microtox IC50 @ 15 min | % | | | | | | | | | | | | | | | | | |
| Naphthenic acids | mg/L | | | | | | | | | | | | | | | | | |
| Total Recoverable Hydrocarbons | mg/L | | | | | | | | | | | | | | | | | |

# Table II - D.1



## Summary of Suncor CT Release Water Chemistry From Commercial Scale Trials

| SAMPLE ID | | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5 water surface | Pond 5-1 | Pond 5-2 | POND 5W | POND 5W | POND 5W | POND 5W |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | | Jun-96 | Jun-96 | Jul-96 | Jul-96 | Jul-96 | Jul-96 | Jul-96 | Jul-96 | Aug-96 | Aug-96 | Aug-96 | Sep-96 | Sep-96 | Sep-96 | Sep-96 | Sep-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Nov-96 | Dec-96 | May-97 | 17-5-96 | Aug-96 | Aug-96 | Jun-96 | Feb-97 | Mar-97 | Mar-97 |
| **Conventional Parameters** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Biochemical Oxygen Demand | mg/L | | | | | | | | | | | | | | | | | | | | | | | | | | | 2.1 | 6.1 | | | | |
| Conductance | µS/cm | | | | | | | | | | | | | | | | | | | | | | | | | | | 2296 | 2280 | 2303 | 2300 | 2505 | 2501 |
| Hardness | mg/L | | | | | | | | | | | | | | | | | | | | | | | | | | | 334 | 326 | 337 | 320 | 442 | 448 |
| pH | units | | | 7.8 | 7.8 | | | 7.9 | | 7.7 | | | 8 | 7.4 | | | | 7.8 | 7.8 | 7.4 | 7.4 | | | 8.1 | 7.4 | 7.6 | 7.5 | 8.18 | 8.18 | 8.06 | 7.94 | 7.6 | 7.67 |
| PP Alkalinity | mg/L | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0.1 | 0.1 | 0.1 | 0.1 |
| Total Alkalinity | mg/L | | | | | | | | | | | | | | | | | | | | | | | | | | | 487 | 488 | 475 | 456 | 534 | 539 |
| Total Dissolved Solids | mg/L | | | | | | | | | | | | | | | | | | | | | | | | | | | 1579 | 1498 | 1572 | 1538 | 1610 | 1623 |
| Total Suspended Solids | mg/L | | | | | | | | | | | | | | | | | | | | | | | | | | | <0.4 | 48 | | | | |
| **Major Ions** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bicarbonate (HCO3) | mg/L | | | 734 | 744 | | | 633 | | 625 | | | 670 | 759 | | | | 730 | 731 | 632 | 662 | | | 524 | 696 | 752 | 697 | 594 | 595 | 579 | 556 | 651 | 657 |
| Calcium | mg/L | 70 | 82 | 106 | 110 | 59 | 59 | 48 | 52 | 83 | 64 | 66 | 118 | 120 | 63 | 69 | 67 | 103 | 104 | 60 | 60 | 62 | 61 | 102 | 114 | 115 | 118 | | 85 | | | | |
| Carbonate (CO3) | mg/L | | | 0 | 0 | | | <DL | | 0 | | | 0 | 0 | | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Chloride | mg/L | 58 | 68 | 55 | 56 | | | 51 | | 27 | 55 | 53 | 85 | 61 | 57 | | | 57 | 56 | 69 | 69 | 69 | 69 | 66 | 60 | 56 | 83 | 52 | 44 | 56.4 | 55.7 | 56.8 | 56 |
| Fluoride | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4.2 | 3.4 | | |
| Hydroxide | mg/L | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0.5 | 0.5 | 0.5 | 0.5 |
| Magnesium | mg/L | 24 | 24 | 28 | 29 | 26 | 25 | 22 | 23 | 31 | 24 | 24 | 26 | 26 | 25 | 25 | 25 | 27 | 28 | 22 | 22 | 24 | 23 | 30 | 25 | 25 | 26 | 28.1 | 27.5 | | | | |
| Potassium | mg/L | 23 | 24 | 32 | 32 | 24 | 23 | | | 25 | 27 | 26 | 28 | 29 | 26 | 26 | 24 | 32 | 32 | 21 | 22 | 22 | 22 | 25 | 26 | 29 | 29 | 19.6 | 18.2 | | | | |
| Sodium | mg/L | 438 | 435 | 505 | 498 | 467 | 430 | 404 | 404 | 465 | 445 | 445 | 436 | 442 | 456 | 484 | 441 | 489 | 495 | 405 | 416 | 434 | 410 | 492 | 442 | 447 | 464 | 441 | 422 | | | | |
| Sulphate | mg/L | 577 | 749 | 759 | 760 | | | 715 | | 689 | 694 | 668 | 821 | 753 | 797 | | | 768 | 763 | 744 | 743 | 743 | 745 | 835 | 713 | 767 | 802 | 654 | 604 | 659 | 664 | 674 | 680 |
| **Nutrients** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nitrate + Nitrite | mg/L | | | | | | | | | | | | | | | | | | | | | | | | | | | 0.016 | 0.016 | 0.02 | 0.023 | 0.089 | 0.026 |
| Nitrogen - Ammonia | mg/L | | | | | | | | | | | | | | | | | | | | | | | | | | | 6.31 | 6.42 | | | | |
| Phosphorus, Total | mg/L | | | | | | | | | | | | | | | | | | | | | | | | | | | 0.008 | 0.020 | | | | |
| Phosphorus,Total Dissolved | mg/L | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0.1 | 0.3 | | |
| **General Organics and Toxicity** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dissolved Organic Carbon | mg/L | | | | | | | | | | | | | | | | | | | | | | | | | | | 48.5 | 51.7 | | | | |
| Microtox IC50 @ 15 min | % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Naphthenic acids | mg/L | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Recoverable Hydrocarbons | mg/L | | | | | | | | | | | | | | | | | | | | | | | | | | | <1 | <1 | | | | |

# Table II - D.1



## Summary of Suncor CT Release Water Chemistry From Commercial Scale Trials

| SAMPLE ID | | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | Pond 5W2 | MIN | MAX | MEAN | STD.DEV | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | | Apr-97 | Apr-97 | May-97 | May-97 | Jun-97 | Jun-97 | Jul-97 | Jul-97 | Jul-97 | Jul-97 | Aug-97 | Aug-97 | Sep-97 | Sep-97 | Nov-97 | Oct-97 | | | | | |
| **Conventional Parameters** | | | | | | | | | | | | | | | | | | | | | | |
| Biochemical Oxygen Demand | mg/L | | | | | | | | | | | | | | | | | 2.1 | 6.1 | 4.1 | | 2 |
| Conductance | µS/cm | 2448 | 2354 | 2394 | 2428 | 2314 | 2270 | 2390 | 2342 | 2305 | 2330 | 2424 | 2296 | 1380 | 2298 | 2322 | 2315 | 1380 | 2810 | 2346 | 203.46 | 34 |
| Hardness | mg/L | 420 | 369 | 418 | 428 | 296 | 351 | 386 | 337 | 305 | 310 | 316 | 297 | 228 | 335 | 365 | 416 | 228 | 448 | 360.9 | 53.5 | 33 |
| pH | units | 7.73 | 7.87 | 7.62 | 7.9 | 8.02 | 7.94 | 8.04 | 7.99 | 8.02 | 8.05 | 8.09 | 8.08 | 7.93 | 8.13 | 8.07 | 7.9 | 6.80 | 8.80 | 7.82 | 0.32 | 84 |
| PP Alkalinity | mg/L | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.01 | 0.10 | 0.10 | 0.02 | 28 |
| Total Alkalinity | mg/L | 516 | 503 | 555 | 539 | 472 | 494 | 531 | 482 | 469 | 467 | 482 | 479 | 314 | 481 | 503 | 524 | 314 | 622 | 499.0 | 49.1 | 32 |
| Total Dissolved Solids | mg/L | 1530 | 1550 | 1577 | 1607 | 1525 | 1558 | 1603 | 1558 | 1402 | 1476 | 1571 | 1515 | 856 | 1604 | 1537 | 1628 | 856 | 1780 | 1541.3 | 144.5 | 32 |
| Total Suspended Solids | mg/L | | | | | | | | | | | | | | | | | <0.4 | 48.00 | | | 1 |
| **Major Ions** | | | | | | | | | | | | | | | | | | | | | | |
| Bicarbonate (HCO3) | mg/L | 629 | 613 | 677 | 657 | 575 | 602 | 647 | 588 | 572 | 569 | 588 | 584 | 383 | 586 | 613 | 639 | 383.00 | 1046 | 673 | 97.7 | 84 |
| Calcium | mg/L | | | | | | | | | | | | | | | | | 8.00 | 157 | 82.4 | 29.4 | 80 |
| Carbonate (CO3) | mg/L | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | <DL | 28 | 0.78 | 3.5 | 83 |
| Chloride | mg/L | 54.3 | 56.4 | 53 | 51.8 | 61.8 | 55.8 | 59.3 | 59.8 | 58 | 56.9 | 57 | 53.2 | 31.6 | 57.8 | 56.6 | 53.4 | 27.00 | 163 | 60.6 | 16.29 | 99 |
| Fluoride | | | | 3.68 | 3.52 | 3.5 | 3.08 | | 3.52 | 4.3 | 3.8 | 4.1 | 3..4 | | 3.9 | 2.84 | 4.2 | 2.84 | 5.84 | 3.84 | 0.77 | 17 |
| Hydroxide | mg/L | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0 5 | 0.5 | 0.5 | 0.5 | 0.50 | 0.50 | 0.50 | 0 | 28 |
| Magnesium | mg/L | | | | | | | | | | | | | | | | | 6 | 46 | 24.7 | 4.40 | 80 |
| Potassium | mg/L | | | | | | | | | | | | | | | | | 15 | 32 | 25.6 | 3.78 | 72 |
| Sodium | mg/L | | | | | | | | | | | | | | | | | 354 | 514 | 445.6 | 36.11 | 81 |
| Sulphate | mg/L | 617 | 658 | 636 | 674 | 624 | 650 | 678 | 644 | 535 | 628 | 656 | 633 | 322 | 694 | 628 | 654 | 140 | 980 | 691.1 | 123.28 | 99 |
| **Nutrients** | | | | | | | | | | | | | | | | | | | | | | |
| Nitrate + Nitrite | mg/L | 0.003 | 0.003 | 0.015 | 0.007 | 0.037 | 0.01 | 0.003 | 0.029 | 0.031 | 0.032 | 0.047 | 0.01 | 0.107 | 0.022 | 0.012 | 0.015 | 0.003 | 0.84 | 0.06 | 0.15 | 32 |
| Nitrogen - Ammonia | mg/L | | | | | | | | | | | | | | | | | 6.31 | 8.20 | 6.37 | | 3 |
| Phosphorus, Total | mg/L | | | | | | | | | | | | | | | | | 0.01 | 0.02 | 0.01 | | 3 |
| Phosphorus,Total Dissolved | mg/L | | | 0.1 | 0.1 | 0.1 | 0.1 | | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 | | 0.1 | 0.1 | 0.1 | 0.00 | 0.30 | 0.12 | 0.06 | 19 |
| **General Organics and Toxicity** | | | | | | | | | | | | | | | | | | | | | | |
| Dissolved Organic Carbon | mg/L | | | | | | | | | | | | | | | | | 48.50 | 51.70 | 50.10 | | 3 |
| Microtox IC50 @ 15 min | % | | | | | | | | | | | | | | | | | | 100 | | | 3 |
| Naphthenic acids | mg/L | | | | | | | | | | | | | | | | | 50 | 83 | 67 | | 3 |
| Total Recoverable Hydrocarbons | mg/L | | | | | | | | | | | | | | | | | 0.9 | <1 | 1 | | 3 |

# Summary of Suncor CT Release Water Chemistry From Commercial Scale Trials

| SAMPLE ID | | CT0108-1 | CT1219 | POND 5 | POND 5 | POND 5 | POND 5 | POND 5 | POND 5 | POND 5 | POND 5 | POND 5 | Pond 5-1 | Pond 5-2 | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | | Jan-96 | Jan-96 | Aug-95 | Sep-96 | Mar-97 | Mar-97 | May-97 | Jul-97 | Sep-97 | Sep-97 | Oct-97 | Aug-96 | Aug-96 | Jun-96 | Feb-97 | Mar-97 | Mar-97 | Apr-97 | Apr-97 | May-97 | May-97 |
| **Total Metals** | | | | | | | | | | | | | | | | | | | | | | |
| Aluminum (Al) | mg/L | | 0.02 | 0.420 | | | | | | | | | 0.08 | 0.53 | | | | | | | | |
| Arsenic (As) | mg/L | | 0.0046 | 0.0060 | | | | | | | | | 0.007 | 0.059 | | | | | | | | |
| Barium (Ba) | mg/L | | 0.06 | 0.121 | | | | | | | | | 0.16 | 0.16 | | | | | | | | |
| Beryllium (Be) | mg/L | | 0.003 | <0.001 | | | | | | | | | 0.006 | 0.006 | | | | | | | | |
| Boron (B) | mg/L | | 3.19 | 2.63 | | | | | | | | | 3.62 | 3.39 | | | | | | | | |
| Cadmium (Cd) | mg/L | | 0.0066 | 0.0016 | | | | | | | | | <0.003 | <0.003 | | | | | | | | |
| Chromium (Cr) | mg/L | | <0.002 | 0.0007 | | | | | | | | | 0.023 | 0.021 | | | | | | | | |
| Cobalt (Co) | mg/L | | 0.0045 | 0.0020 | | | | | | | | | <0.003 | <0.003 | | | | | | | | |
| Copper (Cu) | mg/L | | 0.003 | 0.0035 | | | | | | | | | | | | | | | | | | |
| Iron (Fe) | mg/L | | <0.01 | 0.19 | | | | | | | | | 0.06 | 1.17 | | | | | | | | |
| Lead (Pb) | mg/L | | <0.0003 | 0.0108 | | | | | | | | | <0.02 | <0.02 | | | | | | | | |
| Lithium (Li) | mg/L | | 0.201 | 0.185 | | | | | | | | | 0.19 | 0.175 | | | | | | | | |
| Manganese (Mn) | mg/L | | 0.024 | 0.0260 | | | | | | | | | 0.065 | 0.116 | | | | | | | | |
| Mercury (Hg) | mg/L | | <0.05 | <0.0001 | | | | | | | | | <0.05 | <0.05 | | | | | | | | |
| Molybdenum (Mo) | mg/L | | 1.14 | 0.739 | | | | | | | | | 1.08 | 0.99 | | | | | | | | |
| Nickel (Ni) | mg/L | | 0.0295 | 0.0108 | | | | | | | | | 0.022 | <0.005 | | | | | | | | |
| Strontium (Sr) | mg/L | | | 1.07 | | | | | | | | | 1.59 | 1.49 | | | | | | | | |
| Vanadium (V) | mg/L | | | 0.0269 | | | | | | | | | 0.005 | 0.007 | | | | | | | | |
| Zinc (Zn) | mg/L | | | 0.018 | | | | | | | | | 0.021 | 0.024 | | | | | | | | |
| **Dissolved Metals** | | | | | | | | | | | | | | | | | | | | | | |
| Aluminum (Al) | mg/L | 0.09 | | 0.0397 | | | 0.06 | 0.01 | | | | | | | 0.01 | 0.04 | | | | | 0.01 | 0.01 |
| Arsenic (As) | mg/L | 0.0038 | | 0.0057 | | | | | | | | | | | | | | | | | | |
| Barium (Ba) | mg/L | 0.07 | | 0.118 | | | 0.14 | 0.13 | | | | | | | 0.12 | 0.16 | | | | | 0.13 | 0.13 |
| Beryllium (Be) | mg/L | <0.001 | | <0.0005 | | | 0.001 | 0.001 | | | | | | | 0.12 | 0.001 | | | | | 0.001 | 0.001 |
| Boron (B) | mg/L | 2.63 | | 2.57 | | | 2.84 | 2.66 | | | | | | | 2.78 | 2.79 | | | | | 2.58 | 2.57 |
| Cadmium (Cd) | mg/L | <0.003 | | 0.0015 | | | 0.001 | 0.008 | | | | | | | 0.0245 | 0.0256 | | | | | 0.0044 | 0.0051 |
| Calcium (Ca) | mg/L | 109 | 98.7 | | 125 | 83 | 84.1 | 124 | 83.6 | 90.5 | 117 | 110 | 87.2 | | 86.9 | 83.3 | 126 | 128 | 120 | 101 | 119 | 122 |
| Chromium (Cr) | mg/L | 0.010 | | <0.0004 | | | 0.014 | 0.002 | | | | | | | 0.002 | 0.007 | | | | | 0.002 | 0.002 |
| Cobalt (Co) | mg/L | <0.003 | | 0.0013 | | | 0.0024 | 0.0038 | | | | | | | 0.0087 | 0.0007 | | | | | 0.0026 | 0.0029 |
| Copper (Cu) | mg/L | 0.002 | | 0.0070 | | | 0.007 | 0.001 | | | | | | | 0.001 | 0.005 | | | | | 0.001 | 0.001 |
| Iron (Fe) | mg/L | <0.01 | | <0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.06 | 0.01 | 0.01 | | | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Lead (Pb) | mg/L | <0.02 | | 0.00065 | | | 0.0003 | 0.0003 | | | | | | | 0.0003 | 0.0003 | | | | | 0.0003 | 0.0003 |
| Lithium (Li) | mg/L | 0.229 | | | | | 0.196 | 0.19 | | | | | | | 0.207 | 0.201 | | | | | 0.178 | 0.178 |
| Magnesium (Mg) | mg/L | 31.2 | 28 | | 29.6 | 28 | 28.1 | 31.1 | 27.8 | 31.6 | 28.8 | 28.3 | 28.1 | | 29.1 | 27.1 | 30.8 | 31.1 | 29.2 | 28.4 | 29.2 | 29.9 |
| Manganese (Mn) | mg/L | 0.052 | | 0.0061 | 0.094 | 0.003 | 0.049 | 0.109 | 0.001 | 0.001 | 0.09 | 0.056 | | | 0.001 | 0.005 | 0.025 | 0.109 | 0.114 | 0.042 | 0.111 | 0.114 |
| Mercury (Hg) | mg/L | <0.05 | | <0.0002 | | | | | | | | | | | | | | | | | | |
| Molybdenum (Mo) | mg/L | 0.893 | | 0.955 | | | 0.837 | 0.819 | | | | | | | 0.847 | 0.895 | | | | | 0.768 | 0.782 |
| Nickel (Ni) | mg/L | 0.017 | | 0.0101 | | | 0.029 | 0.0478 | | | | | | | 0.128 | 0.0792 | | | | | 0.032 | 0.0345 |
| Potassium (K) | mg/L | 20.2 | 21.3 | | 17.2 | 17.4 | 16.5 | 16.2 | 16.3 | 17.7 | 16.8 | 16.8 | 19.6 | | 16.7 | 16.3 | 15.2 | 15.4 | 15.1 | 14.7 | 14.9 | 15.1 |
| Selenium (Se) | mg/L | 0.0043 | <0.0002 | 0.0034 | | | | | | | | | | | | | | | | | | |
| Silicon (Si) | mg/L | 2.87 | 2.61 | | | | 3.49 | 3.28 | | | | | | | 3.49 | 3.48 | | | | | 3.26 | 3.08 |
| Silver (Ag) | mg/L | 0.003 | <0.0002 | <0.0002 | | | 0.0008 | 0.0001 | | | | | | | 0.0001 | 0.0001 | | | | | 0.0001 | 0.0001 |
| Sodium (Na) | mg/L | 459 | 490 | | 414 | 420 | 415 | 407 | 409 | 463 | 411 | 412 | 441 | | 434 | 414 | 381 | 384 | 380 | 385 | 387 | 386 |
| Strontium (Sr) | mg/L | 1.74 | 1.57 | 1.06 | | | 1.22 | 1.36 | | | | | | | 1.21 | 1.25 | | | | | 1.27 | 1.3 |
| Sulphur (S) | mg/L | 242 | 266 | | | | 228 | 249 | | | | | | | 230 | 215 | | | | | 235 | 242 |
| Titanium (Ti) | mg/L | <0.003 | <0.003 | 0.0007 | | | 0.003 | 0.003 | | | | | | | 0.003 | 0.007 | | | | | 0.003 | 0.003 |
| Uranium (U) | mg/L | <0.5 | 0.0068 | 0.00465 | | | 0.0024 | 0.0064 | | | | | | | 0.0126 | 0.0048 | | | | | 0.0056 | 0.0061 |
| Vanadium (V) | mg/L | 0.028 | 0.052 | 0.0247 | | | 0.009 | 0.025 | | | | | | | 0.023 | 0.032 | | | | | 0.002 | 0.002 |
| Zinc (Zn) | mg/L | 0.002 | 0.004 | 0.028 | | | 0.011 | 0.001 | | | | | | | 0.001 | 0.146 | | | | | 0.001 | 0.001 |

Notes:

Mean and standard deviations were calculated based on detectable results

# Table II - D.1



## Summary of Suncor CT Release Water Chemistry From Commercial Scale Trials

| SAMPLE ID | | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | POND 5W | Pond 5W2 | MIN | MAX | MEAN | STD.DEV | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | | Jun-97 | Jun-97 | Jul-97 | Jul-97 | Jul-97 | Jul-97 | Aug-97 | Aug-97 | Sep-97 | Sep-97 | Nov-97 | Oct-97 | | | | | |
| **Total Metals** | | | | | | | | | | | | | | | | | | |
| Aluminum (Al) | mg/L | | | | | | | | | | | | | 0.02 | 0.53 | 0.21 | 0.28 | 4 |
| Arsenic (As) | mg/L | | | | | | | | | | | | | 0.00 | 0.60 | 0.02 | 0.03 | 4 |
| Barium (Ba) | mg/L | | | | | | | | | | | | | 0.06 | 0.16 | 0.13 | 0.06 | 4 |
| Beryllium (Be) | mg/L | | | | | | | | | | | | | <0.001 | 0.01 | 0.01 | 0.002 | 4 |
| Boron (B) | mg/L | | | | | | | | | | | | | 2.63 | 3.62 | 3.40 | 0.22 | 4 |
| Cadmium (Cd) | mg/L | | | | | | | | | | | | | 0.0016 | 0.0066 | 0.007 | | 4 |
| Chromium (Cr) | mg/L | | | | | | | | | | | | | 0.001 | 0.02 | 0.02 | 0.01 | 4 |
| Cobalt (Co) | mg/L | | | | | | | | | | | | | <0.003 | 0.005 | 0.0045 | | 4 |
| Copper (Cu) | mg/L | | | | | | | | | | | | | 0.00 | 0.004 | | | 2 |
| Iron (Fe) | mg/L | | | | | | | | | | | | | <0.01 | 1.17 | 0.41 | 0.66 | 4 |
| Lead (Pb) | mg/L | | | | | | | | | | | | | <0.0003 | <0.02 | | | 4 |
| Lithium (Li) | mg/L | | | | | | | | | | | | | 0.18 | 0.20 | 0.19 | 0.01 | 3 |
| Manganese (Mn) | mg/L | | | | | | | | | | | | | 0.02 | 0.12 | 0.07 | 0.05 | 4 |
| Mercury (Hg) | mg/L | | | | | | | | | | | | | <0.0001 | <0.05 | | | 4 |
| Molybdenum (Mo) | mg/L | | | | | | | | | | | | | 0.99 | 1.14 | 1.07 | 0.07 | 4 |
| Nickel (Ni) | mg/L | | | | | | | | | | | | | <0.005 | 0.03 | 0.03 | | 4 |
| Strontium (Sr) | mg/L | | | | | | | | | | | | | 1.07 | 1.59 | 1.54 | | 3 |
| Vanadium (V) | mg/L | | | | | | | | | | | | | 0.01 | 0.03 | 0.00 | | 3 |
| Zinc (Zn) | mg/L | | | | | | | | | | | | | 0.02 | 0.02 | 0.02 | | 3 |
| **Dissolved Metals** | | | | | | | | | | | | | | | | | | |
| Aluminum (Al) | mg/L | 0.05 | 0.01 | | 0.02 | 0.06 | 0.01 | 0.6 | 0.04 | | 0.02 | 0.02 | 0.03 | 0.01 | 0.60 | 0.06 | 0.14 | 18 |
| Arsenic (As) | mg/L | | | | | | | | | | | | | 0.00 | 0.006 | | | 2 |
| Barium (Ba) | mg/L | 0.14 | 0.12 | | 0.14 | 0.13 | 0.12 | 14 | 0.13 | | 0.22 | 0.12 | 0.17 | 0.07 | 14.00 | 0.95 | 3.36 | 18 |
| Beryllium (Be) | mg/L | 0.001 | 0.001 | | 0.002 | 0.002 | 0.003 | 0.001 | 0.002 | | 0.001 | 0.001 | 0.001 | <0.0005 | 0.12 | 0.01 | 0.03 | 18 |
| Boron (B) | mg/L | 2.85 | 2.7 | | 2.83 | 2.73 | 2.73 | 2.88 | 2.76 | | 2.88 | 2.71 | 2.95 | 2.57 | 2.95 | 2.76 | 0.11 | 18 |
| Cadmium (Cd) | mg/L | 0.0002 | 0.0002 | | 0.0065 | 0.0409 | 0.0639 | 0.0002 | 0.002 | | 0.0064 | 0.0073 | 0.0039 | <0.003 | 0.06 | 0.01 | 0.02 | 18 |
| Calcium (Ca) | mg/L | 71.3 | 93.7 | 107 | 86.7 | 76.5 | 78.9 | 78.2 | 74.5 | 63 | 85.8 | 97.6 | 115 | 63.00 | 128.00 | 97.63 | 18.92 | 31 |
| Chromium (Cr) | mg/L | 0.003 | 0.002 | | 0.002 | 0.006 | 0.002 | 0.014 | 0.013 | | 0.002 | 0.002 | 0.002 | <0.0004 | 0.01 | 0.01 | 0.005 | 18 |
| Cobalt (Co) | mg/L | 0.0145 | 0.0035 | | 0.0024 | 0.0054 | 0.0048 | 0.0222 | 0.0003 | | 0.0019 | 0.0021 | 0.0018 | 0.0003 | 0.02 | 0.005 | 0.01 | 18 |
| Copper (Cu) | mg/L | 0.003 | 0.003 | | 0.007 | 0.004 | 0.001 | 0.001 | 0.004 | | 0.002 | 0.002 | 0.004 | 0.001 | 0.01 | 0.003 | 0.00 | 18 |
| Iron (Fe) | mg/L | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.03 | 0.01 | 0.01 | 0.01 | 0.58 | 0.01 | 0.58 | 0.03 | 0.11 | 30 |
| Lead (Pb) | mg/L | 0.0003 | 0.0003 | | 0.0003 | 0.0006 | 0.0003 | 0.0003 | 0.0003 | | 0.0003 | 0.0016 | 0.0003 | 0.0003 | <0.02 | 0.002 | 0.005 | 18 |
| Lithium (Li) | mg/L | 0.208 | 0.198 | | 0.204 | 0.184 | 0.177 | 0.204 | 0.205 | | 0.201 | 0.183 | 0.204 | 0.18 | 0.23 | 0.20 | 0.01 | 17 |
| Magnesium (Mg) | mg/L | 28.5 | 28.3 | 28.8 | 29.1 | 27.6 | 27.4 | 29.2 | 26.8 | 17.1 | 29.3 | 29.3 | 31.2 | 17.10 | 31.60 | 28.65 | 2.50 | 31 |
| Manganese (Mn) | mg/L | 0.014 | 0.017 | 0.099 | 0.017 | 0.005 | 0.013 | 0.026 | 0.023 | 0.096 | 0.001 | 0.005 | 0.014 | 0.001 | 0.11 | 0.05 | 0.04 | 30 |
| Mercury (Hg) | mg/L | | | | | | | | | | | | | <0.0002 | <0.05 | | | 2 |
| Molybdenum (Mo) | mg/L | 0.866 | 0.837 | | 0.876 | 0.833 | 0.837 | 0.871 | 0.842 | | 0.904 | 0.881 | 0.92 | 0.77 | 0.92 | 0.85 | 0.04 | 18 |
| Nickel (Ni) | mg/L | 0.012 | 0.0445 | | 0.0364 | 0.104 | 0.0956 | 0.022 | 0.0005 | | 0.0096 | 0.0356 | 0.0306 | 0.001 | 0.13 | 0.04 | 0.04 | 18 |
| Potassium (K) | mg/L | 17.1 | 15.9 | 14.8 | 17 | 15.6 | 15.4 | 17.3 | 16.4 | 8.66 | 17.4 | 15.4 | 17.3 | 8.66 | 21.30 | 16.38 | 2.10 | 31 |
| Selenium (Se) | mg/L | | | | | | | | | | | | | <0.0002 | 0.004 | 0.002 | 0.003 | 3 |
| Silicon (Si) | mg/L | 3.56 | 3.37 | | 3.52 | 3.48 | 3.41 | 3.54 | 3.33 | | 4.31 | 3.31 | 3.74 | 2.61 | 4.31 | 3.40 | 0.35 | 18 |
| Silver (Ag) | mg/L | 0.0001 | 0.0022 | | 0.0001 | 0.0001 | 0.0001 | 0.0006 | 0.0001 | | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.003 | 0.0005 | 0.001 | 19 |
| Sodium (Na) | mg/L | 434 | 413 | 391 | 427 | 403 | 385 | 439 | 419 | 222 | 426 | 403 | 438 | 222.00 | 490.00 | 409.42 | 43.48 | 31 |
| Strontium (Sr) | mg/L | 1.2 | 1.22 | | 1.21 | 1.14 | 1.12 | 1.26 | 1.18 | | 1.29 | 1.27 | 1.46 | 1.06 | 1.46 | 1.29 | 0.16 | 19 |
| Sulphur (S) | mg/L | 233 | 223 | | 242 | 226 | 228 | 234 | 207 | | 235 | 236 | 248 | 207.00 | 266.00 | 234.39 | 13.29 | 18 |
| Titanium (Ti) | mg/L | 0.01 | 0.004 | | 0.003 | 0.003 | 0.003 | 0.011 | 0.013 | | 0.003 | 0.003 | 0.004 | <0.003 | 0.01 | 0.005 | 0.003 | 19 |
| Uranium (U) | mg/L | 0.0004 | 0.0071 | | 0.0051 | 0.0077 | 0.0004 | 0.0079 | 0.0024 | | 0.0067 | 0.0046 | 0.0075 | 0.0004 | <0.5 | 0.03 | 0.12 | 19 |
| Vanadium (V) | mg/L | 0.017 | 0.033 | | 0.033 | 0.027 | 0.024 | 0.002 | 0.014 | | 0.029 | 0.035 | 0.044 | 0.002 | 0.05 | 0.02 | 0.01 | 19 |
| Zinc (Zn) | mg/L | 0.002 | 0.009 | | 0.011 | 0.017 | 0.005 | 0.002 | 0.008 | | 0.015 | 0.005 | 0.043 | 0.001 | 0.15 | 0.02 | 0.03 | 19 |

# Summary of Suncor CT Release Water Chemistry From Commercial Scale Trials

| SAMPLE ID | | CT1219 | POND 5 | POND 5 | Pond 5-1 | Pond 5-2 | MIN | MAX | MEAN | STD.DEV | N |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | | Jan-96 | Aug-95 | Dec-95 | Aug-96 | Aug-96 | | | | | |
| **Target PAHs and Alkylated PAHs** | | | | | | | | | | | |
| Naphthalene | ppb | <0.02 | <0.2 | 0.05 | <0.02 | <0.02 | <0.02 | <0.2 | 0.03 | 0.02 | 5 |
| Methyl naphthalenes | ppb | 0.08 | <0.2 | 0.06 | 0.03 | 0.03 | 0.03 | 0.08 | 0.05 | 0.02 | 5 |
| C2 Subst'd naphthalenes | ppb | 0.25 | <0.4 | 0.11 | 0.11 | 0.10 | 0.10 | <0.4 | 0.14 | 0.07 | 5 |
| C3 Subst'd naphthalenes | ppb | 0.07 | <0.4 | 0.30 | 0.10 | 0.10 | 0.07 | <0.4 | 0.14 | 0.11 | 5 |
| C4 Subst'd naphthalenes | ppb | 2.0 | <0.4 | 0.56 | 0.19 | 0.23 | 0.19 | 2.00 | 0.75 | 0.85 | 5 |
| Acenaphthene | ppb | <0.02 | <0.2 | 0.16 | 0.07 | 0.03 | <0.02 | <0.2 | 0.07 | 0.08 | 5 |
| Methyl acenaphthene | ppb | 0.17 | <0.4 | 0.19 | 0.11 | 0.10 | 0.10 | <0.4 | 0.14 | 0.04 | 5 |
| Acenaphthylene | ppb | <0.02 | <0.2 | <0.02 | 0.02 | 0.03 | <0.02 | <0.2 | 0.02 | 0.01 | 5 |
| Anthracene | ppb | <0.02 | <0.2 | <0.02 | <0.02 | <0.02 | <0.02 | <0.2 | | | 5 |
| Dibenzo(a,h)anthracene | ppb | <0.02 | <0.2 | <0.02 | <0.02 | <0.02 | <0.02 | <0.2 | | | 5 |
| Benzo(a)Anthracene/Chrysene | ppb | 0.27 | <0.2 | <0.02 | <0.02 | <0.02 | <0.02 | 0.27 | 0.15 | | 5 |
| Methyl benzo(a)anthracene/chrysen | ppb | 0.50 | <0.4 | 0.06 | <0.04 | <0.04 | <0.4 | 0.50 | 0.16 | 0.23 | 5 |
| C2 Subst'd benzo(a)anthracene/chry | ppb | 0.83 | <0.4 | 0.10 | <0.04 | 0.06 | <0.4 | 0.83 | 0.26 | 0.38 | 5 |
| Benzo(a)pyrene | ppb | <0.02 | <0.2 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | | 5 |
| Methyl benzo(b&k) fluoranthene/m | ppb | 0.30 | <0.4 | <0.04 | <0.02 | <0.02 | <0.02 | <0.4 | 0.17 | 0.18 | 5 |
| C2 Subst'd benzo(b& k) fluoranthen | ppb | 0.18 | <0.4 | <0.04 | <0.04 | <0.04 | <0.04 | 0.18 | 0.08 | 0.07 | 5 |
| Benzo(b&k)fluoranthene | ppb | <0.02 | <0.2 | <0.02 | | | <0.02 | <0.2 | | | 3 |
| Benzo(g,h,i)perylene | ppb | <0.02 | <0.2 | <0.02 | <0.02 | <0.02 | <0.02 | <0.2 | | | 5 |
| Biphenyl | ppb | <0.04 | <0.4 | <0.04 | <0.04 | <0.04 | <0.04 | <0.4 | 0.04 | 0.00 | 5 |
| Methyl biphenyl | ppb | <0.04 | <0.4 | <0.04 | 0.09 | 0.11 | <0.04 | <0.4 | 0.07 | 0.04 | 5 |
| C2 Substituted biphenyl | ppb | 0.25 | <0.4 | <0.04 | 0.07 | 0.07 | <0.04 | <0.4 | 0.11 | 0.10 | 5 |
| Dibenzothiophene | ppb | 0.07 | <0.2 | <0.02 | <0.02 | <0.02 | <0.02 | <0.2 | 0.05 | | 5 |
| Methyl dibenzothiophene | ppb | 0.65 | <0.4 | <0.04 | 0.05 | 0.06 | <0.04 | 0.05 | 0.20 | 0.30 | 5 |
| C2 Substituted dibenzothiophene | ppb | 2.2 | <0.4 | 0.39 | 0.17 | 0.23 | 0.17 | 2.20 | 0.75 | 0.97 | 5 |
| C3 Subst'd dibenzothiophene | ppb | 4.1 | <0.4 | 0.85 | 0.20 | 0.34 | <0.2 | 4.10 | 1.37 | 1.84 | 5 |
| C4 Subst'd dibenzothiophene | ppb | 4.4 | <0.4 | 0.58 | 0.32 | 0.46 | 0.32 | 4.40 | 1.44 | 1.98 | 5 |
| Fluoranthene | ppb | <0.02 | <0.2 | <0.02 | <0.02 | <0.02 | <0.02 | <0.2 | | | 5 |
| Methyl fluoranthene/pyrene | ppb | 0.65 | <0.4 | 0.09 | 0.06 | 0.07 | 0.06 | 0.65 | 0.22 | 0.29 | 5 |
| Fluorene | ppb | 0.03 | <0.2 | <0.02 | <0.02 | <0.02 | <0.02 | <0.2 | 0.03 | | 5 |
| Methyl fluorene | ppb | 0.30 | <0.4 | <0.04 | 0.07 | 0.07 | <0.04 | <0.4 | 0.12 | 0.12 | 5 |
| C2 Substituted fluorene | ppb | 1.1 | <0.4 | 0.14 | 0.50 | 0.54 | 0.14 | 1.10 | 0.57 | 0.40 | 5 |
| Indeno(c,d-123)pyrene | ppb | <0.02 | <0.2 | <0.02 | <0.02 | <0.02 | <0.02 | <0.2 | | | 5 |
| Phenanthrene | ppb | 0.09 | <0.2 | <0.02 | <0.02 | <0.02 | <0.02 | <0.2 | 0.06 | | 5 |
| Methyl phenanthrene/anthracene | ppb | 0.79 | <0.4 | <0.04 | <0.04 | <0.04 | <0.04 | 0.79 | 0.23 | 0.38 | 5 |
| C2 Subst'd phenanthrene/anthracene | ppb | 4.5 | <0.4 | 0.23 | 0.05 | 0.09 | 0.05 | 4.50 | 1.22 | 2.19 | 5 |
| C3 Subst'd phenanthrene/anthracene | ppb | 3.6 | <0.4 | 0.44 | 0.04 | 0.13 | 0.04 | 3.60 | 1.05 | 1.71 | 5 |
| C4 Subst'd phenanthrene/anthracene | ppb | 1.7 | <0.4 | 0.38 | 0.04 | 0.11 | 0.04 | 1.70 | 0.56 | 0.78 | 5 |
| 1-Methyl-7-isopropyl-phenanthrene | ppb | <0.04 | | <0.04 | | | <0.04 | <0.4 | | | 2 |
| Pyrene | ppb | <0.02 | <0.2 | 0.04 | <0.02 | <0.02 | <0.02 | <0.2 | 0.03 | | 5 |
| **Target PANHs** | | | | | | | | | | | |
| quinoline | ppb | <0.02 | <0.2 | <0.02 | <0.03 | <0.05 | <0.02 | <0.05 | 0.03 | 0.01 | 4 |
| 7-Methyl quinoline | ppb | <0.02 | <0.2 | <0.02 | 0.16 | 0.15 | <0.02 | 0.16 | 0.09 | 0.08 | 4 |
| C2 Subst'd quinoline | ppb | <0.02 | <0.2 | <0.02 | 0.14 | 0.19 | <0.02 | 0.19 | 0.09 | 0.09 | 4 |
| C3 Subst'd quinoline | ppb | <0.02 | <0.2 | <0.02 | 0.17 | 0.30 | <0.02 | 0.30 | 0.13 | 0.14 | 4 |
| Acridine | ppb | <0.02 | <0.2 | <0.02 | <0.03 | <0.05 | <0.02 | <0.05 | 0.03 | 0.01 | 4 |
| Methyl acridine | ppb | <0.02 | <0.2 | <0.02 | <0.03 | <0.05 | <0.02 | <0.05 | 0.03 | 0.01 | 4 |
| Phenanthridine | ppb | <0.02 | <0.2 | <0.02 | <0.03 | <0.05 | <0.02 | <0.05 | 0.03 | 0.01 | 4 |
| Carbazole | ppb | <0.02 | <0.2 | <0.02 | <0.03 | <0.05 | <0.02 | <0.05 | 0.03 | 0.01 | 4 |
| Methyl carbazole | ppb | <0.02 | <0.2 | <0.02 | <0.03 | <0.05 | <0.02 | <0.05 | 0.03 | 0.01 | 4 |
| C2 Subst'd carbazole | ppb | <0.02 | <0.2 | <0.02 | <0.03 | <0.05 | <0.02 | <0.05 | 0.03 | 0.01 | 4 |
| **Phenolics** | | | | | | | | | | | |
| Phenol | ppb | 0.2 | <2 | <0.02 | | | <0.02 | 0.20 | | | 2 |
| o-Cresol | ppb | <0.5 | <2 | <0.02 | | | 0.02 | 0.50 | | | 2 |
| m-Cresol | ppb | <1 | <2 | 0.5 | | | 1.00 | <2 | | | 2 |
| p-Cresol | ppb | <0.5 | <2 | <0.02 | | | 0.02 | 0.50 | | | 2 |
| 2,4-Dimethylphenol | ppb | 0.5 | <2 | 1.0 | | | 0.50 | 1.00 | | | 2 |
| 2-Nitrophenol | ppb | <2 | <4 | <0.4 | | | 0.40 | 2.00 | | | 2 |
| 4-Nitrophenol | ppb | <20 | <40 | <4 | | | <4 | <20 | | | 2 |
| 2,4-Dinitrophenol | ppb | <20 | <40 | <4 | | | <4 | <20 | | | 2 |
| 4,6-Dinitro-2-methyl phenol | ppb | <20 | <40 | <4 | | | <4 | <20 | | | 2 |
| **Volatile organics** | | | | | | | | | | | |
| Acetone | ppb | <1500 | | <1500 | | | | <1500 | | | 2 |
| Acrolein | ppb | <1500 | | <1500 | | | | <1500 | | | 2 |
| Acrylonitrile | ppb | <1500 | | <1500 | | | | <1500 | | | 2 |
| Benzene | ppb | <15 | | <15 | | | | <15 | | | 2 |
| Bromodichloromethane | ppb | <15 | | <15 | | | | <15 | | | 2 |
| Bromoform | ppb | <15 | | <15 | | | | <15 | | | 2 |
| Bromomethane | ppb | <150 | | <150 | | | | <150 | | | 2 |
| 2-Butanone (MEK) | ppb | <1500 | | <1500 | | | | <1500 | | | 2 |
| Carbon disulfide | ppb | <15 | | <15 | | | | <15 | | | 2 |
| Carbon tetrachloride | ppb | <15 | | <15 | | | | <15 | | | 2 |
| Chlorobenzene | ppb | <15 | | <15 | | | | <15 | | | 2 |
| Chloroethane | ppb | <150 | | <150 | | | | <150 | | | 2 |
| 2-Chloroethyl vinyl ether | ppb | <75 | | <75 | | | | <75 | | | 2 |
| Chloroform | ppb | <15 | | <15 | | | | <15 | | | 2 |
| Chloromethane | ppb | <150 | | <150 | | | | <150 | | | 2 |
| Dibromochloromethane | ppb | <15 | | <15 | | | | <15 | | | 2 |
| Dibromomethane | ppb | <15 | | <15 | | | | <15 | | | 2 |
| 1,2-Dichlorobenzene | ppb | <15 | | <15 | | | | <15 | | | 2 |
| 1,3-Dichlorobenzene | ppb | <15 | | <15 | | | | <15 | | | 2 |
| 1,4-Dichlorobenzene | ppb | <15 | | <15 | | | | <15 | | | 2 |
| cis-1,4-Dichloro-2-butene | ppb | <30 | | <30 | | | | <30 | | | 2 |
| trans-1,4-Dichloro-2-butene | ppb | <75 | | <75 | | | | <75 | | | 2 |
| Dichlorodifluoromethane | ppb | <15 | | <15 | | | | <15 | | | 2 |
| 1,1-Dichloroethane | ppb | <15 | | <15 | | | | <15 | | | 2 |
| 1,2-Dichloroethane | ppb | <15 | | <15 | | | | <15 | | | 2 |
| 1,1-Dichloroethene | ppb | <15 | | <15 | | | | <15 | | | 2 |
| trans-1,2-Dichloroethene | ppb | <15 | | <15 | | | | <15 | | | 2 |
| 1,2-Dichloropropane | ppb | <15 | | <15 | | | | <15 | | | 2 |
| cis-1,3-Dichloropropene | ppb | <15 | | <15 | | | | <15 | | | 2 |
| trans-1,3-Dichloropropene | ppb | <15 | | <15 | | | | <15 | | | 2 |
| Ethanol | ppb | <1500 | | <1500 | | | | <1500 | | | 2 |
| Ethylbenzene | ppb | <15 | | <15 | | | | <15 | | | 2 |
| Ethylene dibromide | ppb | <15 | | <15 | | | | <15 | | | 2 |
| Ethyl methacrylate | ppb | <3000 | | <3000 | | | | <3000 | | | 2 |
| 2-Hexanone | ppb | <3000 | | <3000 | | | | <3000 | | | 2 |
| Iodomethane | ppb | <15 | | <15 | | | | <15 | | | 2 |
| 4-Methyl-2-pentanone (MIBK) | ppb | <3000 | | <3000 | | | | <3000 | | | 2 |
| Methylene chloride | ppb | <15 | | <15 | | | | <15 | | | 2 |
| Styrene | ppb | <15 | | <15 | | | | <15 | | | 2 |
| Tetrachloroethylene | ppb | <15 | | <15 | | | | <15 | | | 2 |
| 1,1,2,2-Tetrachloroethane | ppb | <75 | | <75 | | | | <75 | | | 2 |
| Toluene | ppb | <15 | | <15 | | | | <15 | | | 2 |
| 1,1,1-Trichloroethane | ppb | <15 | | <15 | | | | <15 | | | 2 |
| 1,1,2-Trichloroethane | ppb | <15 | | <15 | | | | <15 | | | 2 |
| 1,2,3-Trichloropropane | ppb | <30 | | <30 | | | | <30 | | | 2 |
| Trichloroethene | ppb | <15 | | <15 | | | | <15 | | | 2 |
| Trichlorofluoromethane | ppb | <15 | | <15 | | | | <15 | | | 2 |
| Vinyl acetate | ppb | <1500 | | <1500 | | | | <1500 | | | 2 |
| Vinyl chloride | ppb | <300 | | <300 | | | | <300 | | | 2 |
| m+p xylenes | ppb | <15 | | 15 | | | 15 | <15 | | | 2 |
| o-xylene | ppb | <15 | | 15 | | | 15 | <15 | | | 2 |

Notes:
Mean and standard deviations were calculated based on detectable results

# Table II-E.1

## Summary of CT Porewater Chemistry

| | | Suncor Bench Scale Trial[1] | | | | Syncrude Field Scale Trial[2] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Suncor (CANMET 1995) | | | | Grab sample of upper substrate after active discharge had ceased (Porewater) | | | | Profiles of porewater quality one month after active discharge | | | |
| | Units | MIN | MAX | MEAN | N | MIN | MAX | MEAN | N | MIN | MAX | MEAN | N |
| **Conventional Parameters** | | | | | | | | | | | | | |
| pH | | | | | | 8.33 | 8.38 | 8 | 3 | 8.25 | 8.61 | 8 | 8 |
| Conductivity | µS/cm | | | | | 4560 | 4780 | 4640 | 3 | 3850 | 6060 | 4553 | 8 |
| **Major Ions** | | | | | | | | | | | | | |
| Bicarbonate | mg/L | | | | | 535 | 746 | 625 | 3 | 500 | 1162 | 689 | 7 |
| Calcium | mg/L | 130 | 150 | 140 | 2 | 62.4 | 73.4 | 67 | 3 | 32.1 | 109 | 61 | 8 |
| Chloride | mg/L | | | | | 509 | 535 | 519 | 3 | 485 | 719 | 584 | 8 |
| Magnesium | mg/L | 28.6 | 33.4 | 31 | 2 | 21.7 | 23.3 | 22 | 3 | 11.5 | 30.1 | 19 | 8 |
| Potassium | mg/L | | | | | 26.1 | 28.9 | 27 | 3 | 15.7 | 26.1 | 20 | 8 |
| Sodium | mg/L | 496 | 580 | 538 | 2 | 1010 | 1110 | 1057 | 3 | 914 | 1330 | 1039 | 8 |
| Sulphate | mg/L | 1192 | 1526 | 1359 | 2 | 1285 | 1312 | 1295 | 3 | 406 | 2076 | 943 | 8 |
| **Total Metals** | | | | | | | | | | | | | |
| Aluminum | mg/L | | | | | 0.389 | 0.697 | 0.5 | 3 | 0.237 | 11.8 | 3 | 8 |
| Boron | mg/L | | | | | 3.72 | 4.01 | 4 | 3 | 2.85 | 3.74 | 3 | 8 |
| Iron | mg/L | | | | | 0.052 | 0.113 | 0.074 | 3 | 0.192 | 2.46 | 1 | 8 |
| Silicon | mg/L | | | | | 2.61 | 3.06 | 3 | 3 | 5 | 24 | 10 | 8 |
| **General Organics and Toxicity** | | | | | | | | | | | | | |
| IC50 | % | | | | | 82 | 100 | 91 | 2 | 73 | 100 | 94 | 8 |
| IC20 | % | | | | | 15 | 20 | 18 | 2 | 13 | 26 | 20 | 8 |
| Naphthenic Acid | mg/L | | | | | | | 94 | 1 | | | | |

Note: Mean and standard deviation calculations are based on detectable results

[1]Suncor bench scale porewater data obtained from April 1995 CANMET Report (WRC 95-26).

[2]Data summarized from Syncrude Canada Ltd. 1995. Non-segregating Tailings: 1995 NST Field Demonstration Summary Report. Table 4.6.4, 7.2.4

# APPENDIX III

# AVAILABLE TOXICITY DATA

Table III-A
Summary of Suncor and Syncrude Acute Toxicity Data


| Scale | Source | Sample ID | Approx. Sample Date | Approx. Age of CT | Water Quality Parameters DO (mg/L) | pH | Conductivity (µS/cm) | BOD5 | Naphthenic Acids (mg/L) | Sulphate (mg/L) | Calcium (mg/L) | Microtox (15 min) IC50 (%) | IC40 (%) | IC30 (%) | IC20 (%) | Trout Survival (96-hr acute) NOEC(%) | LOEC(%) | LC50 (%) | LC25(%) | LT50(hr) | survival(%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SUNCOR | | | | | | | | | | | | | | | | | | | | |
| BENCH SCALE | EVS -Untreated (week 10) | | Aug-94 | 5 mnts + 10 wks | | | | | | | | | | | | | | | | >96 | 100 |
| | EVS- Basic (Suncor sediments+TFM) (week 10) | | Aug-94 | 5 mnts + 10 wks | | | | | | | | | | | | | | | | 96 | 50 |
| | EVS- Basic+P+aeration (week 10) | | Aug-94 | 5 mnts + 10 wks | | | | | | | | | | | | | | | | >96 | 100 |
| | EVS-Inoculated (Basic+P+aeration+bacteria) (week 10) | | Aug-94 | 5 mnts + 10 wks | | | | | | | | | | | | | | | | >96 | 100 |
| | EVS-Open (week 10) | | Aug-94 | 5 mnts + 10 wks | | | | | | | | | | | | | | | | >96 | 100 |
| | EVS-Recirculated (week 10) | | Aug-94 | 5 mnts + 10 wks | | | | | | | | | | | | | | | | >96 | 100 |
| | Gypsum- 1994 bench-scale tests | | Sep-94 | | | 8.2 | 3230 | | 66 | 1320 | 139 | | | | 53 | | | | | | 0 |
| | EVS-Baseline (week 0) | | Aug-94 | 5 months | | | | | | | | | | | | | | | | 4 | 0 |
| | EVS-Baseline (week 0) | | Aug-94 | 5 months | | | | | | | | | | | | | | | | 9 | 0 |
| | SYNCRUDE | | | | | | | | | | | | | | | | | | | | |
| | Flume Test Sample | | May-95 | | | 8.4 | 3600 | | 76 | 1040 | 36 | 58 | | | 13 | | | | | | |
| | NST Bench Test | | Jun-95 | | | 8.8 | 3550 | | | 897 | 19 | 72 | | | 12 | | | | | | |
| FIELD SCALE | High CaSO4-WRC (Nov-95) | | Jun-95 | wks to mnts | | | | | | | | 73 | | | | | | 71 | | | |
| | High CaSO4-WRC (Oct-95) | | Jun-95 | wks to mnts | | | | | | | | 74 | | | | | | | | | |
| | Lower CaSO4-WRC (Nov-95) | | Jun-95 | wks to mnts | | | | | | | | 91 | | | | | | 71 | | | |
| | Lower CaSO4-WRC (Oct-95) | | Jun-95 | wks to mnts | | | | | | | | 73 | | | | | | | | | |
| | NST swim pool (Oct-95) | | Jun-95 | wks to mnts | | | | | | | | 71 | | | | | | | | | |
| | NST swim pool (Aug-95) | | Jun-95 | wks to mnts | | | | | | | | 82 | | | | | | | | | |
| | Lease 86 (CT made June 95) | RW160-T0013 | Jun-95 | wks to mnts | 6.3 | 7.8 | 2100 | | 76 | 640 | 100 | 72 | 43 | 25 | 15 | | | <10 | | | 30 |
| | CT Pit 3 (nutrients) | RW162-T0018 | Jun-95 | wks to mnts | | | | | 85 | | | 64 | 38 | 23 | 13 | | | | | | |
| | | RW162-T0031 | Jul-95 | wks to mnts | | | | | 76 | | | 100 | 59 | 29 | 15 | | | | | | |
| | | RW162-T0033 | Aug-95 | wks to mnts | | | | | 87 | | | 89 | 50 | 28 | 16 | | | | | | |
| | | RW162-T0057 | Sep-95 | wks to mnts | 8.7 | 8.5 | 2200 | | 77 | 700 | 56 | 100 | 76 | 36 | 17 | | | 18 | | | 20 |
| | CT Pit 2 (no nutrients) | RW163-T0013 | Jun-95 | wks to mnts | 7.1 | 8 | 2100 | | 94 | 700 | 82 | 65 | 38 | 22 | 13 | | | <10 | | | 0 |
| | | RW163-T0017 | Jul-95 | wks to mnts | | | | | 87 | | | 59 | 36 | 22 | 13 | | | | | | |
| | | RW163-T0030 | Aug-95 | wks to mnts | | | | | 79 | | | 95 | 49 | 25 | 13 | | | | | | |
| | | RW163-T0032 | Aug-95 | wks to mnts | | | | | 73 | | | 100 | 57 | 30 | 15 | | | | | | |
| | | RW163-T0038 | Sep-95 | wks to mnts | | | | | 62 | | | 100 | 84 | 42 | 21 | | | | | | |
| | | RW163-T0056 | Sep-95 | wks to mnts | | | | | 63 | | | 100 | 91 | 43 | 20 | | | | | | |
| | | RW163-T0065 | Oct-95 | wks to mnts | | 8.5 | 2200 | | 69 | 710 | 59 | 81 | 49 | 30 | 18 | | | >100 | | | 60 |
| | CT Pit 1 (reservoir) | RW164-T0014 | Jun-95 | wks to mnts | 8.5 | 8 | 2100 | | 89 | 614 | 120 | 76 | 41 | 22 | 12 | | | <10 | | | 30 |
| | | RW164-T0018 | Jul-95 | wks to mnts | | | | | 83 | | | 100 | 77 | 37 | 18 | | | | | | |
| | | RW164-T0031 | Aug-95 | wks to mnts | | | | | 78 | | | 100 | 52 | 26 | 13 | | | | | | |
| | | RW164-T0033 | Aug-95 | wks to mnts | | | | | 70 | | | 100 | 57 | 27 | 13 | | | | | | |
| | | RW164-T0039 | Sep-95 | wks to mnts | | | | | 62 | | | 100 | 66 | 35 | 18 | | | | | | |
| | | RW164-T0057 | Sep-95 | wks to mnts | | | | | 63 | | | 100 | 95 | 45 | 22 | | | | | | |
| | | RW164-T0067 | Oct-95 | wks to mnts | 10.7 | 8.3 | 2200 | | 68 | 690 | 88 | 93 | 47 | 24 | 12 | | | <10 | | | 0 |
| | Inflow to constructed wetlands | | Jun-95 | wks to mnts | 8.7 | 8 | 600 | | 4 | 73.3 | 50.4 | >100 | | | >100 | | | >100 | | | 100 |
| | Outflow to constructed wetlands | | Jun-95 | wks to mnts | 6.5 | 7.4 | 620 | | 5.2 | 63.2 | 58.2 | >100 | | | >100 | | | >100 | | | 100 |
| | CT composite of above samples | RW159 | Jun-95 | wks to mnts | | | | | | | | | | | | 25 | 50 | 37 | 31 | | |
| | CT Wetland (95)- Trench 1 | | Jun-95 | wks to mnts | 10 | 8.1 | 1700 | | 66 | 564 | 72 | 100 | | | 25 | | | >100 | | | 100 |
| | CT Wetland (95)- Trench 9 | | Jun-95 | wks to mnts | 6.4 | 7.8 | 1860 | | 67 | 581 | 61.5 | 100 | | | 15 | | | >100 | | | 100 |
| | CT Wetland (95)- Trench 5 | | Jun-95 | wks to mnts | 7.5 | 7.9 | 1920 | | 71 | 608 | 69.3 | 100 | | | 18 | | | 55 | | | 50 |
| | CT Wetland (95)- Trench 8 | | Jun-95 | wks to mnts | 7 | 7.8 | 1580 | | 54 | 454 | 61.5 | 95 | | | 23 | | | >100 | | | 100 |
| | SYNCRUDE | | | | | | | | | | | | | | | | | | | | |
| | 1995 CT water (fresh) | | Aug-95 | Fresh | | | 4785 | | 75 | 1286 | 102 | 100 | | | 28 | | | 60 | | | |
| | 1995 CT water (8 months) | | Jun-96 | 8 months | | | | | | | | | | | 26 | | | 100 | | | 90 |
| | 1995 CT water (11 months) | | Aug-96 | 11 months | | | | | | | | | | | 49 | | | 100 | | | 100 |
| | 1995 CT water (21 months) | | Aug-97 | 21 months | | | | | | | | | | | 55 | | | | | | |
| | CT Oct. 95 (NSTPD1) | | Oct-95 | composite? | | | | | | | | | | | 28 | | | 60 | | | 0 |
| | CT June 96 (NSTPD1) | | Jun-96 | composite? | | | | | | | | | | | 26 | | | 100 | | | 90 |
| | CT Aug. 96 (NSTPD1) | | Jun-96 | composite? | | | | | | | | | | | 49 | | | 100 | | | 100 |
| | NST release water (from NST mix deposited in MFT cell)[1] | | Aug-Oct 95 | composite? | | 8.3 | 4603 | | 82 | 1182 | 56 | 81 | | | 13 | | | | | | |
| | Porewater deposited in NST cell (grab sample-surface)[1] | | Aug-Oct 95 | composite? | | 8 | 4370 | | 75 | 1099 | 63 | 100 | | | 21 | | | | | | |
| | Porewater deposited in NST cell (grab -porewater)[1] | | Aug-Oct 95 | composite? | | 8 | 4640 | | 94 | 1295 | 67 | 91 | | | 18 | | | | | | |
| | Porewater deposited in NST cell (porewater profile)[1] | | Aug-Oct 95 | composite? | | 8 | 4553 | | | 943 | 61 | 94 | | | 20 | | | | | | |

| Scale | Source | Sample ID | Approx. Sample Date | Approx. Age of CT | Water Quality Parameters DO (mg/L) | pH | Conductivity (µS/cm) | BOD5 | Naphthenic Acids (mg/L) | Sulphate (mg/L) | Calcium (mg/L) | Microtox (15 min) IC50 (%) | IC40 (%) | IC30 (%) | IC20 (%) | Trout Survival (96-hr acute) NOEC(%) | LOEC(%) | LC50 (%) | LC25(%) | LT50(hr) | survival(%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COMMERCIAL SCALE | SUNCOR | | | | | | | | | | | | | | | | | | | | |
| | Pond 5 | | Aug-96 | composite? | | 7.83 | 2750 | | 83 | | | 100 | | | 30 | | | | | | |
| | Pond 5 | | Aug-96 | composite? | | 7.87 | 2560 | | 87 | | | 100 | | | 18 | | | | | | |
| | Pond 5 | | Aug-96 | composite? | | 7.75 | 2330 | | 79 | | | 90 | | | 18 | | | | | | |
| | Pond 5- surface | | Aug-96 | composite? | | 7.19 | 2570 | | 64 | | | 100 | | | 36 | | | | | | |
| | Pond 5- 3 m depth | | Aug-96 | composite? | | 7.11 | 2650 | | 65 | | | 100 | | | 33 | | | | | | |
| | Pond 5- 5.8 m depth | | Aug-96 | composite? | | 7.06 | 2650 | | 66 | | | 100 | | | 35 | | | | | | |
| | Pond 5- Catwalk #3 (porewater) | | Aug-96 | composite? | | 8.93 | | | 53 | | | 100 | | | 42 | | | | | | |
| | Pond 5- #3 | | Aug-96 | composite? | | 8.39 | 2140 | | 65 | | | 100 | | | 29 | | | | | | |
| | Pond 5- Catwalk#1 (surface) | | Aug-96 | composite? | | 8.45 | 2200 | | 75 | | | 100 | | | 28 | | | | | | |
| | Pond 5- Catwalk#1 (bottom) | | Aug-96 | composite? | | 8.64 | 2180 | | 70 | | | 100 | | | 32 | | | | | | |
| | Pond 5- Catwalk#2 (2 m depth) | | Aug-96 | composite? | | 8.64 | 2180 | | 76 | | | 100 | | | 23 | | | | | | |
| | Pond 5- Catwalk#3 (2 m depth) | | Aug-96 | composite? | | 8.61 | 2210 | | 75 | | | 100 | | | 31 | | | | | | |
| | Pond 5- Drain #1 | | Aug-96 | composite? | | 8.15 | 2230 | | 66 | | | 100 | | | 42 | | | | | | |
| | Pond 5- Drain #2 | | Aug-96 | composite? | | 8.34 | 1924 | | 64 | | | 100 | | | 26 | | | | | | |
| | Pond 5- Catwalk #3 (porewater) | | Aug-96 | composite? | | 8.17 | 2150 | | 63 | | | 100 | | | 41 | | | | | | |
| | Pond 5- Catwalk #3 | | Aug-96 | composite? | | 7.76 | 2240 | | 57 | | | 100 | | | 20 | | | | | | |
| | Pond 5- Catwalk #1 (all depths) | | Aug-96 | composite? | | 8.4 | 2020 | | | | | | | | | | | 50-100 | | | 0 |
| | Pond 5- Catwalk #1 (all depths) | | Aug-96 | composite? | | | | | | | | | | | | | | | | | |
| | Pond 5- CT Grab (in Aug. 21) | | Aug-97 | composite? | 7.4 | 8.3 | 2190 | 3.4 | | | | >91 | | | 32 | | | 71 | | | |
| | Pond 5- CT water | | Oct-97 | composite (fresh) | 8.6 | 7.7 | 2410 | | | | | >91 | | | >91 | | | 62 | | | |
| | Pond 5- CT water (composite) | | Oct-97 | aged 3 wks | 8.6 | 7.7 | 2410 | | | | | | | | | | | | | | |
| | Pond 5- CT water (composite) | | Oct-97 | aged 6 wks | 6.4 | 8.2 | 2730 | 3.7 | | | | | | | | | | 71 | | | |

Data summarized from Syncrude Canada Ldt. 1995 NST Field Demonstration Summary Report. Table 4.6.4, 7.2.4

| Source | Trout | Fathead Minnow (7 day) | | | | | *Daphnia* Survival (48-hr acute) | | | | | *Ceriodaphnia* Survival test (7 day) | | | | | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Alevin survival (%) | LC25 (%) | LC50 (%) | LOEC (%) | NOEC (%) | survival(%) | NOEC(%) | LOEC(%) | LC25(%) | LC50 (%) | survival(%) | NOEC(%) | LOEC(%) | LC25 (%) | LC50 (%) | Survival(%) | |
| **SUNCOR** | | | | | | | | | | | | | | | | | |
| EVS -Untreated (week 10) | 100 | | | | | | | | | | | | | | | 60 | Suncor EVS report 1995a |
| EVS- Basic (Suncor sediments+TFM) (week 10) | 68 | | | | | | | | | | | | | | | 100 | Suncor EVS report 1995a |
| EVS- Basic+P+aeration (week 10) | 35 | | | | | | | | | | | | | | | 100 | Suncor EVS report 1995a |
| EVS-Inoculated (Basic+P+aeration+bacteria) (week 10) | 64 | | | | | | | | | | | | | | | 100 | Suncor EVS report 1995a |
| EVS-Open (week 10) | 30 | | | | | | | | | | | | | | | 100 | Suncor EVS report 1995a |
| EVS-Recirculated (week 10) | 68 | | | | | | | | | | | | | | | 100 | Suncor EVS report 1995a |
| Gypsum- 1994 bench-scale tests | | | | | | | | | | | | | | | | | Suncor EVS report 1995a |
| EVS-Baseline (week 0) | 0 | | | | | | | | | | | | | | | 13 | Suncor EVS report 1995a |
| EVS-Baseline (week 0) | | | | | | | | | | | | | | | | 13 | Suncor EVS report 1995a |
| **SYNCRUDE** | | | | | | | | | | | | | | | | | |
| Flume Test Sample | | | | | | | | | | | | | | | | | Syncrude 1995 Field test |
| NST Bench Test | | | | | | | | | | | | | | | | | Syncrude 1995 Field test |
| High CaSO4-WRC (Nov-95) | | | | | | | | | | >100 | | | | | | | CANMET WRC 95-11 |
| High CaSO4-WRC (Oct-95) | | | | | | | | | | >100 | | | | | | | CANMET WRC 95-11 |
| Lower CaSO4-WRC (Nov-95) | | | | | | | | | | >100 | | | | | | | CANMET WRC 95-11 |
| Lower CaSO4-WRC (Oct-95) | | | | | | | | | | >100 | | | | | | | CANMET WRC 95-11 |
| NST swim pool (Oct-95) | | | | | | | | | | | | | | | | | CANMET WRC 95-11 |
| NST swim pool (Aug-95) | | | | | | | | | | | | | | | | | CANMET WRC 95-11 |
| Lease 86 (CT made June 95) | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| CT Pit 3 (nutrients) | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| CT Pit 2 (no nutrients) | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| CT Pit 1 (reservoir) | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| | | | | | | | | | | | | | | | | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| Inflow to constructed wetlands | | | | | | | | | | | | | | | | 57 | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| Outflow to constructed wetlands | | | | | | | | | | | | | | | | 63 | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| CT composite of above samples | | | | | | | >100 | >100 | >100 | >100 | | 50 | 100 | 44 | 64 | | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| CT Wetland (95)- Trench 1 | | | | | | | | | | | | | | | | 16 | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| CT Wetland (95)- Trench 9 | | | | | | | | | | | | | | | | 51 | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| CT Wetland (95)- Trench 5 | | | | | | | | | | | | | | | | 0 | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| CT Wetland (95)- Trench 8 | | | | | | | | | | | | | | | | 33 | Suncor, Lease 86 (EVS-Wetlands 1996 report) |
| **SYNCRUDE** | | | | | | | | | | | | | | | | | |
| 1995 CT water (fresh) | | | 75 | | | 0 | | | | >100 | >100 | | 50 | | 50 | | Syncrude 1995 Field test |
| 1995 CT water (8 months) | | | | | | | | | | | | | | | | | Syncrude 1995 Field test |
| 1995 CT water (11 months) | | | 100 | | | 100 | | | | >100 | >100 | | 100 | | 100 | | Syncrude 1995 Field test |
| 1995 CT water (21 months) | | | | | | | | | | | | | | | | | Syncrude 1995 Field test |
| CT Oct. 95 (NSTPD1) | | | 75 | | | 0 | | | | 100 | 100 | | 50 | | 50 | | Syncrude 1995 Field test |
| CT June 96 (NSTPD1) | | | | | | | | | | | | | | | | | Syncrude 1995 Field test |
| CT Aug. 96 (NSTPD1) | | | 100 | | | 100 | | | | 100 | 100 | | 100 | | 100 | | Syncrude 1995 Field test |
| NST release water (from NST mix deposited in MFT cell)[1] | | | | | | | | | | | | | | | | | Syncrude 1995 Field test |
| Porewater deposited in NST cell (grab sample-surface)[1] | | | | | | | | | | | | | | | | | Syncrude 1995 Field test |
| Porewater deposited in NST cell (grab -porewater)[1] | | | | | | | | | | | | | | | | | Syncrude 1995 Field test |
| Porewater deposited in NST cell (porewater profile)[1] | | | | | | | | | | | | | | | | | Syncrude 1995 Field test |

| Source | Trout | Fathead Minnow (7 day) | | | | | *Daphnia* Survival (48-hr acute) | | | | | *Ceriodaphnia* Survival test (7 day) | | | | | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Alevin survival (%) | LC25 (%) | LC50 (%) | LOEC (%) | NOEC (%) | survival(%) | NOEC(%) | LOEC(%) | LC25(%) | LC50 (%) | survival(%) | NOEC(%) | LOEC(%) | LC25 (%) | LC50 (%) | Survival(%) | |
| SUNCOR | | | | | | | | | | | | | | | | | |
| Pond 5 | | | | | | | | | | | | | | | | | Suncor Pond 5 East |
| Pond 5 | | | | | | | | | | | | | | | | | Suncor Pond 5 East |
| Pond 5 | | | | | | | | | | | | | | | | | Suncor Pond 5 East |
| Pond 5- surface | | | | | | | | | | | | | | | | | Suncor Pond 5 East |
| Pond 5- 3 m depth | | | | | | | | | | | | | | | | | Suncor Pond 5 East |
| Pond 5- 5.8 m depth | | | | | | | | | | | | | | | | | Suncor Pond 5 East |
| Pond 5- Catwalk #3 (porewater) | | | | | | | | | | | | | | | | | Suncor Pond 5 East |
| Pond 5- #3 | | | | | | | | | | | | | | | | | Suncor Pond 5 East |
| Pond 5- Catwalk#1 (surface) | | | | | | | | | | | | | | | | | Suncor Pond 5 East |
| Pond 5- Catwalk#1 (bottom) | | | | | | | | | | | | | | | | | Suncor Pond 5 East |
| Pond 5- Catwalk#2 (2 m depth) | | | | | | | | | | | | | | | | | Suncor Pond 5 East |
| Pond 5- Catwalk#3 (2 m depth) | | | | | | | | | | | | | | | | | Suncor Pond 5 East |
| Pond 5- Drain #1 | | | | | | | | | | | | | | | | | Suncor Pond 5 East |
| Pond 5- Drain #2 | | | | | | | | | | | | | | | | | Suncor Pond 5 East |
| Pond 5- Catwalk #3 (porewater) | | | | | | | | | | | | | | | | | Suncor Pond 5 East |
| Pond 5- Catwalk #3 | | | | | | | | | | | | | | | | | Suncor Pond 5 East |
| Pond 5- Catwalk #1 (all depths) | | | | | | | | | | | | | | | | | Suncor Pond 5 East |
| Pond 5- Catwalk #1 (all depths) | | | | | | | | | | | | 50 | 100 | 81 | >100 | | Suncor Pond 5 East |
| Pond 5- CT Grab (in Aug. 21) | | 62 | 74 | 100 | 50 | | 100 | >100 | >100 | >100 | | 100 | >100 | 95 | >100 | | Project # 972-2205-6045 |
| Pond 5- CT water | | 33 | 41 | 13 | 25 | | 100 | >100 | >100 | >100 | | 25 | 50 | 27 | 35 | | Project # 972-2205-6045 |
| Pond 5- CT water (composite) | | | | | | | 100 | >100 | >100 | >100 | | 50 | 100 | 60 | 74 | | |
| Pond 5- CT water (composite) | | 61 | 74 | 100 | 50 | | | | | | | 50 | 100 | 41 | 58 | | |

ata summarized from Syncrude Canada Ldt. 1995 NST Field Dem

## Table III-B
## Summary of Suncor and Syncrude Chronic Toxicity Data

| Type | Source | Sample ID | Approx. Sample Date | *Ceriodaphnia* Reproduction Test (7 day) | | | | *Selanastrum* Growth Inhibition (72-hr) | | | | Fathead Minnow Growth Inhibition (7 days) | | | | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | IC25 (%) | IC50 (%) | NOEC(%) | LOEC(%) | IC25(%) | IC50(%) | NOEC(%) | LOEC(%) | IC25(%) | IC50(%) | NOEC(%) | LOEC(%) | |
| FIELD SCALE | **SUNCOR** | | | | | | | | | | | | | | | |
| | CT water (composite from pits) | RW159 | Jun-95 | 14 | 20 | 13 | 25 | 45 | 78 | 25 | 50 | | | | | Suncor, Lease 86 data |
| | **SYNCRUDE** | | | | | | | | | | | | | | | |
| | 1995 CT water (fresh) | | | | 32 | 13 | | 72 | 93 | 50 | 100 | | | | | Syncrude 1995 field tests |
| | 1995 CT water (8 months) | | | | | | | | | | | | | | | Syncrude 1995 field tests |
| | 1995 CT water (11 months) | | | | 83 | 60 | | 10 | 56 | 6 | 13 | | | | | Syncrude 1995 field tests |
| | 1995 CT water (21 months) | | | | | | | | | | | | | | | Syncrude 1995 field tests |
| | CT Oct. 95 (NSTPD1) | | | | 32 | 13 | | | 93 | | 50 | | | | | Syncrude 1995 field tests |
| | CT June 96 (NSTPD1) | | | | | | | | | | | | | | | Syncrude 1995 field tests |
| | CT Aug. 96 (NSTPD1) | | | | 83 | 50 | | | 56 | | 13 | | | | | Syncrude 1995 field tests |
| COMMERCIAL SCALE | **SUNCOR** | | | | | | | | | | | | | | | |
| | Pond 5- Catwalk#1 (all depths) | | Aug-96 | 30 | 42 | 25 | 50 | | | | | | | | | Suncor Pond 5 East |
| | Pond 5- CT Grab (Aug. 21) | | Aug-97 | 16 | 22 | 13 | 25 | 74 | 50 | 25 | 50 | >50 | >50 | 50 | >50 | Suncor Pond 5 East |
| | Pond 5- CT water | | Oct-97 | 63 | 75 | 50 | 100 | 25 | 41 | 25 | 50 | 26 | 36 | 25 | 50 | Project # 972-2205-6045 |
| | Pond 5- CT composite (aged 3 wks) | | Oct-97 | 32 | 39 | 25 | 50 | | | | | | | | | Project # 972-2205-6045 |
| | Pond 5 -CT composite (aged 6 wks) | | Oct-97 | 24 | 33 | 25 | 50 | 27 | 40 | 25 | 50 | 32 | 48 | 13 | 25 | Project # 972-2205-6045 |

## APPENDIX IV

## CT WORKSHOP MEETING MINUTES

**Golder Associates Ltd.**

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Golder Associates

September 16, 1997

972-2205/6045

Suncor Energy Inc.
Sustainable Growth
P.O. Box 4001
Fort McMurray, Alberta
T9H 3E3

Attention: Mr. Martin Holysh

**RE: CT WORKSHOP MEETING NOTES - SEPTEMBER 8, 1997**

Dear Mr Holysh:

This letter contains notes taken during the CT workshop held on September 8, 1997 at Golder Associates' office in Calgary. These notes synthesize the major topics of discussion and may not define the comments and ideas of individual participants.

Attendees: Martin Holysh, Don Klym, Don Sheeran - Suncor
Mike Rogers, Mike MacKinnon, Terry Van Meer, John Ellingsen, Martin Fung - Syncrude
Randy Mikula - CANMET
Randy Shaw, John Gulley, J.P. Bechtold, with appearances from Zsolt Kovats, Ian Mackenzie, Farida Bishay, Mike Rankin - Golder Associates

1. John Gulley opened the meeting with a review of the workshop purposes, which included:
    - a review of existing information,
    - update the knowledge base described in the "Silver Bullet",
    - identify on-going studies and expected completion dates, and
    - highlight data gaps in the existing information base.

2. Suncor requested copies of Randy Shaw's projected impact slides detailing relative chemical concentrations in the Athabasca and Muskeg Rivers in 2040.

**Review of CT Chemistry**

3. Review of CT chemistry data held by Golder revealed that Golder does not have all of the available information on hand. Suncor, Syncrude and CANMET agreed to furnish Golder with the following reports and/or data:

| Individual | Report/study results |
|---|---|
| Martin Fung | 2 studies by Li (1996) concerning plant growth on CT |
| Mike MacKinnon | studies by Bill Shaw at UofA (1993-1995) detailing lab experiments using acid/lime and gypsum CT |

| | |
|---|---|
| | UofA studies (1991?) detailing acid/lime CT chemistry and toxicity |
| | multi-volume NST report detailing results from Syncrude's 1995 field testing |
| | monthly/quarterly progress reports from Syncrude's commercial demo project, as they become available |
| | studies by Brian Brownell at CCIW examining the potential soluble components of PAHs associated with fine tails |
| Randy Mikula | reports produced by Suncor - believe these describe both lab and field studies |
| Don Sheeran | monthly/quarterly commercial trail reports (1995 to present) |

4. There was general agreement that CT water data has to categorized as follows:

   Bench Scale

   Field Scale

   - On Line (controlled), which includes
     - Syncrude's 1995 NST field test
     - Suncor's pump tests
   - Commercial Trails, which includes
     - Suncor's Commercial Demonstration Project, Oct '95 and ongoing
     - Syncrude's Commercial Demonstration Project, Aug '97 and ongoing.

   Operational

   Reclamation

5. There was general agreement that the influence of CT aging, operational water recycling, decay rates, sand to fines rations and reclamation landscape designs need to be considered. Towards this end, Golder will prepare a matrix detailing the directional influence of these factors on CT water chemistry (i.e., whether decay, aging, etc. is expected to increase, decrease or have no effect on chemical concentrations in CT release waters).

6. Mike MacKinnon stressed the fact that only conservative ions such as chloride, sodium and sulphate will build up in the recycle waters; metals, PAHs and other organics reach an equilibrium relatively quickly, and will not accumulate beyond equilibrium concentrations. However, Syncrude has not observed an increase in sulphate levels in their Mildred Lake Settling Basin. Where the missing sulphate is remains unclear.

7. Mike MacKinnon informed the attendees that the deeper layers of CT solid deposits (i.e., > 30 cm below the upper crust) turn anaerobic within several months. Redox potentials in the upper 30 cm will remain positive, while lower levels are negative. Sulphides form, but remain in the deposit. Should the buffering capacity of the deposit be exhausted, then solubilization of the sulphide could occur.

8. Mike MacKinnon also indicated that sources of bioavailable carbon in CT deposits could include naphthenic acids and other hydrocarbons tied up within the solid matrix, hence the conversion of sulphates to sulphides described above.

9. Although some individuals feel that lab studies are the best example of what to expect from the CT process, Suncor and Syncrude agreed that once Golder has synthesized all of the available lab and operational CT data, Mike MacKinnon and Don Sheeran will sit down with Golder representatives and decide what numbers will be used as representative CT data.

**Review of CT Toxicity**

10. Generally agreed that when reporting toxicity results, one must indicate whether we are discussing fresh, aged, diluted and/or treated CT. These results should also be subdivided into the categories previously discussed in (4)

11. As with CT chemistry, Golder is missing several reports detailing CT toxicity which the following individuals have agreed to supply to us:

| Individual | Report/study findings |
|---|---|
| Terry Van Meer | report by Kevin Shirwin (UofW) describing zooplankton and phytoplankton abundance/growth under chronic conditions |
| | will e-mail Lisa Peters (UofW grad. student) and direct her to release progress report detailing her work with fish hatchability and growth in CT environment |
| | will e-mail Paula Sivic (UofA grad. student) and direct her to release progress report detailing her work with fathead minnows in South Bison Pond |
| | reports/study findings detailing macrophyte growth and microbial profiles in CT ponds |
| Mike MacKinnon | report detailing Joanne Parrott's fish MFO study |
| | study results describing CT soil characterization |
| Martin Fung | report detailing work done at Vegreville examining earthworm survival and seedling emergence tests |

**Terrestrial Issues**

12. General agreement that ecosystems can be established on CT reclamation surfaces. However, we still lack a field demo to confirm this hypothesis. Issues of possible concern include:

i) whether the CT capping layer will remain saturated or will local hydrology result in dry tailings sand overlain with a thin layer of topsoil. Dry sand would prohibit plant growth.

ii) root growth may be limited if the underlying CT matrix becomes anoxic, which, according to (3) is likely to occur.

**Air Issues**

13. General agreement that methane production will not occur so long as sulphate levels remain high. Sulphates will likely change to sulphides, but they will not volatilize unless buffering capacity of CT deposits exhausted (which is unlikely to occur).

14. Gord Kemp from Suncor is monitoring emissions from existing tailings ponds. His findings are to be forwarded to Golder by Don Sheeran.

15. Volatile organic carbons (VOCs) are presently being monitored at both Suncor and Syncrude. Work at Suncor completed by Concord, while Jacques Whitford surveyed Syncrude site. Results are to be forwarded to Golder by Don Sheeran and Mike MacKinnon.

16. Dust not likely to be an issue, since CT solidifies to cement-like solid which will experience very little wind erosion.

**Aquatics Issues**

17. Golder highlighted potential problems in far future scenarios when CT and sand seepage will make up the bulk of water flowing though the Muskeg River and other small tributaries in the oil sands leases. This could have significant toxicity issues which may require mitigation.

18. Although fish studies have been done using refinery and other process affected waters, no study has yet been done to investigate the potential for CT water to result in fish tainting. General agreement that one should be done.

**Health Issues**

19. Syncrude has completed a study of naphthenate toxicity. It was designed by Deib Berkholz, from ETL, and used bacterial enzymes to screen for mutagenic and other cellular effects. Although membrane transfer and general cellular processes where affected, no mutagens were identified. Similarly, very low PAH levels were observed to accumulate in SPMDs (semi-permeable membrane devices) exposed to CT.

20. Mike MacKinnon is to furnish Golder with Dr. Richard San's 1980 report on pond water toxicity. It was produced by the B.C. Cancer Society.

21. General agreement that Golder should initiate a simple mutagenic test on whole effluent CT to determine whether or not mutagens are present.

**Proposed CT Document**

22. General agreement that proposed document should have a general focus, and act as a reference paper for CT chemistry and toxicity. As a result:
    - Chapter 3 will incorporate matrix discussed in (5),
    - Chapter 4 will be reduced to several paragraphs included in Chapter 1, and
    - Chapters 5 and 6 will be eliminated.

**General Issues**

23. Mike Rogers stressed the need to clearly indicate the influence of the CT process on final water and solids chemistry. The CT process should not become the "scape-goat" for reclamation and disposal problems which would have occurred in any case. We are simply adding calcium sulphate to a mixture of tailings sand and mature fine tails, two substances which have been well defined and already exist at the plant.

24. South Bison Pond and High Sulphate Wetland identified as possible surrogates for CT water and solids, respectively, due to their high sulphate content.

We hope these meeting notes are sufficient for your purposes and would be pleased to discuss any comments you may have.

Yours very truly,

**GOLDER ASSOCIATES LTD.**

J.P. Bechtold, M.A.Sc.
Water Quality Specialist

John Gulley, M.Sc., P. Biol.
Oil Sands Project Director

cc: Don Klym (Suncor)
Don Sheeran (Suncor)
Mike MacKinnon (Syncrude)
Randy Mikula (CANMET)
Randy Shaw (Golder)
Mike Rankin (Golder)
Zsolt Kovats (Golder)
Terry Van Meer (Syncrude)
John Ellingsen (Syncrude)
Martin Fung (Syncrude)
Mike Rogers (Syncrude)
Ian Mackenzie (Golder)
Farida Bishay (Golder)

# APPENDIX V

# GLOSSARY OF TOXICOLOGICAL TERMS

| | |
|---|---|
| Acute Toxicity | Mortality that is produced within a short exposure period (e.g., within 24 to 96 h). |
| Chronic Toxicity | Toxicity marked by a long duration, that produces an adverse effect on organisms. The end result of chronic toxicity can be death although the ususal effects are sublethal (e.g., inhibiting reproduction or growth). |
| IC50 | The median inhibitory concentration; that is the concentration of a substance (toxicant, stimulant etc.) that causes a specified effect (i.e., inhibition of bioluminescence) to a level equal to 50% less than the control tested in a laboratory toxicity test of specified duration. The effect as well as the exposure-time must be specified (e.g., 15 min IC50). An IC20 would mean that there was inhibition of bioluminescence to a level 20% less than the control. The IC20 will always be lower (or the same if ≥ 100%) than the IC50. |
| LC50 | The median lethal concentration; that is, the concentration of material in water to which test organisms are exposed that is estimated to be lethal to 50% of the test organisms. The LC50 is usually expressed as a time-dependent value (e.g., 24-h or 96-h LC50). |
| LT50 | The median lethal exposure period; that is, the time (exposure period) it takes for the undiluted sample (i.e., 100% concentration) to be lethal to 50% of the toxicity test organisms. |
| Microtox | An automated (Beckman Instruments Inc.) rapid screening assay which determines the EC50 concentration of a material in water based on the reduciton of the amount of incident light emitted by a culture of fluorescent bacteria. |
| NOEC | No Observed Effect Concentration. That is, the concentration at which no effect on the toxicity test organism is observed. |
| LOEC | Lowest Observed Effect Concentration. That is, the concentration at which effects on the toxicity test organism are first observed. |