

**APPROACHES TO
OIL SANDS WATER RELEASE**

Prepared by the
Oil Sands Water Release
Technical Working Group

March 1996

FOREWORD

This report provides government and industry staff with up-to date information, methodologies, and approaches to direct the preparation and review of documents and applications required under the Environmental Protection and Enhancement Act. It also will assist in the development of guidelines and operating procedures. This report is available to the public so that interested individuals similarly have access to the most current information on environmental protection.

This report may be cited as:

Oil Sands Water Release Technical Working Group, 1996. Approaches to Oil Sands Water Releases. 34 pp.

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1.0 INTRODUCTION

1.1 Purpose of the Oil Sands Water Release Technical Working Group (OSWRTWG)

Government and industry agreed on the need to form a joint Oil Sands Water Release Technical Working Group to look at the issue of potential water releases from Oil Sands operations. The need arose from the following:

- The Oil Sands operators are anticipating that several liquid effluent streams and water from reclaimed landscape units may require release to the environment.
- Government agencies are anticipating applications for water release.
- These water releases are complex and in some instances, unique to the Oil Sands industry. Currently the effects of these potential releases are not fully understood.
- There is a range of approaches and tools to assess and evaluate the potential impact of water releases to the environment, including those releases currently regulated.
- The various approaches and tools will require specific technical and environmental effects information to support the operators' Environmental Impact Assessments (EIAs) and Environmental Protection & Enhancement Act (EPEA) applications. Much of the information and understanding needed is common to the various approaches and tools.

The "mission" of the group was to outline the scope of work needed to evaluate the acceptability of releasing process-affected waters to the environment. To do this, the Oil Sands operators and government agencies had to share information and further define the procedures to be used.

1.2 Terms of Reference

The initial objectives (Deliverables) of the OSWRTWG included, but were not to be limited to:

- A review of existing information on the character, quantity and timing of water releases;
- A review of technological strategies for the treatment of potential water releases;
- Identification of approaches and tools to assess and evaluate water releases;
- Identification of technical information required to develop and apply evaluation approaches, including data on water quality and quantity, and benchmark environmental health data;
- Identification and prioritization of gaps in existing information; and
- Recommendations for a workplan to allow completion of an evaluation of the potential for release to the environment of waters affected by Oil Sands operations.

1.3 Composition

Figures 1a and 1b respectively show the general composition and activities of the OSWRTWG. Table 1 lists the members of the group. Industry provided the chairperson. Technical representatives and alternates came from:

<u>Industry</u>	<u>Provincial Government</u>	<u>Federal Government</u>
Syncrude	Alberta Environmental Protection	Environment Canada
Suncor	Alberta Energy	Fisheries and Oceans

1.4 Schedule and Meetings

The Technical Working Group held four workshops as follows:

Workshop 1:	Water Releases and Treatment Technologies	June 28, 1995
Workshop 2:	Status of Receiving Waters	June 29, 1995
Workshop 3:	Review of Workshops 1 and 2	August 21, 1995
Workshop 4:	Assessment Techniques	August 22, 1995

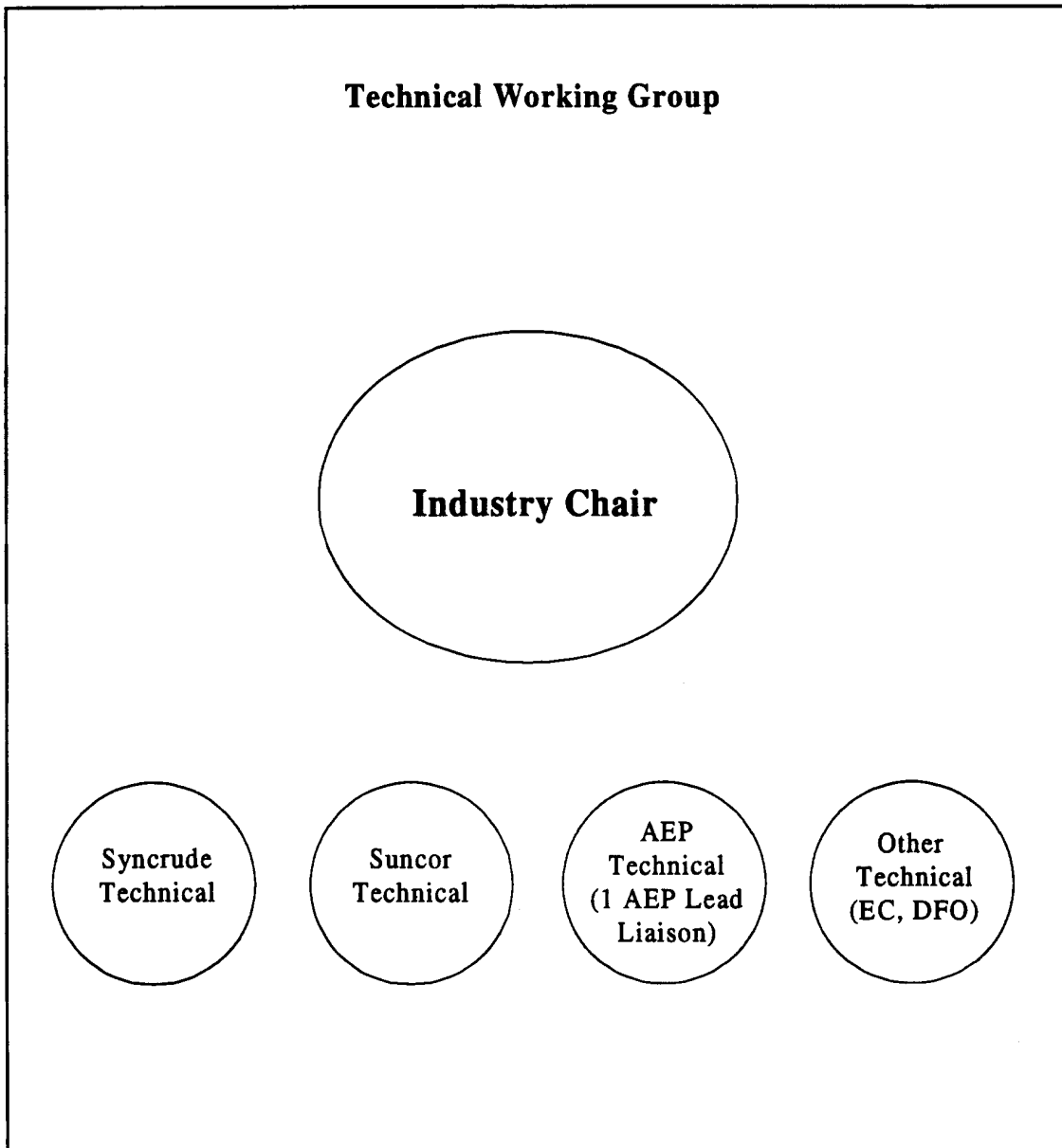
Available members of the group also met on September 25, 1995, to review the initial results of toxicity testing on Suncor Dyke Drainage Water and to finalize the next round of testing. The group also discussed proposals for tainting studies and for evaluating natural versus industry induced effects on fish biomarkers.

2.0 CLASSIFICATION AND CHARACTERIZATION OF WATERS

2.1 Classification

The OSWRTWG used the term "water release" to describe waters that potentially could be directly or indirectly released into the environment from Oil Sands facilities. This term included two main categories: operational and reclamation water releases. The following two tables categorize various source waters from Oil Sands operations and summarize the general nature of the two types of water releases. Figure 2 and 3 provide conceptual diagrams of Suncor's Oil Sands facility in terms of potential releases from future operations and from reclaimed landscapes.

Figure 1a. Technical Working Group General Composition



AEP = Alberta Environmental Protection
EC = Environment Canada
DFO = Department of Fisheries and Oceans

Figure 1b. Technical Working Group Activities

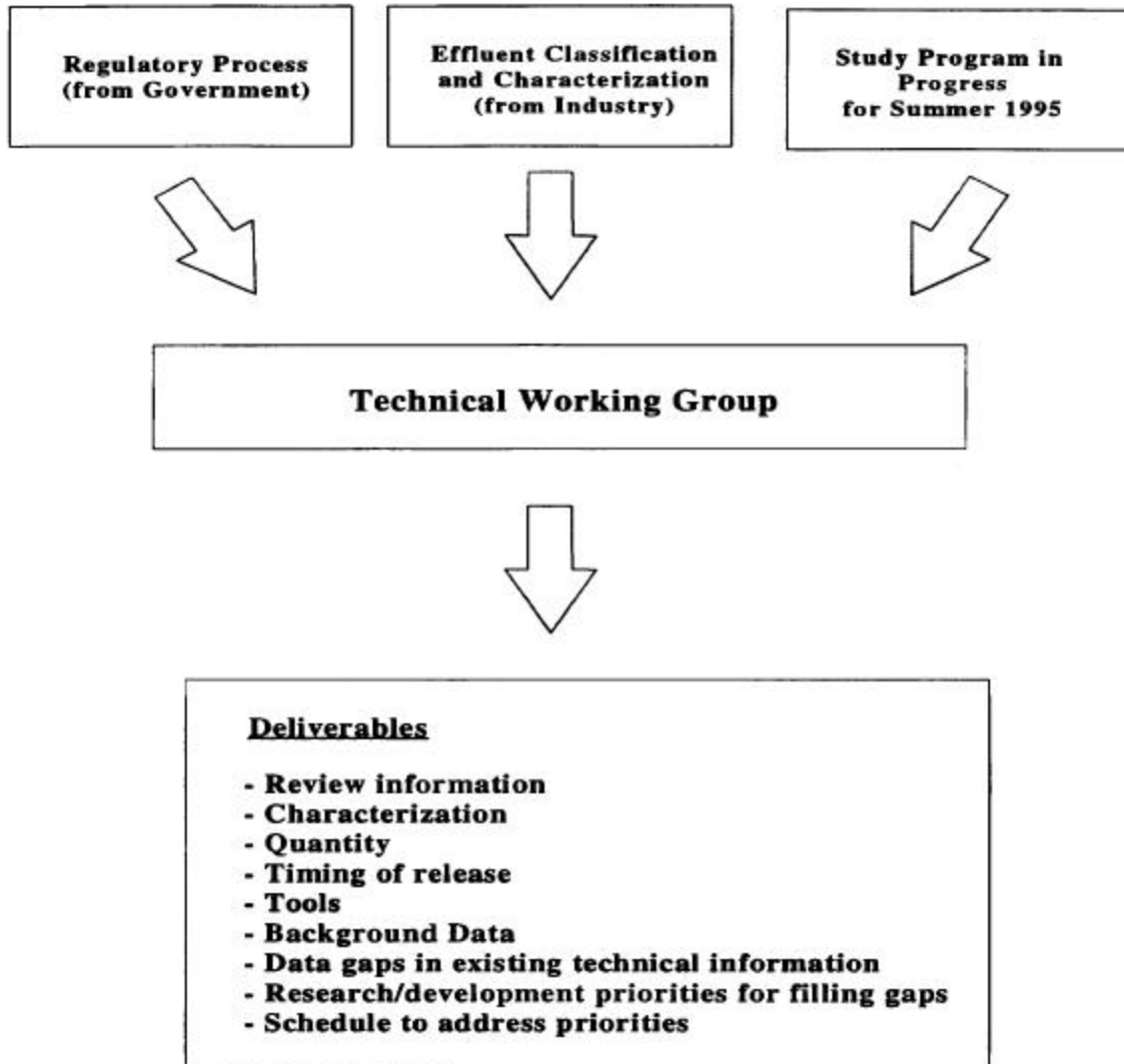


Table 1. Oil Sands Water Release Technical Working Group

Name	Affiliation	Alternates & Technical Support
Hal Hamilton (Chair)	Golder Associates	Randy Shaw
Richard Nelson	Alberta Energy	
Neil Chymko (Government Liaison)	Alberta Environmental Protection Land Reclamation Division	Chris Powter
Bob Martel	Alberta Environmental Protection Air & Water Approvals Division	Jay Nagendran
Ian MacKenzie	Alberta Environmental Protection Environmental Assessment Division Source Standards Branch	Leigh Noton W. Kindzierski
Paul Shewchuk	Alberta Environmental Protection Environmental Assessment Division Environmental Criteria Branch	Bryan Kemper Earle Baddaloo
Wayne Nelson	Alberta Environmental Protection Fisheries Management Division	
Brian Brownlee	Environment Canada Aquatic Ecosystem Protection Branch	
Lyle Lockhart	Department of Fisheries and Oceans Arctic Habitat Science Division	
John Gulley	Suncor	Don Sheeran Don Klym
Mike MacKinnon	Syncrude	Hans Boerger Terry Van Meer

Oil Sands source waters can be categorized as follows:

OPERATIONAL WATER RELEASES	RECLAMATION WATER RELEASES
Consolidated tails or composite tailings release water = CT release water Tails	Fine tails release water (i.e., into capping layer in wet landscape scenario)
Collected seepage waters from dykes and structures	Runoff and drainage from reclamation units: <ul style="list-style-type: none"> - Sand dumps and dykes - CT deposits - Fine tails deposits - Coke piles, plus other waste areas (e.g., landfills, sulphur pile, etc.) - Wetland treatment systems - Overburden dumps
Mine drainage (runoff, dewatering)	
Upgrading wastewaters (cokers, upgrader)	
Cooling waters	
Sewage treatment system wastewaters	
Others - undefined new process waters	
	Reclaimed lease groundwaters

Characteristics of each water type include:

OPERATIONAL WATER RELEASES	RECLAMATION WATER RELEASES
Point source "streams" or facility discharges	Non-point source diffuse waters, which may be directed through wetlands and lakes
Discharged over life-of-project or shorter timeframe	Released at slow rates over large areas for extended timeframes
Controllable	Non-controllable
Treatable in managed treatment systems	Altered through natural systems or constructed wetlands
Can be compared to ambient water quality guidelines	Water quality guidelines may not directly apply to all parameters
Potential to cause regional off-site impacts	Primarily an on-site water management issue; part of maintenance-free reclamation landscapes

Figure 2. Water Releases from Future Suncor Operations
(Type A = operational water releases; Type B = reclamation water releases)

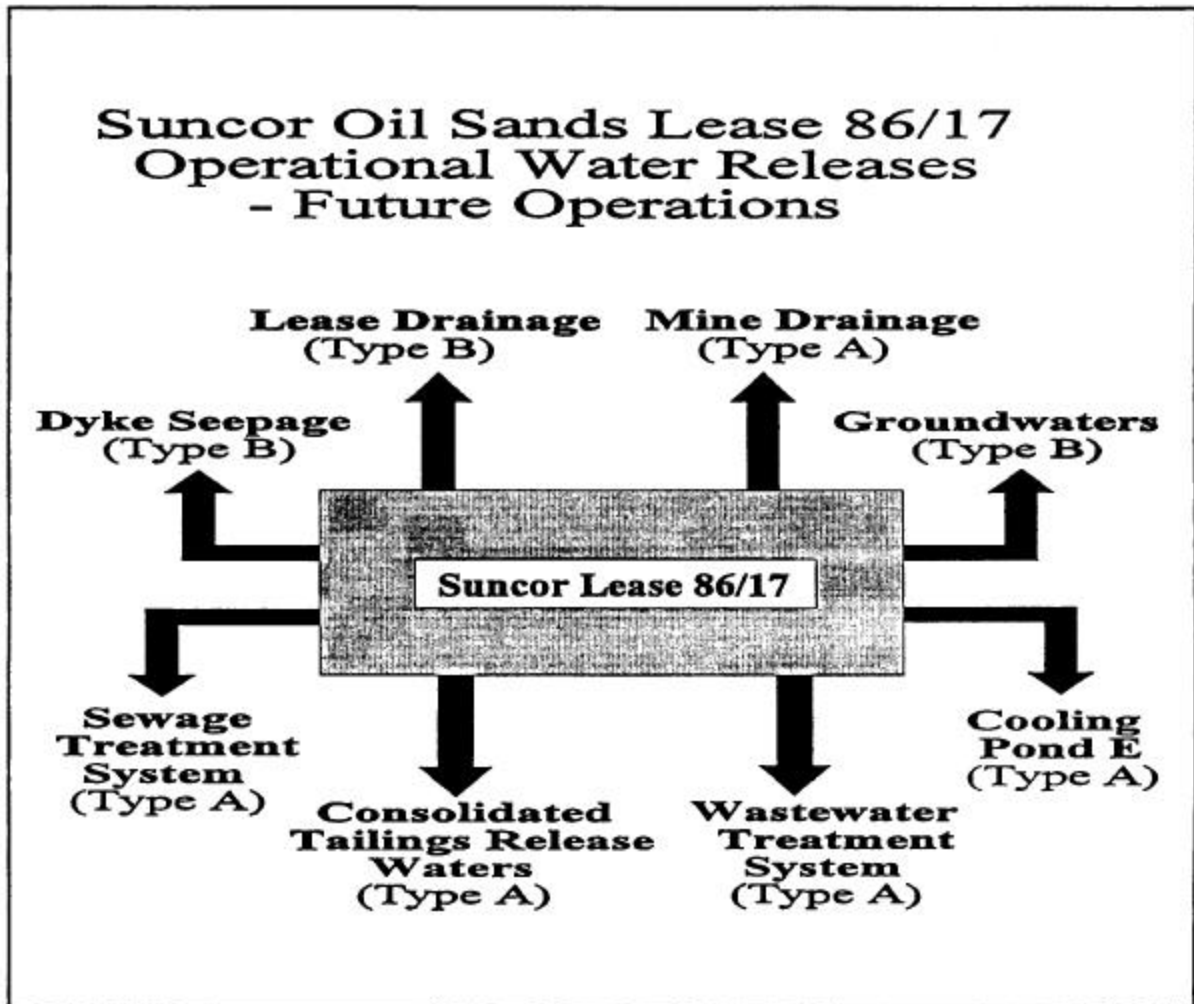
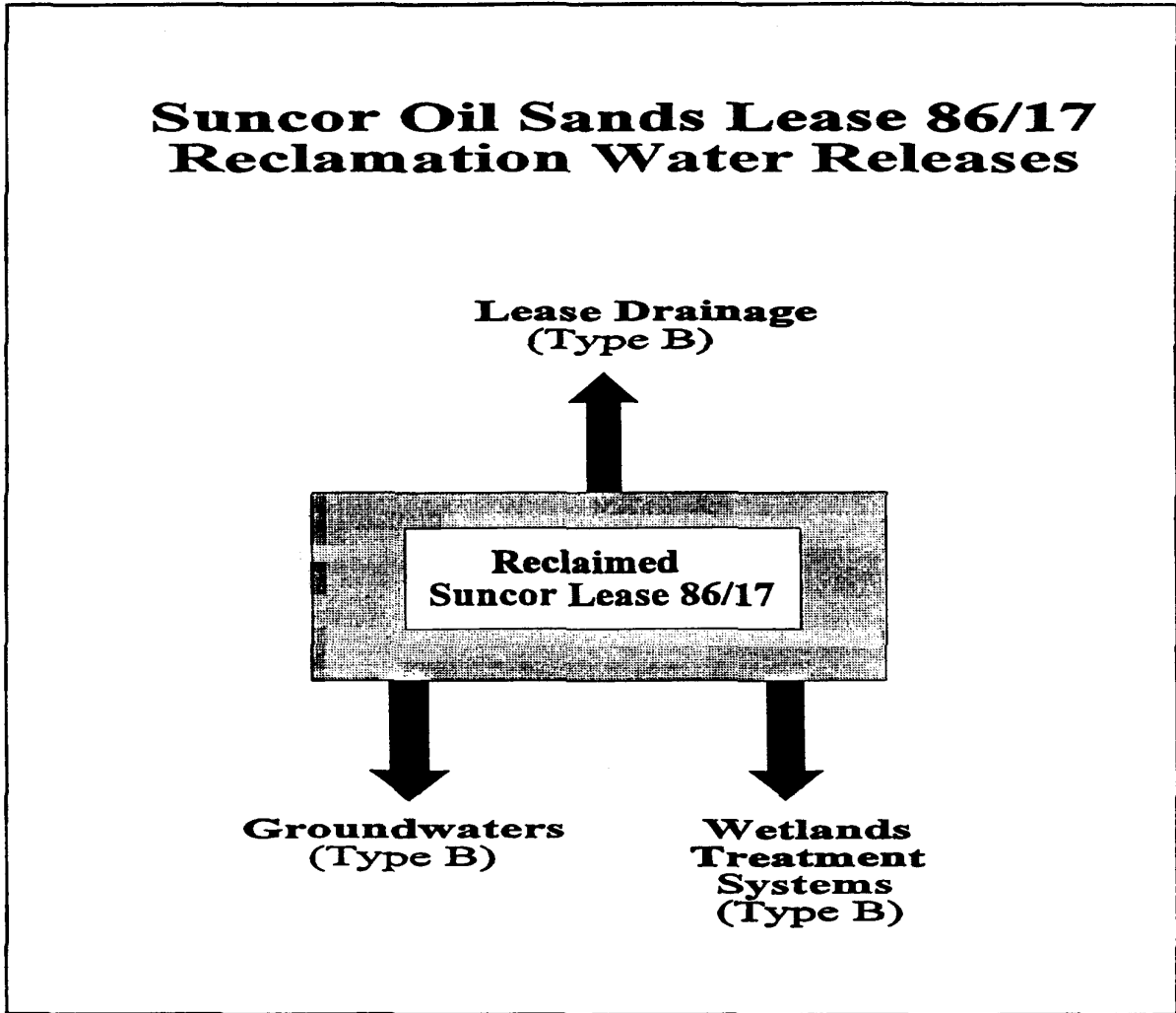


Figure 3. Potential Releases from Reclaimed Suncor Lease
(Type B = reclamation water releases)



2.2 Characterization

Data on the timing and volume of potential releases, as well as physical, chemical and toxicological characteristics of each water, is being compiled. Suncor has completed a review of their current operational, future operational, and reclamation water releases. In addition, a database is being developed with water information collected at the Syncrude and Suncor operations. This database is intended to form the information base for evaluations documented in the EIA, EPEA applications, and will generally support the regulatory decision process carried out by Provincial and Federal agencies.

Water management options (e.g., CT chemical treatment processes and water recycle procedures) affect the quality of both operational and reclamation release waters. Over time there will be a proportional shift from mostly operational to primarily reclamation water releases, although some reclamation water releases do exist currently.

From a toxicological perspective, the key water release issues are chronic toxicity, as measured by standard chronic tests (e.g., *Ceriodaphnia*, *Selenastrum*), and on-site and off-site aquatic ecosystem "integrity" as measured by community and ecosystem parameters (e.g., structure, function, processes).

The EIAs being prepared by the Oil Sands operators will characterize water releases at a sufficient level of detail to identify and evaluate environmental impacts. They will also address varying potential loads of point and non-point discharges over the life-of-project time frame (i.e., 15 to 20 years) and beyond (e.g., 50 to 100 years). Detailed water balances, discharge points, release rates and physical-chemical-toxicological characteristics will be defined in the EPEA applications.

A primary issue that arises in evaluating water releases is characterization of receiving water conditions; in particular, conditions in the Athabasca River. Considerable work on characterization has been done by government agencies and industry. Examples include the Athabasca River Studies conducted by Alberta Environmental Protection, the Alberta Oil Sands Environmental Research Program (AOSERP), and the Northern River Basins Study (NRBS). The companies have also implemented detailed programs in support of the upcoming EIAs and EPEA applications. Workplans for these studies were reviewed by the OSWRTWG.

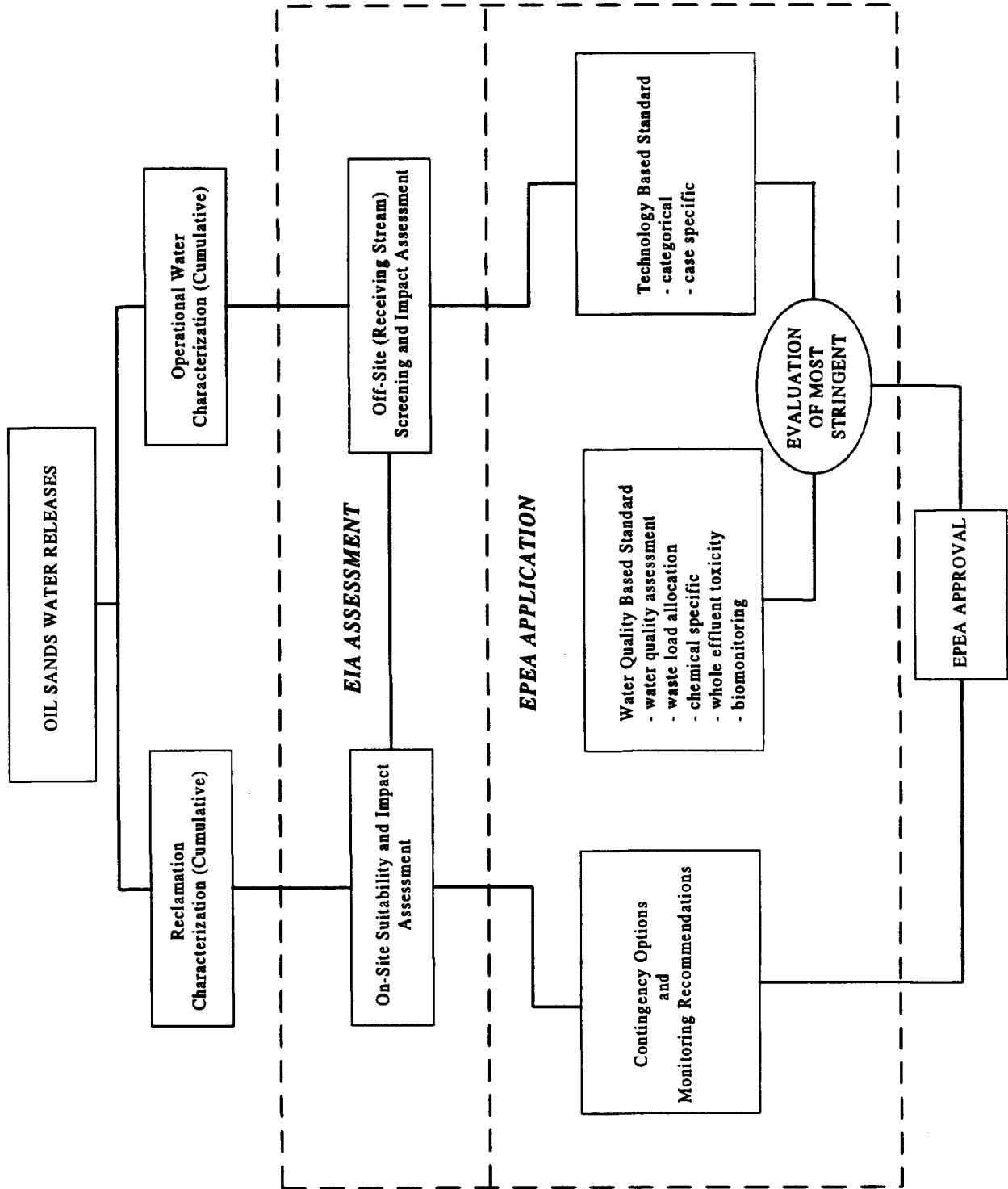
3.0 APPROACHES AND TOOLS TO ASSESS AND EVALUATE WATER RELEASES

3.1 General Framework

Figure 4 presents a general assessment framework for evaluating both reclamation and operational water releases from the Oil Sands facilities to the Athabasca River. The general framework recognizes the following:

- Management of reclamation and operational water releases requires strategies appropriate to each water type. The primary management focus for reclamation waters is ensuring on-site ecological sustainability and minimization of impacts to on-site users. This will by inference ensure off-site protection. The primary management focus for operational water discharge is off-site protection of the receiving environment.
- Under the Environmental Protection and Enhancement Act, Oil Sands operators must deal with the management of both reclamation and operational water releases.
- When an Environmental Impact Assessment is required, it will evaluate and assess the environmental implications of the project. EIAs should consider the impacts of both reclamation and operational water releases, including their cumulative effects. They should also evaluate the sustainability of reclamation waters on-site prior to release. In general, the on-site water systems should be biologically productive, non-hazardous and sustainable.
- If there is a major change in operating philosophy that may affect the environment, such as the release of operational waters, the EIA must address potential impacts in detail. The Terms of Reference for the EIAs currently being prepared by Suncor and Syncrude specify a considerable level of detail in both data collection and assessment.
- An EPEA application for operational water releases must use the general procedures developed by Alberta Environmental Protection for all Alberta industries. These procedures consider water release standards from both a technology and ambient water quality basis. Alberta Environmental Protection will generally adopt the more conservative of the two when issuing an EPEA approval.

Figure 4. Oil Sands Water Release Assessment Framework



- For reclamation waters, the EPEA application must present a plan which shows how the reclaimed system will be created. The plan must ensure that on-site systems will be non-hazardous and viable and should include monitoring and assessment programs. It should also address contingency plans in the event that concerns are identified.
- If an EPEA application is submitted at the same time as the EIA, then both documents will be addressed through a coordinated and integrated review process.

Table 2 summarizes the information requirements and assessment tools which can be used for characterization and assessment purposes. In addition, Alberta Environmental Protection has published several documents that provide policy and procedural guidance on operational water releases. These include:

1. Industrial Limits and Policy Overview (AEP, 1995a)
2. A summary of Alberta Industrial Standards and Monitoring Requirements (AEP, 1995b)
3. Water Quality Based Effluent Limits Procedures Manual (AEP, 1995c)

3.2 Technology Based Standards

Categorical technology based standards are developed on an industry specific basis. The standards, which are based on observed performance of proven pollution control equipment, are applied uniformly across an industry category consistent with the age and type of facility. Economic factors are also considered when the categorical technology standards are developed. Currently, there are no category specific technology standards for Oil Sands facilities.

For Oil Sands operational water releases, case specific technology based standards must be developed using existing data on the performance of similar type process and treatment facilities in complementary industries. Economic factors are to be considered when developing case specific technology based standards. In the absence of adequate existing data, new treatment technologies may have to be derived.

The development of case specific technology standards for the Oil Sands industry will be required for the EPEA applications. These standards must address operational water releases from consolidated or non-segregated tailings deposits. Methods for deriving technology based standards are generally available from Alberta Environmental Protection.

Table 2. Oil Sands Water Release Assessment - Information Requirements and Assessment Tools**Water Characterization**

- Chemical Quality
- Toxicity Profile
- Discharge Volumes and Locations

Treatment Technology Review

- Technology Screening
- Categorical/Case-Specific Standard Deviation

Field Investigations

- On-Site
 - Field Trials and Demonstration
- Off-Site
 - Background Hydrology and Water Quality
 - Aquatic Habitat
 - Water Use Survey
 - Ecosystem Integrity Assessment

Assessment Tools

- On-Site
 - Hydrologic and Water Quality Models
 - Health & Eco-Risk Assessment
- Off-Site
 - Hydrologic and Water Quality Model (Near & Far Field)
 - Whole Effluent Toxicity Assessment
 - Health & Eco-Risk Assessment

3.3 Water Quality Effluent Based Standards

Alberta Environmental Protection has published a policy on the derivation of water quality based effluent standards (AEP, 1995a). The policy states: "When developing a discharge limit, AEP will consider limits developed from a site specific assessment of water quality impacts. These limits are developed using the procedure outlined in the *Water Quality Based Effluent Limits Procedure Manual* (AEP, 1995)."

Water quality based effluent standards are derived by calculating how much of a given substance can be discharged under certain restrictive or worst-case conditions while still maintaining instream objectives. These worst case conditions are selected to occur infrequently enough that if water quality objectives are exceeded, the discharge will not result in undue stress on the receiving environment."

The procedures manual gives guidance on design conditions to be considered for the receiving environment, including mixing zones, and the ambient water quality objectives against which the waste load allocation is to be assessed. The *Alberta Ambient Surface Water Interim Guidelines (1993)* are to be used as the first source of ambient guidelines. However, the procedures recognize that these Alberta objectives are currently under review and do not address all water quality parameters of interest. Therefore, other guidelines such as the *Canadian Water Quality Guidelines* or *USEPA Water Quality Criteria* can be employed.

In conducting the water quality based assessment, background water quality in the receiving environment must be considered. Background water quality is relevant to the Oil Sands area because the Athabasca River upstream of Suncor and Syncrude may exceed current ambient water quality guidelines for some parameters. Impact on sensitive aquatic habitats and downstream water users must also be considered in the assessment.

The evaluation can either be chemical specific, or a whole effluent toxicity approach can be employed. The OSWRTWG recommends both methods be employed for Oil Sands release waters. The whole effluent toxicity technique allows evaluation and management of discharge waters where residual toxicity in the discharge cannot be clearly correlated with the presence of specific chemicals. This is the case for Oil Sands release waters which may exhibit acute and chronic toxicity, the cause of which has not been completely defined. An additional component of the water quality based standard approach is biomonitoring. Biomonitoring serves to confirm that the chemical specific or whole effluent toxicity approach is achieving the desired degree of environmental protection. Biomonitoring can include conducting bioassays on the water releases or biological monitoring of the receiving environment downstream from the release.

The procedures defined by the Alberta Environmental Protection policy focus on the EPEA approval phase of the process. Many of the same assessment tools should be employed at the EIA stage to demonstrate that impacts associated with water releases will not be detrimental to downstream water users or aquatic ecosystem integrity.

3.4 On-Site Sustainability of Reclamation Waters

Reclamation waters are by nature diverse in source and variable in flow and quality. Those waters cannot be treated in conventional wastewater treatment systems, and therefore, technology based standards are not applicable. The first point of exposure and potential impact will be on the reclamation landscape itself. Natural biodegradation assimilation processes intrinsic to natural wetland systems will serve to minimize or eliminate potential effects. In addition, constructed wetlands may be used to enhance natural processes. If reclamation water quality management results in adequate on-site conditions, off-site effects should consequently be insignificant.

The principle of on-site sustainability should essentially lead to the protection of biological and ecosystem integrity. This refers to the capability of on-site systems to support and maintain a community of organisms that is balanced, integrated, adaptive and comparable to natural systems in terms of composition, diversity, functional organization and ecological processes.

An important consideration when evaluating the sustainability of reclamation water releases, in particular seepage waters, is that when they are first released to surface drainage systems they may show evidence of acute or chronic toxicity as measured by aquatic toxicity tests. These on-site receiving water systems may exhibit a gradation in water quality as natural processes take over and mitigate the effects of any contaminants that may be present. Similarly, if constructed wetlands are used, the water entering the wetlands may show evidence of toxicity which will dissipate with passage of the water through the system. Although they may exhibit some level of acute and chronic toxicity as measured by standard tools, field research has indicated that drainage and wetland systems will be biologically active and inhabited by a community of organisms. This community should be ecologically viable but may not be fully representative of undisturbed habitats.

At the EIA stage, assessment tools such as water quality models, as well as health and ecological risk assessment techniques, should be used to evaluate on-site reclamation waters for potential contaminants of concern. From an off-site perspective, release of these waters to the Athabasca River should be considered for potential cumulative impacts. Since these waters cannot be treated prior to release, except through natural wetland processes, adequate river assimilative capacity must be available. Otherwise, additional water quality management will be needed.

At the EPEA application stage, more advanced modeling and assessment should be used to evaluate on-site suitability in greater detail than is required for the EIA. Additional lab and field scale demonstration studies should be used to support assessments developed in the EIA. Since the management focus is to have sustainable reclamation waters on-site, there should be no need to develop formal release standards for reclamation waters as is done for operational waters. However, if problems in the performance of the on-site systems are identified, a review of the causes will be required, as well as development and implementation of solutions. These systems will also require monitoring for a sufficient period of time to confirm their performance.

4.0 SUMMARY OF INFORMATION BASE AND REQUIREMENTS

4.1 Water Characterization

As indicated in the assessment framework presented in Section 3.0, understanding water quality from both a chemical and toxicological perspective is required for all reclamation and operational water releases. The OSWRTWG reviewed the available information base. Major findings with regard to this information include:

- Substantial data on ion, nutrients, trace metal and organic parameter data such as oil and grease and phenols are available for most operational and reclamation waters. There are limited data on specific organic contaminants, especially the substituted PAHs. The OSWRTWG has established a priority list of chemical parameters and toxicological variables that should be used to characterize all Oil Sands water releases.
- There is a need to continue collection of data on chronic toxicity and ecosystem integrity.
- Considerable effort is being expended by government agencies and the Oil Sands industry to use liver enzyme analysis; in particular, induction of Mixed Function Oxidases (MFO), as an indicator that fish are being exposed to hydrophobic compounds. This is just one of a number of biomarkers that scientists can use to assess chemical exposure. Given the developmental nature of using and evaluating biomarkers such as MFOs, positive results do not necessarily mean that an individual fish or fish population is actually being adversely impacted.

Recommendations

1. The chemical and toxicological parameter list developed by the OSWRTWG should be used as the basis for characterization of operational and reclamation water releases.

2. An integrated database should be prepared which documents oil sands water characterization and monitoring as well as field demonstration studies. The database will provide information to identify priority parameters, rationalize the screening process for compounds of concern, and serve as the data source for impact analysis and evaluations presented in the EIA and EPEA applications. The database should include chronic toxicity data (i.e., LC50, EC50, EC20, IC25, NOEC, LOEC, LOAEC). The best available information should be entered at the appropriate time by the companies or individual researchers. This database would be made available to all interested parties.
3. Gaps in the toxicity profile of potential release waters for both acute and chronic tests should be filled. In particular, data for Alberta Environmental Protection test suite is required to apply the whole effluent toxicity waste load allocation technique recommended by Alberta Environmental Protection.
4. A summary of all toxicity data should be pulled together; especially for chronic toxicity and ecosystem integrity. The summary should provide descriptions (objectives, parameters, methods, schedule), as well as a discussion of key findings and observations for completed, on-going and proposed work. The summary should include both lab and field investigations.
5. The potential of Oil Sands waters to induce biomarkers response, including MFOs, should be defined under laboratory conditions. Biomarkers are a potentially useful assessment tool; however, they constitute an emerging science. Further work is needed to establish their relationship to adverse biological effects.
6. The commitments on characterization of reclamation waters, as outlined in the Syncrude-Fort McKay Agreement and the 1993 Syncrude Workshops, should be reviewed
7. Athabasca River background water quality parameters which exceed ambient guidelines need to be identified. The causes of the "exceedances" should be determined (e.g., seasonal variation, tributary input). This information is needed to develop site specific guideline alternatives (See section 4.3.2: Ambient Water Quality Guidelines). However, an issue which must be addressed is the applicability of ambient guidelines in situations where natural background values are in themselves "exceedances" of the guidelines.

4.2 Technology Based Standards

There are currently no technology based categorical standards for Oil Sands operational water releases. There is a database for Suncor's upgrader wastewater treatment system which includes historic data on treatment performance and effluent water quality. This can be used to develop a case specific technology standard. Consolidated tailings (CT) water releases are unique and technology based standards will have to be developed from the characterization data being generated from completed laboratory studies and field trials being implemented by Suncor in 1995, and by Syncrude in 1996.

Procedures developed by Alberta Environmental Protection (AEP, 1995c) provide guidance on the methods for deriving case specific technology based standards and also define requirements for conducting the economic analysis. As previously noted in the discussion of the assessment framework in Section 3.1, the more conservative of the water quality or technology based standards is ultimately used for the EPEA approval.

Recommendations

1. Upgrader discharges from Suncor will require the development of case specific technology based standards. This should be based on existing performance data on similar processes and treatment facilities in complementary industries, economic considerations, and the collection of new information where needed.
2. The Oil Sands operators should collect the data required to define technology based standards for potential CT release waters. This evaluation should include review of alternative treatment technologies and economic analysis of unit treatment costs for each technology evaluated.

4.3 Receiving Environment Assessment and Derivation of Water Quality Based Effluent Standards

A water quality based assessment of waters releases and derivation of water quality based standards requires:

- Characterization of water releases as reviewed in Section 4.1;
- Understanding of background water quality and aquatic ecosystem integrity for the Athabasca River;
- Selection of appropriate ambient water quality guidelines which can be used to evaluate releases;
- Application of appropriate assessment methods.

4.3.1 Background Water Quality and Aquatic Ecosystem Health of the Athabasca River

Alberta Environmental Protection has monitored background water quality for a broad spectrum of parameters in the Athabasca River for a number of years. Additional data on water quality, aquatic habitat information and aquatic ecosystem health have been collected by the Northern River Basins Study (NRBS). These data will become available in early 1996. The focus of the NRBS program was the upper Athabasca River basin, however, some data for fish biomarkers, fish contaminant levels and benthic invertebrate community structure was obtained at selected locations in the Oil Sands reach of the river.

Environment Canada, through the Program for Energy Research and Development (PERD), has also collected data on Polyaromatic Hydrocarbon (PAH) residues in river sediments and biota. In addition, they have investigated toxicity of suspended particulate material in the river, and collected fish biomarker information for walleye and goldeye from the lower Athabasca River.

Aquatic habitat conditions were defined in the late 1970's by the Alberta Oil Sands Environmental Research Program (AOSERP). Additional studies have been conducted by Suncor and Syncrude as part of specific monitoring programs. In recent years, Syncrude has also been collecting fish habitat information for selected reaches of the Athabasca River.

Suncor is collecting, for its Steepbank Mine EIA, detailed aquatic habitat information for the Athabasca River reach adjacent to their leases and through the lower Steepbank River. Similarly, Syncrude is collecting aquatic habitat and water quality information from the Muskeg River, in part for its Aurora Mine EIA. In addition to these data, the companies are also collection biomarker and fish health information for selected fish species.

Recommendations

1. Programs implemented for the Steepbank and Aurora Mine EIAs should be designed to collect information that clearly defines current contaminant residue levels and ecosystem integrity health for the Athabasca River in the Oil Sands reach. These programs should also evaluate effects on ecosystem integrity that may be caused by upstream development activities or regional exposure of the system to background hydrocarbons and other contaminants.

2. Ecosystem health assessment endpoints (ecosystem "objectives") and measurement endpoints (ecosystem indicators) should be further defined for the Athabasca River. Within the context of ecosystem integrity there is a need to address the degree of change that would be considered "harmful or unacceptable".
3. A program of field and laboratory investigations focussed on clarifying the relative effects of existing developments and background regional contaminant levels on fish biomarkers and health should be defined and integrated into existing field and laboratory programs.
4. The NRBS database should be utilized to help establish the baseline aquatic conditions in the lower Athabasca River in the vicinity of the current Oil Sands operations. This effort should include current work being conducted for NRBS on sediment chemistry and toxicity, and experimental lipid bags deployed to index MFO response in the river and existing effluents. The relevance of the NRBS work with respect to surveys of MFO biomarker responses in fish, and the use of experimental lipid bags, is still considered to be a research activity and not directly applicable to regulatory requirements. Nevertheless, the data should be used.

4.3.2 Ambient Water Quality Guidelines

Aquatic impacts related to water releases from Oil Sands facilities needs to be evaluated against benchmark environmental guidelines. Alberta Environmental Protection's procedures for developing water quality based effluent standards make reference to the *Alberta Ambient Surface Water Quality Interim Guidelines* as one set of ambient guidelines. They also indicate alternative guidelines such as the CCME or USEPA water quality guidelines can be applied. Discussions by the OSWRTWG further noted that site specific, reach specific, or basin specific guidelines can be employed in these assessments where unique conditions warrant.

Acute toxicity of reclamation water releases has been characterized and considerable research conducted in an attempt to identify the constituent fractions responsible for the toxicity. There is evidence that suggests that the primary source of potential toxicity in the reclamation and other process-affected waters is a group of polar organics called naphthenic acids. The OSWRTWG carefully considered the background information on naphthenic acids and evidence for the linkage of this group to toxicity. Although the naphthenic acids appear to be the major source of potential toxicity, the data suggest a weak correlation between the level of naphthenic acids and the degree of toxicity. This is theorized to be due to unpredictably varying levels of numerous individual naphthenic acids which may vary in their toxicity.

The OSWRTWG believes that the management of naphthenic acids, like other substances for which instream guidelines do not exist, can be achieved through the use of acute and chronic toxicity testing as the assessment and management endpoints. This approach is taken with all major industrial dischargers in Alberta. The whole effluent toxicity approach eliminates the need to explicitly define substances and their potential toxic effects. It also addresses the issue of potential interactive and synergistic effects of multiple chemicals in an effluent. Information from whole effluent studies on one of the operational water releases, Suncor dyke drainage water, is expected in the last quarter of 1995.

Early investigations indicate that some water quality parameters in the Athabasca River may exceed provincial or national water quality guidelines due to upstream activities or natural background concentrations unique to the Oil Sands region. Constituents which fall into this category need to be clarified and cross referenced against potential water releases. Where there is overlap, the cause of the exceedance should be evaluated. Exceedances caused by natural background conditions can be accommodated in the assessment process defined by Alberta Environmental Protection. In some instances, it may be necessary to consider development of site specific, reach specific or basin specific ambient water quality guidelines.

Modifications of guidelines to reflect local conditions will warrant additional industry sponsored experimental and field studies to evaluate effects on indigenous aquatic receptors and species at risk to potential exposure to Oil Sands water releases. These modifications would involve a public stakeholders consultation review process.

Recommendations

1. A report on naphthenic acids, their chemical characteristics, their link to toxicity and issues associated with developing an ambient guideline should be documented in a discussion paper prepared by Alberta Environmental Protection with collaboration from Oil Sands industry and other technical specialists.
2. Development of analytical fractionation methodologies to determine the principal substances within groupings of naphthenic acids other toxic substances should continue in order to provide additional information and strategies in the longer term management of water releases.
3. The whole effluent toxicity approach should be applied and implemented for oils sands water releases.

- 4 It would be appropriate to plan and proceed with Toxicity Identification Evaluation (TIE) studies of the principal water releases anticipated over the longer term (i.e., five years). This would incorporate studies on the chronic effects of serial dilutions of acid extractable fractions of representative operational and reclamation water releases. These studies could also integrate an analysis of potential tainting components that may be linked to the presence of compounds containing sulfur and nitrogen.
- 5 A screening level assessment of constituents which may exceed water quality guidelines due to background conditions or upstream contaminant sources should be conducted. This screening assessment should be used as the basis to identify priority parameters and to decide whether site specific water quality objectives should be developed for the upcoming EIAs and EPEA approval applications.

4.3.3 Assessment Tools

The Oil Sands industry has developed tools for predicting downstream water quality in the Athabasca River; in particular, the Reclamation Landscape (or Contaminant Distribution and Fate) Model developed to model water quality conditions on both reclaimed leases and in the receiving water environment. This tool can be used to predict potential water quality for cumulative water release scenarios. It also allows assessment of the health and ecological risk that could be associated with these releases.

Alberta Environmental Protection has defined procedures that should be followed in developing a water quality based standard for approved water releases (AEP, 1995c). This document includes information required for conducting chemical specific waste load allocations, mixing zone assessments and whole effluent toxicity assessments. These procedures can be applied to both the EPEA approval and EIA phases of the process.

The screening and wasteload allocation procedures used by Alberta Environmental Protection provide methods for impact assessment and standard setting that are based on proven technical and scientific approaches. Similar approaches are used by the federal government, the USEPA and the Ontario Ministry of Environment. The Alberta Environmental Protection procedures include instream guidelines for acute and chronic whole effluent toxicity.

The various assessment tools build safety factors into their procedures by using conservative assumptions. In addition, biomonitoring is used to ensure that the water quality based standards are appropriate and effectively protect the environment.

Recommendations

1. Existing information should be used to screen maximum allowable loadings from Oil Sands facilities to the Athabasca River using the wasteload allocation procedures of the Alberta Environmental Protection guidelines. These screening level maximum loadings should be cross referenced against potential water scenarios to evaluate substances requiring more detailed characterization, impact analysis or development of ambient receiving stream guidelines.
2. Where ambient water quality guidelines are not available or are difficult to apply (e.g. complex mixtures), defined procedures such as whole effluent toxicity assessment should be applied.
3. Human health water quality criteria from the USEPA, which to some extent addresses bioaccumulative and carcinogenic concerns, should be screened and evaluated. The ability to deal effectively with carcinogens, compounds that bioaccumulate, substances of potential concern that do not have published instream criteria, and sediment integrity, should be evaluated. Approaches such as risk assessment should be considered.

The assessment for Oil Sands water releases should include a Cumulative Environmental Assessment (CEA) which considers scenarios of maximum likely release from all existing and proposed facilities. This CEA should employ tools developed by the industry, the waste load allocation methods recommended by AEP, and health and ecological risk assessment techniques. The latter will allow a level of analysis that is potentially broader in scope than some of the more site specific waste load allocation procedures.

4.4 On-site Sustainability

The Oil Sands industry has extensively studied water quality impacts and on-site sustainability of wetlands systems on reclaimed leases. This has included development of demonstration scale projects which have been monitored for chemistry, toxicity, ecosystem structure and some levels of ecosystem function. The work includes experimental pits developed at Syncrude in 1989 and various experiments done at Suncor over the last ten years. In 1994 Syncrude developed a large scale demonstration pond. A collaborative research project on the pond is underway involving industry, government and university researchers. The project will evaluate chronic toxicity and ecosystem structure and function. Since 1991, Suncor has conducted extensive research on the use of constructed wetlands to treat reclamation water releases for acute toxicity. Both Syncrude and Suncor have compiled substantial databases on chemistry, toxicity and aquatic biology for these demonstration systems.

In parallel with the field experiments, the Oil Sands industry has developed a Reclamation Landscape Model of the on-site wetland systems. This computer model allows prediction of both chemical and biological conditions, and has been extensively calibrated against the existing field experiments. It can make projections on potential full scale systems, and was used to evaluate the feasibility of a wetland reclamation system proposed by Syncrude during their 1993 ERCB hearing.

Recommendations

1. The demonstration scale experiments currently underway should continue to document information on physical-chemical conditions, chronic toxicity, and ecosystem structure and function. Programs should also evaluate patterns in long term chronic toxicity and ecosystem integrity.
2. Data on chronic toxicity and ecosystem integrity for reclamation water releases should be summarized for both lab and field studies. Key findings should be highlighted.
3. The commitments in the Syncrude-Fort McKay Agreement and the 1993 Syncrude Workshops should be reviewed in relation to the design and implementation of research and monitoring programs.
4. Health and ecological risk assessment techniques should be applied to evaluate the contaminant hazard to on-site users and wildlife communities on the reclaimed landscape.
5. Assessment and measurement endpoints need to be developed for reclamation water releases in order to address protection of on-site ecosystem health and sustainability. These should essentially lead to the protection of biological and ecosystem integrity (i.e., the ability of on-site systems to support and maintain a community of organisms that is balanced, integrated, adaptive, and comparable to natural systems in terms of composition, diversity, functional organization and ecological processes). The biological "criteria" developed should reflect reference conditions (desired state based on representative undisturbed habitats) and should measure ecologically important attributes. At the current time, the criteria should not be used for setting limits but rather should provide guidance. An approach should be developed that integrates information for a number of attributes on individuals, populations, communities and ecosystem.
6. There should be a recognition that constructed wetlands will have a well-developed, sustainable biological community; however, it may not be representative of natural undisturbed wetlands in the region.

5.0 SUMMARY OF FINDINGS

A summary of findings and recommendations is presented in Table 3. The table also indicates who should be responsible for implementing these recommendations and the general priority, including a timeframe. Three general timeframes were established:

short-term: normally one year or less but may extend to two years

medium-term: three to five years

long-term: five years or more

6.0 REFERENCES

Alberta Environmental Protection, 1995a. Industrial Limits and Policy Overview. Environmental Regulatory Service. 8pp.

Alberta Environmental Protection, 1995b. Summary of Alberta Standards and Monitoring Requirements. Environmental Regulatory Service. 11pp.

Alberta Environmental Protection, 1995c. Water Quality Based Effluent Limits Procedures Manual. Environmental Regulatory Service. 54 pp. + appendices.

TABLE 3. OSWRTWG SUMMARY OF INFORMATION BASE AND REQUIREMENTS

Findings	Recommendations	Priority	Parties
4.1 Water Characterization	short-term = < 1 year but up to 2 years medium-term = 3 to 5 years long-term = 5 years or more		
1. Waters can be classified as operational releases and reclamation releases.	a) Use the classification scheme to establish a consistent framework to discuss the components and features of water releases.	N/A	Industry/Government
2. Extensive physical, chemical and toxicity data currently exist; however, it needs to be in a more accessible, manageable form.	a) Prepare an integrated database which documents water characterization, monitoring, chronic toxicity data, and field studies. Use the database to identify priority parameters, rationalize the screening process, serve as the basis for analyses and evaluations in the EIA and EPEA applications, and to make decisions.	short-term	Industry
	b) Make the data base available to all parties.	short-term	Industry
3. Extensive data are required on the timing and volume of releases.	a) Complete scenarios for current operational, future operational, and reclamation water releases.	medium-term	Industry
4. Reclamation options (e.g., CT treatment processes) and water recycle affect the characteristics and management of water releases	a) Consider the environmental implications of reclamation options in decisions on different alternatives.	medium-term	Industry
5. Certain water quality parameters may exceed Alberta's Ambient Surface Water Quality Interim Guidelines.	a) Identify parameters that exceed the guidelines and review the reasons.	short-term	Industry/Government
	b) Review the applicability of guidelines in the situation where natural background levels may exceed the guidelines.	short-term	Industry/Government
6. Acute and chronic toxicity data, as measured by standard tests (e.g., <i>Ceriodaphnia</i> , <i>Selenastrum</i>) need to be further enhanced, as well as ecosystem integrity as measured by population, community and ecosystem parameters (e.g., structure, function, processes).	a) Fill gaps in the toxicity profile of potential release waters for both acute and chronic tests. Collect data for AEP's test suite for the Whole Effluent Toxicity waste load allocation protocol.	short-term	Industry
	b) Continue efforts on field and demonstration tests to obtain comprehensive ecosystem data. Obtain the input of stakeholders in the design, implementation and interpretation of data.	medium-term	Industry/Government
7. Biomarkers (MFOs) and fish health indicators can assist assessments.	a) Conduct lab and field studies to define the potential of water releases to induce MFO response, and changes in fish health indicators.	short-term	Industry/Government
8. Fish tainting potential is a key issue.	a) Conduct taste studies on fish tainting potential for water releases.	short-term	Industry

4.2 Technology Based Standards			
<p>1. Categorical technology-based standards are not available for oil sands water releases. Case specific technology based standards must be developed:</p> <ul style="list-style-type: none"> - historic data base available for Suncor's upgrader wastewater treatment system. - CT release waters are new and unique - AEP method available to develop technology based standards 	<p>a) In EPEA application, develop case specific technology based standards for upgrader discharges:</p> <ul style="list-style-type: none"> - existing performance data on similar type process and treatment facilities in complementary industries - economic considerations - collect new information in absence of adequate existing information 	short-term	Industry
	<p>b) In EPEA application, develop data required to define technology based standards for potential CT release waters:</p> <ul style="list-style-type: none"> - include review of alternative treatment technologies - include unit treatment costs 	medium-term	Industry
	<p>c) In EIA, screen potential treatment technologies and define potential water release concentration and loadings</p>	medium-term	Industry
4.3 Receiving Environment Assessment and Derivation of Water Quality Based Effluent Standards			
4.3.1 Background Water Quality and Aquatic Ecosystem Integrity of the Athabasca River			
<p>1. There are a number of completed, on-going or planned studies:</p> <ul style="list-style-type: none"> - AEP regional water quality in Athabasca River - NRBS data on MFO response, fish contaminant levels, and benthic invertebrates (available 1995/96) - PERD data on PAH residues in sediments and biota, toxicity of suspended solids, MFO response in walleye and goldeye in lower Athabasca - AOSERP aquatic habitat in Athabasca and tributaries - Syncrude/ Suncor monitoring programs; Syncrude's fish habitat studies in Athabasca - Suncor/Syncrude EIAs: aquatic habitat, biomarkers and fish health information in Athabasca, Steepbank and Muskeg Rivers 	<p>a) EIAs for Steepbank and Aurora Mines need to:</p> <ul style="list-style-type: none"> - define current contaminant residue levels and ecosystem integrity in Oil Sands reach - define effects of upstream developments or natural regional exposure to hydrocarbons, through lab and field program on biomarkers 	short-term	Industry
	<p>b) Define assessment and measurement endpoints for Athabasca ecosystem integrity. Define the degree of change in measurement endpoints that would be considered unacceptable or harmful.</p>	medium-term	Industry/Government
	<p>c) Extensively use NRBS database to assist with establishment of baseline aquatic conditions (sediment chemistry and toxicity; MFO response in river and effluents). Recognize developmental status of MFO and lipid bag studies.</p>	medium-term	Industry/Government

4.3.2 Ambient Water Quality Guidelines			
<p>1. Some water quality parameters in the Athabasca River may exceed interim guidelines. Site, reach or basin specific guidelines can be employed where unique conditions warrant. These may require additional industry sponsored work and public consultation.</p>	<p>a) Conduct a screening level assessment of constituents that may exceed interim guidelines due to upstream discharges or natural sources.</p>	short-term	Industry/Government
	<p>b) Identify priority parameters and decide whether assessment methods can accommodate these exceedances or site specific guidelines should be developed for the upcoming EIAs and approval applications.</p>	short-term	Industry/Government
<p>2. Primary source of toxicity appears to be naphthenic acids.</p>	<p>a) Prepare a discussion paper on characteristics of naphthenic acids, their link to toxicity, and issues associated with setting an ambient guideline.</p>	short-term	Industry/Government
<p>3. Currently, there is not a well established correlation between the level of naphthenic acid and the degree of toxicity due to:</p> <ul style="list-style-type: none"> - complexity of toxic response (i.e., the same concentration of naphthenic acids in different samples or waste streams produce different degree of toxicity) - complexity of the naphthenic acids as a group (number of carbon atoms, number of ring structures) - current limitations in isolating and characterizing the individual acids and their toxicity <p>A chemical specific criterion can aid water release management (e.g., by helping to explain and account for changes in toxicity).</p>	<p>a) Plan and proceed with a Toxicity Identification Evaluation study of the principal water releases expected over the long term. Incorporate serial dilutions to study chronic effects. Develop a guideline for naphthenic acids as a group or for particular components that may account for a significant portion of the toxicity.</p>	medium-term	Industry
<p>4. Whole effluent waste load allocation is an effective management tool for dealing with complex mixtures such as Oil Sands water releases. It eliminates the need to explicitly define the chemical substances and their concentrations that cause toxic effects.</p>	<p>a) Proceed with implementation of the whole effluent assessment approach.</p>	short-term	Industry
	<p>a) Evaluate the fish flesh tainting potential of water releases.</p>	medium-term	Industry
<p>5. Water releases have the potential to taint fish flesh.</p>			

4.3.3 Assessment Tools			
4.3.3.1 General Framework			
<p>1. Management of reclamation and operational water releases requires strategies appropriate to each type.</p>	<p>a) For reclamation waters, focus on on-site ecological sustainability and minimization of impacts to on-site users. On-site sustainability should ensure off-site protection. For operational waters, focus on off-site protection of receiving environment.</p>	<p>N/A</p>	<p>N/A</p>
<p>2. Regulatory processes under the Environmental Protection and Enhancement Act require the identification and assessment of environmental impacts, and the management of both operational and reclamation water releases.</p>	<p>a) When an EIA is required, it should consider both operational and reclamation water releases and their cumulative effects. The EIA should evaluate the sustainability of reclamation waters on-site prior to release. These waters should be biologically, productive, non-hazardous and sustainable.</p>	<p>N/A</p>	<p>N/A</p>
	<p>b) If there is a major change in operating philosophy that may affect the environment, such as the release of operational waters, the EIA must address potential impacts in detail.</p>	<p>N/A</p>	<p>N/A</p>
	<p>c) For operational water releases, AEP has developed procedures that are applicable to all Alberta industries. The procedures consider both technology based and water quality based approaches and adopt the more conservative when issuing an EPEA Approval.</p>	<p>N/A</p>	<p>N/A</p>
	<p>d) For reclamation water releases, the EPEA Application must show that aquatic systems will be established and demonstrate that they are viable, sustainable, non-hazardous, and maintenance free.</p>	<p>N/A</p>	<p>N/A</p>
<p>3. If an EPEA Application is submitted at the same time as the EIA, both documents will be addressed through a coordinated and integrated review process.</p>			

4.3.3.2 Application of Assessment Tools			
<p>1. The Oil Sands industry has developed tools for predicting water quality conditions in the reclaimed lease and in the receiving stream:</p> <ul style="list-style-type: none"> - can address cumulative effects - can assess risks (health, ecological) <p>AEP has defined procedures for developing water quality based standards for water releases. The procedures can use or combine several approaches:</p> <ul style="list-style-type: none"> - chemical specific - whole effluent toxicity - biomonitoring <p>The assessment tools build safety factors into their procedures by using conservative assumptions. Biomonitoring is used to confirm the appropriateness of water quality based standards.</p>	<p>a) Where water quality guidelines have been developed, determine maximum allowable loadings from Oil Sands facilities using AEP's waste allocation guidelines.</p> <ul style="list-style-type: none"> - cross-reference these loadings against potential release scenarios to identify parameters of concern - for the identified parameters, conduct more detailed assessments of source characterization, impact analysis or development of ambient guidelines 	short-term	Industry
	<p>b) Where water quality guidelines are not available or are difficult to apply (e.g., complex mixtures):</p> <ul style="list-style-type: none"> - apply defined methods such as whole effluent toxicity - evaluate the ability of water quality based standards and whole effluent toxicity to handle carcinogens, compounds that bioaccumulate and components that may accumulate in sediment - review USEPA criteria which deal extensively with human health and carcinogens - consider risk based approaches for these areas 	short-term	Industry/Government
	<p>c) Assess Oil Sands water releases through a cumulative environmental assessment which considers scenarios of maximum likely release from all existing and proposed facilities. A number of tools can be used:</p> <ul style="list-style-type: none"> - those developed by industry - AEP waste load allocation methods - health and ecological risk assessment which are broader in scope than waste load allocation 	medium-term	Industry
	<p>d) Define assessment and measurement endpoints for Athabasca River ecosystem integrity. Define the degree of change in measurement endpoints that would be considered unacceptable or harmful.</p>	medium-term	Industry/Government

4.4 On-site Sustainability			
<p>1. Considerable research is completed, on-going, or planned on water quality impacts and on-site sustainability of wetlands and water bodies. This includes lab, field, and demonstration studies addressing chemistry, toxicity and ecosystem development and function.</p>	<p>a) Continue to develop data on chemistry and ecosystem structure and function.</p>	<p>medium-term</p>	<p>Industry</p>
	<p>b) Summarize all chronic and ecosystem integrity data for reclamation release waters for lab and field investigations. Summarize key findings.</p>	<p>short-term</p>	<p>Industry</p>
	<p>c) Review and incorporate, where appropriate, the commitments in the Ft. McKay Agreement and 1993 workshops on characterization of water-capped fine tails lakes.</p>	<p>medium-term</p>	<p>Industry</p>
<p>2. On-site sustainability should lead to the protection of biological integrity (i.e., the ability of on-site systems to support and maintain a community of organisms that is balanced, integrated, adaptive and comparable to natural systems in terms of composition, diversity, functional organization and ecological processes. Currently, there is not a clear definition of what constitutes a sustainable system</p>	<p>a) Develop assessment and measurement endpoints for reclamation water releases to address on-site ecosystem health and sustainability. Establish criteria based on "reference" conditions. Use a number of attributes at the individual, population, community and ecosystem level.</p>	<p>medium- to long-term</p>	<p>Industry/Government</p>
	<p>b) Apply health and ecological risk assessment techniques to evaluate potential risk to on-site users and wildlife communities in the reclaimed landscape.</p>	<p>medium-term</p>	<p>Industry</p>
<p>3. Some water releases, such as dyke seepage, will continue over a long time frame and may exhibit acute aquatic toxicity when first expressed into surface drainage. Suncor has conducted extensive research on the use of wetlands to treat reclamation water releases for acute toxicity.</p>	<p>a) Recognize that constructed wetlands will have a well-developed, sustainable biological community; however, it may not be representative of natural, undisturbed wetlands in the region.</p>	<p>N/A</p>	<p>N/A</p>
	<p>a) Continue to develop and refine the wet landscape computer model.</p>	<p>short to medium-term</p>	<p>Industry</p>
<p>3. A wet landscape computer model has been developed to predict physical, chemical and biological conditions. It has been calibrated against field data and continues to be updated.</p>			

7.0 GLOSSARY OF TERMS

1993 Syncrude Workshops A series of three workshops on the water capping reclamation concept. They arose out of a commitment in the Syncrude-Fort McKay Agreement to consult with Fort McKay, the ERCB, and AEP on planning and research issues. They were held in October 1993, during the course of the ERCB Public Hearing on Syncrude's application to expand and continue the operation of their Mildred Lake Facility. The topics covered were biodegradation, littoral zone and capping layer.

Acute Toxicity Toxicity that is expressed over a short period relative to the lifespan of the organism, usually a few minutes to a few days.

Alberta Ambient Surface Water Quality Interim Guidelines Interim guidelines released in September 1993, by Alberta Environmental Protection. They address 40 water quality parameters and describe water quality suitable for most uses either through direct use or prepared for use by common water treatment practices. They apply to surface waters except in areas of close proximity to outfalls.

Biomarker Biochemical, physiological, and histological changes as well as aberrations in organisms used to estimate either exposure to chemicals or resultant effects.

Chronic Toxicity Toxicity that is expressed over a longer period and incorporates the organism's long term response to the toxicant.

Consolidated Tails Consolidated Tailings are formed when chemicals such as gypsum (or acid-lime) are added to Oil Sands tailings, resulting in the flocculation or coagulation of fine particles. This process enhances the permeability of tailings, especially at relatively low solids contents (high void ratios). The result is that the consolidated tailings undergo a significant volume reduction during sedimentation and initial consolidation, which commences almost immediately after deposition. Clear decant water (CT release water) is deposited on top of the consolidated tailings.

The rate of initial consolidation depends largely on the fines content of the tailings. Once the fines content is greater than 25% (sands to fine ratio smaller than 3), the rate of consolidation decreases considerably. It also depends on the type and

concentration of additives and the length of mixing time. There is usually an optimum additive concentration at which the tailings yield the best rate of initial consolidation. Longer mixing times tend to produce tailings yield the best rate of initial consolidation.

EC20 The effective concentration that would cause a discernable sublethal toxic effect to 20% of the test organisms. The concentration may be expressed as mg/L in water or mg/kg in soil or sediment. Effective concentrations are used where an individual's response other than mortality is being measured.

EC50 The effective concentration that would cause a discernable sublethal toxic effect to 50% of the test organisms

Fine Tails Release Water Entrained process extraction water that is slowly released from fine tails as they consolidate.

IC25 The inhibiting concentration that would cause a 25% reduction in a nonlethal biological measurement of the test organisms, such as reproduction or growth.

LC50 The concentration that is lethal to 50% of the test population, known as the median lethal concentration.

LO(A)EC Lowest observed (adverse) effects concentration. The lowest concentration in the dilution series at which the biological response of interest was observed.

MFOs Mixed Function Oxidase. A protein family involved in the biotransformation of organic chemicals, resulting in molecular changes to the chemical. The changes produce metabolites which may be toxic or non-toxic.

NOEC No observed effects concentration. This is the highest concentration at which the adverse effects are not observed (e.g., 100% survival), and is always the next lowest concentration to LOEC in the dilution series.

Reclamation Landscape Model Computer simulation model developed by the Oil Sands industry to simulate aquatic systems and the fate of chemical compounds on reclaimed leases. The model has also defined quality of water flowing off leases.

Reclaimed Landforms Landforms that remain after mining and reclamation. They can be made up of overburden, lean oil sands, muskeg, tailings sand, consolidate fine tails or mature fine tails capped with a water layer. Terrestrial landforms are capped with a layer of soil material and revegetated.

Syncrude-Fort McKay Agreement A joint Syncrude-Fort McKay submission to the ERCB during the Syncrude Public Hearing. It was dated September 7, 1993, and summarized the findings of discussions on reclamation elements in Syncrude's ERCB Application and, in particular, the elements dealing with fine tailings. It summarized areas where Syncrude and Fort McKay were in agreement as well as areas where no agreement exists.

Wet Landscape Reclamation Reclamation of fine tails through water capping.