WET POND RECLAMATION AT SUNCOR

ROBERT MARTIN

SUNCOR INC. OIL SANDS GROUP

ABSTRACT

The issue of how to best manage the wastes resulting from the bitumen extraction processes is complex.

When clays contained in the oil sands are subjected to the Clark Hot Water Extraction Process a sludge is formed. This sludge is contained in large tailings ponds. It is very stable and releases the water it contains very slowly. The sludge accumulates during the operational phase of the project and will be fluid long after the project is completed. Ultimate reclamation of the sludge pond areas is a significant environmental issue.

Investigations at Suncor found that sludge ponds are a necessary component of an oil sands operation. Studies also indicate that reclaiming sludge ponds as lakes would be manageable and environmentally acceptable.

A management approach which integrates the needs of all stakeholders in resolving the sludge pond issue is necessary.

INTRODUCTION

The orderly development of oil sands is becoming increasingly important as conventional crude oil reserves decline.

Currently, the two Fort McMurray commercial ventures use the Clark Hot Water Extraction Process. Tailings ponds are constructed to contain recycled waters and wastes from the extraction and upgrading processes. Included in the wastes is a stable sludge formed from clays which originated from the ore body in the mine.

The current Suncor lease will be mined by about 2003. Upon abandonment of the lease, one pond, which will contain all the sludge from the years of operation, will be left as a lake. The decision to pursue the lake or "wet pond" option was reached after many alternatives were extensively analyzed.

The key factors considered were:

1. Geotechnical Stability
2. Technical Feasibility
3. Environmental Acceptability

WHAT IS SLUDGE?

Clays are associated with the oil sands ore body. Sometimes the clays are in such large bands that they can be excluded from the mining operation. At other times they are so dispersed in the ore that they must be carried with the oil sands to the extraction processing plant.

Clay lumps are screened out of the feed to bitumen separation equipment. This oversized clay can be trucked away and buried in a landfill.

The remaining clays are carried into the process but nearly all are rejected to the tailings stream at some point. The clays, along with debitumenized sand, recycled water, and unrecovered hydrocarbons, are discharged to large tailings ponds. At the tailings pond most of the clays become closely associated with the deposited sands. However, about 32 per cent of the clays become a sludge which is contained by the pond.

HOW DOES SLUDGE BEHAVE?

Sludge contains a mixture of bitumen (4-5%), minerals (25-40%) and a lot of water (55-70%). Included with the minerals are adsorbed organics. The pH is slightly alkaline and varies between 8 to 8.5.

The pore fluid contains primarily sodium carbonate and sodium bicarbonate. Also included are calcium, magnesium, potassium, sulphates and chlorides.

The top one to three meters of sludge settles fairly rapidly and is called transitional sludge.

Most of the sludge in the ponds is classified as "terminal" sludge. It is very stable and releases the water it contains very slowly. As mining continues, more ponds must be built to contain this material. The sludge will continue to remain fluid long after operations have ceased, which causes environmental concerns about long term security.

All of the clay is not equally significant in sludge formation. The ultra-fine particles, which constitute less than 15 per cent of the total clay materials, are the prime cause of water retention. These clays become enveloped by a film of water and a very stable condition develops.

Suncor has developed the capability to predict the amount of sludge that will be formed during processing. Accurate identification of clay quality is a basic factor in the determination.

Terminal sludge is a gel-like material containing at least 30 % solids. The solids content precludes fish life and yet is too easily fluidized to support traffic. The tailings water which carries the sludge to the pond, and which forms the remaining 70 % of sludge, is acutely toxic to fish .

ENVIRONMENTAL SIGNIFICANCE

Suncor has conducted a variety of studies to investigate the top water quality and potential for reclamation. These studies have included investigations on actual tailings ponds, field test facilities and the laboratory.

The assessment criteria for acceptability included biological, toxicological, chemical and physical considerations.

Laboratory treatments studies led to the conclusion the water could be improved through the biodegradation processes. The process was found to be oxygen and phosphate deficient and temperature dependent. Under optimum conditions (phosphate addition, aeration seeding and mixing at 27°C) the water was rendered not acutely toxic to Rainbow Trout after six days of treatment.

Tar Island Dyke is the containment structure built around Pond 1. Observations of the reclamation success in that area are quite positive. Ten tree species and 17 shrubs species are growing. Indigenous plants such as willows, reeds, sow thistle and poplar have recolonized the area. Mammals such as beaver, fox, coyotes and deer, as well as 200 species of birds, have been seen in the vicinity. This reclamation success has been achieved in an area where the water quality is influenced by dyke seepage water. Areas of seepage are some of the most productive. Nutrients in the dyke drainage water may contribute to the reclamation success. This demonstrates how difference the conclusions can be, depending on the test used. This conclusion is very positive compared to the results one could obtain from a fish bioassay test for acute toxicity.

Inside the dykes few plants and almost no animals can be found. But there are exceptions to this. Near Pond 1A trees are growing on the bank directly beside the pond.

It is anticipated that the top water quality will be the primary environmental concern (with successful isolation of the sludge from the surface environment) after reclamation is initiated. Test results indicate the reclamation of the top water would naturally occur given enough time but with treatment the rate of improvement could be increased.

The results of the biological monitoring of field tests indicate that with treatment there is a general increase in numbers and diversity of species. Less pollution tolerant species are able to survive.

Water chemistry also improved in the field tests. Tailings pond water has 17 parameters non-compliant to Alberta Environment criteria (1977). During tests, trends to decreased organics, metals, biological oxygen demand and suspended solids were observed. Oxygen content increased.

The pH increased from about 8 to about 9.5. The increase may to be due to an anomaly caused by lack of circulation in the test tank.

After treatment, field tests showed as few as seven non-compliant parameters. Ruth Lake, a water body in the immediate vicinity has four non-compliant parameters when compared to the same stringent criteria.

In summary, tailings pond top water has a restricted biology. The water is amenable to in situ treatment. When treated the water will support a diverse aquatic community and most water quality parameters will be within target criteria limits. It is necessary to conduct more studies to confirm these conclusions.

OPERATIONAL PLAN

An operational plan has been developed, based on the current Development and Reclamation Approval Plan. This operational plan has incorporated treatments identified from tests and professional judgement as being desirable in the ultimate abandonment scenario.

Suncor currently has five tailings ponds (Attachment 1). With the exception of one small pond (Pond 1A) that will be left containing only water, all the pond contents will ultimately be delivered to a pond (Pond 5) at the south end of the final mine pit (Attachment 2). The pond will contain 135×10^6 cubic meters of sludge.

The sludge will be isolated from the environment at large. It will be buried under a permanent cap of top water (Attachment 3). This cap of top water will absorb the emissions from the sludge. Natural processes will keep the top water non-toxic and productive. The top water will also be a buffer zone to protect the sludge from being disturbed by changes near the pond surface.

The natural tendency of sludge to release water very slowly will be used to the advantage of the reclamation plan. Terminal sludge has a permeability of $3 \times 10_{-7}$ and becomes even less permeable as time passes. Therefore, water will be retained within the pond basin by formation of a day liner from consolidating sludge.

A large containment dyke will be built on the mine pit side. It will have a clay core to minimize permeation of waters to the outside. There will be a seepage collection system to control and recycle waters from the dyke.

In plain view there will be three major components to the reclaimed area (Attachment 2).

1. A pond (Pond 5) containing sludge buried under 7 to 20 meters of top water. This is where most of the water quality improvement will occur. It is the reactor vessel.

Phosphate will be added to enhance the biodegradation process. Organics in the top water, which can cause toxicity or fish tainting, will be broken down. In time this will result in a reduced oxygen requirement for biodegradation. More oxygen will be available for other purposes. The phosphate will also cause increased growth of plant life and increased photosynthetic production of oxygen.

The deep water will facilitate settling of contaminants, and formation of a quiescent zone where settled materials will have a tendency to remain.

The sludge below the top water will have less hydrocarbons content than "historical" sludge. This reduction will be due to improved recoveries of oils before disposal. The sludge from Pond 1 and Pond 1A, which produce methane, will be diluted with the less contaminated sludge from "new" production and from Ponds 2 and 3. The lower hydrocarbon content will result in reduced potential for methane production and less potential for recontamination of the water by sludge emissions. The sludge will be cooler than at present and will continue to cool over time. This should further retard methane production rates and the potential mobilization of contaminants caused by methane movement.

2. There will be an upstream area consisting primarily of a wetland and reçlaimed waste dumps which will provide fresh inflows of water, nutrients, and colonizing indigenous species.

3. Finally there will be a wetland developed below the reclaimed pond. This wetland will be constructed in a natural limestone channel that lies at the base of the final mine pit. There will be no sludge stored in this area. This area will become a final treatment "trim" pond should any of the water leaving Pond 5 need additional treatment. About 25 per cent of this channel is less than 10 feet deep and a littoral area of high biological productivity is expected to develop. Muskeg will be spread on the wetland bottom to facilitate biological colonization.

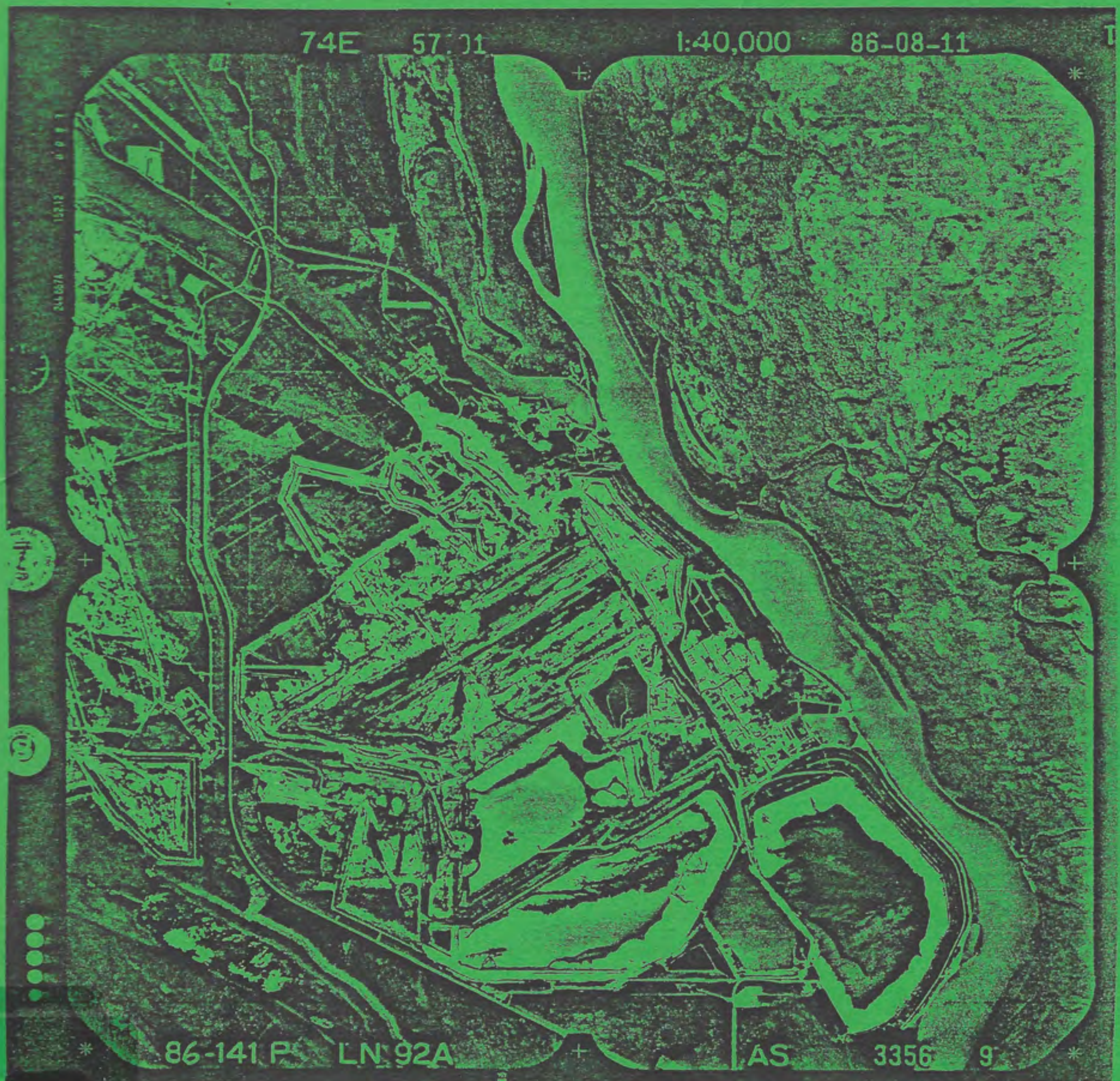
CONCLUSION

Permanent ponds that are geotechnically secure can be constructed. Wet ponds are technically necessary and the environmental issues can be managed.

This is a complex multi-disciplinary problem with far reaching implications. A coordinated and co-operative management approach that will integrate the needs of the various stake-holders is necessary.

Land Reclamation of Oil Sands & Heavy Oil Developments

Proceedings of the Alberta Reclamation Conference '90



Compiled by C.B. Powter

Alberta Chapter, Canadian Land Reclamation Association

1991

Land Reclamation of Oil Sands & Heavy Oil Developments

Proceedings of the Alberta Reclamation Conference '90

Held September 18 and 19, 1990
Fort McMurray, Alberta

Compiled by C.B. Powter
Alberta Chapter, Canadian Land Reclamation Association
1991

Recycled Paper

DISCLAIMER

The views expressed in the papers are those of the authors and do not necessarily reflect thoe views of the Alberta Chapter, Canadian Land Reclamation Association or the proceedings compiler.

The papers have not been edited or reviewed.

This publication may be cited as:

Powter, C.B. (Compiler), 1991. Land Reclamation of Oil Sands & Heavy Oil Developments. Proceedings of the Alberta Reclamation Conference '90. Alberta Chapter, Canadian Land Reclamation Association.

Front Cover: 1986 airphoto of the Suncor facility, north of Fort McMurray, Alberta.

TABLE OF CONTENTS

DEDICATION

These proceedings are dedicated to the memory of Bruce Runge and Michael Mensforth. These two reclamationists passed away in the fall of 1990 while on the job.

Bruce Runge worked for Western Oilfield Environmental Services Ltd. as Operations Manager and was on his way to conduct a pipeline inspection in the Primrose Lake area when the helicopter he was in crashed on the outskirts of Edmonton. Bruce was 45 years old.

Michael Mensforth worked as a reclamation technologist for Alberta Environment, Land Reclamation Division and was on his way to a site in northern Alberta when he was killed in a freak vehicle accident. Micheal was 35 years old.

The loss of these two specialists is a blow to the small reclamation community of our province. It also points out to the rest of us that ours can be a dangerous profession and that safety is critical in our business.

SPONSORS

The Alberta Chapter of the Canadian Land Reclamation Association would like to thank the following sponsors for making the conference and tour a success:

Interprovincial Pipe Lines Company
Luscar Ltd.
Norwest Labs
Nova Corporation of Alberta
Petro-Canada Inc.
Syncrude Canada Limited
Suncor, Inc.
Western Oilfield Environmental Services Ltd.

The Chapter also thanks the conference organizers:

David Walker
Darlene Hergott
David Lloyd
Gail Harrison
Kerby Lowen
Roger Laurin
Chris Powter

Special thanks to the staff at Syncrude and Suncor for their presentations, for the tours and especially for the lunch and supper on the tour.

Thanks also to the staff at Alberta Forest Service who helped with transportation and various duplicating requests, and to the staff of the Fort McMurray Oil Sands Interpretive Centre who provided the facilities for the conference and responded to last minute requests for audio-visual needs.