ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM REVIEW FOR THE FISCAL YEAR 1983/84

AOSERP Report 132

Alberta
ENVIRONMENT
Environmental Protection Services
Research Management Division

ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM REVIEW FOR THE FISCAL YEAR 1983/84

RESEARCH MANAGEMENT DIVISION
Alberta Environment

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RESEARCH PROGRAM

AOSERP Report 132

1986

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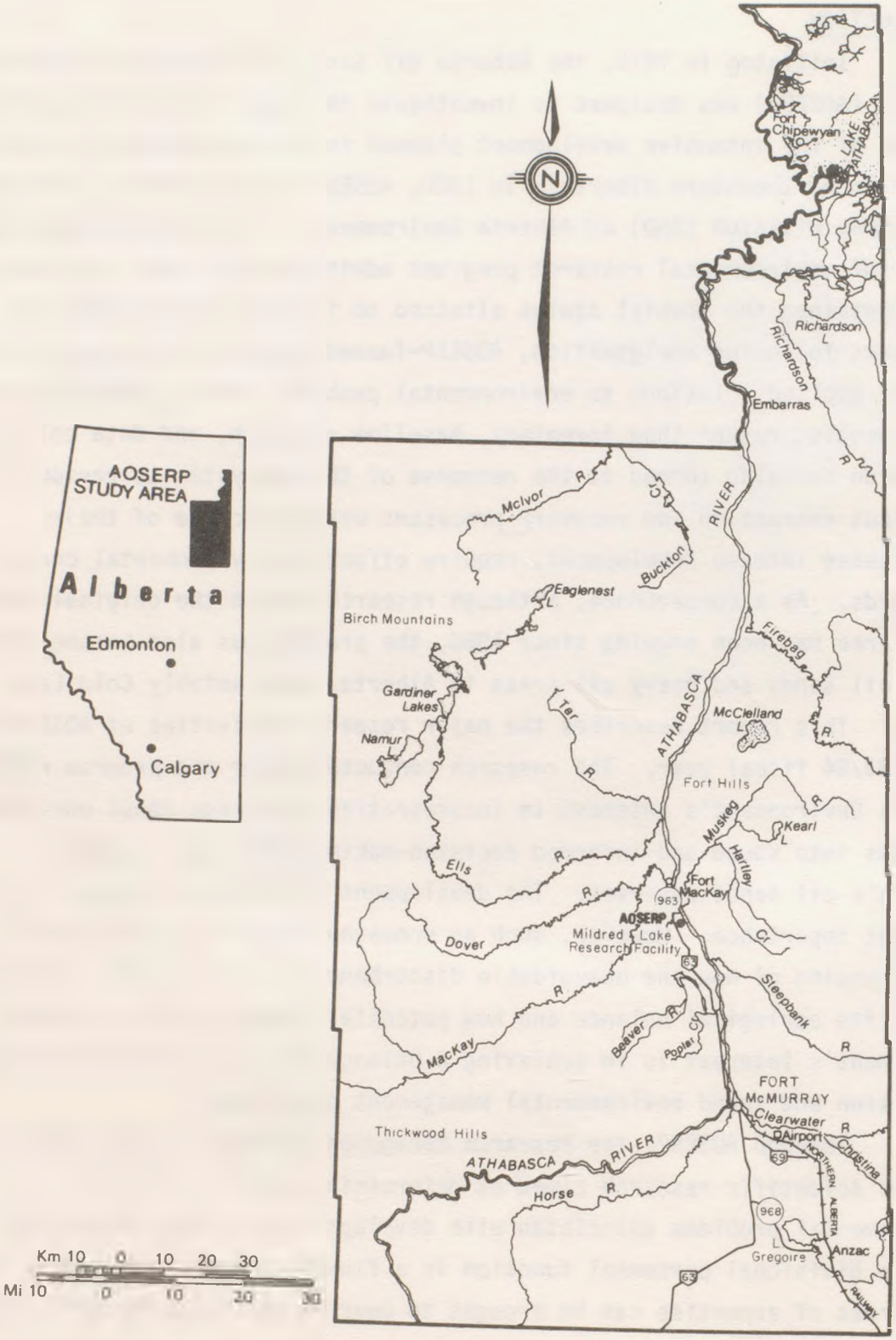
INTRODUCTION

Initiated in 1975, the Alberta Oil Sands Environmental Research Program (AOSERP) was designed to investigate the potential environmental effects of the intensive development planned for the Athabasca Oil Sands region in northeastern Alberta. In 1980, AOSERP was absorbed by the Research Management Division (RMD) of Alberta Environment. The program became one of a number of environmental research programs administered by the division, but has maintained the special status allotted to it prior to amalgamation. In the years following amalgamation, AOSERP-funded research has expanded to address applied solutions to environmental problems arising from oil sands developments, rather than inventory, baseline research, and data collection. Attention has also turned to the response of the ecosystem to various in situ oil sands extraction and recovery processes which, because of their anticipated intense development, require effective environmental control standards. As a consequence, although research within the original AOSERP study area has been ongoing since 1980, the program has also become active in other oil sands and heavy oil areas in Alberta, most notably Cold Lake.

This report describes the major research activities of AOSERP during the 1983/84 fiscal year. The research conducted under the program reflects Alberta Environment's interest in incorporating knowledge about environmental problems into sound and informed decision-making about the recovery of Alberta's oil sands reserves. The development of this vast energy resource is of great importance. However, such an endeavour must be guided by an understanding of how the unavoidable disturbances to the natural environment affect its ecological balance and how potential damage can be mitigated. The Department's interest is in achieving a balance between efficient energy production and sound environmental management practices.

Through AOSERP, the Research Management Division funds, manages, and reviews scientific research aimed at determining applied solutions to environmental problems associated with development of energy resources. Because divisional personnel function in a flexible matrix management system, many areas of expertise can be brought to bear in the planning and designing



Location of the original AOSERP study area.

of environmental research projects. Disciplines represented by the division include climatology, pedology, biology, ecology, sociology, and hydrology. Staff members also act as a scientific resource for various government agencies and industries concerned with oil sands development.

Support for AOSERP is provided by a camp and laboratory at Mildred Lake, located north of Fort McMurray. The Mildred Lake facility is designed as a base for environmental research within an area that is directly affected by oil sands development. It is used by both large and small consulting firms and private energy companies, as well as by a number of governmental and other agencies.

The following report is divided into four sections, each addressing a major research area in which projects were funded under AOSERP. These areas are:

1. The environmental effects of atmospheric emissions;
2. The environmental consequences of in situ extraction technologies;
3. The effects of energy production on humans; and
4. Land reclamation.

ENVIRONMENTAL EFFECTS OF ATMOSPHERIC EMISSIONS

The Acid Deposition Research Program was designed to plan and implement research specific to Alberta that would concisely address the following objectives:

1. To characterize sensitive environmental ecosystems and develop methodologies to identify and/or predict measurable short- and long-term effects of acidic or acidifying substances on Alberta ecosystems;
2. To determine the characteristics and quantities of both long-range emissions and those generated locally, and to examine their effects on the environment;
3. To develop a basis and approach for preventive strategies and environmental protection; and
4. To co-ordinate departmental research on acid deposition with other private and public agencies in Alberta and the rest of Western Canada.

In 1983/84, work on acidic and acidifying substances concentrated on characterizing and quantifying their ecological effects. Such research continued to be a major activity in the Division. Considerable effort was expended to develop a more thorough understanding of the atmosphere-biosphere interface. A newly developed model shows great promise for simulating this relationship.

The emission of acid forming substances into the atmosphere and their deposition and subsequent impact on the ecosystem are of significant concern. Because the magnitude and intensity of deposition is irregular and sporadic, the response of vegetation to pollution episodes is dependent upon the relationship and timing of the incident and the physiological development of the receptor. Specific projects have been geared to the accurate and frequent measurements of pollutant concentration occurrences and their interface with physiological, phenological, and productivity responses in vegetation species. Data generated will be used to develop a computerized numerical model for integrating chronic air pollutant exposures and tree growth response. A second major interface, between soil nutrients, microbiological processes, and vegetation, is also being studied.

Regional surveys to sample and chemically analyse event rainfall and the snowpack for total pollutant loadings in the Athabasca Oil Sands region were continued. Wet deposition, however, is only one of two major mechanisms in the transfer of pollutants from source to receptor. Air pollutants released into the atmosphere are deposited continuously and cumulatively through both dry- and wetfall processes. Methodologies and instrumentation technology for measuring dry deposition were developed and implemented in the field.

In conjunction with the aforementioned studies, research to determine the transport, dispersion, and transformation rates of oxides of sulphur and nitrogen emissions was continued. Such research is intended to facilitate the investigation of the medium- to long-range transport of acid forming emissions from a major emission source in the area.

The Acid Deposition Research Program will provide scientific information for reviewing and evaluating Alberta's air quality standards, will assist in current and future planning of industrial development, and will enable a good understanding of the potential for environmental acidification. This program will thereby establish a basis for sound, long-term environmental management. The data collected will be used in the development of methodologies that will identify and/or predict environmental deterioration caused by acid forming emissions.

The Research Management Division played a major role in the planning, development, and co-ordination of a major new program in Alberta during 1983/84, the Alberta Government/Industry Acid Deposition Research Program (AGIADRP). This important program is sponsored and managed on a fifty-fifty basis by government and industry, and has an estimated budget of $8 million over the next seven years. The planning and development of subsequent phases of the departmental Acid Deposition Research Program, managed by the Research Management Division, will be integrated and co-ordinated with AGIADRP.

PROJECTS

Air Quality Data Acquisition

The emission of acid forming substances into the atmosphere and their deposition and subsequent impact on the ecosystem are of current concern. The magnitude and intensity of deposition follows an episodic pattern; however, the response of vegetation to pollution is dependent upon the relationship and timing of the episode and the physiological development of the receptor. Therefore air quality/atmospheric data must be interfaced with receptor response measurements.

To facilitate the implementation of an ecological monitoring research program, an air quality monitoring station was established in the vicinity of a permanent sample plot on the Sandalta lease in the Athabasca Oil Sands area. The station continuously measures meteorological data and ambient concentrations of acid forming gases, and takes integrated measurements of wet- and dryfall particulate matter. Data generated will be used to develop numerical models for interfacing air quality/atmospheric data to plant response measurements.

An interim report will be available from the Research Management Division.

Contractor: D.S. Chadder, PROMET Environmental Group Ltd.

Funding: $70 000.00 (Research Management Division)

Chemistry of Summer Precipitation in the Athabasca Oil Sands Area

Atmospheric pollutants are scavenged from the air by rainfall. Analysis of this rain provides some indication of the amount and distribution of chemical elements and components that are present in the air. Projects to collect and chemically analyse rainfall on an event basis have been ongoing since 1976 in the Athabasca Oil Sands area. Emissions from industrial sources in this region are under careful scrutiny. Concern is that these parameters would change in space and time as a result of additional atmospheric emission sources. The continued monitoring will delineate any possible changes in the nature and spatial distribution of wetfall deposition from these sources.

Objectives of the study are to:

1. Identify trends in the chemical characteristics of rainfall;
2. Develop the most appropriate and successful sampling and analysis techniques for precipitation chemistry; and
3. Provide a data base to quantify changes in the input rate of atmospheric trace substances into sensitive ecosystems.

Contractor: D.S. Chadder, PROMET Environmental Group Ltd.
E. Peake, Kananaskis Centre for Environmental Research
N. Das, Alberta Environmental Centre

Funding: $56 000.00 (Research Management Division)

Chemistry of Winter Precipitation in the Athabasca Oil Sands Area

As an ongoing project since 1976, the accumulated snowpack in the Athabasca Oil Sands area has been extensively sampled and chemically analysed. The principal objectives of the project have been to quantify the total ionic and particulate loading of the snowpack and to qualitatively assess the spatial distribution of pollutant deposition resulting from the emissions from industrial sources in the area. This information will provide the baseline data required to assess the impact of future industrial developments in the area. Developmental research work was also implemented that would investigate the chemical composition of meltwater and the fractionation of ions during snowmelt.

Contractor: D. LaBerge, CHEMEX Labs (Alberta) Ltd.

Funding: $40 000.00 (Research Management Division)

Determination of Dispersion, Pollutant Trajectories, and Precipitation-Acidifying Processes through Aircraft Measurements

Initiated in 1982 as a co-operative effort between the Alberta Research Council and the Research Management Division, the project investigates the dispersion and transport of sulphur dioxide and oxides of nitrogen from point source plumes in the oil sands area near Fort McMurray. The chemical transformation and rate of removal of these acid forming emissions by both clouds and precipitation will also be investigated. The airborne field measurements will provide baseline information for future

pollutant trend analyses and will be vitally important for tracking pollutant/air mass trajectories from the emission sources.

An interim report will be available from the Research Management Division.

Contractor: M. English and L. Cheng, Alberta Research Council

Funding: $50 000.00 (Research Management Division)
$50 000.00 (Alberta Research Council)

Determination of the Roughness Length in the Athabasca Oil Sands Region

The Gaussian frequency distribution model developed for the Research Management Division provides a reasonable approximation of the ground level concentrations (g.l.c.) of pollutants emitted into the atmospheric boundary layer from point sources. Roughness length (Z_o), a measure of how much mechanical mixing is generated by wind blowing over a particular surface, is a key variable in the model. The location and magnitude of the g.l.c. can therefore be altered with slight variations in Z_o.

The purpose of the project is to increase the reliability of the Gaussian model by determining a more representative value for Z_o for the oil sands area. The model will then be a more powerful tool for reliably predicting ground level concentrations of pollutants. To facilitate this, the project will

1. Empirically estimate Z_o from existing minisonde and acoustic sounder data collected in the AOSERP area by matching the lower portion of the wind profile to the logarithmic law profile; and
2. Evaluate the feasibility of using aircraft-derived measurements to estimate Z_o. Aircraft-derived Z_o values will be correlated with empirically derived values to ascertain the validity and reliability of this technique.

Contractor: R. Rudolph, INTERA Technologies Ltd.

Funding: $44 000.00 (Research Management Division)

Dry Deposition of Acid Forming Emissions in Alberta

The measurement of acid forming emissions deposition relies on two components: wet- and dryfall accumulation. In Alberta, dry deposition is

considered to be at least as important as wet deposition; unfortunately, dry deposition rates are not well documented. This project, currently being conducted in the Athabasca Oil Sands area, will continuously measure ambient concentrations of sulphur dioxide and collect integrated data on the quality and quantity of dry- and wetfall particulate matter. This study will promote the development and field testing of measurement techniques for the dry deposition of sulphur dioxide and the subsequent derivation of dry deposition velocities.

The project is a specific component of an integrated research effort to assess the impact of total acid deposition on terrestrial ecosystems. It will provide the information necessary to assess the total deposition occurring in the vicinity of an oil sands plant and to define source-receptor relationships.

An interim report will be available from the Research Management Division.

Contractor: D.S. Chadder, PROMET Environmental Group Ltd.

Funding: $87 000.00 (Research Management Division)

Effects of Deposition of Acid Forming Substances on Nutrient Cycling in a Forest Ecosystem

The effects of deposition of acid forming substances on (1) nutrient release from decomposing litter; (2) distribution and leaching characteristics of key nutrients in the litter/soil system; and (3) the uptake of nutrients by mycorrhizal and non-mycorrhizal jackpine seedlings will be studied.

The first annual report is available from the Research Management Division,

Contractor: D. Parkinson, University of Calgary

Funding: $40 688.00 (Research Management Division)

Effects of Deposition of Acid Forming Substances on Organic Matter Decomposition and Microbial Activity

This study will investigate organic matter transformations in the litter layer of jackpine woodland ecosystems under different levels of impact from acid forming emission substances. Sampling of litter fall, decomposition

rates, biological activity, and total microbial biomass will be done. Major reactions in carbon (energy) flow are to be measured and correlated with the impact of the acid forming substances.

The first annual report is available from the Research Management Division.

Contractor: D. Parkinson, University of Calgary

Funding: $29 159.00 (Research Management Division)

The Effects of Nitrogen Oxides on Native Vegetation, Soils, and Water near a Compressor Installation

The sensitivity of select natural plant species to injury by low concentrations of nitrogen oxide and/or nitrogen dioxide stress was determined. Also examined were the effects of nitrogen oxides on the availability of certain plant nutrients in the soil. These studies will be integrated with the compressor station-ecosystem distribution inventory for Alberta, as well as with information on known emissions of oxides of nitrogen.

A final report will be available from the Research Management Division late in 1985.

Contractor: A. Legge, University of Calgary

Funding: $95 000.00 (Research Management Division)
$30 000.00 (Standards and Approvals Division)

Impacts of Air Pollutant Mixtures on Forest Vegetation and Soils

The study is designed to use both laboratory and field investigations to identify and quantify forest tree responses to single and multiple exposures of acid forming pollutants. For the Athabasca Oil Sands area, a predictive capability for changes in forest soils and vegetation will be developed. Both current and future rates of pollution deposition are being considered.

Annual reports are available from the Research Management Division.

Contractor: P. Addison, Canadian Forestry Service

Funding: $30 000.00 (Research Management Division)

Nutrient Redistribution in Jackpine as an Indication of Acid Deposition Stress

The feasibility of using non-destructive analytical methods to detect changes in tree wood chemistry is being examined. Tree cores will be analysed for temporal nutrient changes related to the emissions from oil sands plants in the Fort McMurray area.

A final report will be available from the Research Management Division late in 1985.

Contractor: A. Legge, University of Calgary

Funding: $40 800.00 (Research Management Division)

Protection of the Biotic Environment

This study evaluated the relative effects of natural and anthropogenic (pollutants) factors on forest ecosystems. Morphologic and growth responses (past and present) in jackpine and aspen stands throughout the Athabasca Oil Sands were studied to determine if pollution effects can be identified and quantified. The research was carried out under the auspices of an Alberta Oil Sands Technology and Research Authority Professorship.

The final report is in preparation.

Contractor: C. Pielou, University of Lethbridge

Funding: $38 308.00 (Grant to University of Lethbridge Professorship) (Research Management Division)

$14 100.00 (Research contract) (Research Management Division)

The Response of Vegetation Communities to Aerial Emissions

This project will determine structural dynamics in the boreal forest in order to compare any natural changes to those induced by aerial emissions. Results from this project will be used, in conjunction with findings from other studies, to develop sensitive and predictive indicators of effects of aerial emissions on forest ecosystems (as an early warning). This study will involve process-related phenomena and will establish the relationship between changes occurring in these processes and the structure and function of terrestrial ecosystem. This project has been integrated with other terrestrial studies.

Annual reports are available from the Research Management Division.

Contractor: G. LaRoi, University of Alberta

Funding: $87 508.50 (Research Management Division)

PUBLICATIONS

Case, J.W. 1983. **Biomonitoring of air pollution in Alberta with lichens and mosses.** Prep. for Alberta Environment, Research Management Division. RMD Report OF-52. 154 pp.

Colley, D.G., R.W. Poon, M.J. Zelensky, and L. Zanzotto. 1984. **Alberta oxides of nitrogen emissions forecast 1980 to 2000.** Prep. for Alberta Environment, Research Management Division by Western Research, Division of Bow Valley Resources Ltd. RMD Report 84/26. 101 pp.

Krouse, H.R. and J.W. Case. 1983. **Sulphur isotope abundances in the Alberta Oil Sands Environmental Research Program study area.** Prep. for Alberta Oil Sands Environmental Research Program by University of Calgary Interdisciplinary Sulphur Research Group (UNISUL) and Department of Physics, University of Calgary. RMD Report OF-55. 99 pp.

Krouse, H.R. and J.W. Case. 1984. **Design, development, and field testing of a mobile nine unit high volume air sampler array.** Prep. for Alberta Environment, Research Management Division by Physics Department, University of Calgary. RMD Report OF-69. 45 pp.

LaRoi, G.H. and M. Ostafichuk. 1983. **Structural dynamics of boreal forest ecosystems on three habitat types in the Hondo-Lesser Slave Lake area of north-central Alberta in 1981.** Prep. for Alberta Environment, Research Management Division by Department of Botany, University of Alberta. RMD Report OF-64. 110 pp.

LaRoi, G.H., M.S. Ross, and M. Ostafichuk. 1983. **Structural dynamics of boreal forest ecosystems on three habitat types in the Hondo-Lesser Slave Lake area of north-central Alberta in 1982. Volume I: Text; Volume II: Appendix.** Prep. for Alberta Environment, Research Management Division by Department of Botany, University of Alberta. RMD Report OF-65. 2 vols.

Nosal, M. 1984. **Atmosphere-biosphere interface: probability analysis and an experimental design for studies of air pollutant-induced plant response.** Prep. for Alberta Environment, Research Management Division by Statistical Research Laboratory, University of Calgary and Statscon, Statistical Consulting Co. RMD Report 83/25. 98 pp.

Ostafichuk, M. and G.H. LaRoi. 1983. **Progress report for 1982: Pinus banksiana-dominated permanent sample plots in the Athabasca Oil Sands.** Prep. for Alberta Environment, Research Management Division by Department of Botany, University of Alberta. RMD Report OF-66. 189 pp.

Sandhu, H.S. and R.P. Angle. 1984. **Air quality and acid rain: an overview.** 26 pp. (Paper prep. for "Impacts of Science and Technology on Environments," a lecture series organized by Edmonton Public School Board.)

EFFECTS OF ENERGY PRODUCTION ON HUMANS

During 1983/84, research into the effects of energy production on humans focused on the effects of plant closures on resource communities and on public involvement in environmental decision-making.

A project that researched the effects of plant closures on a single-resource community was completed during the year. This project assessed the socio-economic impacts of plant closures on the quality of life of individuals and families and covered a wide range of social and economic indicators.

A comprehensive literature search and a review of current techniques for public involvement strategies in water resource management was undertaken for the Community Affairs Branch of the Environmental Assessment Division. This provided background for an evaluation of the public involvement component of the Beaver River-Cold Lake Water Management Study. The report primarily dealt with data from 1978 to 1983.

PROJECTS

Effects of Plant Closures: Phase I

An assessment of the socio-economic impacts of plant closures on the quality of life of individuals and families within the community of Brooks was completed. Analysis of the data provided the basis for recommendations concerning long- and short-term strategies to reduce the socio-economic impacts of future closures.

Contractor: Anna Parkinson Urban Consultants Ltd.

Funding: $34 500.00 (Research Management Division)

Population Turnover in Fort McMurray: Phase II

A questionnaire identifying why people moved from resource towns was designed and pre-tested in Phase I. Implementation of that questionnaire to former residents of Fort McMurray will identify why people move from resource towns.

Contractor: Thames Group Research

Funding: None in 1983

PUBLICATIONS

Krahn, H. 1984. **Labour market segmentation in Fort McMurray.** Prep. for Alberta Environment, Research Management Division by Department of Sociology, University of Alberta. RMD Report OF-71. 329 pp. (Ph.D. thesis)

ENVIRONMENTAL CONSEQUENCES OF IN SITU EXTRACTION TECHNOLOGY

The research emphasis of the aquatic component of AOSERP during 1983/84 addressed the potential effects on surface and groundwater resources of in situ oil sands extraction and recovery. There were three major areas of investigation:

1. The most extensive research involved a regional assessment of the hydrological and hydrochemical characteristics of the Cold Lake Oil Sands deposit, where a steam injection pilot plant has been operated by Esso Resources for several years and a potential production facility is in the final planning stage.
2. A companion project monitored the location and cause of seismic events in the Cold Lake area. The objective of this project was to provide detailed baseline data to monitor the in situ steam injection process and determine if it was contributing to ground deformation and/or movement.
3. The third project identified the toxic and carcinogenic products that are generated by several different in situ processes.

The objective of each of these projects is to evaluate the possible environmental hazards and human health risks associated with in situ oil sands recovery processes. The synthesis of the results from these studies will provide the Department with the integrated environmental information necessary for making informed management decisions for the safe environmental development of oil sands resources by in situ extraction and recovery processes.

PROJECTS

Analysis of Aquatic Monitoring Data in the Athabasca Oil Sands Area

The objective of this project was to analyse the relationship between water quality and benthic invertebrate data based on samples collected during monitoring programs carried out on the Athabasca River. Specifically, this task involved the use of multivariate statistical analysis to: (1) evaluate which few water quality parameters of the many measured would be useful in long-term monitoring programs designed to detect municipal and industrial impacts; and (2) determine if water quality parameters could be used to predict the distribution and abundance of benthic invertebrates at sites within the study area.

Contractor: Dr. G. Walder, Sigma Biometrics

Funding: $15 000.00 (Research Management Division)

International Conference on Oil and Fresh Water: Chemistry, Biology, and Technology

This grant contributed to the organization and presentation of a major international conference on oil pollution of fresh water, held on 1984 October 15-19. The conference brought together experts from the disciplines of chemistry, biology, and engineering. By means of invited and contributed papers, it served as a review of all available and current research on oil pollution of freshwater systems. Special attention was given to contamination resulting from oil spills, synthetic crude oil production, and industrial/urban runoff.

Contractor: Dr. S.E. Hrudey, University of Alberta

Funding: $10 000.00 (Research Management Division) (Grant)

Oil Sands In Situ Combustion Products

This project was undertaken to identify contaminants in the fluids and gases associated with in situ fire-flood produced bitumen, and identify the possible environmental hazards and human health risks arising from these toxic and carcinogenic materials.

Contractor: E. Peake, Kananaskis Centre for Environmental Research, University of Calgary

Funding: $50 000.00 (Research Management Division)
$50 000.00 (Alberta Oil Sands Technology Research Authority)

A Regional Assessment of Hydrogeological and Hydrochemical Conditions in the Cold Lake Oil Sands Deposit

This project is an integral part of the Department's effort to assess the extent and quality of groundwater resources in the Cold Lake region to protect the resources from contamination by industrial activity. At present, no technology exists for a quantitative prediction of the potential regional-scale effects of lost process or wastewaters on a pre-existing groundwater regime in three dimensions in the presence of high pressure, high temperature steam injected in a widely distributed pattern of boreholes. This project seeks to establish such a technology through the development of a three-dimensional framework of tne hydrostratigraphy, hydrodynamics, and hydrochemistry of the Cold Lake Oil Sands area. It will also identify the processes inherent to both in situ recovery and deep waste disposal methods, and will evaluate their possible effects on both local and regional groundwater regimes. Recommendations will be made for further study aimed at the quantification of these potential impacts on both local and regional scales.

Contractor: Dr. G. Gabert, Alberta Research Council

Funding: $229 000.00 (Research Management Division)
$104 607.00 (Alberta Research Council)

PUBLICATIONS

Andres, D.D. In prep. **The hydraulic erodability of cohesive materials.** Alberta Research Council, Internal Report SWE 83-04.

Andres, D.D. and P.F. Doyle. 1983. **Analysis of breakup and ice jams on the Athabasca River at Fort McMurray, Alberta.** Submitted to the Canadian Journal of Civil Engineering. Alberta Research Council, Contribution Series Paper 1214.

Boerger, H. 1983. **Distribution and abundance of macrobenthos in the Athabasca River near Fort McMurray.** Prep. for Alberta Environment, Research Management Division by Department of Physics, University of Calgary. RMD Report OF-53. 77 pp.

Elhadi, N., R.A. Harrington, I. Hill, Y.L. Lau, and B.G. Krishnappan. 1983. **River mixing: a state-of-the-art report.** Accepted for publication in the Canadian Journal of Civil Engineering.

Hudson, H.R. 1983. **Discussion of bedload and size distribution in a paved gravel bed stream.** Submitted to Journal of Hydraulic Engineering, ASCE. Alberta Research Council, Contribution Series Paper 1155.

Hudson, H.R. In prep. **Fluvial sediment yield in Alberta. IN: Proceedings of the Soil Erosion and Land Degradation Conference.** November 1983; Saskatoon, Saskatchewan.

Hudson, H.R. In prep. **Sediment yield research in Alberta.** Alberta Research Council, Internal Report SWE 83-05.

Hudson, H.R. 1984. **Aspects of the hydrologic and sediment regimes of the Muskeg River Basin and the consequences of vegetation removal.** Prep. for Alberta Environment, Research Management Division by Department of Civil Engineering, Alberta Research Council. RMD Report L-84. 46 pp.

LAND RECLAMATION

Petroleum extraction from oil sands causes several reclamation problems, the most serious being current tailings disposal systems. At the end of its 25-year life cycle, a typical oil sands plant producing 19 900 m^3 (125 000 barrels) per day of synthetic crude oil will require a 22 to 31 km^2 tailings pond. The 360 000 000 m^3 of sludge in the pond will remain liquid indefinitely, and must be impounded behind tailings sand dykes 55 to 100 m high. A cover of grasses, legumes, and shrubs will provide erosion protection. Since tailings sand lacks nutrients and drains excessively rapidly, it must be amended with peat and mineral fines to initiate soil development. Extensive areas of overburden dumps and flat tailings sand must also be reclaimed to various land uses.

Research into the reclamation requirements of oil sands development is aimed at defining techniques whereby a self-sustaining, erosion-free cover can be established on tailings sand dykes, and tailings sands storage and overburden dumps can be returned to productive forest. The resulting soil and plant community combinations must not only fulfill these land use requirements, but must also sustain themselves without indefinite maintenance.

The regulation of surface disturbances in Alberta is the responsibility of the Land Conservation and Reclamation Council, which oversees reclamation research programs. To assist in technical matters related to the development and administration of research programs, the Council appointed the Reclamation Research Technical Advisory Committee (RRTAC), which consists of eight members representing the departments of Agriculture, Energy and Natural Resources, and Environment, and the Alberta Research Council. The Research Management Division represents Alberta Environment on RRTAC and provides project managers and administrative support for many of the projects in this program.

To pool resources and avoid duplication, RRTAC and the industry's Oil Sands Industry Environmental Association (OSIEA) have initiated a joint Reclamation Research Program for oil sands areas. Three priorities have been identified: (1) woody plant research, (2) soil reconstruction, and (3) equipment development.

The Woody Plant Research Program is now underway, and test plots for the Soil Reconstruction Research Program have been prepared. Some initial work on choice and modification of existing equipment has been done as part of the Soil Reconstruction Research Program.

PROJECTS

Mycorrhizal Development on Severely Disturbed Soils

This study examined the potential of natural inoculum in stored peat and developed effective mycorrhizal associations for oil sands reclamation.

Four reports to be published in 1985 will describe the nature and rate of micro-organism establishment in mine spoils and the influence of various reclamation treatments in creating a stable plant-soil system.

Contractor: D. Parkinson, University of Calgary

Funding: $86 140.00 (Land Conservation and Reclamation Council-Heritage Savings Trust Fund)

Oil Sands Tailings Soil Reconstruction

Using the results of a study undertaken to determine the minimum physical, chemical, and biological properties of soil required to support three vegetation types, a joint government-industry reclamation project was initiated to identify methods of reconstructing soils from tailings sand, peat, and clayey materials that will support a self-maintaining woody shrub and tree cover. A flat tailings sand experimental site was constructed on the Syncrude Canada Ltd. lease at Fort McMurray.

Fifty-four plots, 22 m wide and 44 m long, were created. Treatments included: (1) three organic carbon levels provided by mixing peat into the tailings sand; (2) three levels of clay provided by mixing fine-textured overburden into the tailings sand; and (3) two mixing depths.

Baseline soil data have been collected and 10 tree and shrub species were planted in the fall of 1984.

Contractor: H. Martens, Hardy Associates (1978) Ltd.

Funding: $108 106.00 (Land Conservation and Reclamation Council-Heritage Savings Trust Fund)

$108 106.00 (Syncrude Canada Ltd., Suncor Inc., and the Oil Sands Industry Environmental Association)

International Inventory of Fertility Analysis for Peat Soils

Peat fertility is a poorly understood subject that has received minimal investigation in North America. Under the auspices of the International Peat Society, an RMD scientist has compiled an international inventory of peat analysis methods used by research institutes where more relevant research has been carried out. The inventory will be used to help develop standard international methodology for peat analysis.

Funding: None in 1983/84

Reclamation Research Review

International reclamation literature is being collected by RMD staff and compiled in a bibliography. A computer program has been developed to allow users to search the bibliography. The data base is kept on a SPIRES file at the University of Alberta. An additional 800 references were added to the computer data base in 1983/84.

Divisional staff prepared a synthesis of literature referenced in the bibliography. This report was published in March 1984, and provides direction for further research in the province.

Funding: $17 500.00 (Land Conservation and Reclamation Council-Heritage Savings Trust Fund)
15 341.00 (Research Management Division)

PUBLICATIONS

Monenco Consultants Ltd. 1983. **Soil reconstruction design for the reclamation of oil sands tailings.** Prep. by Monenco Consultants Ltd. for the Oil Sands Environmental Study Group and Alberta Land Conservation and Reclamation Council. Report No. OSESG-RRTAC 83-1. 196 pp. (Available from Queen's Printer.)

Sims, H.P., C.B. Powter, and J.A. Campbell. 1984. **Land surface reclamation: a review of international literature.** Prep. for Alberta Land Conservation and Reclamation Council by Research Management Division. Report No. RRTAC 84-1. 2 vols. 1549 pp. (Available from Queen's Printer.)

Zak, J.C. and D. Parkinson. 1983. Effects of surface amendation of two mine spoils in Alberta, Canada, on vesicular-arbuscular mycorrhizal development of slender wheatgrass: a 4-year study. Canadian Journal of Botany 61:788-803.

CUMULATIVE LIST OF AOSERP PUBLICATIONS TITLES

1. AOSERP First Annual Report, 1975
2. Walleye and Goldeye Fisheries Investigations in the Peace-Athabasca Delta - 1975
3. Structure of a Traditional Baseline Data System
4. A Preliminary Vegetation Survey of the AOSERP Study Area
5. The Evaluation of Wastewaters from an Oil Sand Extraction Plant
6. Housing for the North. The Stackwall System Construction Report - Mildred Lake Tank and Pump House
7. A Synopsis of the Physical and Biological Limnology and Fishery Programs within the Alberta Oil Sands Area
8. The Impact of Saline Waters upon Freshwater Biota. A Literature Review and Bibliography
9. A Preliminary Investigation into the Magnitude of Fog Occurrence and Associated Problems in the Oil Sands Area
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13. Plume Dispersion Measurements from an Oil Sands Extraction Plant, March 1976
14. (No report published)
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18 Interim Compilation of Stream Gauging Data to December 1976 for AOSERP
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59. Semi-Aquatic Mammals: Annotated Bibliography

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101. Woodland Caribou Population Dynamics in Northeastern Alberta

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