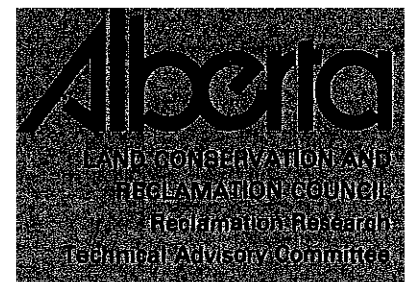


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REPORT #
ERTAC 80-2

Alberta's Reclamation Research Program - 1979



13 May 1980

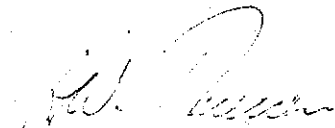
The Hon. John W. (Jack) Cookson
Minister of the Environment
222 Legislative Building
EDMONTON, Alberta

Dear Sir:

Enclosed herein is the report "Alberta's Reclamation
Research Program - 1979".

This program status report was prepared by the Reclamation
Research Technical Advisory Committee under the direction of the
Alberta Land Conservation & Reclamation Council.

Respectfully,



H. W. Thiessen, P. Ag.
Chairman, Alberta Land Conservation
and Reclamation Council
Assistant Deputy Minister
Alberta Environment

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INTRODUCTION

The regulation of surface disturbances in Alberta is the responsibility of the Land Conservation and Reclamation Council. The Council executive consists of a chairman from the Department of the Environment and two deputy chairmen from the Department of Energy & Natural Resources. Among other functions, the Council oversees programs for reclamation of abandoned disturbances and reclamation research. The reclamation research program was established to provide answers to the many practical questions which arise in reclamation. Funds for implementing both the operational and research programs are drawn from Alberta's Heritage Savings Trust Fund.

To assist in technical matters related to the development and administration of the research program the Council appointed the Reclamation Research Technical Advisory Committee (RRTAC). The Committee first met in March, 1978 and consists of eight members representing the Alberta departments of Agriculture, Energy & Natural Resources, Environment and the Alberta Research Council. The Committee meets regularly to update research priorities, review solicited and unsolicited research proposals, arrange workshops and otherwise act as a referral and coordinating body for reclamation research.

Additional information on the Reclamation Research Program may be obtained by contacting:

Dr. P. F. Ziemkiewicz, Chairman
Reclamation Research Technical Advisory Committee
Alberta Energy & Natural Resources
9915 - 108 Street
Edmonton, Alberta
(427-8042)

THE SETTING

Most of Alberta's industrial activity occurs in three major biophysical regions: The Plains, where most of the province's agricultural land is located, the Mountains and Foothills where recreation, forestry and watershed values are predominant, and Northeast Alberta, where wildlife and some forestry values exist.

Coinciding with these regions are three major disturbance types:

- 1) Plains: coal mines operated in conjunction with electrical generating plants,
- 2) Mountains and Foothills: metallurgical coal mines and high-quality thermal coal for export, and
- 3) Northeast Alberta: oil sand mining and extraction facilities.

While it is expected that research results will often have province-wide application, the division of the program among the three biophysical regions has proved helpful in identifying priorities and directions for the research program.

THE RESEARCH PROGRAM

Following is a summary of ongoing research projects as of March, 1980. Results will be made public as they become available.

1. PLAINS

OBJECTIVES

To return crop land to pre-mining levels of productivity. Productivity is taken to include both agricultural and hydrologic capabilities.

THE PROBLEM

The geology and climate of the Plains dictate the major constraints to reclamation. The overburden is usually rich in sodic clays which become sticky when wet and massive and compacted when dry. These properties restrict plant growth and hinder agricultural operations. Surfacing sodic spoils with non-sodic material or other amendments may re-establish agricultural values on reclaimed land. Identification of the required depth of surfacing materials and/or the selection of amendments is a major area for research. The question is complicated by the possibility of upward salt migration through surface material ^{1/}. Surface mining in these sodic formations may also result in degradation of groundwater quality and productivity.

APPROACH

Recognizing the interaction between surface treatments and groundwater in determining eventual land productivity, the RRTAC, and members of the Coal Industry have developed a program for the Plains which includes both agricultural and hydrologic aspects of reclamation. The projects are designed so that the same basic designs can be transferred to other sites around the Alberta Plains. This will yield consistent information and will facilitate policy-making and the development of regional reclamation standards and practices.

^{1/} Power, J. F., Sandoval, F.M. and Ries, R.E., 1979. Topsoil-subsoil requirements to restore North Dakota mined land to original Productivity. Mining Engineering 31(12): 1708-1712.

The expansion of mining on the south side of the Battle River near Forestburg, Alberta provided an excellent opportunity to establish a research program encompassing all phases of the mining-reclamation process. These projects are concerned with salt generation and transport after mining, while another project examines surface treatments which may allow re-establishment of agriculture on surface-mined lands.

PROJECTS

Battle River Project

1. Restoration of Agricultural Productivity (79-6-SCH)

Several reclamation techniques will be tried at the Forestburg South site to return the post-mining landscape for former levels of agricultural productivity. Treatments will include: depth of non-sodic overburden placement over sodic spoil 0-3 m, use of bottom ash as an impediment to capillary salt/water rise, use of ash as a sodic spoil amendment in combination with gypsum and reconstruction of topsoil using different horizons and mixtures. Salt migration on sloped spoils covered with 0.5 m of non-sodic overburden will also be studied. This is a co-operative study with Manalta Coal Ltd., Luscar Ltd., and Alberta Power Ltd. The design is a series of factorial analyses of variance so factor interactions can be evaluated. This project began in 1979 and may be expanded to include more mining sites in the future.

Battle River Project

2. Plains Hydrology and Reclamation (79-2-MOR)

This study looks at the impacts of surface mining on the regional groundwater, geology and soils. The main objectives include the identification of: 1) changes in groundwater quality and quantity after mining, 2) sources and release rates of groundwater contaminants (mainly salts), and 3) changes in distribution of groundwater after mining. (Will the groundwater carry salts to the surface, will the watertable drop or will the watertable re-establish at pre-mining levels?)

Critical groundwater and geologic parameters will be identified which may allow us to predict the "reclaimability" of a site prior to mining. This project began in 1979 and, like the previous study, can be expanded to other sites in the future.

Battle River Project

3. Contribution of Groundwater Organic Compounds to Salinization in Plains Surface Mining (79-22-HOD)

This is a literature review to assess the significance of organic compounds in regulating the salinization of groundwater and soils after surface mining.

Battle River Project

4. Biogeochemical Processes (79-27-HOD)

This project examines the microbiology and organic chemistry of

mine spoil salinization and was instituted to complement the inorganic chemistry approach taken in the Plains Hydrology Reclamation Project. The combination of these studies will give us a clearer picture of the chemical, geological and groundwater factors which will, in the long run, determine the viability of agriculture on the post-mining landscape in Alberta.

5. Physical and Chemical Changes in Stockpiled Topsoil (79-26-FUJ)

A topsoil stockpile near Bow City, Alberta, is being monitored along with undisturbed topsoil to determine whether adverse changes in the soil occur during storage. Ultimately this line of research will indicate how long topsoil can be stored before deterioration occurs.

II. MOUNTAINS AND FOOTHILLS

OBJECTIVES

1. Control of erosion on a wide variety of disturbances including coal mines, mineral exploration sites, coal ash pits and oil and gas well sites.
2. Return of forested lands to previous levels of productivity.
3. Return of wildlife range to previous levels of productivity.

THE PROBLEMS

The Mountains and Foothills present an often harsh climate for vegetation establishment. The site conditions in the early stages of reclamation are often very dry, windy, cold and the soil is invariably poor in plant nutrients. Consequently, few of the commercially available

plant species which are successful in reclamation at low elevations are successful in the mountains. Subalpine and Alpine sites are particularly difficult.

In areas where commercial forests are to be re-established a conflict may arise between the competing objectives of erosion control and reforestation. This results from competition between the seeded grasses and tree seedlings.

Other considerations make reclamation in the mountains and foothills different from that of the Plains. While reclaimed lands on the Plains will come under some form of management (farming, managed grazing, recreation or urban uses), reclamation in the mountains and foothills must create a self-sustaining cover which will often receive no further management other than periodic logging. So the plant communities created in reclamation must not only allow for reproduction of desirable plants on the sites, but reclamation must also set the stage for the development of a soil-plant system which will not deteriorate in time.

APPROACH

Because of these constraints reclamation research in the mountains and foothills should develop techniques whereby government and industry operators can, after a period of reclamation, walk away from the site reasonably confident that the site will not require further treatment.

Research, therefore, concentrates on developing grasses, legumes and woody plants capable of surviving and reproducing in Subalpine and Alpine environments. Other research aims at management practices which will facilitate plant establishment under harsh conditions. Another critical area for research will be fertilizer management on reclaimed areas and the development of fertilizer rates, grades and intervals which will accelerate the development of stable plant communities. Due to the variety of disturbances in the mountains and foothills and the variety of environments, research will tend to be more site specific than on the plains.

PROJECTS

1. Selection of Native Grasses for Reclamation (79-7-WEI)

In the mountains and foothills there are many sites where reclamation with present techniques is impossible because the forage and lawn grasses now used in reclamation are poorly adapted. This study is selecting native grasses which are known to invade disturbances in the Subalpine and Alpine. Selections are made on the basis of commercial potential and fitness for reclamation.

2. Native Grasses for Reclamation: Selected Line Adaptability Trials (79-23-WEI)

By early 1979 the above study had produced nine selected lines of native grass species. To ensure that the selected lines had not lost their tolerance to high-elevation conditions in the process of development, a series of test plots was established: 1) to evaluate

their fitness to Subalpine and Alpine conditions, 2) to compare their performance to selected agronomic grasses, and 3) to evaluate their respective fertilizer requirements.

3. Optimization of Erosion Control and Reforestation Potential of Reclaimed Areas (79-26-MIH)

This study will identify the level of herbaceous cover which will prevent erosion yet permit tree seedling growth. This study will also identify methods of arriving at the optimal levels of herbaceous cover.

4. Use of Mat Mulches (79-17-TAK)

The relative effectiveness of various roll-out Mat Mulches and ridging treatments will be evaluated on unamended coal spoils.

5. Evaluation of Native-Agronomic Grass/Legume Mixes for Reclamation of Subalpine Disturbances (79-18-RUS)

Certain agronomic grasses and legumes are known to quickly establish an erosion-controlling cover while native grasses generally grow more slowly. This experiment tests which of several native/agronomic seed mixes provides the best combination of erosion-control and long-term stability.

6. Revegetation of Ash Disposal Areas, Grande Cache (78-1-MAC)

This project will test depths of overburden required to revegetate these disposal sites. Also, ash-overburden mixtures will be examined.

III. NORTHEAST ALBERTA

OBJECTIVES

1. To develop techniques whereby a self-sustaining, erosion-free cover can be established on oil sand tailings pond dykes.
2. Return tailings sand storage areas to productive forest.

THE PROBLEM

Northeast Alberta contains all of Canada's surface-mineable oil sands. The facilities required to extract this valuable petroleum resources present several problems for reclamation. By far the greatest problem lies with the tailings disposal systems currently employed.

At the end of its 25 year life a typical oil sand plant producing 19,900 m³/day (125,000 barrels/day) of synthetic crude oil will require a 22 to 31 km² (8.5 to 12 mi²) tailings pond. The liquid contents of the pond will primarily consist of 360 million cubic meters of sludge. Estimates on the time required for the sludge to solidify vary from hundreds to thousands of years. Maintaining the integrity of the outer surface of the sand dykes against erosion for this sort of time period will pose a unique reclamation challenge.

Mine pits filled with sand will present the other major disturbance requiring reclamation. While these surfaces will occupy about the same area as the tailings ponds, reclamation problems will be minor in comparison. For, while the tailings sand is nearly devoid of nutrients, the proper surface amendments and plant cover should permit acceptable reclamation.

APPROACH

With these constraints in mind the Research Program has been designed around two major areas: building a soil on tailings sand and developing suitable plant species for revegetation.

As in the Mountains and Foothills, proper reclamation in North-east Alberta will produce landform and plant community combinations which will fulfill their land use requirements without indefinite maintenance.

PROJECTS

1. Soil Reclamation Study: Phase 1 Literature Review (79-24-OSE)

This is a joint Industry-Alberta Government project aimed at identifying available soil-building materials in the Oil Sands area and developing methods of combining these materials into productive soils. Phase I, which is a literature review and collation of existing information, is being funded in 1979-80. It is intended that this will be followed by one or more experimental phases in succeeding years.

2. Selection of Tree and Shrub Varieties for Oil Sand Reclamation (79-13-DUN)

This study will help select those native and introduced woody species which will be useful in reclamation of disturbances caused by oil sand mining and extraction.

IV GENERAL

PROJECT

1. Reclamation Review (78-6-SIM)

Compilation and presentation of all literature pertinent to

reclamation in Alberta. This will be a handbook of known techniques and will identify the gaps in our current knowledge.

2. Establishment of Biological Activity in Oil Sands Tailings and Coal Mining Overburden (78-4-PAR)

This study looks at the nature and rate of micro-organism establishment in spoils and the influence of various reclamation treatments in establishing a stable plant-soil system. The project includes both laboratory and field work and studies spoils produced by Plains Coal mining, Mountain and Foothills Coal Mining as well as oil sand mining and extraction.

3. Species Suitability Manual (79-5-W/P)

This manual will catalogue available information on the many species used or useable in reclamation. This will help field personnel design seed mixes which are better adapted to their particular needs.

4. Survey to Determine the Occurrence of Microbial Root Sheaths (79-8-L/R)

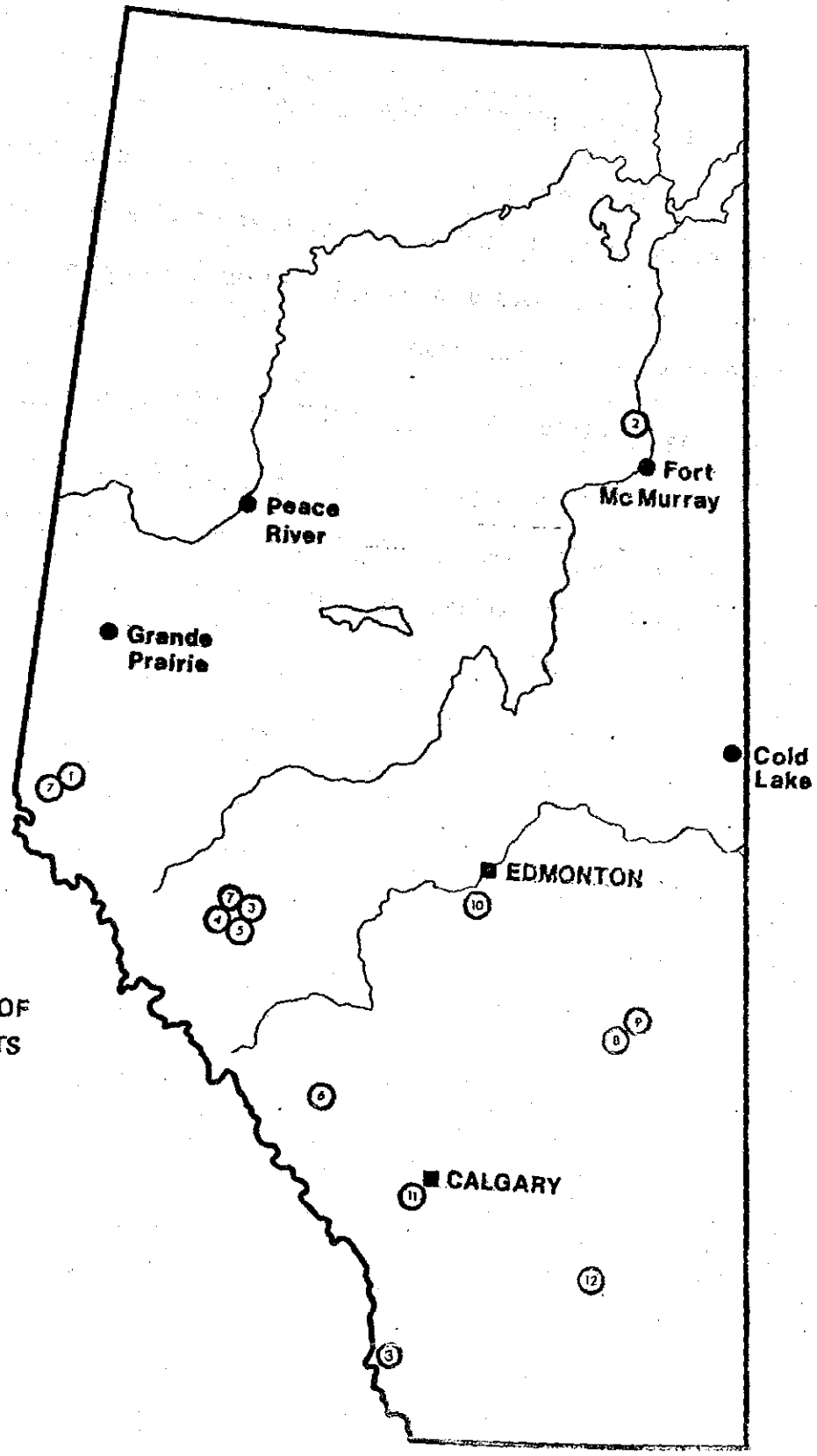
Preliminary work suggests that root sheaths may be a significant source of N-fixation for plants growing in nutrient-poor soils. Rather than engage in an extensive research program, the Committee chose the survey approach to look for root sheath occurrence on reclaimed and undisturbed areas. Correlations will be made between plant vigor and root sheath occurrence. If a relationship becomes apparent further studies may be instigated.

5. Chemical Characterization of Bottom Ash and Fly Ash From Four Alberta Power Stations (78-2-MCC)

Samples will be collected over a period of time and analysed to determine if fly and bottom ash chemistry varies among the various coal seams and power plants, and whether ash from a given source varies significantly through time.

6. Plant Nutrient-Agronomic Potential of Coal Ash (78-20-MCC)

Various rates of fly ash and bottom ash have been mixed with two soils and a sodic spoil to determine whether ash addition can enhance growth of barley, rape and alfalfa.



**LOCATION OF
FIELD PLOTS**

Legend

- 1 - 79 - 1 - MAC
- 2 - 79 - 13 - DUN
- 3 - 79 - 16 - MIH
- 4 - 79 - 17 - TAK
- 5 - 79 - 18 - RUS
- 6 - 79 - 20 - WAL
- 7 - 79 - 23 - WEI
- 8 - 79 - 2 - MOR
- 9 - 79 - 6 - SCH
- 10 - 79 - 7 - WEI
- 11 - 78 - 4 - PAR
- 12 - 79 - 26 - FUJ

RESEARCH PROJECTS 1979-80

<u>Managing Agency (Research Organization)</u>	<u>Proposal</u>	<u>Research Subject</u>	<u>RRTAC Budget \$</u>
Alberta Forest Service (ARC)	79-1-MAC	Revegetation of ash disposal pits McIntyre Mines, Grande Cache	10,610
(LGL Ltd.)	78-8-L/R	Survey: Enhancement of plant growth by root-microorganism associations.	15,785
(AFS)	79-13-DUN	Selection of woody plants for Oil Sands Reclamation	0 ^{1/}
(AFS)	79-16-MIH	Establishment of tree and shrub seedlings in erosion controlling vegetation cover, Coal Branch Crowsnest.	0
(AFS)	79-17-TAK	Use of Mat Mulches on difficult reclamation slopes, Cadomin.	0
(AFS)	79-18-RUS	Evaluation of Native-Agronomic grass and legume seed mixes for reclamation of Sub- alpine disturbances, Cadomin.	0
(AFS)	79-25-PAR	Native woody plants for use in reclamation: Literature review.	0
Fish & Wildlife Div. (DWA)	79-20-WAL	Ya Ha Tinda Ranch: Native Grass Seeding Study	8,300
Scientific & Eng. Services (Techman Ltd.)	79-5-W/P	Species suitability manual for reclamation in Alberta	50,000

<u>Managing Agency (Research Organization)</u>	<u>Proposal</u>	<u>Research Subject</u>	<u>RRTAC Budget \$</u>
(Dalcor Ltd.)	79-24-OSE	How to develop soils on Oil Sand Solid Tailings	10,000
(U of A)	79-23-WEI	Selected native grass test plots: Alpine and Subalpine	8,250
Environment Research Secretariat (Res. Sec.)	78-6-SIM	Review of reclamation information pertinent to Alberta	57,000 <i>ATA</i>
(ARC)	79-2-MOR	Hydrologic impacts on Plains Coal Mining, Forestburg South	750,000 ✓
(Techman Ltd.)	79-6-SCH	Reclamation of Plains strip mines for crop production, Forestburg South	55,000 ^{2/} ✓
(Kananaskis Centre U of C)	79-22-HOD	Literature Review: Effects of Organic compounds on groundwater salinization after surface coal mining	15,600 ✓
(U of A)	79-7-WEI	Development of Native Grasses for Reclamation	90,161 ^{3/}
(U of C)	78-4-PAR	Establishment of Biological activity in coal mining spoil and oil sand solid tailings	113,300

<u>Managing Agency (Research Organization)</u>	<u>Proposal</u>	<u>Research Subject</u>	<u>RRTAC Budget \$</u>
Env. Tech. Dev. Branch (TDB)	79-26-FUJ	Physical and chemical changes in stock-piled topsoil	0
(TDB)	78-2-MCC	Chemical characterization of bottom and fly ash from four power stations in Alberta	6,000
(TDB)	78-2-MCC	Agronomic potential of fly and bottom ash	<u>0</u>
			\$1,190,006

* Project indicating no RRTAC Budget are funded by the Managing Agency

1/ AOSERP - Funded until April, 1980.

2/ Joint funding with Alberta Power, Manalta, Luscar. The companies will cover the cost of materials handling.

3/ Joint funding with Parks Canada (\$22,000).

PROGRESS IN FULFILLING 1978-79
RECLAMATION RESEARCH PRIORITIES

February, 1980.

PLAINS - SURFACE COAL MINING

A. PHYSICAL PROBLEMS

Hydrology: effects of surface mining and reclamation on surface and groundwater movement, quality, quantity and subsequent effects on salt migration.

- 79-2-MOR - Plains Hydrogeology Reclamation Study
- *79-22-HOD - Literature Review: Effects of Organic Compounds on Salinization
- 79-27-HOD - Biogeochemical Processes in Salinization

Ash Disposal: ash chemistry and the effects of ash on soil physical and chemical properties.

- 79-1-MAC - Revegetation of Ash Lagoons, Grande Cache.
- 78-2-MCC - Variability of Coal Ash.
- 78-20-MCC - Greenhouse study - Crop tolerance to ash in three soil types.
- *78-5-P/R - Chemistry and Physical Characteristics of Fly Ash
- 79-6-SCH - Bottom and fly ash as amendment to sodic spoils.

Overburden Classification: for fitness as a near surface material after regrading.

- 79-2-MOR - Weathering Products of Spoils - Inorganic Chemistry
- 79-27-HOD - Weathering Products of Spoils - Organic Chemistry

Erosion Control: surface configuration to minimize erosion. Stability of non-sodic materials placed over sodic spoils.

- 79-6-SCH - Stability of topsoil over sodic spoil slopes.

(This area has otherwise been sufficiently studied in the U.S.A.)

Landscaping: for optimal final land use.
(Proposal 80-14-MAR under review)

B. BIOTIC PROBLEMS

Soils: reconstruction of chernozemic, Luvisolic and solonetzic soils.

- 79-6-SCH - Reclamation of sodic spoils, reconstruction of Torlea Solonetzic soils.
- 79-26-FUJ - Chemical changes in stockpiled topsoil.
- 78-4-PAR - Biological activity in stockpiled topsoil.

C. CULTURAL PRACTICES

Management of Reclaimed Land: - toward specified final land use.
(Move to low priority)

MOUNTAINS AND FOOTHILLS

A. PHYSICAL PROBLEMS

Dump Design: to optimize revegetation success.

(This is an area which would fall more closely under the Coal Mining Research Centre or as a DRRC - Sponsored Engineering Study. Remove from RRTAC priority list).

**Overburden Classification

for fitness as a growth medium.

Drill Sites: reclamation of areas damaged by spills and machine operations.

(Already sufficiently researched. Drop from priority list).

B. BIOTIC PROBLEMS

Ecology: Autecology of reclamation species, synecology of reclamation plant communities.

- 78-3-M/P - N-uptake of native grasses.
- 79-8-L/R - N-fixation on grass roots.

**Native Species: development, testing and propagation of native woody and herbaceous species for reclamation.

79-7-WEI - Development of Native Grasses for Reclamation.

79-23-WEI - Establishment of test plots for native grass lines.

79-5-W/P - Species suitability manual for reclamation.

79-25-PAR - Literature Review - Propagation of Native Shrub Species.

**Soil Reconstruction :optimal mixtures of horizons and other materials.

C. CULTURAL PRACTICES

Planting: timing, method, seed mixes.

79-16-MIH - Optimizing erosion control and shrub planting survival.

79-18-RUS - Native and Agronomic seed mix trials.

Fertilization: - rate, grade, timing of application

79-23-WEI - Maintenance fertilization requirements of selected native grass lines and agronomic grasses.

79-4-PAR - Effects of organic vs. inorganic fertilization.

Mulches: selection, rate, application method.

79-17-TAK - various roll-out mat mulches on a dry-windy site

78-4-PAR - Various organic amendments to mine spoils.

NORTHEAST ALBERTA

A. PHYSICAL

Soil Construction on Oil Sand Solid Tailings

79-24-OSE - Phase I literature review: soil properties required to meet reclamation objectives.

Phase II Field Trials: validation of recommendations developed in Phase I

B. BIOTIC

** Native Shrubs

79-14-DUN - selection of suitable native shrubs for reclamation.

78-4-PAR - effects of various amendments on tailings sand.

** Ecology - nutrient and organic matter dynamics on amended tailings sand.

C. CULTURAL PRACTICES

Equipment and Development: develop capability to incorporate prepared soils to 1 m depths.

** Shrub and Tree in erosion-controlling vegetation.

Establishment:

* - Project Terminated, Final Report Accepted

** - Subject of Additional Studies.

RRTAC Publication Status

Report #

Title

Published

79-1	Reclamation Research Funding Application Procedures
79-2	Proceedings: Workshop on Native Shrubs in Reclamation
80-1	Test Plot Establishment; Native Grasses for Reclamation
80-2	Alberta's Reclamation Research Program - 1979
80-3	The Role of Organic Compounds in Salinization of Plains Coal Mining Sites

In Preparation

80-4	Proceedings: Workshop on Reconstruction of Forest Soils in Reclamation
80-5	Manual of Species Suitable for Reclamation in Alberta

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