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

and

The Hon. John Fraser
Minister of the Environment
Environment Canada
Ottawa, Ontario

Sirs:

Enclosed is the report "Interim Report on Reclamation for Afforestation by Suitable Native and Introduced Tree and Shrub Species".

This report was prepared for the Alberta Oil Sands Environmental Research Program, through its Vegetation Technical Research Committee (now part of the Land System), under the Canada-Alberta Agreement of February 1975 (amended September 1977).

Respectfully,

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# INTERIM REPORT ON RECLAMATION FOR AFFORESTATION BY SUITABLE NATIVE AND INTRODUCED TREE AND SHRUB SPECIES

## DESCRIPTIVE SUMMARY

### ABSTRACT

AOSERP project VE 7.1 was initiated to carry out field investigations in the revegetation of oil sands mine wastes (waste dumps and tailings sand) with trees and shrubs. The main objective of the project is to select species of trees and shrubs which are adapted to conditions on these waste materials. Up to 1977, the project was involved mainly with demonstrations, and in 1977-78, field trails were initiated. To date, emphasis has been placed on the use of exotic trees and shrubs; in the future, species native to the oil sands area will be emphasized. For this purpose, extensive collections were made of seeds of trees and shrubs native to the AOSERP study area for use in future nursery production and field trials.

Data are now being collected on seedling survival and performance (vigour and growth) and on the general adaptability of the trees and shrubs to the waste materials in trials established in 1977-78.

### BACKGROUND AND PERSPECTIVE

This was a core project of the former AOSERP Vegetation Technical Research Committee (now part of the Land System) and has been designed to identify genotypes of native and exotic trees and shrubs suitable for reclamation of sites disturbed by oil sands development in the AOSERP study area.

The project was initiated under the Land Use Branch of the Alberta Forest Service, and in early 1977-78 was transferred to the present proponents.

Redirection was begun in the 1977-78 fiscal year and was primarily concerned with the establishment of a statistical design, the initiation of a collection of propagules from naturally invading woody plants in the AOSERP study area, and the development of a plan to salvage all possible information from the data on plants that were collected or planted during the first two years of the project.

## ASSESSMENT

The report "Interim Report on Reclamation for Afforestation by Suitable Native and Introduced Tree and Shrub Species", which was prepared by J.N. Sherstabetoff, B.G. Dunsworth, and S.K. Takyi of the Reforestation and Reclamation Branch of the Alberta Forest Service (Alberta Energy and Natural Resources), has been reviewed and accepted by the Alberta Oil Sands Environmental Research Program.

In view of the limited results to date, Program Management of AOSERP recommends that the report not be published, but be made available by filing copies in selected libraries.

The report includes discussion on the demonstration plantings established in 1974 to 1976, and description and explanation of the planting trials established in 1977-78.

The content of this report does not necessarily reflect the views of Alberta Environment, Fisheries and Environment Canada, or the Alberta Oil Sands Environmental Research Program. The mention of trade names for commercial products does not constitute an endorsement or recommendation for use.

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# INTERIM REPORT ON RECLAMATION FOR AFFORESTATION BY SUITABLE NATIVE AND INTRODUCED TREE AND SHRUB SPECIES

by

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ALBERTA OIL SANDS
ENVIRONMENTAL RESEARCH PROGRAM

Project VE 7.1

March 1979

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## ABSTRACT

AOSERP project VE 7.1 was initiated to carry out field investigations in the revegetation of oil sands mine wastes (waste dumps and tailing sand) with trees and shrubs. The main objective of the project is to select species of trees and shrubs which are adapted to conditions on these waste materials. Up to 1977, the project was involved mainly with demonstrations, and in 1977-78, field trials were initiated. To date, emphasis has been placed on the use of exotic trees and shrubs; in the future species native to the oil sands area will be emphasized. For this purpose, extensive collections were made of seeds of trees and shrubs native to the AOSERP study area for use in future nursery production and field trials.

Data are now being collected on seedling survival and performance (vigour and growth) and on the general adaptability of the trees and shrubs to the waste materials in trials established in 1977-78.

ACKNOWLEDGEMENTS

This project was administrated by the Reforestation and Reclamation Branch, Alberta Forest Service, Alberta Energy and Natural Resources. The authors acknowledge the co-operation of several agencies and people. In particular, appreciation is expressed to: D. Klym and T. Shopik of Great Canadian Oil Sands Ltd., Fort McMurray; O. Glanfield of the Alberta Forest Service, Fort McMurray; A. Langevin and A. Fedkenheuer of Syncrude Canada Ltd., Fort McMurray and Edmonton; the Provincial Tree Nursery, Oliver, Alberta; and the Prairie Farm Rehabilitation Act Federal Tree Nursery, Indian Head, Saskatchewan.

The project was administrated by J. Selner, Land Use Branch, Alberta Forest Service from April 1975 until May 1977. During this period R. Thompson and D. Phillips were the project foresters. We gratefully acknowledge their efforts in the early parts of this project. We also would like to thank Program Management and support staff of AOSERP for their services, and especially D. Taylor, project technician, for dedicated technical assistance.

This research project VE 7.1 was funded by the Alberta Oil Sands Environmental Research Program, a joint Alberta-Canada research program established to fund, direct, and co-ordinate environmental research in the Athabasca Oil Sands area of north-eastern Alberta.

# 1. INTRODUCTION

Development of the Athabasca Oil Sands requires the disturbance of large amounts of publicly-owned forested land. Ultimately, most of the disturbed land will have to be rehabilitated to a reasonably productive and aesthetic condition.

Energy demands over the next twenty years are expected to necessitate an increased recovery of bitumen from the Athabasca Oil Sands deposits. The method of recovery in the shallow deposits will remain dependent on surface mining for some time. Surface disturbances also result from exploration, access lines, pipelines, powerlines, granular material extraction, and plant construction. Land subjected to these types of disturbances generally is easier to rehabilitate than land under the more severe stress of oil sands surface mining operations.

The low success in introducing trees and shrubs onto mine wastes in conventional reclamation operations has indicated a need for continuing research if long term success in rehabilitation of the mine wastes is to be achieved. In general, the Alberta Oil Sands Environmental Research Program (AOSERP) project VE 7.1 is designed to evaluate the use of native and introduced trees and shrubs for suitability as plant cover in the reclamation areas mined for their oil sands deposits.

The project has been active since 1975. Tree and shrub seedlings planted on the Great Canadian Oil Sands Ltd. (GCOS) lease in 1974 by Land Use Branch, Alberta Forest Service were incorporated into the project in 1975. All plantings up to 1976-77 were demonstrations rather than statistically designed trials.

In May 1977, there was a redirection of the general long-term objectives of the project to the following:

(1) "To conduct field research on native and naturalized exotic woody species for survival and growth on pure and amended tailings and spoil materials;

(2) To determine causes of mortality and develop mitigation procedures in conjunction with other projects;

(3) To test ecotypes from invading populations of other disturbed sites for performance on disturbed soils resulting from oil sands mining;

(4) To make recommendations for afforestation plantings trials; and

(5) To develop recommendations of genotypes which should be placed in nursery production for large-scale afforestation trials."

This interim report describes the existing demonstration plantings (1974 through 1976) and trials (1977). The design, objectives, methodology, data collection, and present status of each year's work are reported.

## 2. RESUME OF THE CURRENT STATE OF KNOWLEDGE

Surface mining results in land distribution which often hinder the establishment of vegetation. The inhospitable properties are common with large land disturbances (Goodman and Bray 1975) and include the following: high levels of potentially toxic elements; extremes of surface temperatures; low or unbalanced nutrient status; wind turbulence; excessive stones and other coarse materials; moisture stress; erosion; steep slopes; unstable substrata; inundation by water; compaction and cementation; and absence of soil micro-organisms (See Appendix 8.3 for photographs). With oil sands surface mining operations, there are the added problems of toxicity due to the presence of bitumen and sterile tailings sand.

The physiological state of the tree and shrub seedlings at planting, their genetic constitution, and site factors (which include competition with established or establishing vegetation), greatly influence tree and shrub establishment and the degree of adaption to a given site (Ruffner and Steiner 1972; Tinus 1974).

In oil sands reclamation, there is virtually no published literature on research into reclamation with trees and shrubs, since most reclamation has been attempted with forage crops. Generally, the factors affecting the establishment of forage crops could be assumed also to affect planted tree and shrub seedling survival and growth on oil sands mine wastes. The most reliable indications as to the future success or failure of revegetation with trees and shrubs are field observations of the operational plantings by industry and the demonstration plantings of this project from 1974 through 1976 (Selner and Thompson in prep.; Alberta Energy and Natural Resources in prep.; Klym and Bary 1975). The planting stock have been mostly exotic species, several of which were not well adapted to the new environment. Some, however, show potential as reclamation material, especially several hybrid *Populus* spp. Cultivars, *Caragana arborescens* Lamb., and *Salix* species on moist sites. In the oil sands environment, rodent damage and competition

from the well-established heavy forage cover for water, nutrients, light, and space have been observed to adversely influence tree and shrub establishment.

Observations of earlier plantings suggest that success in establishing trees and shrubs on waste piles depends mainly on the medium on which they are planted. On overburden piles constructed of undifferentiated materials (including peats, shales, sands, low-grade oil sands, till, etc.), percentage survival is generally dependent upon the nature of material in the microsite. On tailings sand amended with peat, survival and growth of seedlings are greatly improved over those on unamended tailings sand. Some success with tree and shrub plantings has been achieved with bareroot seedlings, rooted cuttings, and containerized stock. Direct seedings of trees, shrubs, and herbs by Lesko (1974) and by this project's demonstrations on unamended tailings sand have been unsuccessful (Selner and Thompson in prep.).

## 3. STUDY AREA

The project study area corresponds with the AOSERP study area (Figure 1), generally delineated by the main deposits of potentially economic oil sands in the Athabasca deposit. Descriptions of the area's climate, topography, vegetation, geology, and soils have been given in several publications (Intercontinental Engineering of Alberta Ltd. 1973; Syncrude Canada Ltd. 1975; Stringer 1976). The demonstrations and trials established to date under this project have been located on the GCOS active mining areas (Figure 2).

All demonstration plantings and trials have been established on the tailings sand pond dike and on the overburden spoil piles (Waste Dumps 5 and 7). The tailings sand dike, the outer shell of which is composed of the sand which remains after bitumen extraction, has been constructed to an overall approximate grade of 2.5:1 and is broken by several berms constructed to decrease slope length and minimize erosion hazards. Both waste dumps are constructed of undifferentiated overburden materials to an approximate grade of 3:1 and are interrupted by several berms.

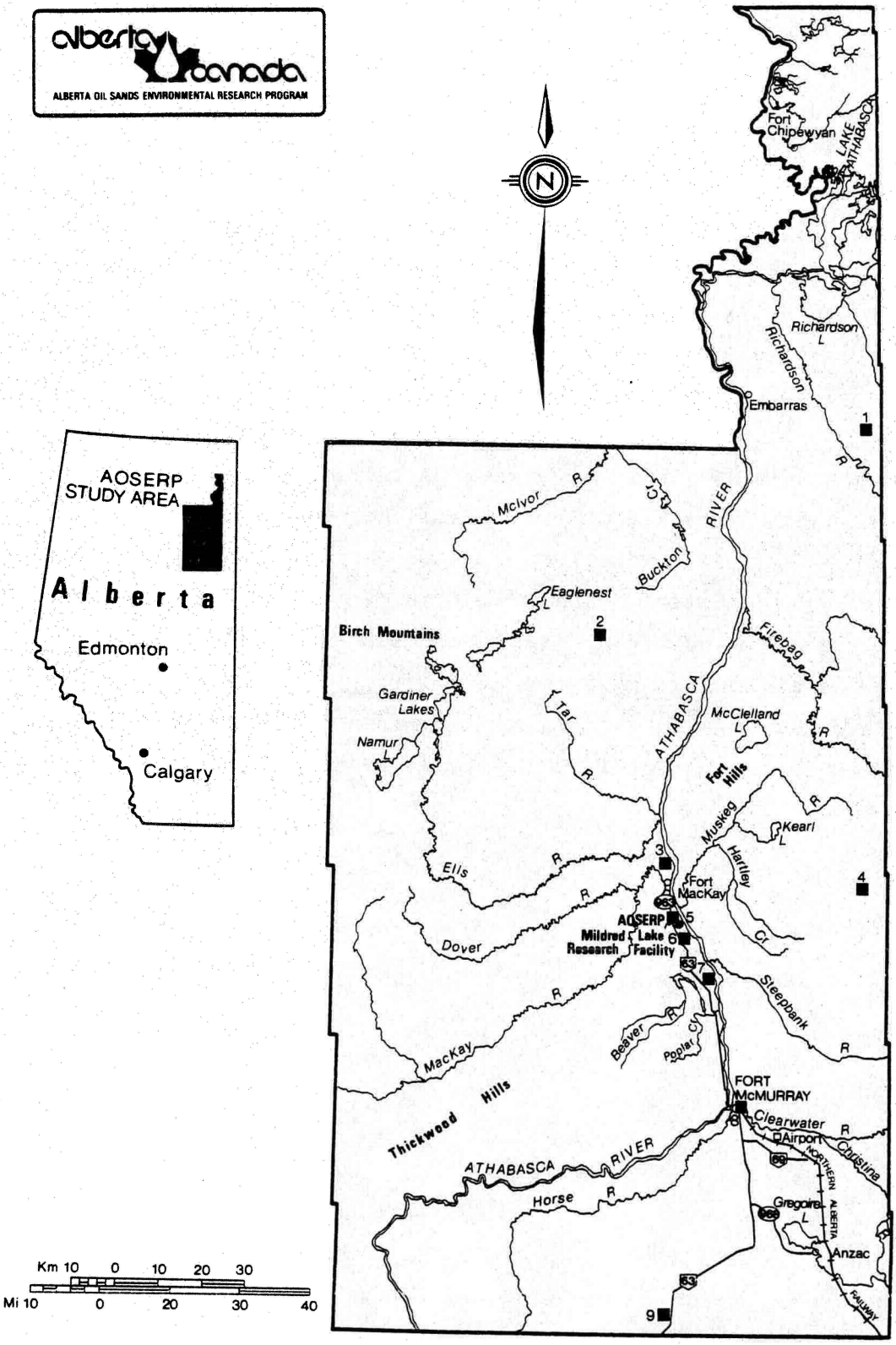



Figure 1. Alberta Oil Sands Environmental Research Program study area (the symbol ■ indicates 1977 native tree and shrub seed collection sites; see also Table 9).

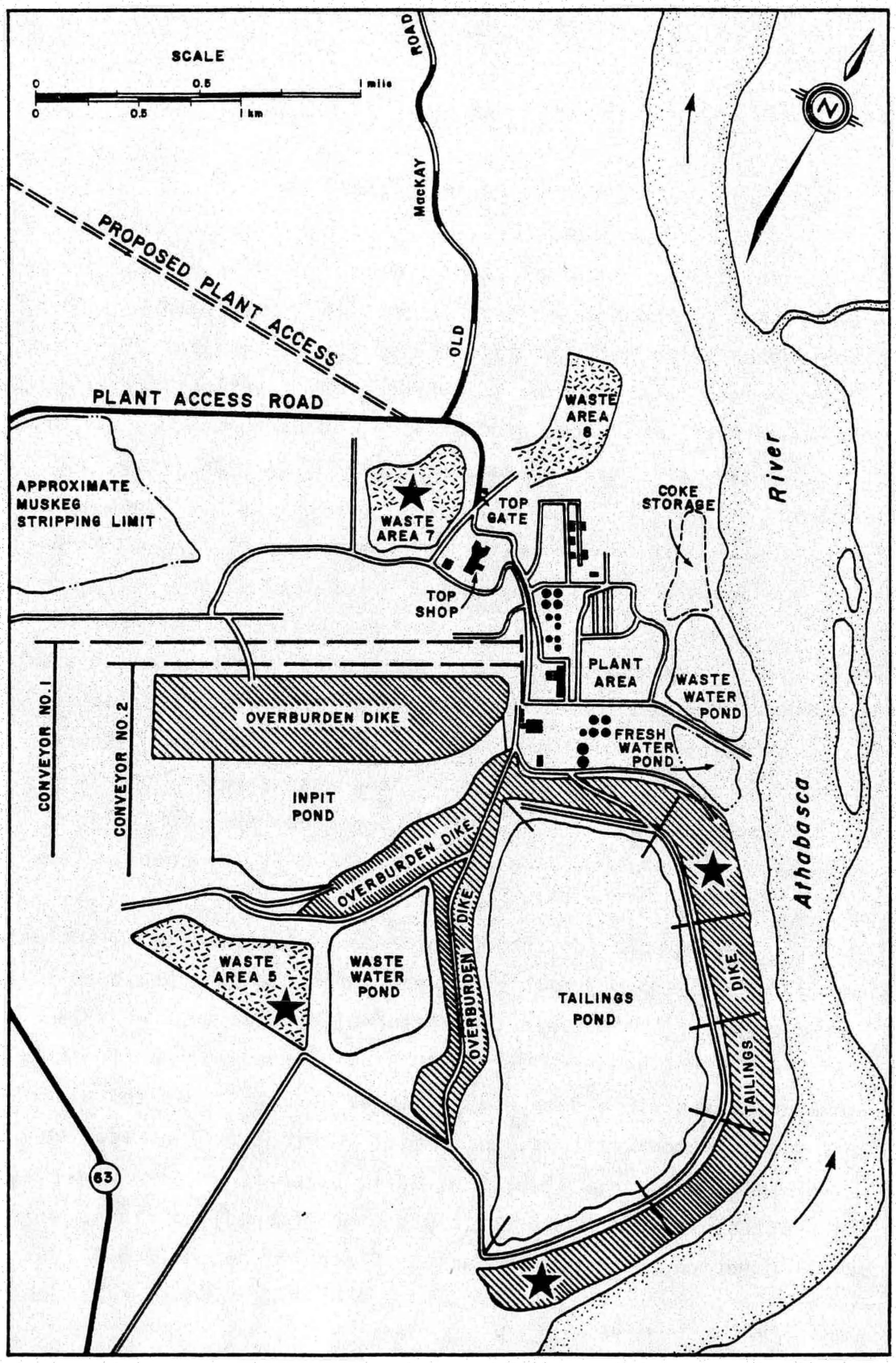



Figure 2. GCOS active mining area showing the general locations (*) of the demonstration plots and trials.

# 4. MATERIALS, METHODS, AND SOURCES OF DATA

## 4.1 THE 1974 DEMONSTRATION PLANTINGS

In 1974, the Land Use Branch of the Alberta Forest Service (AFS) carried out several plantings of tree and shrub seedlings on the tailings dike and on an overburden pile (Waste Dump 5). These plantings were incorporated into the program of project VE 7.1 in 1975, upon the establishment of AOSERP. The plantings primarily were demonstrations on the adaptability and performance of several exotic species of trees and shrubs on the waste materials. Scattered plots 10 m by 10 m in size in the demonstration areas (Figures 3 and 4) were each planted with a given species of tree or shrub using the Swedish planting mattock. A total of 11 species were planted, primarily exotics whose seed sources were not known. There were, in general, 100 seedlings planted per plot, with approximately 1 m between rows and 1 m between seedlings. Seedling plantings coincided with hydroseeding with legumes and grasses. There is no record as to how the seedbed was prepared, but it could be safely assumed that the seedbed preparation which is employed by GCOS was carried out at the site by the company (see Section 4.2.1).

Information on the performance of the seedlings, including survival, condition, growth rate, and rodent damage, has been collected annually. The evaluation methodology used for the 1974 plantings is the same as for the 1975 plantings (see Section 4.2.3). The accumulated field data are yet to be analyzed. As the plantings were mostly demonstrations, the useful information (not statistically valid) to be derived will be limited to comparisons among species. The species planted, number of plots, age of seedling stock, and seedling source are given in Tables 11 and 12 (Appendix 8.4).

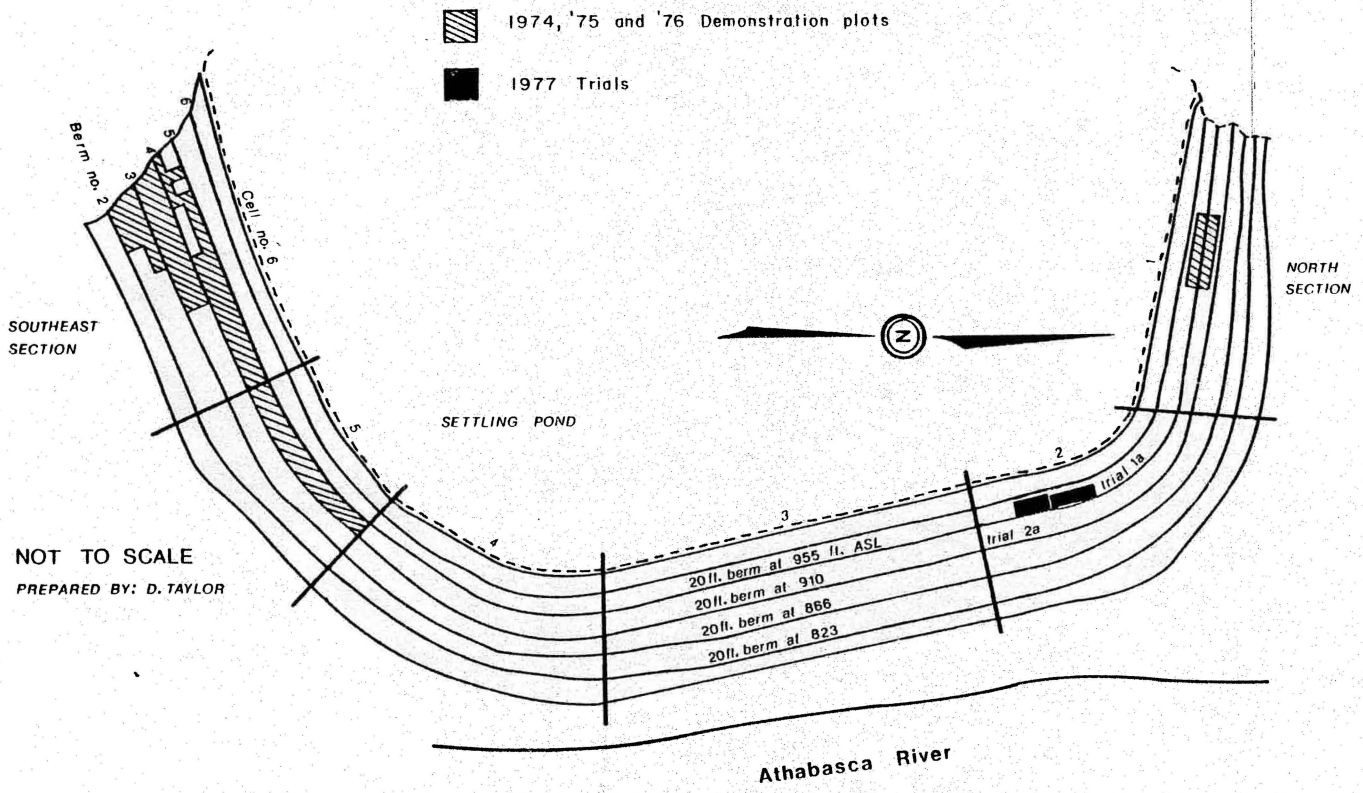



Figure 3. Areas on tailings dike planted with tree and shrub species.

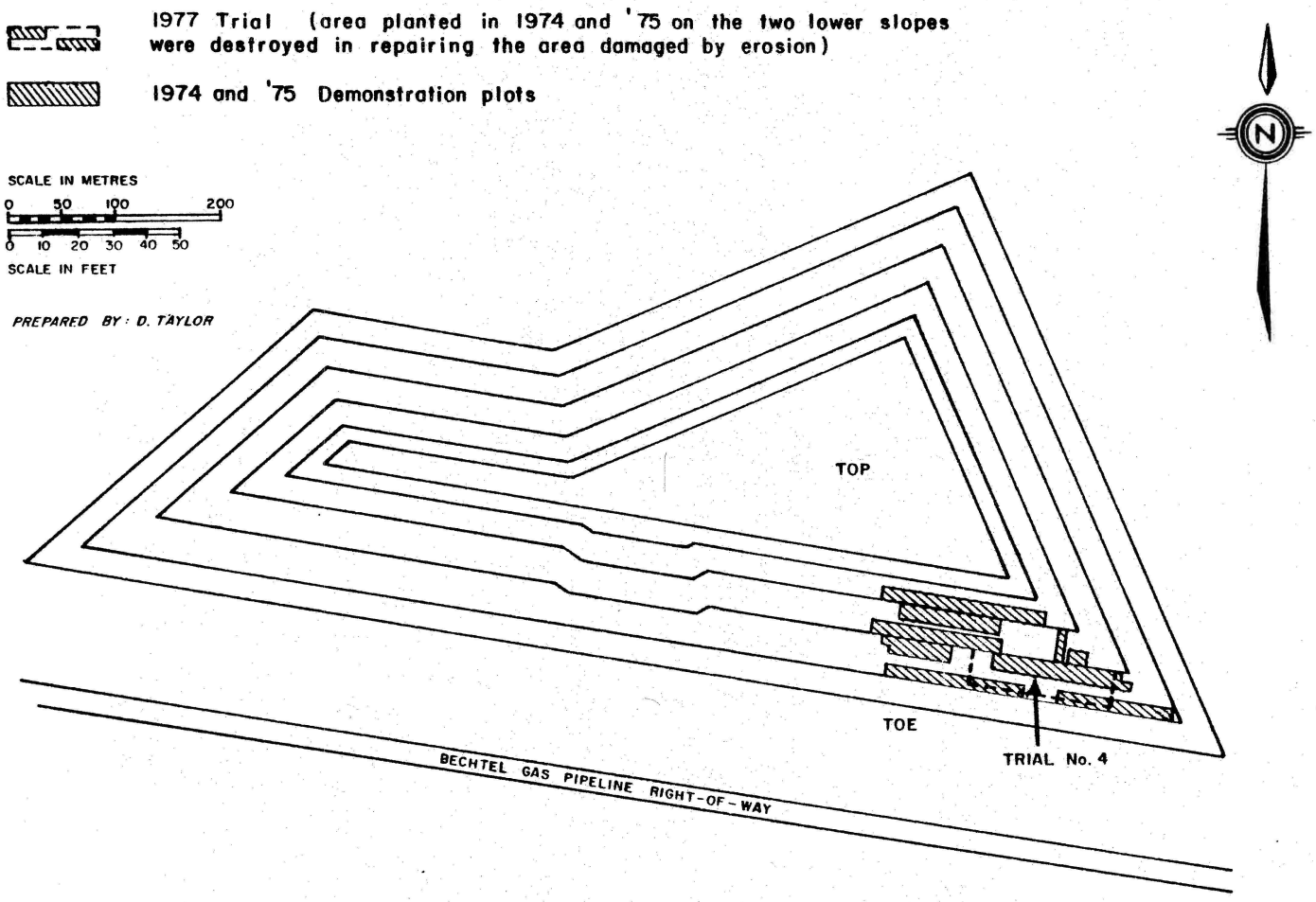



Figure 4. Areas on waste dump 5 planted with tree and shrub seedlings.

## 4.2 THE 1975 DEMONSTRATION PLANTINGS

Field operations in 1975, as in 1974, were demonstration plantings on the tailings dike (Figure 3) and on the waste dumps (Figures 4 and 5). The general objectives of these plantings were to demonstrate that reclamation by afforestation is possible on oil sands mine wastes and to compare tree and shrub seedling performance as a basis for later selection of species suitable for afforestation.

### 4.2.1 Site Preparation

In the areas on the dike planted with tree and shrub seedlings, peat was incorporated into the tailings sand to a depth of approximately 15 cm before hydroseeding in 1972, 1973, and 1974. As the area had existing vegetation, manual scarification with the planting tool was carried out before planting. On Waste Dump 7, with the exception of the lower part of the northwest slope, peat was incorporated into the overburden material to a depth of approximately 20 cm between February and May 1975, followed by hydroseeding. Seed mix composition and mulch application rates were not recorded. On Waste Dump 5, hydroseeding was carried out in 1974 after peat had been incorporated into the overburden material to a depth of approximately 30 cm. Seed mix composition and application rates were not recorded. As there was forage cover already present, manual scarification was carried out before planting.

### 4.2.2 Seedling Stock and Planting

The 14 tree and shrub species and 5 hybrid poplar clones (bareroot or containerized seedlings varying considerably in age; Table 1) which were planted came from four nurseries: Provincial Tree Nursery, Alberta Agriculture, Oliver, Alberta; Devon Nurseries Ltd., Devon, Alberta; Lacombe Nurseries Ltd., Lacombe, Alberta; and Greenacres Nursery Ltd., Brooks, Alberta. The geographic origins of the test genotypes are largely unkown. There was a lack of uniformity in the plant stock, site selection,

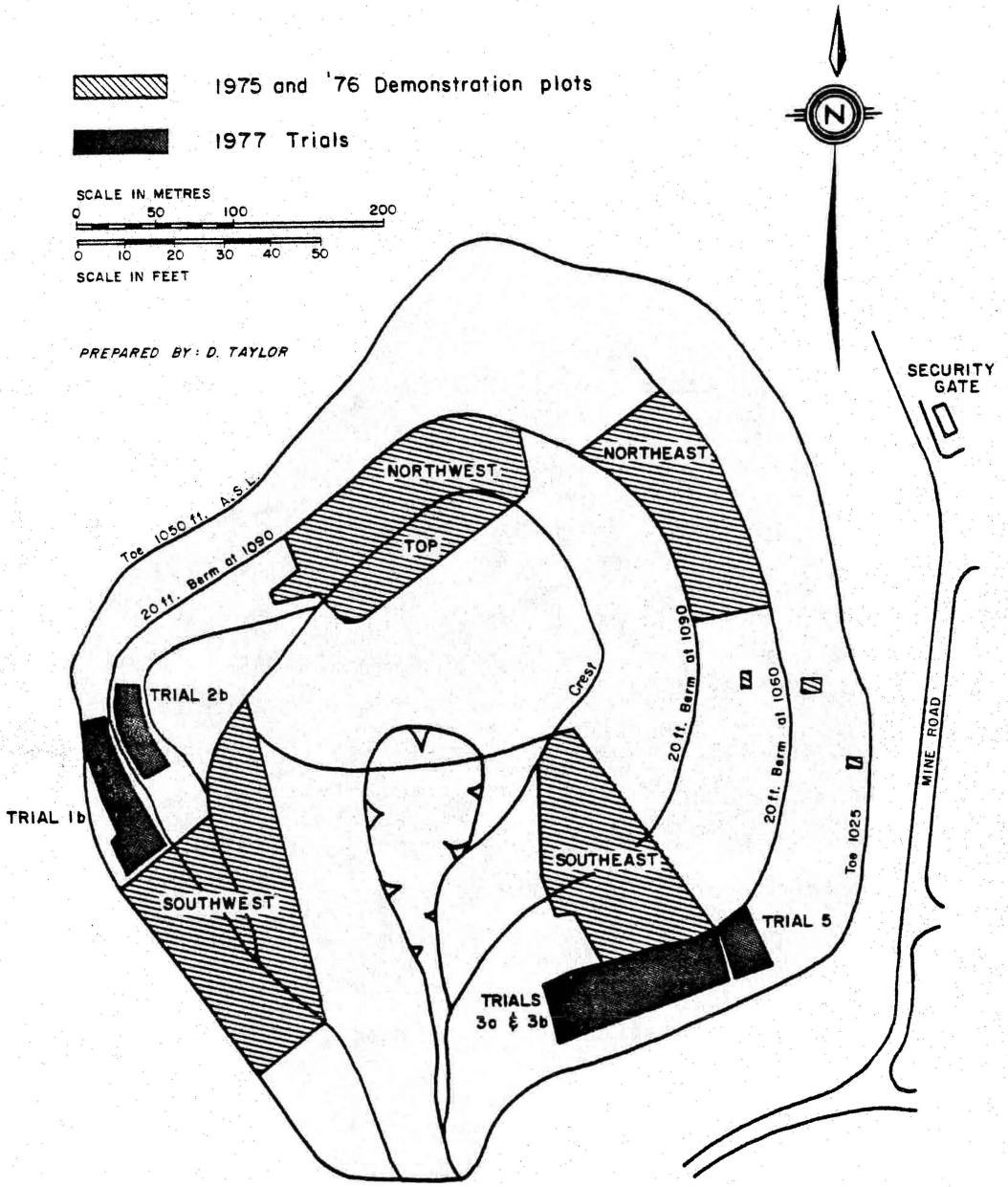



Figure 5. Areas on Waste Dump 7 planted with tree and shrub seedlings.

Table 1. Age, source, and seedling types of tree and shrub species planted on demonstration plots in 1975.

| Species | Nursery Source[a] | Age[b] |
|---|---|---|
| *Acer negundo* L. (Manitoba maple) | L | 2-0 |
| | D | 2-0 |
| | 0 | 2-0 |
| *Alnus rugosa* (Du Roi) Spreng. (speckled alder) | 0 | 1 c |
| | 0 | 2 c |
| *Betula alba* L. (white birch) | 0 | 2-0 |
| *Betula papyrifera* Marsh. (paper birch) | 0 | 1-0 |
| *Caragana arborescens* Lam. (caragana) | 0 | 2-0 |
| *Cornus stolonifera* Michx. (red oxier dogwood) | 0 | 2-0 |
| *Fraxinus pennsylvanica* Marsh. var. *subinterrigma* (Vahl) Fern. (green ash) | 0 | 2-0 |
| *Lonicerta tatarica* L. (Tatarian honeysuckle) | 0 | 2-0 |
| *Populus balsamifera* L. (balsam poplar) | 0 | 1 c |
| | 0 | 2-0 |
| *Populus* spp. Hybrid clones: Parentage: | | |
| Brooks #6 *Populus* x *deltoides* Bartr. cv. 'Brooks' Griffin. | B | 1-0 |
| Brooks #10 *Populus* x *deltoides* Bartr. cv. 'Brooks' Griffin. | L | 2-0 |
| Griffin *Populus deltoides* x Russian Griffin | L | 2-0 |
| | B | 1-0 |
| Northwest *Populus* x *deltoides* Bartr. cv. Northwest | L | 2-0 |
| Russian *Populus* x Petrowskyana Schnei. | B | 1-0 |
| *Populus trichocarpa* Torr. and Gray (black cottonwood) | 0 | 2-0 |
| *Picea glauca* (Moench.) Voss. (white spruce) | 0 | 3-2 |
| | 0 | 2 c |
| | 0 | 1 c |
| *Picea mariana* (Mill.) BSP. (black spruce) | 0 | 2 c |
| | 0 | 1 c |
| *Picea pungens* Engelm. (Colorado blue spruce) | 0 | 3-4 |
| *Pinus banksiana* Lamb. (jack pine) | 0 | 3-3 |
| | 0 | 3-0 |
| | 0 | 1 c |
| *Pinus contorta* Dougl. var. *latifolia* Engelm. (lodgepole pine) | 0 | 3-0 |
| | 0 | 2 c |
| | 0 | 1 c |

continued ...

Table 1. Concluded.

| Species | Nursery Source[a] | Age[b] |
|---|---|---|
| *Prunus padus* L. (mayday) | 0 | 2-0 |
| *Prunus virginiana* L. (chokecherry) | 0 | 2-0 |
| *Quercus macrocarpa* Michx. (bur oak) | 0 | 2-0 |
| *Rhamnus davurica* Pall. (buckthorn) | B | 2-0 |
| *Salix alba* L. (golden leaf willow) | 0 | 1-0 |
| *Salix acutifolia* Willd. (acute leaf willow) | L | 2-0 |
| | L | 1-0 |
| | 0 | 1-0 |
| *Salix amygdaloides* Anderss. (peach leaf willow) | 0 | 1-0 |
| *Salix pentandra* L. (laurel leaf willow) | 0 | 1-0 |
| | L | 2-0 |
| *Ulmus americana* L. (American elm) | 0 | 2-0 |
| *Ulnus pumila* L. (Chinese elm) | B | 2-0 |
| | 0 | 2-0 |

[a]Nursery Source: B = Brooks Nursery, Alberta
D = Devon Nursery, Alberta
L = Lacombe Nursery, Alberta
0 = Oliver Provincial Tree Nursery, Alberta

[b]Age: bare root stock: A-B format in which A = # of years in seedbed
B = # of years in transplant bed.
container stock: 1 c, 2 c: one or two growing seasons in containers.

and to some extent site treatment (Tables 13 to 16, Appendix 8.4). Planting of the 210 scattered plots was carried out in spring (14 May to 15 June) and fall (16 to 25 October). The basic planting pattern, as in 1974, was 10 rows of 10 seedlings per row with a spacing of 1-1.3 m, to provide 100 seedlings per plot. Some fertilization of the seedlings was carried out, but a systematic approach to fertilization was lacking, and there appeared to be no accurate record of the rates applied to individual species in individual plots. The fertilization carried out was in addition to GCOS's annual maintenance fertilization of the established forage cover.

### 4.2.3 Data Collection

Types of data collected to date on all the 1975 plantings are summarized in Table 2. The evaluation methodology used up to and including 1976 has been described in the earlier Interim Reports (Alberta Energy and Natural Resources 1976; Selner and Thompson in prep.). The evaluation methodology used in the 1977 assessments is given in Section 4.4.7.

## 4.3 THE 1976 DEMONSTRATION PLANTINGS

The demonstration plantings carried out in 1976 essentially followed the patterns of those done in 1974 and 1975. Although the plantings were demonstrations, it appears that their main objectives were: (1) to determine and compare the performance of various tree and shrub species; (2) to determine the effect on species performance of the use of two different planting tools; (3) to examine the influence of slope position on species performance; (4) to study and compare three methods of direct planting of native cuttings; and (5) to study the potential of direct seeding of woody species. Figures 3 and 5 give the approximate locations of the 1976 planting sites on the tailings dike and on Waste Dump 7.

Table 2. Data type collected for plantings established in 1975.

| Data Collected | Time of Data Collection | | | |
|---|---|---|---|---|
| | Fall 1975 September | Summer 1976 21 June-6 July | Fall 1976 18 Aug.-29 Sept. | Fall 1977 October |
| Survival | X | X | X | X |
| Condition | X | X | X | X |
| Growth | X | X | X | X |
| Small Mammal Damage | X | X | X | X |
| Erosion | | X | X | X |
| Insect Damage | | | | X |
| Dieback | | | | X |
| Disease/deficiences/ toxicities | | | | X |

### 4.3.1 Site Preparation

On the tailings dike, preparation of the areas planted with tree and shrub seedlings in 1976 is the same as described for 1975 plantings (Section 4.2.1). Hydroseeding of the sites planted in 1976 had been carried out by GCOS in 1971, 1972, and 1974. These sites had been fertilized annually by GCOS to maintain a good growth of the ground cover. Manual scarification was carried out at planting. On Waste Dump 7, the same method of site preparation which was carried out on the 1975 planting sites was employed.

### 4.3.2 Seedling Stock and Planting

Tree and shrub bareroot and containerized stock for the 1976 plantings originated at the PFRA Federal Tree Nursery at Indian Head, Saskatchewan and at the Provincial Tree Nursery at Oliver, Alberta. Table 3 lists the species of trees and shrubs planted in 1976 by source and age. The geographical origins of the seeds from which the seedlings were grown are largely unkown.

In the direct planting of stem cuttings of native balsam poplar (*Populus balsamifera* L.), two stem sizes were used in both spring and fall. While the samller stems for both planting seasons were collected from the same source, unfortunately only spring cuttings of the larger stems were from the same source. The general planting pattern was the same as for 1975 and the planting, as in two previous years, were intended as a demonstration. A total of 223 plots were planted on Waste Dump 7 and 256 plots on the tailings dike, in spring (26 April to 27 May) and fall (8 to 22 October) (see Tables 17 through 20, Appendix 8.4).

### 4.3.3 Data Collection

The types of data collected on the demonstration plantings for 1976 are summarized in Table 4. The evaluation methods employed are as given in Selner and Thompson (in prep.) and the Progress Report for 1976-77 (Alberta Energy and Natural Resources in prep.). The evaluation methodology used in the 1977 assessments is given in Section 4.4.7.

Table 3. Age, source, and seedling types of tree and shrub species planted on demonstration plots in 1976.

| Species | Nursery Stock[a] | Age[b] |
|---|---|---|
| *Acer ginnala* Maxim. (amur maple) | IH | 2-0 |
| *Acer negundo* L. (Manitoba maple) | 0 | 2-0 |
| | IH | 2-0 |
| *Alnus crispa* (Ait.) Pursh. (green alder) | 0 | 1 8/12c |
| *Alnus tenuifolia* Nutt. (river alder) | 0 | 1 8/12c |
| *Betula papyrifera* Marsh. (paper birch) | 0 | 1 8/12c |
| *Caragana arborescens* Lam. (caragana) | IH | 2-0 |
| *Crataegus cerronis* Pall. (chocolate hawthorn) | IH | 2-0 |
| *Elaeagnus angustifolia* L. (Russian oliver) | IH | 2-0 |
| *Fraxinus pennsylvanica* Marsh. var. *subintegerrima* (Vahl) Fern. (green ash) | 0 | 2-0 |
| | IH | 2-0 |
| *Larix siberica* Lebeb. (Siberian larch) | IH | 2-0 |
| *Lonicera tatarica* L. (tartarian honeysuckle) | 0 | 2-0 |
| *Picea glauca* (Moench.) Voss. (white spruce) | IH | 2-2 |
| *Picea pungens* (Mill) BSP. (black spruce) | IH | 2-3 |
| *Pinus contorta* Dougl. var. *latifolia* Engelm (lodgepole pine) | IH | 2-3 |
| *Populus balsamifer* L. (balsam poplar) | * | * |
| | 0 | 1-0 |
| *Prunus padus* L. (mayday) | IH | 2-0 |
| *Prunus virginiana* L. (chokecherry) | 0 | 2-0 |
| | IH | 2-0 |
| *Pseudotsuga menziesii* (Mirb.) Franco (Douglas fir) | 0 | 4-0 |
| *Salix fragilis* var. '*basfordiana*' (Basford willow) | IH | 2-0 |
| *Salix* spp. (willows) | 0 | 1-0 |
| *Syringa villosa* L. (late lilac) | 0 | 2-0 |
| | IH | 2-0 |
| *Syringa vulgaris* L. (common lilac) | 0 | 2-0 |
| *Ulmus americana* L. (American elm) | 0 | 1 8/12c |
| | IH | 2-0 |
| *Ulmus pumila* L. (Chinese elm) | 0 | 2-0 |

continued ...

Table 3. Concluded.

| Species | Nursery Source[a] | Age[b] |
|---|---|---|
| *Populus* spp. hybrid clones Parentage: | | |
| Acuminata Ryb. | IH | 1-0 |
| Angulata Aiton. syn. P.d. angulata species | IH | 1-0 |
| Berolinensis #4 P. laurifolia x Nigra | IH | 1-0 |
| BNW #4 P. berolinensis x P. Northwest | IH | 1-0 |
| Brooks #2 P. Deltoides Barfr. cv. 'Brooks' Griffen. | IH | 1-0 |
| Brooks #4 P. x deltoides Bartr. cv. 'Brooks' Griffen. | IH | 1-0 |
| Brooks #5 P. Deltoides Bartr. cv. 'Brooks' Griffen. | IH | 1-0 |
| C-regenerata P. x euramericana | IH | 1-0 |
| Carolina #3 P. x euramericana | IH | 1-0 |
| D709 PA P. x petrowskiana | IH | 1-0 |
| Eucalyptus P. x euramericana | IH | 1-0 |
| Gelrica P. x euramericana | IH | 1-0 |
| Jackii #18 P. taccumahacca x deltoides | IH | 1-0 |
| Nigra P. deltoides x unknown sp. (selection) | IH | 1-0 |
| Northwest P. deltoides x balsamifera | IH | 1-0 |
| P38 - P 38 P. tacamahacca x Simonii | IH | 1-0 |
| 44 - 55 P. deltoides x Russian | IH | 1-0 |
| P.V. P. petrowskiana x caudina | IH | 1-0 |
| PX Grandis P. x euramericana | IH | 1-0 |
| PX Mann unkown | IH | 1-0 |
| Serotina de Selys P. x euramericana | IH | 1-0 |
| Tristis #1 P. balsamifera x tristis | IH | 1-0 |
| Walker P. deltoides x Russian | IH | 1-0 |

[a]Nursery Source: IH = Indian Head, Saskatchewan
O = Oliver Provincial Tree Nursery, Alberta

[b]Age: bareroot stock: A-B (e.g. 2-3) format with
A = # of years in seed bed
B = # of years in transplant bed.
container stock: 1 8/12c = 1 year 8 month growing period in container.

* Not recorded.

Table 4. Data type collected for planting established in 1976.

| Data Collected | Time of Data Collection | | |
|---|---|---|---|
| | Fall 1976<br>18 August-<br>29 September | Summer 1977<br>25 June-<br>10 July | Fall 1977<br>13 September-<br>12 October |
| Survival | X | X | X |
| Condition | X | | X |
| Total height (growth) | X | | X |
| Small mammal damage | X | X | X |
| Erosion | X | X | X |
| Insect damage | | | X |
| Dieback | | | X |
| Disease/deficiences/ toxicities | | | X |

4.3.4 Outlines of 1976 Demonstration Plantings

1. Title: Tree and shrub species selection.

   The objectives of this planting were:

   (1) To compare the overall performance of 23 trees and shrub species and 26 poplar clones; and

   (2) To determine the influence of aspect on tree and shrub performance.

   Treatments were in the following categories:

   (1) Species;

   (2) Site (aspect, slope position, fertility, and ground cover);

   (3) Planting stock (age; type--bareroot cutting or seed, container seedling; stock source); and

   (4) Establishment season: planting time (fall versus spring).

2. Title: Effect of planting methods on seedling performance.

   The objective of the planting was:

   To determine the influence of type of planting tool on the survival of bareroot cuttings of Manitoba maple.

   Treatments for this study were:

   (1) Swedish tree planting mattock; and

   (2) Planting bar.

3. Title: Effects of position on slope on performance of *Salix fragilis* var. *basfordiana* Redher (Basford willow).

   The objective was:

   To determine the influence of moisture availability (dike drainage) on the willow performance.

   The treatment consisted of:

   Two positions on slope (above berm 4 and above berm 5) on two aspects of the tailings sand dike.

4. Title: Direct planting of mature stem cuttings of native balsam poplar clones.

The objective was:

To compare the performance of unrooted stem cuttings with that of bareroot cuttings.

The treatments were:

(1) Conventional bareroot cuttings planted with Swedish mattock; and

(2) Unrooted small stem cuttings planted by "shoving in".

5. Title: Effect on germination of presoaking seeds for use on the tailings sand dike.

The objective was :

To determine feasibility of direct seeding of trees by presoaking seeds in the field.

The treatments were:

(1) Unsoaked; and

(2) Presoaked in water for 24 hours at 23°C; surface of seeds allowed to dry before planting.

There were 12 seedlots of 9 conifer species and 4 seedlots of 4 deciduous species.

## 4.4 THE 1977 TRIALS

### 4.4.1 Introduction

The tree and shrub seedlings established from 1974 through 1976 on both the tailings dike and the overburden piles on the GCOS lease were intended primarily as a basis for species selection. As these plantings were all demonstrations, interpretations of the data collected will be limited in scope. Results from these demonstration plantings will, however, be useful in giving preliminary indications of the species which, in the short term, are adapted to the drastically-disturbed, mine-wastes environment. The 1977 trials which were

agronomic or silviculture in nature, incorporated some of the intended objectives of the earlier demonstration plantings.

In general, the objectives of these trials were to determine species adaptability to the oil sands mine wastes and to study problems inherent in introducing trees and shrubs onto oil sands mine wastes. Some of the treatments considered in studying these problems include soil fertility (Figure 14, Appendix 8.3), forage competition (Figure 16, Appendix 8.3), and the use of amendments to reduce erosion and enhance the establishment of forage ground cover, as well as trees and shrubs. As some of the trials were laid out on sites that had an existing forage cover, provisions were made for the assessment of cover type, density, and pattern and also of small mammal (rodent) damage in these trials and in some plots of the earlier demonstration plantings (Sections 4.1, 4.2, and 4.3). The information will be used to determine the relationship of these factors to performance of the introduced trees and shrubs on the site and to establish if rodent damage poses significant problems in reclamation with trees and shrubs. Included in the 1977 field work was the collection of 23 native tree and shrub seedlots (representing 11 species) to be used for future testing, since the project will be emphasizing native species in the future. In 1977, the choice of a species for a trial depended on the types of species available from the supplies at planting time. In all trials, all species except two were reared at the PFRA Federal Tree Nursery at Indian Head, Saskatchewan; the species from this source were all exotics. The two native species tested were reared at the Provincial Tree Nursery, Oliver, Alberta (Table 5). Trial locations are shown in Figure 3, 4, and 5.

### 4.4.2 Site Preparation

The area on the tailings dike where the 1977 trials (Trials 1a and 2a) were established was first seeded by GCOS to grasses and legumes in 1974. Seedbed preparation was the same as described earlier for the demonstration plantings on the dike from 1974 through 1976. The area on Waste Dump 7 on which Trials 1b and 2b were

Table 5. Age and source of bare root seedlings planted in 1977 trials.

| Species | Nursery Source[a] | Age[b] |
|---|---|---|
| *Acer negundo* L. (Manitoba maple) | IH | 2-0 |
| *Caragana arborescens* Lam. (caragana) | IH | 2-0 |
| *Elaeagus angustifolia* L. (Russian olive) | IH | 2-0 |
| *Fraxinus pennsylvanica* Marsh. var. *subintegerrima* (Vahl) Fern. (green ash) | IH | 2-0 |
| *Populus balsamifera* L. (balsam poplar) | 0 | 2-0 |
| *Populus* spp. Hybrid clones: parentage: | | |
| Northwest P. deltoides x balsamifera | IH | 1-0 |
| Walker P. deltoides x Russian | IH | 1-0 |
| Vernirubens P. x eurameriana | IH | 1-0 |
| *Salix acutifolia* Willd. (acute leaf willow) | IH | 2-0 |
| *Salix fragilis* var. *basfordiana* Redher (Basford willow) | IH | 1-0 |
| *Salix pentandua* L. (laurel leaf willow) | IH | 2-0 |
| *Salix* spp. (willow species) | 0 | 1-0 |
| *Shepherdia argentea* Nutt. (thorny buffalo-berry) | IH | 2-0 |
| *Ulmus americana* L. (American elm) | IH | 2-0 |
| *Ulmus pumila* L. (Chinese elm) | IH | 2-0 |

[a]Nursery Source: IH = Indian Head Nursery, Saskatchewan
0 = Oliver Provincial Tree Nursery, Alberta

[b]Age: bareroot stock: A-B format with A = # of years in seedbed
B = # of years in transplant bed.

established was hydroseeded with grasses and legumes in June 1976. Site preparation on the dump was similar to that described for the demonstration plantings of 1975 and 1976. Field operation for the trials (Trials 3a, 3b, 4, and 5) established in areas on the waste dumps on which there was no vegetation established prior to 1977 is described later under Sections 4.4.8.3.1, 4.4.8.4.1, and 4.4.8.5.1. In these trials, rocks and pieces of wood larger than approximately 10 cm in diameter or length were removed to facilitate the use of a garden tiller to incorporate amendments and fertilizers.

### 4.4.3 Forage Cover Establishment

Areas on the waste dumps which had not revegetation with agronomic forages prior to 1977 and on which trials (Trials 3a, 3b, 4, and 5) were laid out were seeded approximately at the same time as the tree seedlings were planted. The seed mix, which is the same as that used by GCOS in 1977 on the waste dumps, is shown in Table 6.

Seeding was done by hand, except for some treatments in Trial 4 in which the required hydroseeding was carried out by GCOS. Inoculation with the appropriate commercial inoculant for each legume was carried out at four times the recommended rate in normal agricultural soils.

### 4.4.4 Soil Sampling and Fertilization

Before any treatments were begun, soil samples were taken on 13 and 14 May 1977, at depths of 0-15 cm, 15-30 cm, and 30-60 cm, from two spots within each plot. Samples from every plot in each trial were bulked by depth, air-dried, and submitted to the Norwest Soil Research Laboratory in Edmonton, Alberta for analyses. The commercial peat, wood pulp (for hydroseeding), and straw, and the peat originating at the lease which was spread by GCOS, were also sampled and treated in the same manner as the soil samples.

Table 6. Species composition of seeding mix and seeding rates used on waste dumps in 1977.

| Species in Mix | Composition of Mix (% by volume) | Seeding Rate (hg/ha) |
|---|---|---|
| Grass Mix: | | |
| Bromegrass (*Bromus inermis* var. Carlton) | 25 | |
| Crested wheatgrass (*Agropyron cristatum* var. Fairway) | 25 | |
| Tall wheatgrass (*Agropyron elongatum* var. Orbit) | 30 | |
| Creeping red fescue (*Festuca rubra* var. Boreal) | 20 | |
| TOTAL | 100 | 78.4 |
| Legume Mix: | | |
| White clover (*Trifolium repens*) --common | 40 | |
| Alsike clover (*Trifolium hybridum*)--common | 30 | |
| Beaver alfalfa (*Medicago sativa*)--common | 30 | |
| TOTAL | 100 | 33.6 |
| Nurse Crop: | | |
| Barley (*Hordeum vulgare*) --conquest | 100 | 44.8 |
| TOTAL | --- | 156.8 |

Fertilizers were broadcast by hand or with a hand cyclone spreader and then incorporated into the overburden materials, using a garden tiller before hand-seeding or hydroseeding. The fertilizers provided the basic nutrients to support the newly-seeded forage crops. Fertilizers were applied on Trials 3 and 4 as outlined in Table 7.

On the trials were forage cover was established before 1977 (Trials 1 and 2), GCOS applied the prescribed 1977 maintenance fertilizer rates for the dike and the waste dumps (dike, 118 kg N : 46 kg P : 90 kg K per ha as 17.5-16-16; and waste dumps, 94 kg N : 40 kg P : 39 kg K per ha as 14-14-7), using a helicopter.

### 4.4.5 Tree and Shrub Planting

Planting of the bareroot tree and shrub stock did not start early in spring, generally the ideal time to plant. Planting was carried out from 20 May through 4 June. Because of the late date, several species were beginning to flush at planting time. Seedling condition was generally poor at planting; this was probably the result of improper handling during storage and transportation. All poor condition seedlings which could be readily identified were culled before planting, including those with heavy fungal growths on the roots. (The fungal growths were later diagnosed at Canadian Forest Service Laboratory at Edmonton to be harmless).

In every trial, the seedlings were spaced in 1-m rows with 1 m between plants, to provide 28 seedlings per 4 m by 7 m plots. The experimental designs of the trails are given in the descriptions of individual trials later. All plantings were carried out using the Swedish mattock. Manual scarification with the mattock was carried out at all sites that had been revegetation before 1977; scarification was done in the immediate area of the planting hole; the area scarified generally was between 15 and 30 cm in diameter.

Table 7. Types of fertilizers and nutrient rates applied on the waste dumps in trials 3 and 4 in 1977.

| Fertilizer | Rate (kg/ha) | Nutrient (kg/ha) N | P | K | S |
|---|---|---|---|---|---|
| Urea, 46-0-0 | 183 | 84 | - | | - |
| Mixed, 10-30-10-4 | 174 | 17 | 22 | 13 | 7 |
| Potash, 0-0-60 | 160 | - | - | 81 | - |
| | TOTAL | 101 | 22 | 94 | 7 |

4.4.6 Forage Cover Assessment

In each trial, the data collected on forage cover were related to tree and shrub performance in light of vegetative competition for moisture, light, and nutrients, and also in light of the amount of protection they provide for small mammals. The extent of small mammal damage was also recorded. The actual air-dry biomass yield data for small areas (1 m by 1 m) in each plot were collected, while visual assessments of the cover type, density, and pattern were made according to the categories given in Section 8.1.

4.4.7 Assessment of Tree and Shrub Seedling Performance

The assessment of the performance of seedlings planted in 1977 was carried out in late summer (28 August through 16 September 1977). An estimate of seedling condition to vigour and actual measurements of percentage survival and height growth were recorded for individual seedlings. Height growth was recorded as the height of the tallest living leader on a seedling. The assessment criteria used are as given in Appendix 8.2.

Regular field observations on the trials were carried out during the growing season, prior to the field assessments (described above) made at the end of the growing season. These field observations provided a limited basis for evaluating the influence of site and general environmental factors on the performance of the seedlings. The assessment of overwintering qualities (Winter hardiness) of the species planted in some of the trials was planned for spring 1978. Time of bud burst will be recorded in the spring, and species flushing after the last spring frost will be considered hardy. The anticipated schedule and types of assessments to be made on these trials are summarized in Table 8.

Table 8. Projected schedule and type of data to be collected for trials established in 1977.

| Response Variables | Year of Data Collection | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
| Percent Survival | XS[b],XF | X | | X | | | | X |
| Condition | XS,XF | X | 3b | X | 3b | | | X |
| Total Height (growth) | X | X | 3b | X | 3b | | | X |
| Crown diameter[a] | X | X | 3b | X | 3b | | | X |
| Mortality factors | X | X | 3b | | | | | X |
| Mouse/Insect damage | X | X | 3b | | | | | |
| Time of bud burst[a] | 1S | 1S | 1S | 1S | 1S | 1S | 1S | 1S |
| Biomass production[a] | | | | X | 3b | | | |

[a]Not recorded in 1977.

[b]S = Spring; F = Fall; X = All trials; 1 = Trial No. 1; 3b = Trial No. 3b.

## 4.4.8 Trial Descriptions

### 4.4.8.1 Trial 1.

Locations:

Trial 1a: Tailings dike (Figure 6).

Trial 1b: Overburden pile, Waste Dump 7 (Figure 6).

Title:

Evaluation of the adaptability of tree and shrub species to growth on oil sands waste materials.

The objectives were:

1. To determine the performance (survival, condition, and growth) of 15 tree and shrub species; and
2. To determine the influence of the growing medium (revegetated tailings sand and undifferentiated overburden) on species performance.

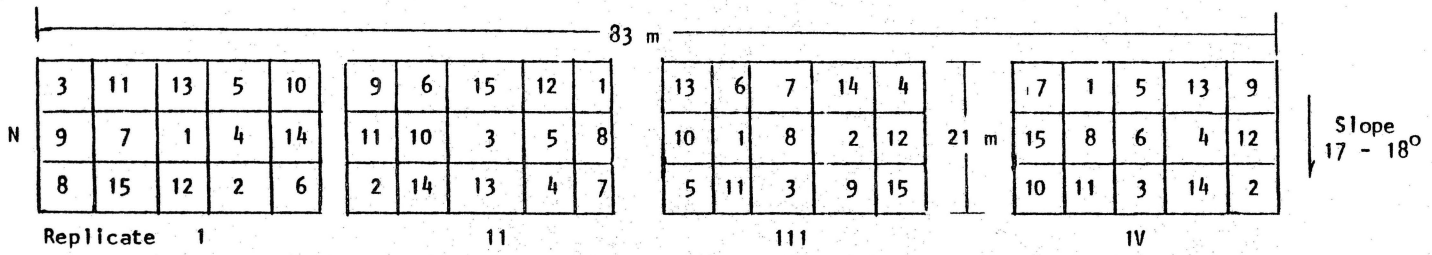
The treatments were 15 tree and shrub species:

1. Local balsam poplar (*Populus balsamifera* L.)
2. Northwest poplar (*Populus deltoides* x *balsamifera*)
3. Walker poplar (*Populus deltoides* x Russian)
4. Vernirubens poplar (*Populus* x euramericana)
5. Green ash (*Fraxinus pennsylvanica* marsh. var. *subintegerrima* (Vahl) Fern.)
6. Chinese elm (*Ulmus pumila* L.)
7. American elm (*Ulmus americana* L.)
8. Manitoba maple (*Acer negundo* L.)
9. Local willow (*Salix* spp.)
10. Basford willow (*Salix fragils* var. *basfordiana* Redher)
11. Laurel willow (*Salix petandra* L.)
12. Acute leaf willow (*Salix acutofolia* Willd.)
13. Caragana (*Caragana arborescens* Lam.)
14. Russian olive (*Elaeagnus angustifolia* L.)
15. Non-local buffaloberry (*Shepherdia canadensis* (L) Nutt.)

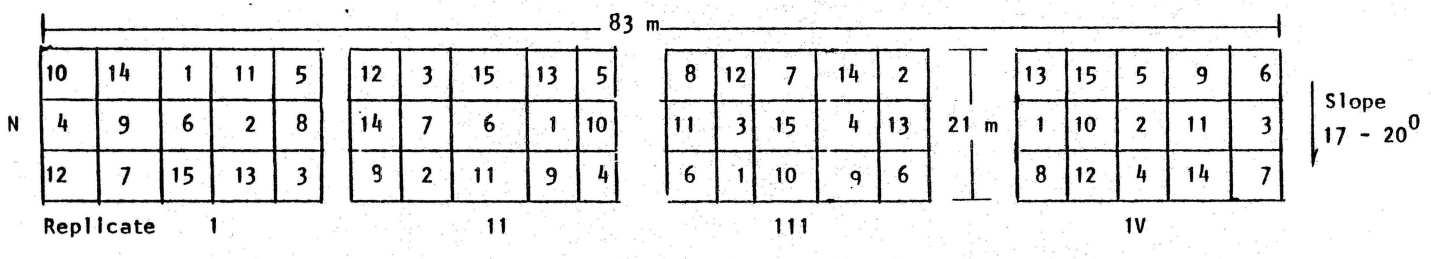
Design:

Randomized block design with four replications per treatment. See Figure 6.

Trial 1a. Tailings dike (Cell 2).




Trial 1b. Overburden pile (Waste Dump 7).




Species:

1. Balsam poplar (local) (*Populus balsamifera* L.)
2. Northwest poplar (*P. deltoides* x *balsamifera*)
3. Walker poplar (*P. deltoides* x *Russian*)
4. Vernirubens poplar (*P.* x *euramericana*)
5. Green ash (*Fraxinus americana* Marsh. var. *subintegerrima* (Vahl) Fern.)
6. Chinese elm (*Ulmus pumila* L.)
7. American elm (*Ulmus americana* L.)
8. Manitoba maple (*Acer negunda* L.)
9. Willow (local) (*Salix* spp.)
10. Basford willow (*Salix fragilis* var. *'basfordiana'*)
11. Laurel willow (*Salix pentandra* L.)
12. Acute leaf willow (*Salix acutifolia*)
13. Caragana (*Caragana arborescens* Lam.)
14. Russian olive (*Elaeagnus angustifolia* L.)
15. Canadian buffalo-berry (*Shepherdia canadensis* (non-local, native) (L.) Nutt.)

Figure 6. Trial Layouts: Trial 1 (species selection).

4.4.8.1.1 Field Operations (Trial 1). Uniformly revegetated areas, on the tailings dike and on the overburden piles were selected for the trial. The plots were staked out and soil samples were taken on 13 May. Tree and shrub plantings were accomplished on the overburden pile from 21 through 24 May and on the tailings dike from 24 through 31 May. At planting time manual scarification was carried out with the planting mattock in an area around the planting hole with a minimum diameter of 15 cm. Fertilizers were applied by GCOS with the aid of a helicopter to both sites in June. The operation was part of the regular maintenance fertilization program of the company. On the dike, 672 kg of 17.5-16-16 fertilizer (118 kg N - 46 kg P - 90 kg K) were applied per ha. On the overburden pile, 672 kg of 14-14-7 fertilizer (94 kg N - 40 kg P - 39 kg K) were applied per ha. Assessment of the vegetative cover competition (hay yields) was carried out by harvesting microplot areas within the trials between 11 and 13 August. Other vegetative cover assessments were carried out in the second half of August. Assessment of tree and shrub performance was carried out in late summer (28 August through 16 September).

4.4.8.1.2 Field Observations (Trial 1). Up to one month after planting, field observations revealed that buds on several plants were not opening. Although seedlings identified as questionable in quality at planting had been culled, it appeared several were missed. Rodent damage to the seedlings appeared to be high, especially on the overburden pile where a heavy sweet clover stand appears to have contributed to the large mouse population.

Soil analyses data are summarized in Table 21 (Appendix 8.4). Discussions of soil analytical results will be provided along with the data collected on the vegetative cover and tree and shrub seedling performance in the 1978-79 Interim Report. The analytical results indicate that generally the undesirable properties of the materials could be readily corrected to achieve successful plant growth.

4.4.8.2 Trial 2.

Locations:

Trial 2a: Tailings dike (Figure 7).

Trial 2b: Overburden pile, Waste Dump 7 (Figure 7).

Title:

Effects of scarification and fertilization on the performance of tree and shrub species on revegetation tailings sand and overburden.

The objectives were:

1. To determine the influence of fertilizers applied one year after seedling establishment on the performance of the seedlings in subsequent years;
2. To determine the influence of scarification on tree and shrub seedling performance; and
3. To study the performance of a tree and shrub species judged from earlier demonstration plantings to have potential for reclamation of oil sands wastes.

The treatments were:

A: Species (two)

Tailings dike (Trial 2a):

1. Acute leaf willow (*Salix acutifolia* Willd.)
2. Local balsam poplar (*Populus balsamifera* L.)

Waste Dump 7 (Trial 2b):

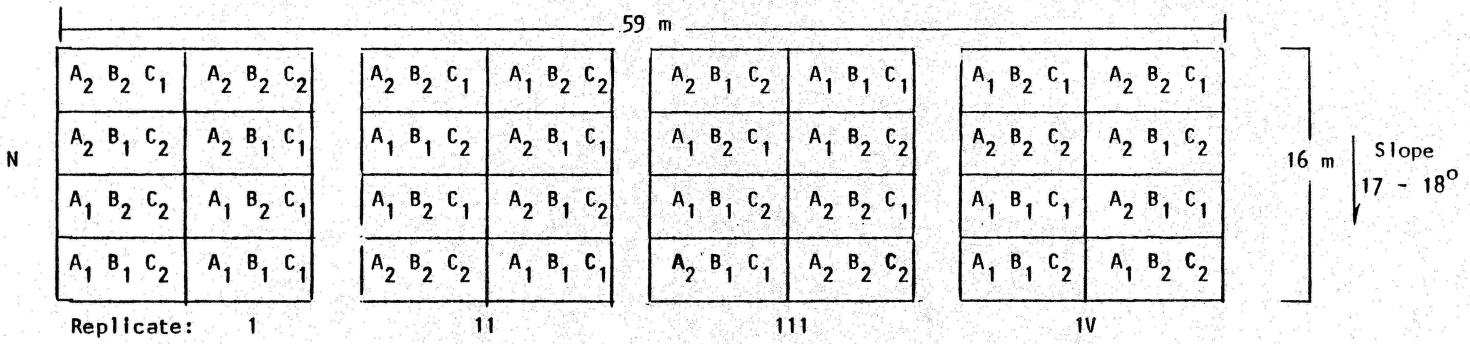
1. Local willow (*Salix* spp.)
2. Local balsam poplar (*Populus balsamifera* L.)

B: Fertilization

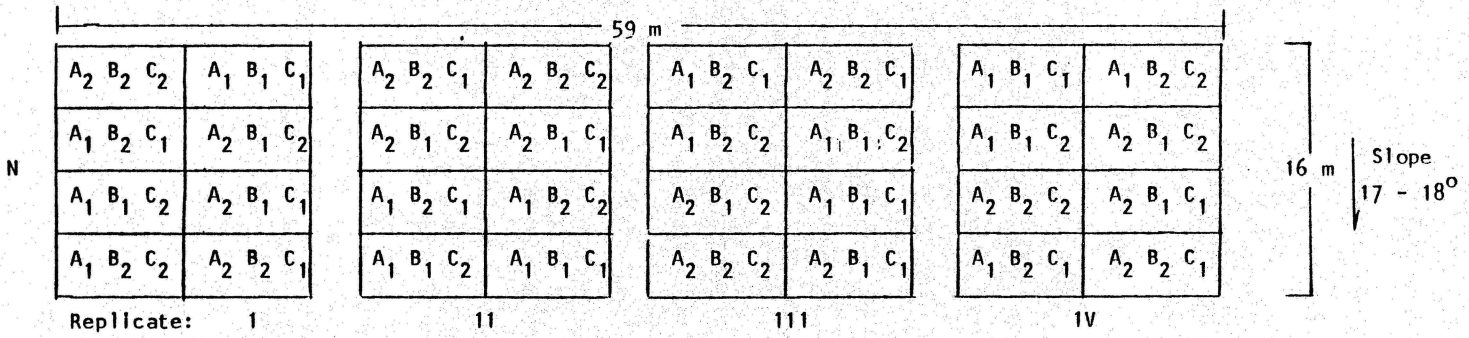
1. Nil
2. NPK application to seedlings in second growing season (requirement in subséquent growing seasons to be subject to seedling performance).

C: 1. None (minimum vegetative cover disturbance around seedling during and after planting).

Trial 2a. Tailings dike (Cell 2).




Trial 2b. Overburden pile (Waste Dump 7).




A = Species:
- Trial 2a: 1. Acute leaf willow (*Salix acutifolia* Willd.)
  2. Local balsam poplar (*Populus balsamifera* L.)
- Trial 2b: 1. Local willow (*Salix* spp.)
  2. Local balsam poplar (*Populus balsamifera* L.)

B = Fertilizer rate:
1. Nil
2. NPK (see text)

C = Scarification rate (see text):
1. Nil
2. Manual (minimum of 15 cm around planting hole)

Figure 7. Trial Layouts: Trial 2 (scarification and fertilization).

2. Manual scarification with planting mattock in area around planting hole of a minimum of 15 cm. Manual rescarification in mid-summer 1977. Chemical scarification of a 30 cm by 30 cm area in the second growing season (1978).

Design:

Randomized block design with four replications per site (see Figure 7).

4.4.8.2.1 Field Operations (Trial 2). Two sites with a uniform forage cover were selected, one on the tailings dike and one on the waste dump. The plots were staked out, and soils on the sites were sampled (0-15 cm, 15-30 cm, and 30-60 cm) on 13 May. Seedling planting was carried out between 20 and 24 May on the waste dump and on 31 May and 1 June on the tailings dike. Fertilizers were applied with a helicopter by GCOS to both sites in June as part of their regular annual fertilization program. The rates and forms of fertilizer applied were the same as described for Trials 1a and 1b (see Section 4.4.8.1.1). The scarification schedule for the middle of the summer was accomplished in the appropriate treatments on 12 August. Assessment of vegetative cover, seedling performance, and other factors was carried out in the same manner as described in Trials 1a and 1b.

4.4.8.2.2 Field Observations (Trial 2). See discussion under the same topic for Trials 1a and 1b (Section 4.4.8.1.2).

4.4.8.3 Trial 3.

Locations:

Trial 3a: Overburden pile, Waste Dump 7 (Figure 8).

Trial 3b: Overburden pile, Waste Dump 7 (Figure 8).

Title:

Trial 3a: Effects of type of seeded forage ground cover on the performance of tree and shrub seedlings on overburden material.

Trial 3b: Effects of type of an already established forage ground cover on the performance of tree and shrub seedlings on overburden material.

The objectives were:

Trial 3a:

1. To compare the influence of newly-seeded forage grass mix, grass-legume mix, and natural invasion ground covers on the establishment of tree and shrub species; and
2. To compare the performance of tree and shrub species judged to have potential for reclamation of newly-seeded areas.

Trial 3b:

1. To compare the influence of already established forage grass mix and grass-legume mix covers on the establishment of tree and shrub species; and
2. To compare the performance of tree and shrub species judged to have the potential for reclamation of areas already established with forage grass mix and grass-legume mix covers.

The treatments were:

Trial 3a: A. Species:

1. Northwest poplar (*P. deltoides* x *balsamifera*)
2. Walker poplar (*P. deltoides* x Russian)
3. Basford willow ( *Salix fragilis* var. *basfordiana* Redham)
4. Laurel willow (*Salix pentandra* L.)

B. Ground cover (seed mix) type:

1. Nil (plots left to be naturally invaded by vegetation).
2. Grass (mix) cover plus a nurse crop.
3. Grass-legume (mix) cover plus a nurse crop.

The seed mixes, seeding rates, and seeding method are described in Section 4.4.3.

Trial 3b: A. Species:

1. Northwest poplar (*P. deltoides* x *balsamifera*)
2. Walker poplar (*P. deltoides* x Russian)
3. Basford willow (*Salix fragilis* var. *basfordiana* Redhem)
4. Laurel willow (*Salix pentandra* L.)

B. Already established ground cover type (1977):

1. Grass (mix) cover (nurse crop not present after first year).
2. Grass-legume (mix) cover (nurse crop not present after first year).

Seed mix, seeding rate, and seeding method were the same as for Trial 3a.

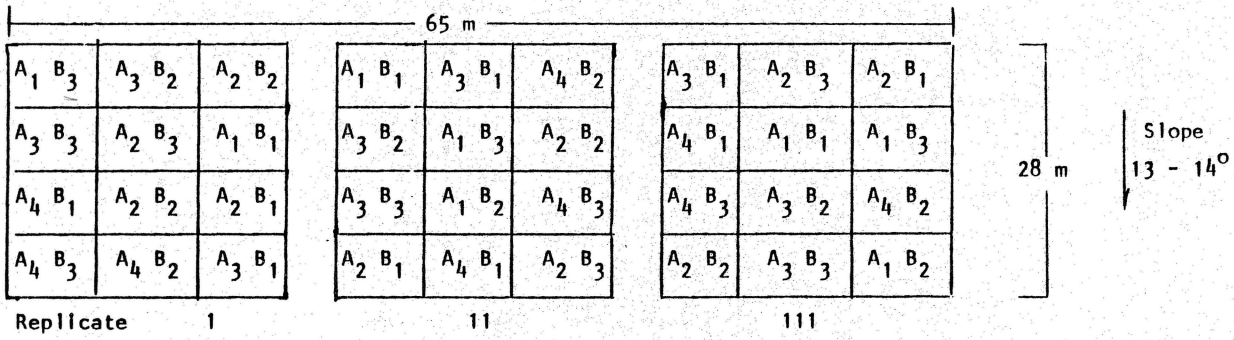
Design:

Trial 3a: Randomized block design with three replications per treatment (see Figure 8).

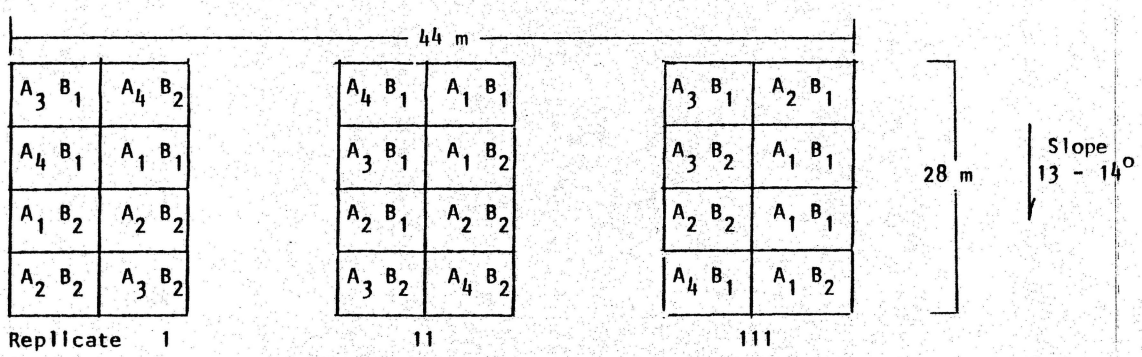
Trial 3b: Randomized block design with three replications per treatment (see Figure 8).

4.4.8.3.1 Field Operations (Trial 3). An unvegetated area of uniform material on the overburden pile was selected for these trials. One major requirement for the choice of the site was that the site should have a strong likelihood of being naturally invaded by native vegetation. As the surface soil material and peat which were mixed with the surface materials of the waste dump by GCOS contained plant materials which could establish at the site the requirement was met. The plots were staked out and composite soil samples were taken (0-15 cm, 15-30 cm, and 30-60 cm) on 13 May. Fertilizer rate, form, and application method as well as seed mix, seeding rate, and seeding method are described in Sections 4.4.4 and 4.4.3. The fertilizers were applied on 17 May, and seeding was

Trial 3a. Overburden pile (Waste Dump 7).




Trial 3b. Overburden pile (Waste Dump 7).




A = Species
1. Northwest poplar (*Populus deltoides* x *balsamifera*)
2. Walker poplar ( *P. deltoides* x *Russian*)
3. Basford willow (*Salix fragilis* L. Var. *'basfordiana'* Redher)
4. Laurel willow (*Salix pentandra* L.)

B = Ground Cover:
Trial 3a: 1. Nil (to be naturally invaded)
2. Grass mix
3. Grass-legume mix
Trial 3b: 1. Grass mix
2. Grass-legume mix

Figure 8. Trial Layouts: Trial 3 (ground covers).

was carried out on 7 June. In Trial 3a, tree and shrub seedling planting preceded forage seeding by 4 days. Assessment of vegetative cover and tree and shrub performance were carried out on approximately the same dates as in Trial 1, and the methods employed in the assessments were the same.

4.4.8.3.2 Field Observations (Trial 3). Although the quality of the seedlings planted was generally poor (Sections 4.4.5 and 4.4.8.1.2), the observed percentage of buds opening one month after planting was greater when forage was not already established (Trial 3) than for the same species on both the dike and overburden pile where forage cover had been established prior to 1977 (see Trials 1 and 2). The preliminary indication is that other factors, as yet undetermined, also might have contributed to the initial poor performance of the tree and shrub seedlings. Estimated percentages of initial establishments for a given species varied considerably between and within replications. This would suggest that there was a considerable variability in seedling quality between bundles (of 25 seedlings each) or that site variability was considerable. In some plots (28 seedlings, representing about one bundle), the percentage of initial establishment approached 100, while in other plots planted with the same species from another bundle the percentage was low. Competition from the forage seeded about the same time that the tree and shrub seedlings were planted was non-existent in the first four weeks after planting, and therefore the percentage of seedlings initially established was hardly influenced by the seeded forage crops. Estimated rodent damage was very minimal in the early stages of seedling establishment, as there was not enough forage cover to encourage the rodents to establish at the site.

Data on the chemical and physical properties of the overburden material at the site are summarized in Table 21 (Appendix 8.4).

4.4.8.4 Trial 4.

Location:

Overburden pile, Waste Dump 5 (Figure 9).

Title:

Effect of various amendments on forage cover establishment and tree and shrub seedling performance on steeply sloped oil sands mine wastes (overburden piles).

The objectives were:

1. To evaluate various amendments for slope stabilization;
2. To study the influence of amendments on agronomic forage ground cover establishments; and
3. To compare the performance of tree and shrub seedlings established on different seedbeds prepared through the use of various amendments.

The treatments were:

A. Species:
   1. Northwest poplar (*Populus deltoides* x *balsamifera*)
   2. Walker poplar (*Populus deltoides* x Russian)
   3. Russian olive (*Elaeagnus angustifolia* L.)
   4. Basford willow (*Salix fragilis* L. var. *basfordiana* Redhem)

B. Amendments:
   1. Peat ($182^3$m /ha) incorporated into the overburden surface before forage seeding and tree and shrub planting.
   2. Straw mulch applied (3,247 kg/ha) with limited incorporation before seeding and tree and shrub seedling planting. Terra Tack II (44 kg/ha) applied to tack down the straw.
   3. Direct hydroseeding with paper mulch slurry (1,117 kg/ha) after tree and shrub seedling planting.
   4. No amendment. Direct seeding on overburden materials before tree and shrub seedling planting.

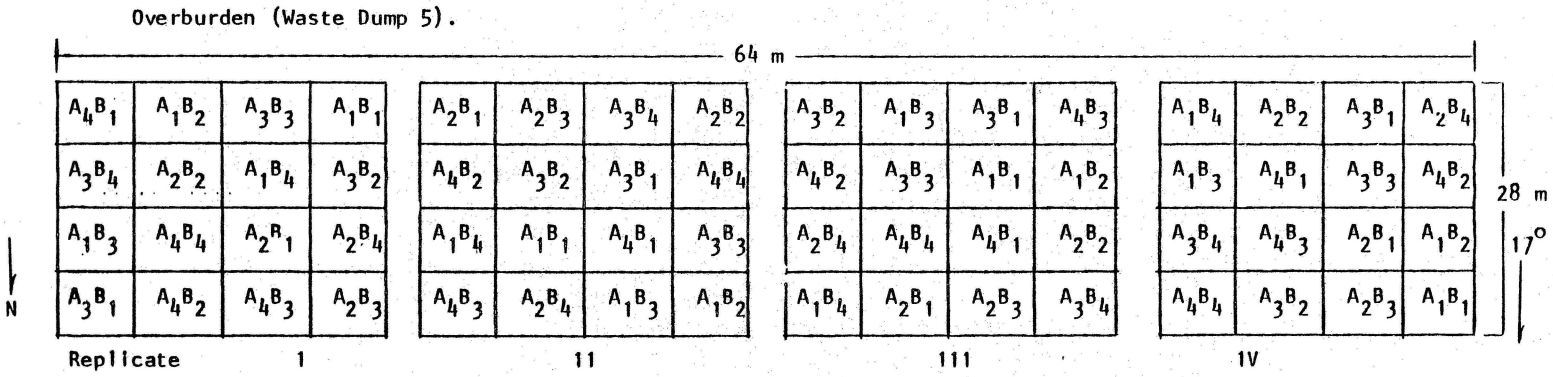



Figure 9. Trial Layout: Trial 4 (amendments).

Design:

A factorial in a randomized block design with four replications per treatment (see Figure 9).

4.4.8.4.1 Field Observations (Trial 4). The site chosen for the trial had been revegetated in 1974 (Figure 4), followed by tree and shrub planting in 1974 and 1975. Vegetation at the site was destroyed when the slope was reshaped in 1976 to repair erosion damage. The trial site was staked out, and composite soil samples were taken (0-15 cm, 15-30 cm, and 30-60 cm) on 14 May. Site preparation, including surface rock removal, fertilization, and the application and incorporation of the amendments, was carried out between 17 and 19 May. Fertilizer rates and method of application were the same as described for Trial 3 (Section 4.4.8.3.1). Tree and shrub seedlings were planted on 3 and 4 June. Seeding of grasses and legumes was carried out on 21 June. The composition of the grass-legume-nurse crop mix has been described in Section 4.4.3. Assessment dates and assessment procedure are the same as described for Trial 3.

4.4.8.4.2 Field Observations (Trial 4). See discussion under the same topic for Trial 3 (Section 4.4.8.3.2).

4.4.8.5 Trial 5.

Location:

Overburden pile, Waste Dump 7 (Figure 10).

Title:

Influence of seasonal broadcast maintenance fertilizer applications to forage cover on the performance of tree and shrub seedlings on a waste pile (overburden).

The objectives were:

1. To determine the effect of fertilizers on revegetation with forage crops and tree and shrub seedlings; and
2. To determine the effect of seasonal (split) fertilizer application on tree and shrub seedling performance.

The treatments were:

A. Fertilization:
   1. Nil
   2. Single (spring) application
   3. Single (summer) application
   4. Split (spring and summer) applications

B. Species:
   1. Caragana (*Caragana arborescens* Lam.)
   2. Vernirubens poplar (*P* x *euramericana*)

Design:

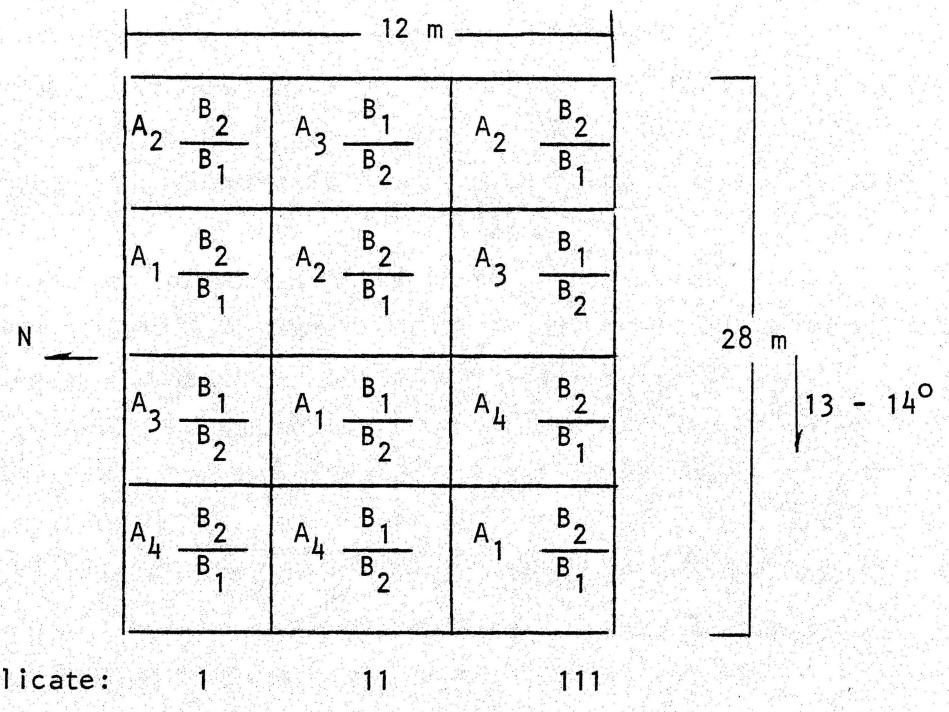
A factorial experiment with a split plot design replicated three times (Figure 10).

4.4.8.5.1 Field Operations (Trial 5). This trial was located adjacent to Trial 3. Field operations, assessment procedures, and the times they were carried out are identical to those of Trial 3. Differences in operations between the trials and those relating to the treatments for each. This trial received no fertilizers in the first growing season. The fertilizer application rates in 1978 will be based on the performance of seedlings in the first growing season.

4.4.8.5.2 Field Observations (Trial 5). See discussion under the same topic for Trial 3 (Section 4.4.8.3.2).

The seeded grass-legume-nurse crop mix grew poorly as a result of the low soil fertility of the unfertilized overburden material, in comparison with the adjacent Trial 3, which was fertilized. In the case of the tree and shrub seedlings, the absence of fertilizers did not appear to have influenced the establishment percentage and only marginally influenced general conditions. (It should be noted that different species were used in Trial 5 and Trial 3, so that the comparisons are only relative.) Soil analyses data are given in Table 21 (Appendix 8.4).

Overburden (Waste Dump 7).




A = Fertilizer (see text):
1. Nil
2. Spring application
3. Summer application
4. Spring and summer (split) applications

B = Species:
1. Caragana (*Caragana arborescens* Lam.)
2. Vernirubens poplar (*P.* x *euramericana*)

Figure 10. Trial Layout: Trial 5 (fertilizer).

## 4.5 SEED COLLECTIONS: NATIVE TREES AND SHRUBS

The collections of seeds of native trees and shrubs were aimed primarily at providing seedlots of containerized seedlings for testing and for trials in 1979 and later in the project. The 11 species collected in 23 seedlots represented some of the species considered to have potential for use in oil sands reclamation because they have naturally invaded several old disturbed sites in the area. Figure 1 shows the collection sites, and Table 9 lists the species collected, the seedlots, and the legal locations of the sources. Generally, seeds were collected at well-drained, flat to gently rolling sites which were either disturbed in the past and had naturally regenerated or were undisturbed. Although the soils at these sites have not been identified at the series level, they are mostly sandy in texture.

In meeting the objective of testing populations for adaptability to oil sands waste materials for the eventual purpose of recommending seed sources and species for reclamation plantings, 16 sites were established in the fall of 1977 for seed collections in 1978 (Figure 11). A preliminary survey of the sites has been completed. Table 10 briefly describes the site locations, some physical characteristics of the sites, and the dominant plant species at the sites, some of which are to be represented in the seed collections.

Table 9. Tree and shrub seeds collected in 1977: species, seedlots, locations, and site descriptions.

| Species | Seedlot | Legal Location | Location[a] | Physical Description of Site | |
|---|---|---|---|---|---|
| *Alnus tenuifolia* Nutt. (mountain alder) | ALD 1-77 | 18-93-10-4 | 5 | Drainage: | well-drained, sandy |
| | | | | Aspect: | none |
| | | | | Slope: | flat |
| | | | | Site condition: | undisturbed |
| | ALD 2-77 | 6-99-2-4 | b | Drainage: | well-drained, sandy |
| | | | | Aspect: | south |
| | | | | Slope: | gently sloping |
| | | | | Site condition: | disturbed |
| | ALD 3-77 | 9-94-6-4 | 4 | Drainage: | moderately well-drained |
| | | | | Aspect: | east |
| | | | | Slope: | gently sloping |
| | | | | Site condition: | undisturbed |
| | ALD 4-77 | 24-100-12-4 | 2 | Drainage: | imperfectly drained |
| | | | | Aspect: | none |
| | | | | Slope: | flat |
| | | | | Site condition: | disturbed |
| *Amelanchier alnifolia* Nutt. (saskatoon) | SAS 1-77 | 8-93-10-4 | 6 | Drainage: | well-drained, sandy |
| | | | | Aspect: | none |
| | | | | Slope: | flat |
| | | | | Site condition: | disturbed |
| *Arctostaphylos uva-ursi* (L.) Spreng (bearberry) | Bear 1-77 | 8-93-10-4 | 6 | Drainage: | well-drained, sandy |
| | | | | Aspect: | none |
| | | | | Slope: | flat |
| | | | | Site condition: | undisturbed |

continued ...

Table 9. Continued.

| Species | Seedlot | Legal Location | Location[a] | Physical Desciption of Site | |
|---|---|---|---|---|---|
| *Betula papyrifera* Marsh. (paper birch) | PAP 1-77 | 20-93-10-4 | 5 | Drainage: | well-drained, sandy |
| | | | | Aspect: | east |
| | | | | Slope: | gently sloping |
| | | | | Site condition: | undisturbed |
| | PAP 2-77 | 20-93-10-4 | 5 | Drainage: | well-drained, sandy |
| | | | | Aspect: | west |
| | | | | Slope: | gently sloping |
| | | | | Site condition: | undisturbed |
| | PAP 3-77 | 13-92-10-4 | 7 | Drainage: | well-drained, sandy |
| | | | | Aspect: | none |
| | | | | Slope: | flat |
| | | | | Site condition: | undisturbed |
| | PAP 4-77 | 13-92-10-4 | 7 | Drainage: | well-drained, sandy |
| | | | | Aspect: | none |
| | | | | Slope: | flat |
| | | | | Site condition: | undisturbed |
| *Cornus stolonifera* Michx. (red-osier dogwood) | DOG 1-77 | 8-93-10-4 | 6 | Drainage: | imperfect |
| | | | | Aspect: | south |
| | | | | Slope: | gently sloping |
| | | | | Site condition: | undisturbed |
| | DOG 2-77 | 16-89-9-4 | 8 | Drainage: | well-drained |
| | | | | Aspect: | none |
| | | | | Slope: | flat |
| | | | | Site condition: | undisturbed |

continued ...

Table 9. Continued.

| Species | Seedlot | Legal Location | Location[a] | Physical Description of Site | |
|---|---|---|---|---|---|
| *Empetrum nigrum* L. (crowberry) | CROW 1-77 | 33-105-6-4 | 1 | Drainage: | well-drained, sandy |
| | | | | Aspect: | south |
| | | | | Slope: | gently sloping |
| | | | | Site condition: | disturbed |
| *Prunus pensylvanica* L.F. (pincherry) | PIN 1-77 | 8-93-10-4 | 6 | Drainage: | well-drained, sandy |
| | | | | Aspect: | none |
| | | | | Slope: | flat |
| | | | | Site condition: | disturbed |
| *Prunus virginiana* L. (chokecherry) | CHO 1-77 | 8-93-10-4 | 6 | Drainage: | well-drained, sandy |
| | | | | Aspect: | south |
| | | | | Slope: | gently sloping |
| | | | | Site condition: | disturbed |
| *Pinus banksiana* Lamb. (jack pine) | JAC 1-77 | 13-84-11-4 | 9 | Drainage: | well-drained |
| | | | | Aspect: | none |
| | | | | Slope: | flat |
| | | | | Site condition: | undisturbed |
| | JAC 2-77 | 27-83-11-14 | b | Drainage: | well-drained |
| | | | | Aspect: | none |
| | | | | Slope: | flat |
| | | | | Site condition: | undisturbed |
| | JAC 3-77 | 18-93-10-4 | 5 | Drainage: | well-drained, sandy |
| | | | | Aspect: | none |
| | | | | Slope: | flat |
| | | | | Site condition: | undisturbed |

continuned ...

Table 9. Continued.

| Species | Seedlot | Legal Location | Location[a] | Physical Description of Site | |
|---|---|---|---|---|---|
| *Pinus banksiana* Lamb. (jack pine) | JAC 4-77 | 9-94-6-4 | 4 | Drainage: | moderately well-drained |
| | | | | Aspect: | none |
| | | | | Slope: | flat |
| | | | | Site condition: | undisturbed |
| | JAC 5-77 | 6-99-2-4 | b | Drainage: | well-drained, sandy |
| | | | | Aspect: | none |
| | | | | Slope: | flat |
| | | | | Site condition: | undisturbed |
| | JAC 6-77 | 24-100-2-4 | 2 | Drainage: | moderately well-drained |
| | | | | Aspect: | none |
| | | | | Slope: | flat |
| | | | | Site condition: | disturbed |
| *Shepherdia canadensis* (L.) Nutt. (Canadian Buffaloberry) | BUF 1-77 | 1-95-11-4 | 3 | Drainage: | moderately well-drained |
| | | | | Aspect: | east |
| | | | | Slope: | gently sloping |
| | | | | Site condition: | undisturbed |
| | BUF 2-77 | 4-93-10-4 | 6 | Drainage: | well-drained, sandy |
| | | | | Aspect: | NW |
| | | | | Slope: | gently sloping |
| | | | | Site condition: | undisturbed |

continued...

Table 9. Concluded.

| Species | Seedlot | Legal Location | Location[a] | Physical Description of Site | |
|---|---|---|---|---|---|
| *Viburnum edule* (Michx.) Raf. (lowbush cranberry) | LOW 1-77 | 1-95-11-14 | 3 | Drainage: | imperfect - moderately well-drained |
| | | | | Aspect: | east |
| | | | | Slope: | gently sloping |
| | | | | Site condition: | undisturbed |
| | LOW 2-77 | 4-93-10-4 | 6 | Drainage: | well-drained, sandy |
| | | | | Aspect: | none |
| | | | | Slope: | flat |
| | | | | Site condition: | undisturbed |

[a]See Figure 1.

[b]Location outside illustrated area.

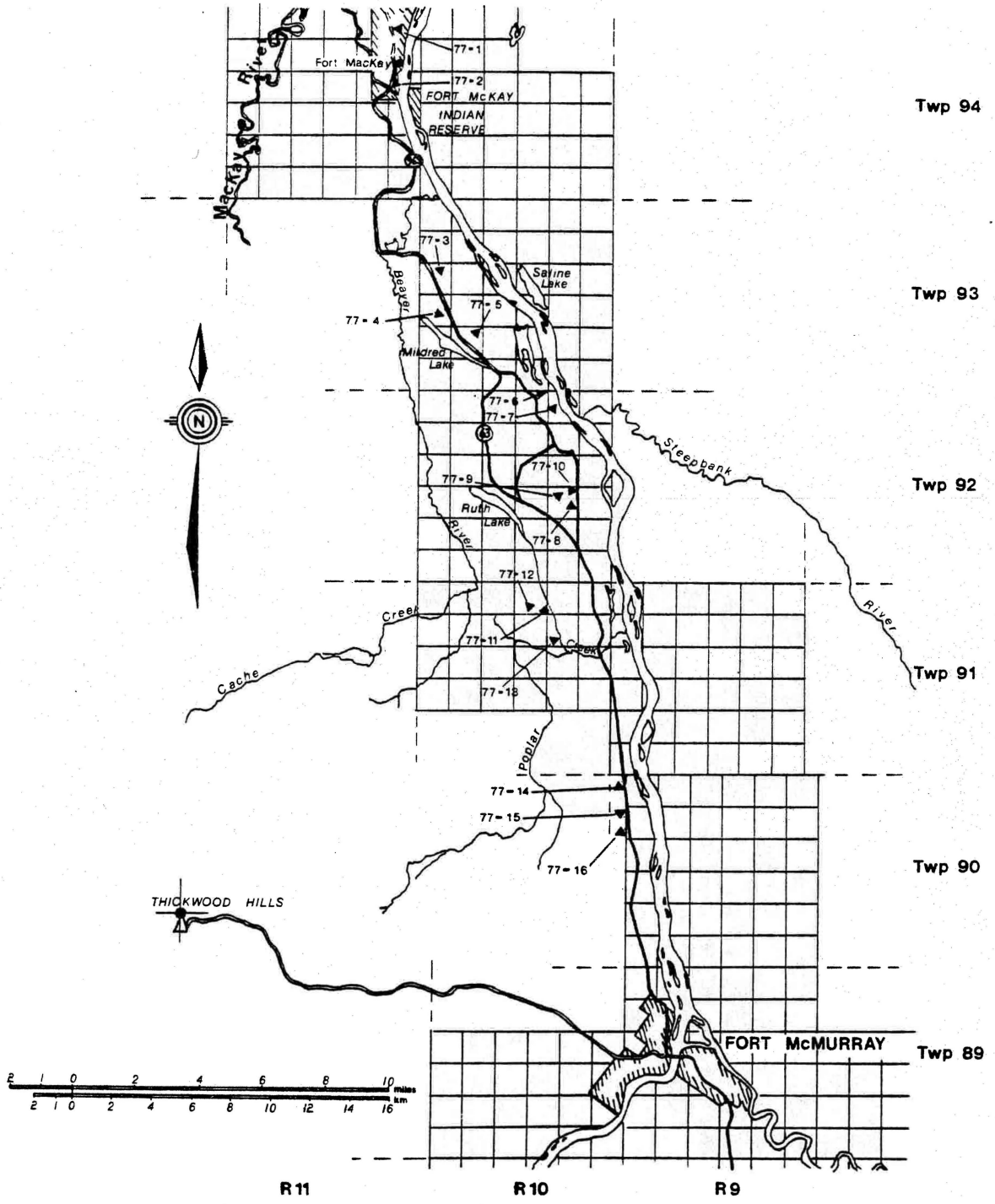



Figure 11. Sites established in 1977 for seed collections in 1978. (See also Table 10.)

Table 10. Seed collection planned for 1978: site location, species present, and site description.

| Site | | | | |
|---|---|---|---|---|
| 1-77 (a) & (b) | Borrow pit 2.4 km N of Fort MacKay on the east side of the road. | Drainage:<br>Aspect:<br>Slope:<br>Conditions: | moderately well-drained<br>none<br>flat<br>(a) disturbed<br>(b) undisturbed | *Sheperdia canadensis* (L.) Nutt.<br>*Populus tremuloides* Michx.<br>*Rosa acicularis* Lindl.<br>*Arctostaphylos uva-ursi* (L.) Spreng.<br>*Potentilla fruticosa* L.<br>*Salix* spp. |
| 2-77 | MacKay River crossing, upper portion of slope, 90-275 m E. of Fort MacKay road. | Drainage:<br>Aspect:<br>Slope:<br>Conditions: | well-drained, sandy<br>south<br>steep<br>undisturbed | *Amelanchier alnifolia* Nutt.<br>*Rosa acicularis* Lindl.<br>*Arctostaphylos uva-ursi* (L.) Spreng.<br>*Cornus stolonifera* Michx.<br>*Symphoricarpus albus* (L.) Blake.<br>*Betula papyrifera* Marsh. |
| 3-77 | Approximately 3.2 km N of AOSERP Mildred Lake Research Facility turnoff and 90 m E of the Fort MacKay road. | Drainage:<br>Aspect:<br>Slope:<br>Conditions: | well-drained, sandy<br>northwest and southwest<br>rolling<br>undisturbed | *Betula papyrifera* Marsh.<br>*Artostaphylos uva-ursi* (L.) Spreng.<br>*Alnus tenuifolia* Nutt.<br>*Vaccinium myrtilloides* Michx.<br>*Cornus canadensis* Michx.<br>*Pinus banksiana* Lamb. |
| 4-77 | Directly W. of AOSERP Facility turnoff, 45 m W of Fort MacKay road. | Drainage:<br>Aspect:<br>Slope:<br>Condition: | well-drained, sandy<br>none<br>flat<br>disturbed | *Artostaphylos uva-ursi* (L.) Spreng.<br>*Vaccinium myrtilloides* Michx.<br>*Alnus tenuifolia* Nutt.<br>*Populus tremuloides* Michx.<br>*Pinus banksiana* Lam.<br>*Amelanchier alnifolia* Nutt. |

continued ...

Table 10. Continued.

| Site | Location[a] | Physical Description of Site | | Species Present |
|---|---|---|---|---|
| 5-77 (a) & (b) | Mildred Lake Airstrip: east and west sides of the strip. | Drainage: | well-drained, sandy | *Alnus* spp. |
| | | Aspect | none | *Populus tremuloides* Michx. |
| | | Slope | flat | *Populus balsamifera* L. |
| | | Conditions: | (a) disturbed | *Rosa acicularis* Lindl. |
| | | | (b) undisturbed | *Salix* spp. |
| | | | | *Prunus pensylvanica* L.F. |
| | | | | *Prunus virginiana* L. |
| | | | | *Arctostaphylos uva-ursi* (L.) Spreng. |
| | | | | *Shepherdia canadensis* (L.) Nutt. |
| | | | | *Pinus banksiana* Lam. |
| | | | | *Amelanchier alnifolia* Nutt. |
| 6-77 | 1.0 km E of Highway 63 along the Syncrude Lower Camp Road; site is N of the road just E. of a small gravel pit. | Drainage: | well-drained, sandy | *Populus tremuloides* Michx. |
| | | Aspect: | east | *Vaccinium myrtilloides* Michx. |
| | | Slope: | gentle | *Arctostaphylos uva-ursi* (L.) Michx. |
| | | Condition: | undisturbed | *Pinus banksiana* Lam. |
| 7-77 | 1.6 km E. of Highway 63 along the Syncrude Lower Camp Road; site is N. of the road. | Drainage: | well-drained, sandy | *Populus tremuloides* Michx. |
| | | Aspect: | none | *Vaccinium mytilloides* Michx. |
| | | Slope: | flat | *Alnus tenuifolia* Nutt. |
| | | Condition: | disturbed | |
| 8-77 | E of the GCOS overburden (Waste Dump 7) beside S security gate. | Drainage: | well-drained, sandy | *Betula papyrifera* Marsh. |
| | | Aspect: | none | *Populus tremuloides* Michx. |
| | | Slope: | flat | *Alnus tenuifolia* Nutt. |
| | | Condition: | undisturbed | *Arctostaphylos uva-ursi* (L.) Spreng. |

continued ...

Table 10. Continued.

| Site | Location[a] | Physical Description of Site | | Species Present |
|---|---|---|---|---|
| 9-77 | 45 m E of 8-77 across a cutline. | Drainage: | well-drained | *Betula papyrifera* Marsh. |
| | | Aspect: | none | *Alnus tenuifolia* Nutt. |
| | | Slope: | flat | *Arctostaphylos uva-ursi* (L.) Spreng. |
| | | Condition: | undisturbed | *Cornus canadensis* Michx. |
| | | | | *Vaccinium myrtilloides* Michx. |
| 10-77 | Crest of GCOS overburden #7 (Waste Dump 7). | Drainage: | well-drained | *Betula pumila* var. *glandulifera* Regel |
| | | Aspect: | variable | *Populus tremuloides* Michx. |
| | | Slope: | very gently rolling | *Populus balsamifera* L. |
| | | Condition: | undifferentiated overburden pile | *Salix* spp. |
| 11-77 | End of the Poplar Creek gravel pit road on the Forest Service gravel pit site. | Drainage: | well-drained, sandy | *Arctostaphylos uva-ursi* (L.) Spreng. |
| | | Aspect: | none | *Populus tremuloides* Michx. |
| | | Slope: | flat | *Vaccinium myrtilloides* Michx. |
| | | Condition: | disturbed | *Salix* spp. |
| | | | | *Shepherdia canadensis* (L.) Nutt. |
| 12-77 | Same as 11-77. | Drainage: | well-drained, sandy | *Arctostaphylos uva-ursi* (L.) Spreng. |
| | | Aspect: | none | *Populus tremuloides* Michx. |
| | | Slope: | flat | *Vaccinium myrtilloides* Michx. |
| | | Condition: | undisturbed | *Salix* spp. |
| | | | | *Shepherdia canadensis* (L.) Nutt. |
| | | | | *Pinus banksiana* (Lam.) |
| 13-77 | E-facing slope of Ruth Lake 0.8 km S of the Poplar Creek gravel road bridge. | Drainage: | well-drained | *Populus tremuloides* Michx. |
| | | Aspect: | east | *Populus balsamifera* L. |
| | | Slope: | flat | |
| | | Condition: | disturbed | |

continued ...

Table 10. Concluded.

| Site | Location[a] | Physical Description of Site | | Species Present |
|---|---|---|---|---|
| 14-77 | 13.8 km N of the north end of the bridge across the Athabasca River from Fort McMurray W of the highway. | Drainage:<br>Aspect:<br>Slope:<br>Condition: | well-drained<br>east<br>gentle<br>disturbed | *Populus tremuloides* Michx.<br>*Salix* spp.<br>*Cornus stolonifera* Michx.<br>*Rosa acicularis* Lindl.<br>*Betula papyrifera* Marsh.<br>*Picea glauca* (Moench) Voss. |
| 15-77 | 1.6 km S of Site 14-77 W of highway. | Drainage:<br>Aspect:<br>Slope:<br>Condition: | well-drained<br>east<br>gentle<br>disturbed | *Alnus tenuifolia* Nutt.<br>*Cornus stolonifera* Michx.<br>*Salix* spp.<br>*Picea glauca* (Moenich) Voss. |
| 16-77 | 0.6 km S of Site 15-77 W of highway. | Drainage:<br>Aspect:<br>Slope:<br>Condition: | well-drained<br>east<br>gentle<br>disturbed | *Populus tremuloides* Michx.<br>*Populus balsamifera* L.<br>*Cornus stolonifera* Michx.<br>*Salix* spp. |

[a]See also Figure 11.

## 5. SUMMARY

This interim report is a descriptive account of the tree and shrub seedling plantings and trials carried out by AOSERP project VE 7.1 on the GCOS lease, since the inception of the project. Design, objectives, methodology, data collection, and the current state of the various studies initiated during this period are reported. To date, emphasis has been placed mostly on exotic (introduced) trees and shrubs; for the future, species native to the oil sands area will receive more attention and emphasis will be placed in plant genetics.

The first task for the authors upon taking over the project in May 1977 was to identify the many demonstration plantings carried out on the waste piles prior to this date. The direction and objectives of the project were reviewed, and it was found exigent to redirect the project towards meeting more specific objectives. Data collection was continued on these demonstration plantings, and a start was made to recompile the accumulated data resulting from these plantings to resolve whether any useful information could be obtained.

Four new studies were initiated on two overburden piles and on the tailings dike in late May and early June 1977. Each of these trials, replicated at least three times, was designed to provide answers to specific questions. Field observations were carried out to evaluate performance of the seedlings and problems associated with growth of the seedlings. Data collected on survival of the seedlings in these trials was started in the fall.

Collections of seeds of some native shrubs and trees from specific sites in the study area, including old disturbed sites, were undertaken to provide seedlings for future studies. Rearing of these seedlings for field studies planned for 1979-80 was started in March 1978 at the Alberta Forest Service Tree Nursery at Smokey Lake, Alberta. Also, the study area was surveyed, and

16 sites, including sites which were previously disturbed and subsequently became revegetated naturally, were selected for additional seed collections in 1978-79. The objective of these collections was to provide ecotypes for testing for adaptability to oil sands wastes.

This interim report does not present or discuss any results, or provide any tentative conclusions or recommendations on the work carried out to date, as the data being collected are not complete and, therefore, have not been analyzed. Field observations and experience gained suggest that several of the introduced exotic species may not be well adapted to the area, primarily because they may not be sufficiently hardy. Although data collected are yet to be analyzed, it appeared that rodent damage to seedlings was heavy in areas where forage cover was particularly dense. The combined effects of rodent damage and competition of forage cover with the tree and shrub seedlings for nutrients, light, and moisture also appeared to drastically inhibit seedling performance.

It is suggested that all future field experiments in this project should be fenced to protect seedlings from being killed by rodents (mice). To serve the same purpose, industry's practice of planting tree and shrub seedlings on oil sands waste piles where dense ground cover exists should be re-examined, as such cover provides habitat for small rodents.

## 6. NEED FOR FUTURE STUDY

The demonstration plantings and trials of the project so far have been comprised mostly of exotic (introduced) species of trees and shrubs, with a very limited number of species native to the study area. Data collected from the demonstration plantings provide little or no basis for specific conclusions or for the recommendation of specific species capable of adapting to severly disturbed sties. There is an apparent and specific need for more intensive study of naturally-invading native plant populations in disturbed sites in the study area, as introduced species may not prove useful for reclamation purposes over the long term. It is planned that future trials will emphasis native species of trees and shrubs likely to adapt readily to the inhospitable environment of oil sands mine wastes. Also needed are further studies of the factors so far encountered which hinder survival and performance of tree and shrubs on the drastically disturbed sites and on the mine waste materials.

The project objectives for 1978-79 and thereafter should continue to stress studies deisnged to provide recommendations of species most suited to large-scale production for afforestation of disturbed sites in the AOSERP study area. They should, as well, recognize the need for investigations into means of control of the factors inhibiting the performance of tested species.

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# 8. APPENDICES

## 8.1 CATEGORIES USED FOR ASSESSING THE FORAGE COVER IN THE 1977 TRIALS

### 1. Percentage area covered (density)

| Code | Class | Description |
|---|---|---|
| 1 | 0-10 | Absent to rare |
| 2 | 10-33 | Occasional |
| 3 | 33-50 | Common |
| 4 | 50-75 | Frequent |
| 5 | 75-100 | Abundant |

### 2. Pattern

| Code | Description |
|---|---|
| A | Present singly or in isolation |
| B | Present in groups |
| C | Present in small patches |
| D | Present in pure stands |

### 3. Cover types

| Code | Description |
|---|---|
| 1 | Native and seeded (total cover)<br>- bare ground<br>- litter and/or rock<br>- trees<br>- shrubs<br>- herbs<br>- grasses |
| 2 | Native (natural invasion, unseeded)<br>- grasses: brome<br>fescue<br>wheatgrass<br>other |

- legumes: alfalfa
  sweet clover
  white clover
  other
- nurse: barley
  other

## 8.2 CRITERIA USED FOR ASSESSING TREE AND SHRUB SEEDLING PERFORMANCE IN THE 1977 TRIALS

1. Survival (percent)

| Code | Description | Criteria |
|---|---|---|
| 0 | Dead | No visible signs to suggest seedling will leaf out at any time. |
| 1 | Alive | Visible signs to suggest parts of seedling or entire seedling still living. |

2. Plant condition (vigour)

| Code | Description | Criteria |
|---|---|---|
| 0 | Dead | Seedling appears dead; no visible signs to suggest seedling will leaf out in next growing season. |
| 1 | Poor | Very little to no growth; poor foliar colour; dead branches and foliage; continued survival doubtful. |
| 2 | Fair | New growth sometimes chlorotic; dead branches and foliage may be present; survival expected. |
| 3 | Good | Good growth; most foliage appears healthy; dead branches and foliage are rare. |
| 4. | Very good to Excellent | Very good growth; good colour of foliage and branches. |

3. General assessments

| Code | Description | Criteria |
|---|---|---|
| A | Poor planting stock | Dead, living foliage never in evidence; buds never opened (most falling in this category were not recognized at planting and therefore were not culled out). |
| B | Improper Planting | Seedling improperly anchored; insufficient compaction of growth medium. |
| C | Erosion | Seedling roots partially or completely exposed as a result of erosion; seedling buried in eroded material. |
| D | Dieback | Dead tops of branches and/or stems present on seedling. |
| E | Disease/ deficiency/ toxicity | Evidence of disolouration; foliage dwarism and necrosis; scorching; lesions; galls; cankers, etc.; severe enough to affect vigour. |
| F | Rodent damage (described below) | Damage caused by small mammals chewing on the bark (girdling). |
| G | Insect damage (described below) | Total or partial defoliation caused by chewing or skeletonizing insects. |
| H | Unkown | Factors not attributable to any of the above (unkown factors are generally site factors such as drought, toxic oil sands, etc., which were not recorded). |

4. Rodent (small mammal) damage

| Code | Class (%) | Criteria |
|---|---|---|
| 1 | 0 | No nibbles on stem bark. |
| 2 | 1-50 | Up to one-half of stem circumference damaged. |
| 3 | 51-99 | Stem circumference over one-half to almost completely damaged. |
| 4 | 100 | Completely girdled (bark destroyed), effectively stopping translocation. |

5. Insect damage

| Code | Class | Criteria |
|---|---|---|
| 1 | 0 | No insect damage to foliage. |
| 2 | 1-20 | Up to one-fifth of estimated foliage area destroyed. |
| 3 | 21-50 | Between one-fifth and one-half of estimated foliage area destroyed. |
| 4 | 51-99 | Between one-half and almost complete defoliation of estimated foliage area. |
| 5 | 100 | Complete defoliation. |

## 8.3 PHOTOGRAPHS OF FACTORS AFFECTING SURVIVAL OR PERFORMANCE

Some of the following plates do not relate directly to the text. They are, however, included here to illustrate problems which have some bearing on the survival and performance of trees and shrub seedlings planted on the mine waste in this project.

Originals of these photographs may be viewed at the AOSERP office, 15th Floor, Oxbridge Place, 9820 - 106 Street, Edmonton.

Figure 12. Erosion contributed to the failure of this white spruce seedling getting established on the tailings dike (1975 demonstration planting). Roots reamined in the original peat in the container and did not penetrate the unamended tailings sand.

Figure 13. The abrasive tailings sand in the frequent sandstorms on the tailings dike may severely impede seedling performance.

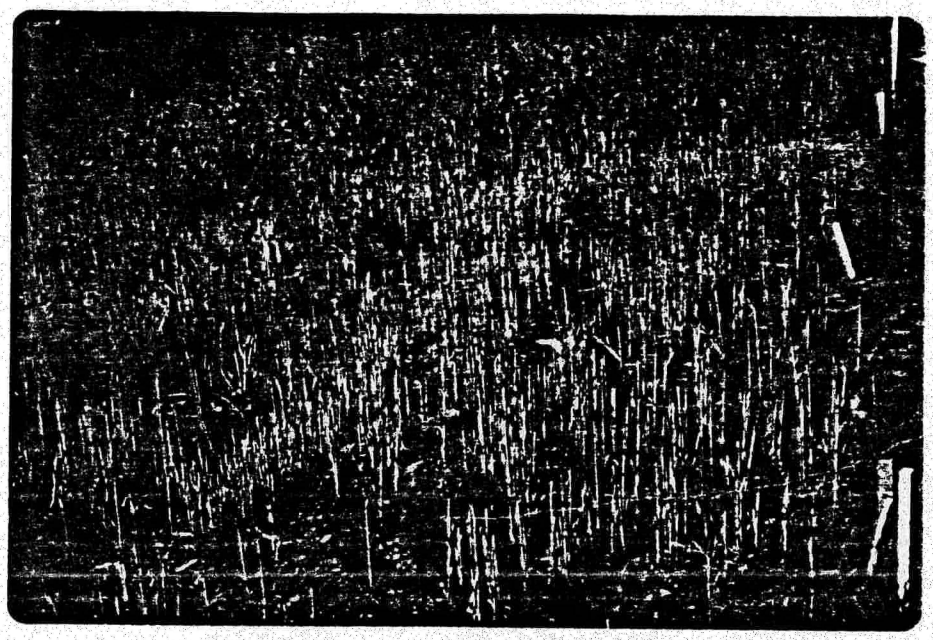

Figure 14. Differences in seeded cover stands on an overburden pile between a fertilized trail (Trial 3, 1977, background) and an unfertilized trail (Trial 5, 1977, foreground) both seeded on the same day.

Figure 15. Water ponding in a depression on a berm on the tailings sand dike has resulted in the survival and better growth of the *Salix petandra* L. (Laurel willow) to the right; downslope (left) has been poor, and several seedlings have died as a result of severe moisture stress (1975 demonstration plantings).

Figure 16. Forage competition (as illustrated by this vigorous growth) on Waste Dump 7 affected the initial establishment and eventual survival of this newly planted *Acer negundo* (Manitoba maple). The rodent (mice) population appears dense in such a protected environment.

Figure 17. Dieback in this exotic willow seedling was perhaps the result of low winter hardiness (1976 demonstration planting, tailing dike). Although the plant may survive from year to year, it may not grow in the long-term.

Figure 18. Small mammal (mice) girdling led to the death of this willow (*Salix* spp.) seedling. Seedling mortality due to rodent damage, although widespread, is essentially high on both the tailings dike and the overburden piles, where the forage cover is particularly dense (Trial 1a, 1977).

Figure 19. Hybrid poplars (1975 demonstration planting, tailings dike) retain their leaves much longer in the fall (picture taken in the last week of September 1977) than the native poplars (background). This perhaps illustrates poor adaptability (winter hardiness) of some introduced exotic species. Bud formation of the hybrid poplar may be delayed or many not be completeed so that an early frost could result in few buds surviving the winter in any given year.

## 8.4 DEMONSTRATION PLANTINGS AND TRIAL SITES

Tables 11 to 21 present data concerning the demonstration plantings from 1974 to 1976, and chemical and physical properties of arial sites established in 1977.

Table 11. Demonstration plantings on tailings dike, spring 1974.

| Species | Total No. of Sites (plots) Planted | Average No. of Plants Planted per Site (plot) | Slope Locations (between berms) | Stock[a] Source | Stock[b] Age |
|---|---|---|---|---|---|
| *Betula papyrifera* Marsh. | 2 | 93 | 1 | * | * |
| *Acer negundo* L. | 1 | 18 | 1 | * | * |
| *Salix arctica* Pall. | 3 | 45 ? | 1 | 0 | 3-0 |
| *Salix acutifolia* Willd. | 2 | 100 | 1 | 0 | 3-0 |
| *Abies balsamea* (L.) Mill. | 1 | 100 | 1 | 0 | 3-0 |
| *Salix* spp. (native) | 2 | 100 | 1 | 0 | 3-0 |
| | 2 | 75 | 1 | 0 | 1c |
| *Picea glauca* (Moench) Voss. | 4 | 100 | 2 | 0 | 3-0 |
| *Pinus contora* Dougl. | 5 | 100 | 2 | 0 | 3-0 |
| *Pinus banksiana* Lamb. | 4 | 100 | 2 | 0 | 3-0 |
| *Populus tremuloides* Michx. | 4 | 67 | 2 | 0 | 1c |
| *Populus balsamifera* L. | 2 | 100 | 1 | 0 | 1c |

*not recorded.

[a]stock source: 0 = Oliver Provincial Tree Nursery, Alberta.

[b]stock age: 3-0 = bareroot stock completing three growing seasons in seedbed, zero years in transplant beds.

Table 12. Demonstration plantings on Waste Dump 5, spring 1974.

| Species | Total No. of Sites (plots) Planted | Average No. of Plants Planted per Site (plot) | Slope Locations (between berms) | Stock[a] Source | Stock[b] Age |
|---|---|---|---|---|---|
| *Pinus contorta* Dougl. | 10 | 93 | 2 | 0 | 3-0 |
| *Pinus banksiana* Lamb. | 8 | 100 | 2 | 0 | 3-0 |
| *Picea glauca* (Moench) Voss. | 13 | 100 | 2 | 0 | 3-0 |
| *Abies balsamea* (L.) Mill. | 2 | 100 | 1 | 0 | 3-0 |
| *Populus balsamifera* L. | 2 | 70 | 1 | 0 | 1c |
| *Populus tremuloides* Michx. | 2 | 126 | 2 | 0 | 1c |
| *Salix* spp. (native) | 2 | 85 | 1 | 0 | 1c |

[a]stock source: 0 = Oliver Provincial Tree Nursery, Alberta.

[b]Stock age: 3-0 = bareroot stock completing three growing seasons in seedbed, zero years in transplant beds.

Table 13. Demonstration plantings on tailings dike, spring 1975.

| Species | Total No. of Sites Planted | Average No. of Plants Planted per Site | Slope Locations | Stock[a] Source | Stock[b] Age |
|---|---|---|---|---|---|
| *Acer negundo* L. | 3 | 103 | 1 | L | 2-0 |
| | 2 | 100 | 1 | 0 | 2-0 |
| *Alnus rugosa* (Du Roi) Spreng. | 8 | 100 | 3 | 0 | 1c |
| | 2 | 100 | 1 | 0 | 2c |
| *Betula alba* L. | 1 | 50 | 1 | 0 | 2-0 |
| *Caragana arborescens* Lam. | 3 | 100 | 1 | 0 | 2-0 |
| *Cornus stolonifera* Michx. | 1 | 50 | 1 | 0 | 2-0 |
| *Framinus pennsylvanica* Marsh. | 1 | 100 | 1 | 0 | 2-0 |
| *Lonicera tatarica* L. | 2 | 50 | 2 | 0 | 2-0 |
| *Populus balsamifera* L. | 4 | 100 | 2 | 0 | 1c |
| | 1 | 39 | 1 | 0 | 2-0 |
| *Populus* spp. Hybrid clones | | | | | |
| Brooks #6 | 1 | 100 | 1 | B | 1-0 |
| Griffen | 1 | 50 | 1 | B | 1-0 |
| Russian | 1 | 93 | 1 | B | 1-0 |
| *Populus trichocarpa* T. & G. | 1 | 19 | 1 | 0 | 2-0 |
| *Picea glauca* (Moench) Voss. | 1 | 100 | 1 | 0 | 3-2 |
| | 8 | 100 | 1 | 0 | 2c |
| | 12 | 100 | 2 | 0 | 1c |
| *Picea mariana* (Mill). BSP. | 6 | 100 | 1 | 0 | 2c |
| | 20 | 100 | 4 | 0 | 1c |
| *Picea pungens* Engelm. | 1 | 50 | 1 | 0 | 3-4 |
| *Pinus banksiana* Lamb. | 3 | 100 | 1 | 0 | 3-3 |
| | 5 | 92 | 1 | 0 | 3-0 |
| | 10 | 100 | 4 | 0 | 1c |

Continued ...

Table 13. Concluded.

| Species | Total No. of Sites Planted | Average No. of Plants Planted per Site | Slope Locations | Stock[a] Source | Stock[b] Age |
|---|---|---|---|---|---|
| *Pinus contorta* Dougl. | 1 | 100 | 1 | 0 | 3-0 |
| | 1 | 100 | 1 | 0 | 2c |
| | 7 | 98 | 4 | 0 | 1c |
| *Prunus padus* L. | 1 | 48 | 1 | 0 | 2-0 |
| *Prunus virginiana* L. | 1 | 25 | 1 | 0 | 2-0 |
| *Quercus macrocarpa* Michx. | 1 | 50 | 1 | 0 | 2-0 |
| *Rhamnus davurica* Pall. | 2 | 59 | 2 | B | 2-0 |
| *Salix alba* L. | 3 | 100 | 2 | 0 | 1-0 |
| *Salix acutifolia* Willd. | 4 | 98 | 2 | L | 2-0 |
| | 2 | 100 | 2 | 0 | 1-0 |
| *Salix amygdaloides* Anderss. | 3 | 98 | 1 | 0 | 1-0 |
| *Salix pentandra* L. | 5 | 110 | 1 | 0 | 1-0 |
| *Ulmus americana* L. | 1 | 100 | 1 | 0 | 2-0 |
| *Ulmus pumila* L. | 1 | 100 | 1 | B | 2-0 |

[a]Stock source: 0 = Oliver Provincial Tree Nursery, Alberta.
L = Lacombe Nursery, Alberta.
B = Brooks Nursery, Alberta

[b]Stock age: A-B format with A = # of years in seedbed.
B = # of years in transplant bed.

1c or 2c format = one or two growing seasons in containers.

Table 14. Demonstration plantings on tailings dike, fall 1975.

| Species | Total No. of Sites Planted | Average No. of Plants Planted per Site | Slope Locations | Stock[a] Source | Stock[b] Age |
|---|---|---|---|---|---|
| *Acer negundo* L. | 1 | 110 | 1 | L | 2-0 |
| | 1 | 100 | 1 | L | 3-0 |
| *Populus* spp. Hybrid clones: | | | | | |
| Brooks #10 | 2 | 109 | 2 | L | 2-0 |
| Northwest | 2 | 110 | 2 | L | 2-0 |
| Griffin | 1 | 110 | 1 | L | 2-0 |
| *Populus balsamifera* L. | 1 | 100 | 1 | 0 | 1c |
| *Salix acutifolia* Willd. | 1 | 100 | 1 | L | 2-0 |
| *Salix pentandra* L. | 1 | 102 | 1 | L | 2-0 |

[a]Stock source: 0 = Oliver Provincial Tree Nursery, Alberta.
L = Lacombe Nursery, Alberta

[b]Stock age: A-B format with A = # of years in seedbed.
B = # of years in transplant bed.

1c or 2c format = one or two growing seasons in containers.

Table 15. Demonstration plantings on Waste Dump 5, spring 1975.

| Species | Total No. of Sites Planted | Average No. of Plants Planted per Site | Slope Locations | Stock[a] Source | Stock[b] Age |
|---|---|---|---|---|---|
| *Acer negundo* L. | 2 | 59 | 2 | D | 2-0 |
| *Alnus rugosa* (Du Roi) Spreng. | 5 | 100 | 3 | 0 | 1c |
| *Caragana arborescens* Lam. | 2 | 100 | 2 | 0 | 2-0 |
| *Fraxinus pennsylvanica* Marsh. | 1 | 71 | 1 | 0 | 2-0 |
| *Lonicera tatarica* L. | 1 | 81 | 1 | 0 | 2-0 |
| *Populus balsamifera* L. | 2 | 100 | 1 | 0 | 1c |
| *Populus trichocarpa* T. & G. | 1 | 100 | 1 | 0 | 2-0 |
| *Picea glauca* (Moench) Voss. | 4 | 101 | 2 | 0 | 1c |
| | 1 | 119 | 1 | 0 | 2c |
| *Picea mariana* (Mill.) BSP. | 8 | 100 | 3 | 0 | 1c |
| *Picea pungens* Engelm. | 1 | 50 | 1 | 0 | 3-4 |
| *Pinus banksiana* Lamb. | 2 | 99 | 2 | 0 | 3-3 |
| | 2 | 98 | 2 | 0 | 3-0 |
| | 5 | 98 | 3 | 0 | 1c |
| *Pinus contorta* Dougl. | 6 | 100 | 3 | 0 | 1c |
| *Rhamnus davurica* Pall. | 1 | 100 | 1 | B | 2-0 |
| *Salix alba* L. | 2 | 97 | 1 | 0 | 1-0 |
| *Salix acutifolia* Willd. | 1 | 203 | 1 | L | 1-0 |
| | 2 | 97 | 1 | 0 | 1-0 |

Continued ...

Table 15. Concluded.

| Species | Total No. of Sites Planted | Average No. of Plants Planted per site | Slope Locations | Stock[a] Source | Stock[b] Age |
|---|---|---|---|---|---|
| *Salix amygdaloides* Anderss. | 2 | 97 | 1 | 0 | 1-0 |
| *Salix pentandra* L. | 2 | 100 | 1 | 0 | 1-0 |
| *Ulmus americana* L. | 1 | 97 | 1 | 0 | 2-0 |
| *Ulmus pumila* L. | 1 | 98 | 1 | 0 | 2-0 |

[a]Stock source: 0 = Olver Provincial Tree Nursery, Alberta.
L = Lacombe Nursery, Alberta.
B = Brooks Nursery, Alberta.

[b]Stock Age; A-B format with A = # of years in seedbed.
B = # of years in transplant bed.

1c or 2c format = one or two growing seasons in containers.

Table 16. Demonstration plantings on Waste Dump 7, fall 1975.

| Species | Total No. of Sites Planted | Average No. of Plants Planted per Site | Slope Locations | Stock[a] Source | Stock[b] Age |
|---|---|---|---|---|---|
| *Acer negundo* L. | 2 | 104 | 2 | L | 2-0 |
| *Betula papyrifera* Marsh. | 1 | 99 | 1 | 0 | 1-0 |
| *Populus* Hybrid Clones: | | | | | |
| Brooks #10 | 2 | 100 | 1 | L | 2-0 |
| Griffin | 2 | 50 | 1 | L | 2-0 |
| Northwest | 2 | 100 | 2 | L | 2-0 |
| *Populus balsamifera* L. | 1 | 100 | 1 | 0 | 1c |
| *Salix petandra* L. | 2 | 97 | 1 | L | 2-0 |
| *Salix acutifolia* Willd. | 1 | 109 | 1 | L | 2-0 |

[a]Stock source: 0 = Oliver Provincial Tree Nursery, Alberta.
L = Lacombe Nursery, Alberta

[b]Stock age: A-B format with A = # of years in seedbed.
B = # of years in transplant bed.

1c or 2c format = one or two growing seasons in containers.

Table 17. Demonstration plantings on tailings dike, spring 1976.

| Species | Total No. of Sites Planted | Average No. of Plants Planted per Site | Slope Location | Stock[a] Source | Stock[b] Age |
|---|---|---|---|---|---|
| *Acer negundo* L. | 14 | 94 | 3 | 0 | 2-0 |
| | 5 | 100 | 2 | IH | 2-0 |
| *Crataegus cerronis* L. | 3 | 48 | 2 | IH | 2-0 |
| *Flaeagnus augustifolia* L. | 2 | 95 | 1 | IH | 2-0 |
| *Frasinum pennsylvanica* Marsh. | 3 | 50 | 2 | 0 | 2-0 |
| | 9 | 28 | 3 | IH | 2-0 |
| *Larix siberica* Lebeb. | 2 | 50 | 1 | IH | 2-0 |
| *Lonicera tatarica* L. | 2 | 88 | 1 | 0 | 2-0 |
| *Picea glauca* (Moench) Voss. | 1 | 44 | 1 | IH | 2-2 |
| *Picea pungens* Engelm. | 2 | 50 | 1 | IH | 2-3 |
| *Populus* spp. Hybrid Clones: | | | | | |
| Acuminata | 2 | 45 | 1 | IH | 1-0 |
| Angulata | 4 | 47 | 1 | IH | 1-0 |
| Berolinensis | 9 | 61 | 2 | IH | 1-0 |
| BNW #4 | 6 | 45 | 1 | IH | 1-0 |
| Brooks #2 | 5 | 50 | 1 | IH | 1-0 |
| Brooks #4 | 9 | 49 | 3 | IH | 1-0 |
| Brooks #5 | 2 | 30 | 1 | IH | 1-0 |
| C-regenerate | 2 | 50 | 1 | IH | 1-0 |
| Carolina #3 | 3 | 56 | 1 | IH | 1-0 |
| D 703PA | 5 | 50 | 1 | IH | 1-0 |
| Eucalyptus | 4 | 55 | 1 | IH | 1-0 |
| Gelrica | 1 | 100 | 1 | IH | 1-0 |
| Jackii #8 | 2 | 50 | 1 | IH | 1-0 |
| Nigra | 3 | 44 | 1 | IH | 1-0 |
| Northwest | 7 | 49 | 3 | IH | 1-0 |

Continued ...

Table 17. Concluded.

| Species | Total No. of Sites Planted | Average No. of Plants Planted per Site | Slope Location | Stock[a] Source | Stock[b] Age |
|---|---|---|---|---|---|
| P38 P38 | 6 | 52 | 2 | IH | 1-0 |
| 45-45 | 11 | 68 | 3 | IH | 1-0 |
| PV-97 | 4 | 50 | 1 | IH | 1-0 |
| PX Grandix | 4 | 50 | 1 | IH | 1-0 |
| PX Mann | 4 | 75 | 1 | IH | 1-0 |
| Serotina de Selys | 10 | 70 | 2 | IH | 1-0 |
| Tristis #1 | 2 | 50 | 1 | IH | 1-0 |
| Walker | 10 | 50 | 1 | IH | 1-0 |
| *Pronus padus* L. | 5 | 50 | 2 | IH | 2-0 |
| *Prunus virginiana* L. | 7 | 50 | 1 | 0 | 2-0 |
| *Salix fragilis* var. Redher *Basfordiana* | 22 | 58 | 4 | IH | 1-0 |
| *Syringa villosa* L. | 5 | 50 | 1 | 0 | 2-0 |
| | 1 | 50 | 1 | IH | 2-0 |
| *Syringa vulgaris* L. | 5 | 50 | 1 | 0 | 2-0 |
| *Ulmus americana* | 4 | 50 | 3 | IH | 2-0 |
| *Ulmus pumila* | 10 | 50 | 2 | 0 | 2-0 |
| | 2 | 100 | 1 | IH | 2-0 |

[a]Stock source: 0 = Oliver Provincial Tree Nursery, Alberta.
IH = Indian Head Nursery, Saskatchewan

[b]Stock age: A-B format with A = # of years in seedbed.
B = # of years in transplant bed.

Table 18. Demonstration plantings on tailings dike, fall 1976.

| Species | Total No. of Sites Planted | Average No. of Plants Planted per Site | Slope Locations | Stock[a] Source | Stock[b] Age |
|---|---|---|---|---|---|
| *Alnus crispa* (Air. Pursh.) | 5 | 50 | 2 | 0 | 1 8/12c |
| *Alnus tennuifolia* Nutt. | 3 | 50 | 1 | 0 | 1 8/12c |
| *Betula papyrifera* March. | 3 | 50 | 1 | 0 | 1 8/12c |
| *Ulmus americana* L. | 11 | 50 | 2 | 0 | 1 8/12c |

[a]Stock source: 0 = Oliver Provincial Tree Nursery, Alberta.

[b]Stock age: A-B format with A = # of years in seedbed.
B = # of years in transplant bed.

1c or 2c format = one or two growing seasons in containers.

Table 19. Demonstration plantings on Waste Dump 7, spring 1976.

| Species | Total No. of Sites Planted | Average No. of Plants Planted Per Site | Slope Location | Stock[a] Source | Stock[b] Age |
|---|---|---|---|---|---|
| *Acer ginnala* Maxim. | 2 | 50 | 1 | IH | 2-0 |
| *Acer negundo* L. | 58 | 93 | 2 | 0 | 2-0 |
| | 15 | 100 | 2 | IH | 2-0 |
| *Caragana arborescens* Lam. | 4 | 50 | 1 | IH | 2-0 |
| *Elaegnus augustifolia* L. | 4 | 48 | 1 | IH | 2-0 |
| *Fraxinus pennsylvanica* Marsh. | 3 | 42 | 1 | 0 | 2-0 |
| *Lonicera tatarica* L. | 8 | 50 | 1 | 0 | 2-0 |
| *Populus balsamifera* L. | 4 | 79 | 1 | 0 | 1-0 |
| *Populus* spp. Hybrid clones: | | | | | |
| Brooks #2 | 2 | 50 | 1 | IH | 1-0 |
| Brooks #5 | 1 | 77 | 1 | IH | 1-0 |
| Nigra | 2 | 50 | 1 | IH | 1-0 |
| 44-45 | 4 | 56 | 1 | IH | 1-0 |
| PX Grandis | 2 | 63 | 1 | IH | 1-0 |
| Serotina de Selys | 5 | 57 | 1 | IH | 1-0 |
| Walker | 3 | 83 | 1 | IH | 1-0 |
| *Pronus virginiana* L. | 4 | 45 | 1 | 0 | 2-0 |
| | 2 | 50 | 1 | IH | 2-0 |
| *Salix fragilis* var Redher. *Basfordiana* | 18 | 100 | 2 | IH | 1-0 |
| *Salix* spp. | 2 | 100 | 1 | 0 | 1-0 |
| *Syringa villosa* L. | 2 | 50 | 1 | IH | 2-0 |
| *Syringa vulgaris* L. | 4 | 46 | 1 | 0 | 2-0 |
| *Ulmus americana* L. | 4 | 50 | 1 | 0 | 1-0 |
| | 3 | 50 | 1 | IH | 2-0 |

Continued ...

Table 19. Concluded.

| Species | Total No. of Sites Planted | Average No. of Plants Planted per Site | Slope Locations | Stock[a] Sources | Stock[b] Age |
|---|---|---|---|---|---|
| *Ulmus pumila* | 5 | 50 | 2 | 0 | 2-0 |
| | 4 | 44 | 1 | IH | 2-0 |

[a]Stock sources: 0 = Oliver Provincial Tree Nursery, Alberta.
IH = Indian Head Nursery, Saskatchewan.

[b]Stock age: A-B format with A = # of years in seedbed.
B = # of years in transplant bed.

1c or 2c format = one or two growing seasons in containers.

Table 20. Demonstration plantings on Waste Dump 7, fall 1976.

| Species | Total No. of Sites Planted | Average No. of Plants Planted per Site | Slope Location | Stock[a] Source | Stock[b] Age |
|---|---|---|---|---|---|
| *Alnus crispa* (Ait. Pursh.) | 5 | 50 | 3 | 0 | 1 8/12c |
| *Betula papyrifera* Marsh. | 3 | 150 | 1 | 0 | 1 8/12c |
| *Ulmus americana* L. | 4 | 112 | 3 | 0 | 1 8/12c |

[a]Stock source: 0 = Oliver Provincial Tree Nursery, Alberta

[b]Stock age: A-B format with A = # of years in seedbed.
B = # of years in transplant bed.

1c or 2c format = one or two growing seasons in container.

## AOSERP RESEARCH REPORTS

| | | |
|---|---|---|
| 1. | | AOSERP First Annual Report, 1975 |
| 2. | AF 4.1.1 | Walleye and Goldeye Fisheries Investigations in the Peace-Athabasca Delta--1975 |
| 3. | HE 1.1.1 | Structure of a Traditional Baseline Data System |
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Table 21. Some chemical and

| Trial | Site | Depth | pH | Available (ppm) P | Available (ppm) $SO_4$-S | Available (ppm) K | Particle Size Distribution % Clay | Silt | Sand |
|---|---|---|---|---|---|---|---|---|---|
| 1a | Waste Dump 7 Vegetated Site | 0-15 cm | 7.0 | <0.1 | 186 | 54 | 16 | 26 | 58 |
| | | 15-30 cm | 7.3 | <0.1 | 112 | 58 | 21 | 27 | 52 |
| | | 30-60 cm | 7.4 | <0.1 | 156 | 70 | 20 | 29 | 51 |
| 1b | Tailings Sand Dike Vegetated Site | 0-15 cm | 7.2 | 18.0 | 16 | 29 | 4 | 6 | 90 |
| | | 15-30 cm | 7.2 | 7.0 | 12 | 28 | 4 | 10 | 86 |
| | | 30-60 cm | 7.2 | 7.0 | 17 | 10 | 2 | 2 | 96 |
| 2a | Waste Dump 7 Vegetated Site | 0-15 cm | 7.3 | <0.1 | 105 | 61 | 23 | 26 | 51 |
| | | 15-30 cm | 7.3 | <0.1 | 127 | 81 | 24 | 29 | 47 |
| | | 30-60 cm | 7.3 | 3.5 | 146 | 59 | 18 | 27 | 55 |
| 2b | Tailings Sand Dike Vegetated Site | 0-15 cm | 7.0 | 31.5 | 11 | 34 | - | - | - |
| | | 15-30 cm | 7.1 | 11.8 | 11 | 26 | - | - | - |
| | | 30-60 cm | 6.7 | 8.0 | 14 | 15 | - | - | - |
| 3a & 3b | Waste Dump 7 Unvegetated Site | 0-15 cm | 7.2 | 0.4 | 112 | 31 | 9 | 24 | 67 |
| | | 15-30 cm | 7.3 | 0.3 | 80 | 48 | 13 | 19 | 68 |
| | | 30-60 cm | 7.2 | 9.5 | 144 | 36 | 10 | 16 | 74 |
| 4 | Waste Dump 5 Unvegetated Site | 0-15 cm | 7.3 | <0.1 | 59 | 38 | 18 | 24 | 58 |
| | | 15-30 cm | 7.3 | <0.1 | 75 | 40 | 16 | 21 | 63 |
| | | 30-60 cm | 7.3 | 0.2 | 115 | 56 | 14 | 22 | 64 |
| | | Peat[a] | 5.2 | 1.0 | 144 | 165 | - | - | - |
| | | Wood Pulp Mulch[a] | 4.4 | - | - | - | - | - | - |
| | | Straw[a] | 6.4 | - | - | - | - | - | - |
| 5 | Waste Dump 7 | 0-15 cm[b] | 7.0 | 2.5 | 156 | 36 | - | - | - |
| | | 15-30 cm[b] | 7.2 | 2.5 | 125 | 41 | - | - | - |
| | | 15-30 cm | 7.2 | 9.5 | 144 | 36 | - | - | - |

[a]Amendments used as treatments.

[b]Same sample as Trial No. 3, 30-60 cm.

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47. TF 1.1.1 A Visibility Bias Model for Aerial Surveys of Moose on the AOSERP Study Area

48. HG 1.1 Interim Report on a Hydrogeological Investigation of the Muskeg River Basin, Alberta

These reports are not available upon request. For further information about availability and location of depositories, please contact:

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