AN OVERVIEW OF LAND RECLAMATION AT SUNCOR

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ABSTRACT

Prior to implementing a large scale reclamation program, the goals must be defined to develop an effective plan of action. This focuses the efforts expended on the program and gives direction to the research, thus increasing the overall efficiency of the operation.

Base line information was collected on soils, vegetation, and wildlife utilization. Then considerable effort was invested on optimum methods to employ in the construction of a soil that would give the nutrients and moisture required for vegetation establishment.

The base soil construction material is salvaged muskeg soil. The muskeg soil is spread on the reclamation areas to a depth of 15 cm. After revegetation treatment detailed monitoring is then utilized to track the development of the created soil. Natural, undisturbed soils are used as a reference to assess the performance of the reconstructed soils. Fertilizer application is adjusted to enhance this development.

The revegetation prescription has been altered based on data from the continued monitoring and assessment work. Little or no seeding to grasses is currently done as these species will out-compete the woody stemmed trees and shrubs planted on the reclamation areas. The tree species outlined in the planting mix reflect the projected vegetation development on the reclaimed soils. Regeneration from salvaged soils and invasion by native plants is hastening the overall development of reclamation area toward the target forest plant communities as evident in the reference sites.

INTRODUCTION

Suncor's Development and Reclamation Plan OS-79-1 states that:

> *"Disturbed lands shall be reclaimed with gentle slopes to primarily a forest use compatible with the predisturbed terrain, providing habitat for wildlife and with possibilities for recreation. Dyke slopes shall be revegetated primarily for erosion control with possibilities for forest and wildlife use."*

Implicit in these goals is the need for the area to be restored with vegetation at least as productive as was common to the area prior to disturbance. This vegetation should develop into a self-sustaining ecosystem consistent with undisturbed sites adjacent to the lease area.

To develop methodologies to achieve these reclamation objectives an understanding is required of the processes that influence ecosystem development. The type of vegetation (and soil) that will develop on the Suncor lease is dependent on climate, topography, parent material, drainage, and time. Of these environmental factors only parent materials and topography can be modified to any extent. The other factors are essentially fixed by virtue of the oil sands mining and extraction methods or by meteorological conditions. By identifying vegetation types on similar natural undisturbed terrain in the area, appropriate successional plant species can be selected for planting. These species can be expected to modify the site conditions, allowing establishment and growth of species characteristic of the mature vegetation type.

PRE-MINING CONDITIONS

The vegetation of the lease prior to mining disturbance was made up of predominantly forest vegetation classified as part of the mixed-wood section of the Boreal Forest Region *(Rowe 1972)*. This section is characterized on upland sites by mixed forests with varying proportions of aspen, white spruce, balsam poplar, balsam fir, and white birch. Aspen typically dominates young forests on recently burned sites, while white spruce dominates mature forests which have escaped recent disturbance. Jack pine occurs locally on dry sandy sites and forms a mixture with black spruce on level tops of some higher hills. Black spruce and larch muskeg occur in depressions and poorly drained flats.

Development of the Athabasca Oil Sands in northeastern Alberta has resulted in several inventory studies of vegetation. The most comprehensive description of vegetation types was prepared by *Stringer (1976)* who identified twelve major types on the basis of structure and understorey composition. Detailed applications of Stringer's classification were used to describe vegetation and forest productivity on Syncrude's Lease 17 *(Peterson and Levinsohn 1977)* and Syncrude's Lease 22 *(Reid and Sherstabetoff 1984)*. Suncor, through application of a similar approach which included interpretation of pre-mine air photos and field sampling of the few residual stands, has described nine major vegetation types. These types (Table 1) were mapped and the forest productivity assessed for the Suncor lease *(Hardy 1989a)*.

TABLE 1

VEGETATION COMMUNITY CHARACTERISTICS

Major Vegetation Type	Vegetation Community	Drainage Class	Site Conditions
Fen (sedge and willow or dwarf birch)	a) Dwarf birch/sedge/sphagnum b) Willow/bluejoint	Very poorly drained	Depressional areas of glaciofluvial plain and floodplain channels; organic soil
Willow-alder scrub	Willow-alder/horsetail	Imperfectly drained	Alluvial sand of point bar, flooded in spring.
White spruce-balsam poplar forest	White spruce-balsam poplar/ red osier dogwood/horsetail	Moderately well to imperfectly drained	Alluvial sand terrace.
White spruce-aspen forest	a) White spruce-aspen/ blueberry/feathermoss b) White spruce-aspen/ prickly rose/bunchberry	Moderately well drained Moderately well drained	Glaciofluvial plain and colluvium Glaciofluvial plain and colluvium
Aspen forest	a) Aspen/low-bush cranberry/ twinflower b) Aspen/low-bush cranberry/ dewberry	Imperfect to moder-ately well drained Moderately well drained	Glaciofluvial plain. Glaciofluvial plain.
Black spruce forest	Black spruce/feathermoss	Poorly drained	Depressional areas of glaciofluvial plain, organic soil and hummocky microtopography.
Black spruce-tamarack forest and bog	Black spruce-tamarack/sedge	Very poorly drained	Depressional areas of glaciofluvial plain, organic soil and hummocky microtopography.
Jack pine forest	a) Jack pine/blueberry/ bearberry b) Jack pine/bog cranberry	Well drained Well drained	Eolian sand dunes. Eolian deposits surrounded by wet depressions.
White spruce-balsam fir forest	White spruce-balsam fir/ feathermoss	Well drained	Alluvial sand terrace.

from Hardy 1989a

SOIL RECONSTRUCTION

To restore soil capabilities to a state equal to or better than predisturbed conditions, reconstructed soil conditions must be defined. The design specifications ensure that the reconstructed soil provides:

(i) adequate moisture supply,

(ii) adequate nutrient supply, and

(iii) acceptable erosion control.

The design specifications can be based on properties of reference (nearby, undisturbed) soil types of parent material and topography and drainage similar to the post-mining terrain. By using available soil-building materials reconstruction can take place.

Types of Surfaces to be Reclaimed

The mining operation creates a variety of land forms that must be reclaimed. Included are the:

(i) tailings sand dykes,

(ii) tailings sand plateaus,

(iii) overburden waste dumps and dykes,

(iv) end pit (wall and floor),

(v) tailings sludge ponds,

(vi) oversize dump, and

(vii) coke pads, sulphur pads, waste water ponds, and roads.

Materials Handling Plan

The materials handling plan for soil reconstruction has been integrated into the mining plan. Surface soil materials were identified and mapped during the development of the Materials Handling Plan. This was accomplished through overburden drilling programs with verification by intensive drilling to determine the depth and extent of the muskeg pockets. Soil reserves have been mapped by Suncor's mine planning computer system.

Three types of soils have been identified for reclamation purposes based on the soil reconstruction specifications. The types are distinguished by depth of organic soil and the nature of the underlying mineral material. The three types are:

Type 1 - Peat, greater than 0.6 metre depth, underlain with fine-textured overburden,

Type 2 - Peat, greater than 0.6 metre, underlain with coarse-textured overburden,

Type 3 - Peat, less than 0.6 metre depth, underlain with mineral overburden.

Surface organic materials are excavated with mining equipment (hydraulic shovels, front end loaders, and trucks) usually during winter. The better material (i.e. > 50% organic) is salvaged for reclamation use. The remainder is disposed of either within the shell of overburden dumps or onto the mine pit floor. Organic material less than 0.6 metres in depth is more difficult to strip and is not usually salvaged for reclamation.

The reclamation soil requirements are based on calculations of surficial areas for permanent reclamation at a rate of 2,263 bank cubic meters (BCM) per hectare to result in a 15 cm layer of applied soil. Through the process of stripping, stockpiling, and spreading, the mineral and organic components of muskeg soil are blended to produce a soil amendment with the properties as described in Table 2.

Reconstructed Soil Properties

The soil reconstruction technique as described above has been used on an operational scale since 1979. Where muskeg is mixed with fine-textured till, the peat/till mixture is designated as Type 1 soil. Where muskeg is mixed with coarse textured material (sand and gravel), the mixture is designated as Type 2 soil. Type 1 soil is the principle tailings sand and overburden soil amendment, while Type 2 muskeg soil is primarily used to amend overburden spoil.

The quality of the final reconstructed soil for both substrates is given in Table 3. After soil reconstruction, the quality of both these types of seedbeds is conducive to vegetation establishment and superior to that which existed in the unamended parent material. It is also a duplicate of the reference soils that have been identified as long term targets.

On the tailing sand reclamation sites the physical properties are enhanced by increasing fines content (clays and silt) from approximately five percent to 35 percent. On Overburden, the textural quality of the reconstructed soil is approximately the same as the muskeg soil amendment because little mixing takes place using the current methodology.

Chemical properties of both seedbeds are enhanced (Tables 4 and 5). The soil pH level for amended tailings sand is slightly above neutral. Other key parameters of soil quality are cation exchange capacity (CEC) and organic carbon. CEC relates to organic matter and mineral fines content and is a measure of the ability of soil to store and release nutrients for plant use. CEC increases from less than 1 to 22 meq/100 g for tailings sand and from about 12 to 44 meq/100 g for overburden. Organic carbon content is improved from less than one percent to about five percent for tailings sands and from about four percent to 13 percent for overburden.

TABLE 2

KEY CHEMICAL AND PHYSICAL PROPERTIES OF SOIL BUILDING MATERIALS

Soil Material	Texture (%) Clay	Silt	Sand	pH	Electrical Conduct-ivity (ms/cm)	Organic Carbon (%)	Total Nitrogen (%)	C/N	Cation Exchange Capacity (meq/100g)	Sodium Adsorb-tion Ratio
* Tailings Sand	3	2	95	7.5	0.1	0.2	0.01	20	0.3	ND
** Overburden Spoil	26	22	52	7.5	2.0	4.2	0.6	69	11.5	6.3
*** Type 1 Muskeg Soil	19	25	56	7.4	0.7	7.6	0.3	28	26.0	4.4
*** Type 2 Muskeg Soil	15	15	70	5.6	1.2	13.5	0.6	23	40.7	2.2

* Adapted from Rowell, 1979 (Suncor 1988a)
** From 1987 operational areas (Suncor 1988a)
*** From 1984 operational program (Suncor 1985)
ND No data

TABLE 3

KEY CHEMICAL AND PHYSICAL PROPERTIES AFTER SOIL RECONSTRUCTION

Amended Substrate	Texture (%)			pH	Electrical Conductivity (mmhos/cm)	Organic Carbon (%)	Total Nitrogen (%)	C/N	Cation Exchange Capacity (me/100g)	Sodium Adsorbtion Ratio	Bulk Density (g/cc)
	Clay	Silt	Sand								
* Tailings Sand	18	14	68	7.7	1.0	5.1	0.11	51	21.0	ND	0.8
** Overburden Soil	18	8	74	6.2	1.5	13.2	0.52	27	43.5	1.7	0.6

* Data from operational areas reclaimed in 1988 (Suncor 1989)
** Data from operational areas reclaimed in 1987 (Suncor 1988a)

TABLE 4

COMPARISON OF SOIL CHEMICAL AND PHYSICAL PROPERTIES FOR AMENDED TAILINGS SAND AND REFERENCE SOILS FOR TAILINGS SAND DYKES

Parameter	Reference Soil*		Suncor**	
	Ae/Bm Horizons	C Horizon	Amended	Tailings
Bulk Density (g/cm^3)	1.4-1.55	1.55	0.8	ND
% Clay and Silt	1-30	1-3	32	5
pH	4.8-6.3	5.7-6.9	7.7	7.5
% Carbon	0-2.8	0.03	5.1	0.2
% Nitrogen	0-0.06	ND	0.11	0.01
C/N	14-54	16	51	20
CEC (meq/100g)	0.5-3.0	0.1-0.4	21	0.3

* Firebag soil, data from Turchenek and Lindsay 1982, Bliss 1977
** Data from operational areas reclaimed in 1988 (Suncor 1989)
ND No data

TABLE 5

COMPARISON OF SOIL CHEMICAL AND PHYSICAL PROPERTIES FOR AMENDED OVERBURDEN AND REFERENCE SOILS FOR WASTE DUMPS

Parameter	Reference Soil*		Suncor**	
	Ae/Bm Horizons	C Horizon	Amended	O/B Spoil
Bulk Density (g/cm^3)	ND	ND	0.6	1.4
% Clay and Silt	29-75	17-56	26	48
pH	4.6-7.0	5.8-8.3	6.2	7.5
% Carbon	0.25-0.83	0.01-0.08	13.2	4.2
% Nitrogen	ND	0.028-0.04	0.52	0.06
C/N	ND	36.7-38.5	27	69
CEC (meq/100g)	2.7-22	3.5-19.1	43.5	11.5

* Firebag soil, data from Turchenek and Lindsay 1982, Cook 1977
** Data from operational areas reclaimed in 1987 (Suncor 1988a)
ND No data

Properties of the amended soils are monitored over time and compared to properties of reference soils selected as representative for the three main post-mining land forms (tailings sand dykes, tailings sand plateaus, and overburden dumps dykes). The most important conditions in defining these reference soils were parent material, groundwater table, and slope angle. Variations which exist for these soils are primarily attributable to topography and drainage.

Tailings sand plateau areas receive soil amendments similar to the tailings sand dyke areas. The major differences for these areas are that they are nearly level with more surface moisture anticipated at the centre of the plateaus.

A comparison of soil chemical and physical properties for amended tailings sand and reference soils for tailings sand plateaus is given in Table 6. Fines content and nitrogen for the amended layer are within the ranges for the Ae/Bm horizons of the reference soil. Differences include the lower bulk density and higher carbon, CEC, and pH of the amended layer. As in the situation for tailings sand dykes, the chemical parameters will likely change with time towards those values found in the reference soil.

Seedbed Preparation

After applying the muskeg soil amendment, Suncor's seedbed preparation for tailings sand begins with the addition of fertilizer prior to mixing. A chisel plow is used to incorporate the muskeg soil to produce a partially mixed seedbed to an average depth of 30 cm.

On the overburden spoil a capping method is used followed by application of fertilizer and a barley nurse crop which is mixed into the seedbed by harrows. This results in minimal mixing of the amendment with the spoil thereby favouring establishment of native species from seed and root fragments in the amendment material.

Field research results *(Rowell 1983, Danielson et al 1982)* indicate that a high organic matter content in the surface soil is favourable from a reclamation standpoint. These studies have shown that vegetation productivity is significantly greater in experimental treatments where peat is applied with minimal incorporation compared to thoroughly mixed treatments. Benefits of a partially mixed amendment layer as an alternative to a homogenous layer include the improved and nutrient moisture supply, along with the regeneration of native vegetation from the soil amendment.

REVEGETATION

The primary objectives of the Suncor revegetation program are to:

(i) Provide an erosion-controlling plant cover on tailings dyke slopes and overburden dump slopes, and

TABLE 6

COMPARISON OF SOIL CHEMICAL AND PHYSICAL PROPERTIES FOR AMENDED TAILINGS SAND AND REFERENCE SOILS FOR TAILINGS SAND PLATEAUS

Parameter	Reference Soil*		Suncor**	
	Ae/Bm Horizons	C Horizon	Amended	Tailings
Bulk Density (g/cm^3)	1.1-1.55	1.55-1.65	0.8	ND
% Clay and Silt	8-34	2-12	32	5
pH	4.7-6.2	5.3-6.2	7.7	7.5
% Carbon	0.14-3.11	0.04-2.11	5.1	0.2
% Nitrogen	0.02-0.14	0.003-0.025	0.11	0.01
C/N	12-36	13-84	51	20
CEC (meq/100g)	0.41-11.5	0.7-2.8	21	0.3

* Firebag soil, data from Turchenek and Lindsay 1982, Cook 1977
** Data from operational areas reclaimed in 1988 (Suncor 1989)
ND No data

(ii) Establish a permanent, self-sustaining cover of forest species, consistent with the undisturbed areas surrounding the lease.

Secondary objectives are to provide habitats which are suitable for wildlife, have potential forestry utilization, and which have possibilities for recreation.

To achieve these objectives Suncor has developed a revegetation program based on field trials and operational experience. This involves seeding of ground covers to control erosion, fertilization, and establishment of appropriate woody plant species. Measures are also taken to encourage the process of native plant invasion onto reclaimed sites.

The Suncor revegetation program is aimed at establishing four main vegetation types on the three main landforms (tailings sand plateaus, tailings sand slopes, and overburden dumps). These starter vegetation types are:

1. **Pine Forest**

   This vegetation type will be established on the edges of tailings sand plateaus and tailing sand slopes.

2. **Poplar-White Spruce/Shrub**

   This vegetation type will be established on the moister areas of the tailings sand plateaus.

3. **White Spruce-Poplar/Shrub Community**

   This vegetation type will be established on the overburden dumps and more mesic sites on tailings dyke slopes (lower portions of the slopes and/or areas with northerly aspects).

4. **Wetland Complex**

   This vegetation type will be established on poorly drained areas of the tailings sand plateaus.

Herbaceous Ground Cover Establishment

The strategy for ground cover establishment during the past seven years has been to develop a ground cover which is able to control erosion but that does not become overly competitive with outplanted woody stock. Past programs prescribed agronomic species at high seeding rates which established easily and provided nearly immediate erosion control, but became restrictive to the establishment of trees and shrubs.

For overburden spoil revegetation, the current approach is to either seed barley by helicopter or hydroseed after seedbed preparation. This annual cereal species, which provides nearly immediate erosion control in the first growing season, produces a litter and root biomass that further controls erosion in succeeding growing seasons. Native plants are able to invade or regenerate from muskeg soil applied during seedbed preparation while outplanting woody stock performance is greatly enhanced. The monitoring program continues to verify this strategy.

For tailings sand dyke slopes, alternative cover types are being evaluated. From 1984 to 1989, a non-agronomic seed mixture with barley used as a nurse crop was seeded in these areas followed by outplanting of trees and shrubs. During the 1990 program, a demonstration area to assess the performance of a barley nurse crop without any grasses seeded has been established. On level tailings sand areas barley has been applied followed by outplanting of tree seedlings in the fall. Grass seed mixtures have been applied to tailings sand slopes to control erosion.

Hydroseeding slurry mixtures are composed of a hydromulch, soil stabilizers, and a small amount of starter fertilizer. The seed used in the program is summarized in Table 7.

Fertilization

Fertilizer is applied annually during the initial years following the reclamation of an area to aid in the rapid development of an erosion controlling vegetation cover. Fertilization is then discontinued so that the developing herbaceous cover will not compete vigorously with planted woody seedlings. Past programs were more concerned with erosion control and thus higher fertilizer application rates and extended maintenance periods were implemented as opposed to the current strategy. Data from the annual monitoring of operational areas supports this change in strategy.

Starter fertilizers which are incorporated into the seedbed are essentially the same for tailings sand and overburden. Rates and composition have been determined from initial field trials and annual monitoring. Maintenance rates are determined from criteria such as soil tests and cover performance. Maintenance periods, which depend on the rate of ground cover establishment, are two to three years for overburden spoil and three to four years for tailings sand. The time of fertilizer application is usually late spring. Typical fertilizer rates are given in Table 8.

Fertilizer is applied by helicopter, hand-broadcasters, and as part of hydroseeding operations. Choice of method is dependent on the size and shape of the area, as well as accessibility. Starter fertilizer is incorporated into the seedbed where possible.

For tailings sand revegetation, a fertilizer blend with medium nitrogen content relative to phosphorus and potassium is incorporated. An application of nitrogen later in the growing season may be added with the rate dependent on the growth and condition of emerging

TABLE 7

SEEDING PROGRAM

Landform	Seed Mixture Composition* Species	% by Weight	Application in kg/ha
Tailings sand slopes	Violet wheatgrass *(Agropyron violacium)*	48	24
	Sheep fescue *(Festuca ovina)*	10	5
	Hair grass *(Deschampsia caespitosa)*	9	4
	Fowl bluegrass *Poa palustris)*	10	5
	Red top *(Agrostis stolonifera)*	5	3
	Kentucky bluegrass *(Poa pratensis)*	4	2
	Meadow foxtail *(Hordeum brachyantherum)*	9	4
	Alsike clover *(Trifolium hybridum)*	5	3
		100	50
Tailings sand plateaus	Barley *(Hordeum vulgare)*	100	50
Overburden dykes/dumps	Barley *(Hordeum vulgare)*	100	50

* All hydroseeder slurries include hydromulch, tackifer, and starter fertilizer applied at rates dependent upon field conditions.

TABLE 8

TYPICAL FERTILIZATION PROGRAM

Starter Fertilizer (first growing season)

	Fertilizer in kg/ha		
	N	P_2O_5	K_2O
Tailings Sand	55	80	80
	60**		
Overburden Spoil	55	70	20
	50**		

Maintenance Fertilizer (second growing season and older)

	Fertilizer in kg/ha		
	N	P_2O_5	K_2O
Tailings Sand	80	30	10
Overburden Spoil	80	30	10

* Fertilizer blend will depend on commercial availability.

** To be applied after emergence of seedlings if deficiency symptoms appear critical.

plants. A moderate rate of the starter fertilizer is applied in the hydroseeder slurry during seeding.

For overburden revegetation, a blend of fertilizer with a medium nitrogen, high phosphorus and medium potassium content is applied and incorporated. Again, when necessary, nitrogen is applied later in the season for growth regulation.

Woody Plant Establishment

Woody plant establishment began on the Suncor lease in 1972. Since then, over one million trees and shrubs of various species have been planted. Research carried out at Suncor has included evaluation of: plant container types, planting time, effect of ground cover density on woody plant survival, fertilizer amendments, species selection, direct seeding, and planting of hardwood cuttings.

Assessment plots are installed in operational areas for inclusion in the annual monitoring program. The results of this research effort have been used to refine the operational afforestation program.

Table 9 shows a typical composition of afforestation stock planned for outplanting. The selection of species and proportions of each species in the planting mix is based on on-going testing under existing field conditions and the vegetative type expected to develop under predicted future conditions. The species selected are representative of different stages of vegetative succession in the region. This means that the woody cover develops and the micro-environment is modified to provide favourable conditions for later successional and climax species. In this manner, the process of natural succession is accelerated towards the target vegetation types.

Seedlings for the planting program are propagated from seed and cuttings collected from the Fort McMurray area. Outplanting periods are early spring and fall depending on logistics and availability of reclaimed areas. Planting is usually completed the same year as soil reconstruction to allow the trees to become established prior to the development of a dense cover of herbaceous plants.

Tree and shrub seedlings are planted at an average total density of 2,500 stems/hectare. This planting density was selected so that sufficient numbers of each species are planted to ensure adequate stocking after initial mortality and to permit the establishment of volunteer plants.

Survival and performance rates of seedlings are variable as there are extraneous factors which influence the survival and overall performance of particular tree species in any area. To determine these rates the Suncor afforestation assessment program has been a valued tool. Data from the assessment program is used to fine-tune the reclamation and tree planting programs.

TABLE 9

PROPOSED AFFORESTATION STOCK FOR OUTPLANTING

	Composition (%)				
	Overburden		Tailings Sand		
Species	Mesic	Wet	Dry	Mesic	Wet
White Spruce	60	20	0	10	25
Pine	0	0	50	25	10
Poplar	20	40	20	25	25
Dogwood	5	10	5	10	10
Rose	5	5	10	10	5
Saskatoon	5	5	10	10	10
Willow	0	20	0	5	10
Raspberry	5	0	5	5	5
	100	100	100	100	100

The current method of seedbed preparation results in improved survival of outplanted speies while providing for the rapid invasion of native species. By having a more diverse plant community, the reclaimed areas are expected to evolve into stands similar to those found adjacent to the Suncor lease. Therefore, all woody stemmed species, both those planted and naturally invading, which are found in the survey plots are recorded. The summary for the 1989 tree assessment program is detailed in Table 10, while Table 11 lists the common and scientific names for woody stemmed species surveyed on reclaimed areas.

This data is used to gain insight on woody stem invasion, survival of planted seedlings, as well as seedling performance. Growth trends and vegetation established in an area can be plotted in reference to data from previous year's assessments. Failures can also be noted thus allowing for prompt remedial action in order to improve the performance of a specific area.

CONCLUSION

To accomplish the Suncor reclamation goals, extensive work was done to assess the pre-disturbed soil and vegetation existing on the lease. The next step was to determine the best resources available to start the reclamation process. Topsoil reserves were quantified then salvaged for utilization on the reclamation areas.

When the post-mining structure was available, muskeg soil was placed on the area to improve the soil quality. Fertilizer was incorporated prior to seeding the barley or grasses. Outplanting of the woody tree and shrub species was usually completed in the fall of the same year.

To determine how the reclaimed sites were developing, a monitoring program was implemented. This has proven to be a valuable tool in assessing reclamation success and aiding in fine-tuning the operational programs.

Monitoring of reclaimed areas indicates the successful development towards a natural forest stand compatible with the undisturbed forest adjacent to Suncor. Development of the areas towards the end goal vegetation is accelerated as more native plant species invade the reclaimed sites. Even on the sites where the erosion controlling agronomic grass cover was utilized, during the early years of reclamation at Suncor, the variability in the vegetation species mix is becoming more complex.

Through field observations, monitoring, and research, the reclamation program at Suncor will continue to be refined as a cost-effective, efficient program. The end result is that the mined-over areas will be returned to a productive land form consistent with our reclamation goals and guidelines.

TABLE 10

1989 TREE ASSESSMENT DATA SUMMARY

Area	Year Planted	Planting Stems/ha	1987 Survey Stems/ha	1988 Survey Stems/ha	1989 Survey Stems/ha
Dyke 2 Plug	1983/85/87	N/A	2480	2186	2911
Dyke 2 (Barley)	1985	2499	2000	1382	2500
Dyke 2 (Hydroseeded)	1985	2499/103*	1150	1012	1152
Dyke 2 East	1988	2952	-	-	1183
Dyke 2 West	1988	2427	-	-	656
Waste Area 5	1983	2500**	-	-	1222
Waste Area 8	1984	2357	3808	3519	3634
Waste Area 8	1987	2764	-	4038	6692
Waste Area 14A	1983	2816	3972	4940	6526
Waste Area 14, 21	1988	2737	-	-	1248
Waste Area 16	1981	N/A	-	-	1683
Waste Area 16	1982	2500	2279	1853	1784
Waste Area 16	1979	N/A	-	-	3576
Waste Area 19	1984	2661	3960	4500	4057
Waste Area 19	1985	2314	2984	3273	2982
Waste Area 19	1988	2728	-	-	1631
Coke Pad	1987	2787**	-	1954	6740
Environmental Berm	1984/87	774/2820*	578	1754	1199
Fire Water Reservoir	1984	2465	3480	2840	4549
Level Tailings Sand	1985	2611	2815	4573	2867
Tar Island Dyke	1988	2728	-	-	1900

- Not Surveyed
N/A Not Available
* Spruce trees excavated from Waste Area 11 and replanted
** Tree seedlings planted into an established vegetative cover

TABLE 11

SCIENTIFIC NAMES OF WOODY STEMMED SPECIES SURVEYED ON RECLAIMED AREAS

Alder	*Alnus crispa*
Aspen	*Populus Tremuloides*
Balsam Fir	*Abies balsamea*
Balsam Poplar	*Populus balsamifera*
Bearberry	*Rhamnus purshiana*
Black Spruce	*Picea mariana*
Blueberry	*Vaccinium myrtilloides*
Bog Birch	*Betula pumila*
Buffalo Berry	*Shepherdia canadensis*
Choke Cherry	*Prunus virginana*
Cranberry	*Viburnum edule*
Jack Pine	*Pinus banksiana*
Larch/Tamarack	*Larix laricina*
Lodgepole Pine	*Pinus contorta*
Northwest Poplar	*Populus deltoides*
Pin Cherry	*Prunus pensylvanica*
Prickley Rose	*Rosa acicularis*
Raspberry	*Rubus idaeus*
Red Osier Dogwood	*Cormus Stolonifera*
Saskatoon	*Amelanchier alnifolia*
Shrubby Cinquefoil	*Potentilla fruticosa*
Willow Species	*Salix sp*
Wild Gooseberry	*Ribes oxyacanthoides*
White Birch	*Betula papyrifera*
White Spruce	*Picea glauca*
Wolf Willow	*Elaeagnus commutata*

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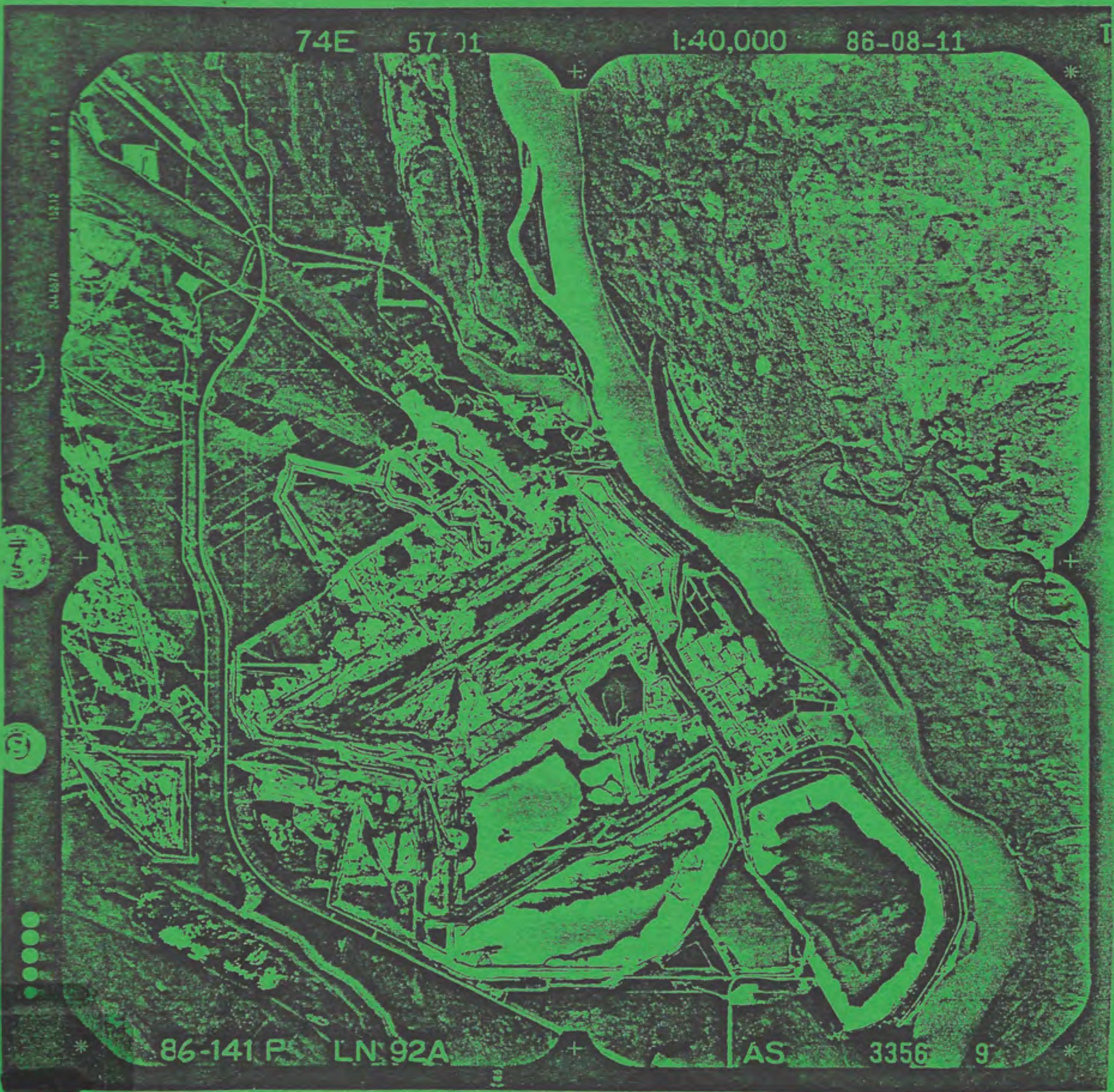

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Front Cover: 1986 airphoto of the Suncor facility, north of Fort McMurray, Alberta.

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DEDICATION

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

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

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

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

SPONSORS

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