RECLAMATION FOR AFFORESTATION BY SUITABLE NATIVE AND INTRODUCED TREE AND SHRUB SPECIES

by

J. SELNER and R. THOMPSON
Forest Land Use Branch
Alberta Forest Service

for

VEGETATION TECHNICAL RESEARCH COMMITTEE
ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

SUB-PROJECT VE 7.1

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ABSTRACT

During 1976, a variety of methods and materials were used in the search for afforestation practices that will assist in the establishment of a self sustaining vegetation cover compatible with land use objectives for the Alberta oil sands area.

The project study area is located on the Great Canadian Oil Sands Company Ltd. mining lease and all test plots were situated on tailings sand (tailings dike) or overburden material (waste dump no. 7).

Twenty four species of trees and shrubs and 23 clones of poplars were tested for their reclamation suitability. In general the poplars showed greater survival and growth than the other species used. Conclusions about individual species will not be made because the significance of one seasons observations on long lived plants is questionable until more long term observations have been made.

The most productive of the eight planting sites used was on the tailings dike where a 10 cm layer of peat was mixed with the tailings sand. Perhaps the most beneficial property of the peat is that it increases the moisture holding capacity of the sand.

Although a Swedish planting mattock was used to plant seedlings, about 1500 Manitoba maple (Acer negundo (Britt.) Sarg.) were planted with a planting bar to assess the effectiveness of a faster planting method. No significant difference resulted from the use of these two tools but it is suspected other factors such as seedling condition and time of planting masked any difference that might have occurred.

Both coniferous and deciduous seeds were used on a seed bed of tailings sand and peat mixed together. The intention was to establish the potential of direct seeding of woody species for revegetation on the tailings dike. Jack pine (Pinus banksiana Lamb.) was the most successful species to germinate and survive. Rodent damage, high soil surface temperature, erosion and proper species selection are some of the problems which have to be solved if direct seeding is going to be useful.

Plots of Basford willow (Salix fragilis var. 'Basfordiana' Redher) were set up on the tailings dike to examine what effect position on the dike's slope might have on seedling performance. While performance did vary along the slope the variance was not consistent between plots.

Eight hundred cuttings of native balsam poplar (Populus balsamifera L.) were planted, and it would seem the larger, more deeply planted cuttings sprouted the best. The performance of cuttings was poor compared to seedlings.

In the fall, approximately 2000 container seedlings were planted to compare their success to spring planted seedlings. This planting time is being investigated as an alternative to the often busy spring season, and it also allows the seedlings to take advantage of favourable early spring growing conditions.

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1. INTRODUCTION

The Athabasca deposit of oil sands occupies nearly six million acres of forest land which is managed by the Alberta Forest Service. It is estimated that approximately one half million acres of this deposit can be extracted by surface mining techniques. Future developments could produce up to one million barrels of oil per day while disturbing approximately six acres of land daily. The volume of waste material that would be deposited at tailings areas has been estimated at two million cubic yards daily.

Realizing the urgent need for methods of reclaiming such areas, the Alberta Forest Service in collaboration with G.C.O.S., started in 1974 its first reclamation research program on the Athabasca oil sands. Approximately eleven acres of tailings dike and waste dump were utilized for research purposes. Seven thousand five hundred trees and shrubs were planted on overburden materials, pure tailings sand and sand mixed with peat. Thirty species of grasses and legumes were seeded in an effort to find quickly establishing nurse crops that provide erosion control and assist the growth of trees and shrubs.

Some of the major comparisons considered in these early trials were native versus introduced species, container versus bare-root stock, spring versus fall planting, tailings sand versus overburden and coniferous versus broad-leaved species.

The experimental design of this program, unfortunately was altered to the extent that a statistically valid analysis of the results became quite difficult. The lack of the necessary acerage for planting trials was one problem and the shortage of suitable species was another.

However this early stage of the afforestation program has shown that reclamation by afforestation is possible on oil sands tailings and should be seriously considered for land where forest stands are a major component of the ecosystem.

Since 1975 the Alberta Forest Service reclamation program (research project VE 7.1) has been funded by Alberta Oil Sands Environmental Research Program; a joint Alberta Canada research program, established to fund, direct and coordinate research into the effects of oil sands development on the renewable resources of the Athabasca oil sands.

During 1975 approximately twenty and one half thousand trees and shrubs were planted in 211 plots. For more details on the 1975 program see Alberta Forest Service (76). As with the 1974 program there was a shortage of suitable seedlings, especially native trees and shrubs having special amelioration properties. We are attempting to overcome these difficulties but factors such as occurrance of good seed years, establishment time for bare-root stock and special seed treatments for "specialty" crops increase the time needed to introduce effective native species.

This report describes the vegetation trials completed during 1976 and discusses the preliminary results obtained from them.

2. STUDY AREA

The project study area is within the Great Canadian Oil Sands Company Ltd. mining lease, located approximately 35 km (22 mi) north of Fort McMurray Alberta (Figure 1). To date, all test plots have been located on the tailings dike, waste dump no. 7 and waste dump no. 5 (Figure 2). The tailings dike is composed of tailings sand produced after the available bitumen has been extracted from the oil sands. The dike has been constructed in terraces for access and erosion control purposes and has an overall slope of 3:1. Both waste dumps were also constructed in terraces but are composed of a mixture of overburden material removed during the mining process. The top of waste dump no. 5 is composed of organic surface material removed from the mining areas. The top berm of the tailings dike is 305 m (1000 ft) above mean sea level. Waste dump no. 7 and no. 5 rise to approximately 350 m (1148 ft) above mean sea level. For a general description of the topography, climate and vegetation of the area and more specific details about the tailings dike and waste dumps, see Lesko (74), Berry (74) and Stringer (75).

ALBERTA OIL SANDS
ENVIRONMENTAL RESEARCH PROGRAM
STUDY AREA

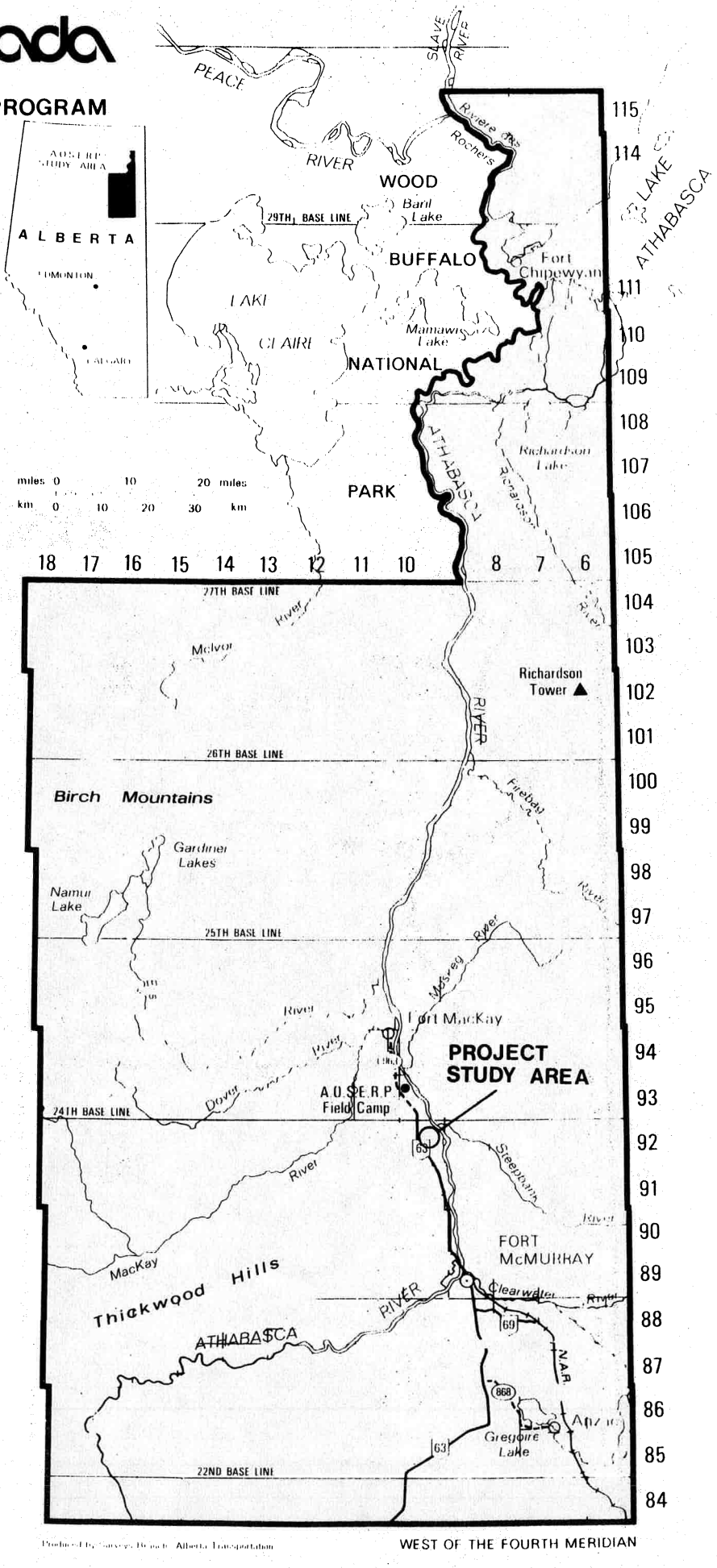
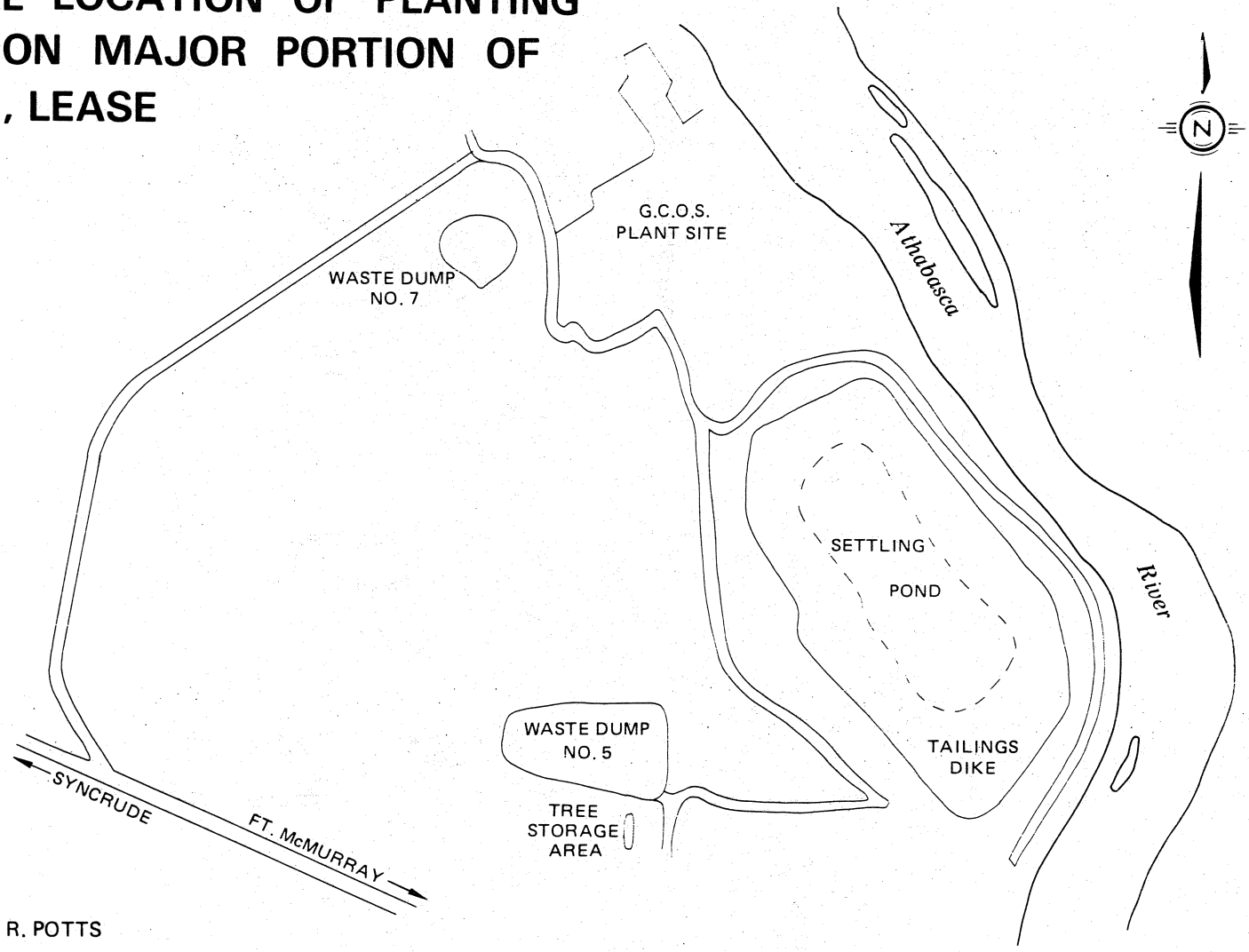


FIGURE 1. Location of Project Study Area

GENERAL LOCATION OF PLANTING AREAS ON MAJOR PORTION OF G.C.O.S., LEASE

NOT TO SCALE



PREPARED BY: R. POTTS
JAN., 1977

FIGURE 2.

3. METHODS AND MATERIALS

3.1 SPECIES SELECTION TRIALS

During 1976, 23 species of trees and shrubs representing a total of 31,911 seedlings were planted on the project study area. Seventeen thousand three hundred fifty nine were planted on waste dump no. 7 (Figure 3) and 14,552 on the tailings dike (Figure 4). The three most numerous seedlings were 5,158 Basford willow (Salix fragilis var. 'Basfordiana' Redher), 8,690 Manitoba maple (Acer negundo L.) and 8,003 poplars (Populus sp.).

All seedlings this year were fertilized in the last week of May by G.C.O.S. On the tailings dike 420 kg/ha (375 lbs/acre) of 8-24-24 and 140 kg/ha (125 lbs/acre) of 46-0-0 were applied by a helicopter using a bucket with a spreader attachment. Five hundred eighty three kg/ha (520 lbs/acre) of 14-14-7 were applied to waste dumps number 5 and 7.

3.1.1 Plot design

With the exception of 1,039 Basford willows, most seedlings were planted in plots of 50 or 100. They were planted in lines of 10 with the number of lines being 5 or 10. The spacing between seedlings was approximately 1 m. Each seedling had a wooden stake placed in the ground 5 to 10 cm from its left hand side as you are facing the plot sign. The stake was necessary to aid in the easy location of the seedling for evaluation purposes because dense vegetation cover often made location difficult.

Except for the north slope of the tailings dike, plot signs have been erected for all plots. The signs are on metal posts at the right hand corner of each plot. During the spring of 1977, all signs will be coded to represent the year of planting and the plot number. For each plot, Appendix 9.2 lists plot number, species, age, seedling type, nursery origin, number planted and the date of planting.

3.1.2 Planting Times and Method

Twenty nine thousand nine hundred sixty one bare-root seedlings were planted between April 26 and May 27 and 1,950 container seedlings between October 8 and October 22. Seedlings were carried around the planting sites primarily in 5 gallon pails filled with moist peat.

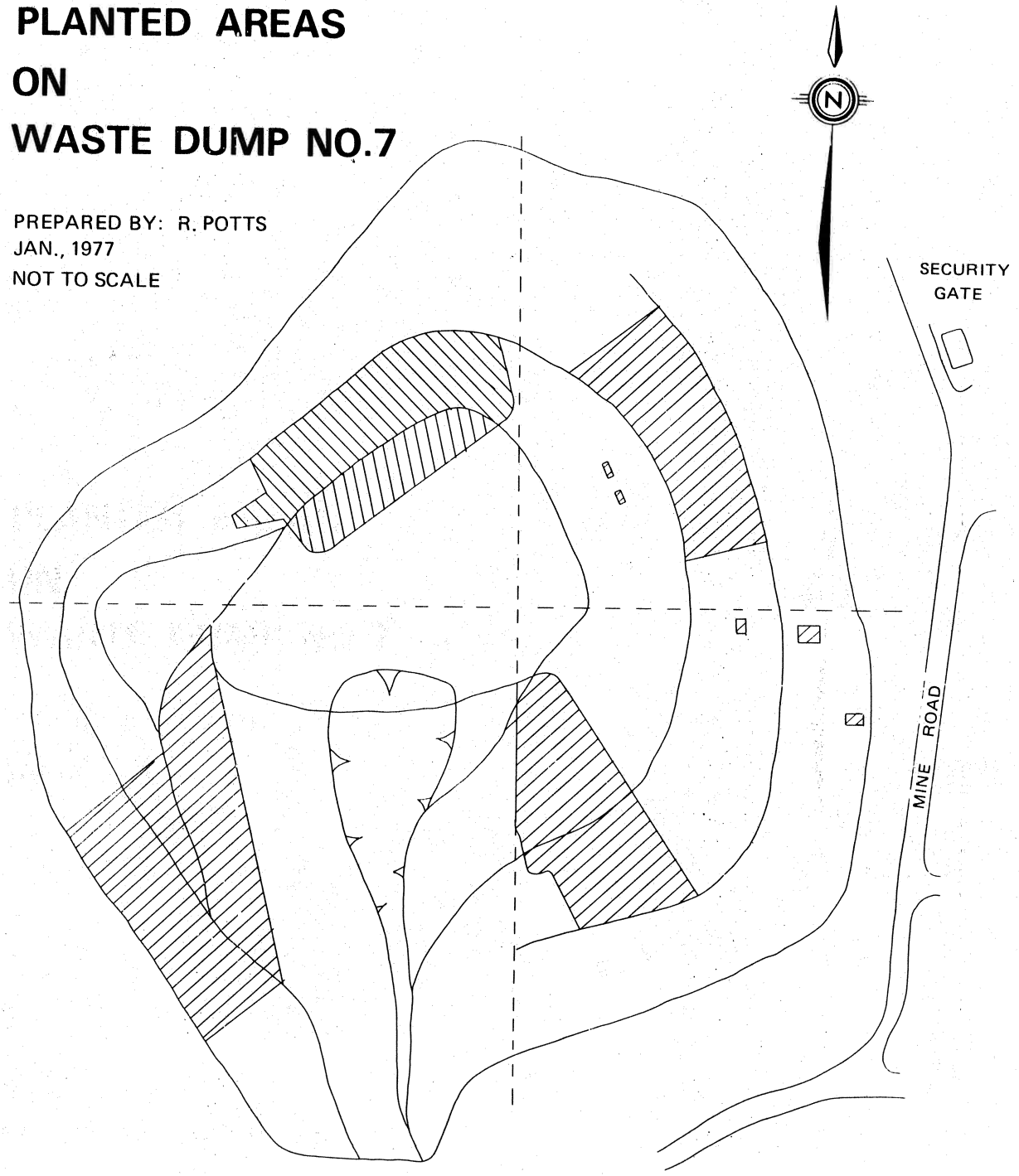

PLANTED AREAS
ON
WASTE DUMP NO.7
PREPARED BY: R. POTTS
JAN., 1977
NOT TO SCALE
N
SECURITY
GATE
MINE ROAD

FIGURE 3.

GENERAL LOCATION OF PLANTED AREAS ON TAILINGS DIKE

NOT TO SCALE
PREPARED BY: R. POTTS
JAN., 1977

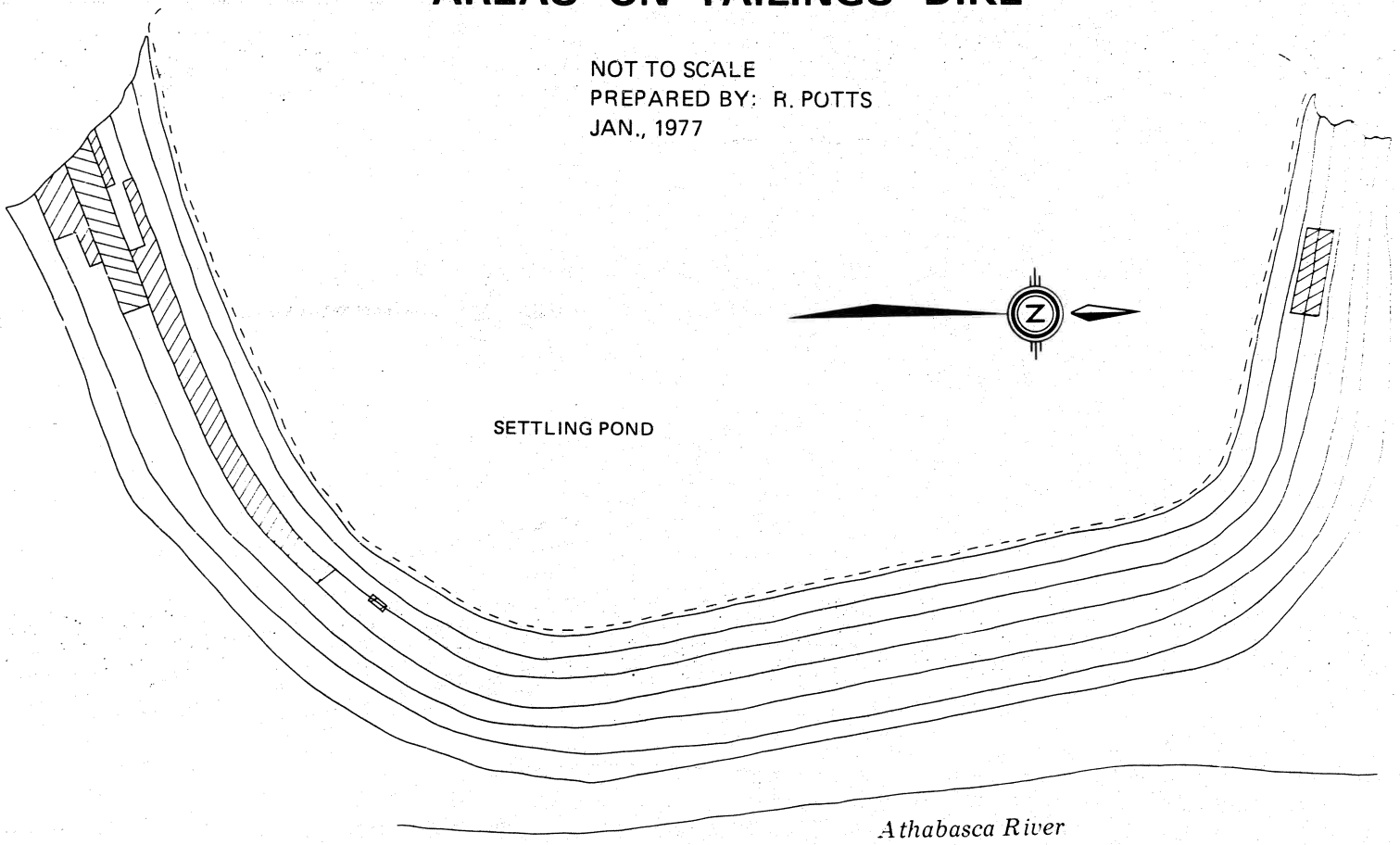


FIGURE 4.

The spring tree planting crew consisted of 10 people who planted 125 to 225 seedlings per man per day, depending on the type of planting site. The planting production was low because of the planting method and size of seedlings used. Since the planting was for research purposes a emphasis was placed on good quality planting, not quantity.

A Swedish tree planting mattock was used as a planting tool. First it was used to scarify an area 25 to 35 cm in diameter so that vegetative competition would be reduced in the immediate vicinity of the seedling. Then a hole approximately 20 cm deep and 17 cm in diameter at the top was most commonly dug. The seedling was placed in this hole so that its root collar was at ground level. The roots were placed in as natural a position as possible and then covered with soil. The soil was firmly packed to eliminate large air spaces and bring the roots in close contact with the soil. This planting method was used instead of other possibly faster techniques because it was felt that the poor growing conditions common to the mine spoil sites made necessary the use of a planting method which gives the seedling the best possible chance to survive.

3.1.3 Planting Sites

As in 1975, two basic planting mediums were used; tailings sand and the mixture of overburden material used in the construction of the waste dumps. As the following list indicates, there were 8 planting sites used in 1976 (Appendix 9.9).

Tailings dike (Figure 4)

1. north section
2. southeast section
3. peat treated areas

Waste dump no. 7 (Figure 3)

1. northeast section
2. northwest section
3. southeast section
4. southwest section
5. top section

The preparation of the peat treated areas on the southeast side of the tailings dike deserves further description because seedling performance on these sites was very good relative to other sites used. These were originally areas where serious gully erosion had occurred. The gullies were backfilled with tailings sand and the slope reconstructed to its original angle.

In the spring of 1976, approximately 10 cm of peat obtained from future mine areas, was spread over the surface of each repaired site. Only on one of these sites (the largest one on the second slope) was the peat purposely mixed with the sand. This was done with a small cat that pushed the top 20 cm of material back and forth until an even mixture of peat and sand was obtained. On the other five peat sites, a good deal of peat and sand mixing occurred when the peat was originally spread on the sand and when the site was disturbed by the planting crew.

For the specific distribution of each species and clone on the different planting sites, see Appendix 9.1.

3.1.4 Species Evaluation

The following three parameters were estimated for each seedling to help predict its suitability for the revegetation problems faced.

1. Survival - Is the seedling alive or dead?
2. Condition - If the seedling is alive, what conditoin is it in?
3. Growth - What increase in height has the seedling shown over the growing season?

The average condition and growth and the survival of each plot was computed and used as the data base for subsequent data analysis. The collection of data on 1976 planted seedlings took place between August 18 and September 29. For a more complete description of how the data was collected, see Appendix 9.4.

3.2 PLANTING METHOD TRIALS

As previously mentioned, the Swedish Tree planting mattock was used for planting because it is one method that offers the best aid to a seedling trying to establish itself under critical conditions. Also, a consistent method of planting is necessary if seedling performance is to be compared between different sites. However, this planting method is not that fast, thus causing planting costs to increase so one alternative, the planting bar, was examined. On May 26 and 27, approximately 2,400 Manitoba maple from the Oliver Provincial Tree Nursery were used in a planting method trial on waste dump no. 7. One thousand seedlings were planted with the mattock and 1400 with the planting bar. The procedure used with the planting bar is described in Smith (62). Both tools were used on the southwest and top site of waste dump no. 7 and the planting bar alone was used on the southeast site.

3.3 PLANTING TIME TRIALS

The success of planting seedlings in the fall is being investigated because it is an alternative to the often busy spring schedule and it also allows a seedling to take the best advantage of early season growing conditions. Between October 8 and 22, approximately 2,000 container [1] seedlings consisting of paper birch (Betula papyrifera Marsh.), green alder (Alnus crispa (Ait.) Pursh.), mountain alder (Alnus tenuifolia Nutt.) and American elm (Ulmus americana L.) were planted on waste dump no. 7 and the tailings dike. In the spring of 1977 the same species, age, and type of seedling will be planted in the same locations so a comparision of the two planting times can be made.

3.4 POSITION ON SLOPE TRIALS

To examine what affect position on slope might have on the growth and vigour of seedlings, six plots were set up on the tailings dike (Appendix 9.3). They were five rows wide and the entire length of the particular berm which the plot was on Subsurface drainage and the terraced shape of the tailings dike, are two of the factors which affect the amount of soil moisture available for plant growth. Since these two factors vary along the slope of the tailings dike, it is expected that seedling performance will do the same. If it can be discovered where along the individual slopes of the tailings dike these factors contribute most to growth, planning for species selection and location will be improved. These same questions might also be asked about the waste dump structures. Due to the good availability of Basford willow, this species was used for this trial. Survival, condition and growth were used to estimate seedling performance.

3.5 NATIVE CUTTINGS

In 1976, 800 cuttings of balsam poplar (Populus balsamifera L.) were planted to demonstrate the potential of cuttings as a revegetation technique. Four hundred were planted on the southeast section of the tailings dike and 400 on the northeast section of waste dump no. 7. At each of these sites, 200 were collected and planted in the spring (May 10-13) and fall (October 6-10).

[1] Ferdinand, Spencer - Lemaire containers. 40.97 cm^3 (2.5 in^3) per cavity.

The cuttings were taken from the main stem of poplar saplings located along the Athabasca river bank just below the tailings dike. One exception was the large size fall cuttings, which were collected a few hundred yards west of the Alberta Forest Service fire bomber base at the Fort McMurray airport.

Two basic types of cuttings were collected. One was a large size cutting 80 to 130 cm long and 1.5 to 7 cm in diameter. The bark had to be smooth and greenish-grey in color and free from any visible rot or infection. The cuttings were delimbed of any branches along its central stem. This size of cutting was planted in trenches a shovel width wide and 50 to 80 cm deep. The cutting was placed in the trench at an angle so that only 2 or 3 cm would be above ground level when the trench was filled in.

The second type of cutting was 15 to 20 cm long and 0.5 to 1.5 cm in diameter. Both ends were cut at a slight angle. The cuttings were forced into the ground as far as possible at a 30^{o} to 45^{o} angle and then the remaining portion was cut off at ground level. Both sizes of cuttings were planted with the stems oriented in a upward position. All cuttings, with the exception of the large size fall ones, were stored in the Athabasca river for approximately 3 days so excessive drying would not occur before planting.

3.6 SEED TRIALS

To assess the potential of using tree and shrub seed as a less expensive method of establishing woody vegetation, the following trials were conducted.

3.6.1 Coniferous Seed Germination Trial

On May 18, coniferous seeds for germination trials were planted on the peat treatments (Appendix 9.3). Two plots, one consisting of soaked seed and the other unsoaked, were used to assess the germination and survival of twelve species of coniferous tree seed in a seed bed made up of a mixture of tailings sand and local peat. The soaked seed was then treated by placing them in water, at room temperature, for 24 hours and then allowing the seed surface to dry. Two provenances of Jack pine (Pinus banksiana Lamb.) and three of white spruce (Picea glauca (Moench) Voss) were used along with lodgepole pine (Pinus contorta Dougl. var. latifolia Engelm.), alpine fir (Abies lasiocarpa (Hook) Nutt.), black spruce (Picea mariana (Mill) B.S.P.), tamarack (Larix laricina (Du Roi) K. Koch), white-bark pine (Pinus albicaulis Engelm.) and Douglas fir (Pseudotsuga menziesii (Mirb.) Franco).

One hundred seeds of each species or provenance were evenly spaced along a shallow trench 1 m long. Each end of the row was marked with a stake and a string between the two stakes indicates the exact position of the seed row. Each species or provenance test was replicated 3 times. The seed rows were made by hand. A shallow trench about 5 mm deep was located just below the string. After the seeds were in place they were covered with a light layer of soil that was packed gently with the hand. In the fall the germination and subsequent seedling survival was recorded for each seed row planted.

3.6.2 Deciduous Broadcast Seed Trials

On May 19, green alder (Alnus crispa (Ait.) Pursh), paper birch (Betula papyrifera Marsh), mountain alder (Alnus tenuifolia Nutt.) and common wild rose (Rosa woodsii Lindl.) seed was broadcast to test its ability to germinate and grow on a seed bed composed of a mixture of tailings sand and local peat. Again the germination capacity of soaked versus unsoaked seed was compared and the soaking treatment was the same as for the coniferous seed. Each combination of species and seed treatment was broadcast by hand over a 25 m^2 area and replicated once. After broadcasting, the seed was immediately mixed with the soil using a garden rake. The plots were also walked on to compact the soil for better moisture retention. These plots are located on the peat treatments (Appendix 9.3). On August 28, transects were completed in all broadcast seed plots. To determine the number of germinants per unit area, five sampling quadrates 0.25 m^2 in size were randomly located in each broadcast seed plot and the number of germinants per quadrate were tallied.

3.7 SOIL SAMPLES

In an effort to correlate seedling performance with soil properties, soil samples of the planting sites were collected on October 23 and 24. Approximately 100 samples were collected and then grouped into 32 composite samples for laboratory analysis. Due to the mixture of overburden material, more than half the samples were taken on waste dump no. 7 because it was expected that the variance in soil properties would be greater than on the tailings dike. At each sample point a 20 cm (8 in) core sample was taken. The laboratory analysis of these results was not available for inclusion in this report.

4. RESULTS AND DISCUSSION

4.1 INTRODUCTION

The data presented in this report should not be used to draw any firm conclusions on the success of afforestation techniques used thus far. The life cycle of most species used is many tens of years and to try anticipate from two years of observations what each species suitability for reclamation will be, is impractical. As an example, note from appendix 9.10 that the survival of Europeon white birch (Betula alba L.) planted during 1975 on the north section of the tailings dike was 74%. This was the second highest survival of any species planted on the site. In the fall of 1976 its survival was reduced to 0%. This example should illustrate that just because one years data has been collected for a tree or shrub species we are not assured of understanding how it will function through the whole of its life cycle.

From the data collected so far, a few observations and trends have been noted and will be discussed. How significant these comments are in terms of long term reclamation only time will tell. This report is an annual one outlining the work completed since April 1, 1976 and so only interim trends and observations have been discussed. A final report will be available at the conclusion of this project.

4.2 PEAT TREATMENT SITES

Appendix 9.5 shows that the growth, survival and condition of seedlings planted on the muskeg treatment sites is significantly higher than that of seedlings planted on other portions of the southeast side of the tailings dike. The same holds true when comparisons are made with the remaining planting sites.

A partial reason for the success of these sites may be that they were planted on April 30 and May 1 allowing the seedlings to take full advantage of available soil moisture which became more scarce as the growing season progressed. Also because the sites were recently reconstructed there was in the spring almost a total absence of vegetative cover. On all other sites the seedlings had to compete with grass species for the limited amount of available moisture and nutrients. This competition did not occur on the peat treated sites so may have contributed to better seedling performance.

The most important factor contributing to the higher seedling productivity of these sites is probably the peat itself. For an explanation of how these sites were prepared refer to section 3.1.3 of Method and Materials. The value of peat for seed bed improvement has already been recognized by G.C.O.S. (Berry (74)) and is included in their operational reclamation. One of peats

most important properties is that it increases the moisture holding capacity of the tailings sand. This is a direct benefit for seedling growth, especially when they are first planted. Adequate moisture enables the seedling to quickly establish their roots at a deeper level where moisture is available for longer periods.

4.3 POPLAR CLONES

Table 1 shows that the performance of 1 year old rooted cuttings representing 23 poplar clones was significantly better than a group consisting of all other species planted.

TABLE 1. Performance of Indian Head[1] Poplar Clones Versus Other Species Planted

	Tailings Dike S.E. section			Tailings Dike Peat Treatments			Waste Dump No. 7 N.E. section		
	S[2]	Gr[3]	Con[4]	S	Gr	Con	S	Gr	Con
Poplars	61*	8*	2.2*	96*	49*	3.0*	96*	20*	2.4*
Others	46	1	1.9	88	17	2.3	86	5	2.1

[1] For culture method and parentage of poplar clones see appendix 9.6

[2] % survival

[3] Average growth (cm)

[4] Average condition as described in appendix 9.4

* Values are significantly different between seedling groups at 95% level of probability

By examining individual species and poplar clone performance (Appendix 9.9) one will also notice that poplar clones are always the best performers at sites where they are planted.

This advantage over other deciduous species is not too suprising because poplars are generally known to be fast growing trees that play a pioneer role on disturbed sites. Their surficial root systems are an additional characteristic favourable for reclamation purposes. On the negative side poplars are relatively short lived and susceptible to a wide variety of fungus and insect problems. The frost hardiness of each clone will also be an important factor affecting the success of these clones. Realizing that one years performance does not indicate their reclamation potential, such clones as 'Serotina de Selys,' 'Walker,' 'Brooks #4,' 'P.X grandis,' 'Northwest' and 'P38 P38' were consistently some of the most successful poplar clones planted. In support of this trend, Steneker (76)

found in Manitoba that four to eight years after planting, 'Walker' and 'Northwest' were among the best performing clones he used.

4.4 SPECIES PERFORMANCE BY SITE

The performance of each species or poplar clone at each 1976 planting site is listed in Appendix 9.9. The overall performance was determined by computing a performance index for each species or poplar clone. The index was computed using the following equation. Due to the range of values obtained, average

Performance Index	= Avg. Species Growth (cm)	+ Avg. Species Survival	+ Avg. Species (10) Condition

survival and growth figures most affected the index value. This was desirable because condition values were based on subjective evaluations and thus were the least desirable parameter for ranking species performance. The majority of condition values ranged between 1 and 3 so were multiplied by 10 to give the condition value a slightly greater effect on the performance index value.

4.4.1 Southeast Section of Tailings Dike

Poplars were the best performers on this site. Tatarian honeysuckle (Lonicera tatarica L.) and Manchurian elm (Ulmus pumila L.) were the most successful non poplar species used and Manchurian elm had very good survival on all other sites it was planted on. Except for the peat sites, American elm (Ulmus americana L.) did not do well on any of the planting sites. Chokecherry (Prunus virginiana L.) had a much greater survival on this site than on the north section of the dike.

4.4.2 Peat Treatment Sites of Tailings Dike

As previously noted the peat treated sites were the most productive of all planting sites used this year. The poplar clones performed better than all other species planted except for Basford willow. The performance index for Basford willow was over 2 1/2 times that on the other two tailings dike sites. Manitoba maple (Acer negundo (Britt.) Sarg.) did not perform well in comparison to the rest of the species planted. This was also the case for the southeast section of the dike.

It is interesting to note that the rooted cuttings of native balsam poplar did not do well compared to the introduced poplar clones.

4.4.3 North Section of Tailings Dike

Performance index values show that the range of species performance on this site is similar to the southeast section of the tailings dike. As previously mentioned, Manchurian elm did well. The survival and growth of Basford willow and green ash (Fraxinus pennsylvanica Marsh. var. subintegerrima (Vahl) Fern.) was similar to that on the southeast section of the dike. Chokecherry and hawthorn (Crataegus cerronis A. Nels.) did not do well on this site.

4.4.4 Northwest Section of Waste Dump No. 7

Relative to the species planted Manchurian elm, green ash, late lilac (Syringa villosa Vahl.) and common lilac (Syringa vulgaris L.) performed well on both this site and the north section of the tailings dike. Native rooted cuttings of willow (Salix sp.) did not perform as well as the introduced Basford willow. Tatarian honeysuckle showed its lowest survival on this site. Here as on the north section of the tailings dike, Basford willow and Manchurian elm had the most growth.

4.4.5 Northeast Section of Waste Dump No. 7

This site was second only to the peat treatments in seedling productivity. This may be due to the apparent steady moisture supply on this site throughout the growing season. Subsurface drainage within the dump seems to favour this site as shown by the relatively good growth of both grass and seedlings and the presence of saturated soil often less than a metre below the surface.

Russian olive (Elaeagnus angustifolia L.) has an index value twice that on the southeast section of the tailings dike. Again Manchurian elm did well compared to American elm, Manitoba maple and native balsam poplar. Good performers on this site such as 'Serotina de Selys,' 'PX Grandis,' 'Walker' and 'Brooks #4' were also good performers on the less favourable southeast section of the tailings dike.

4.4.6 Southwest Section of Waste Dump No. 7

Although the survival of Basford willow is high, 86%, its condition is low, 1.6. Manchurian elm and Manitoba maple performed much the same on the other waste dump sites.

4.4.7 Southeast Section of Waste Dump No. 7

This was the poorest site on the waste dump and both species planted here, Basford willow and Manitoba maple, did quite poorly. Having mostly a south exposure the site became dry quite early in the growing season. The ground was very hard and rocky, making it difficult to plant in.

4.4.8 Top Section of Waste Dump No. 7

Manchurian elm had an average growth of 17 cm which was the best of any site it was planted on. Again native willow did not perform as well as Basford willow. Except for the peat treatments, this was the only site where Manitoba maple has shown positive growth. The relatively good growth of all species planted here might be related to the fact that this site has no slope.

4.4.9 Survival of 1974 and 1975 Planting Stock

Appendix 9.9 shows the change in survival between 1976 and 1975 for species planted in 1974 and 1975. As expected, the trend is for mortality to increase over time. This increase was most extreme for American elm, Bur oak (Quercus macrocarpa Michx.) and white birch (Betula alba L.) on the north section of the tailings dike. Caragana (Caragana arborescens Lam.) was one large exception to this trend with its mortality going down 9% on the southeast section of the tailings dike and 5% on waste dump no. 5. This could be explained by assuming seedlings observed as dead in 1975 produced sprouts in 1976. A wide variety of experimental treatments were applied to most of the species in these appendices and a more intensive long term evaluation of these results will be necessary before any conclusions can be made. For more information on work done in 1974 and 1975, refer to this project's 1975 progress report.

4.5 PLANTING METHOD TRIALS

Table 2 indicates that there was no real difference in the growth, condition or survival of the Manitoba maple as a result of using the Swedish planting mattock or the planting bar.

TABLE 2 Survival, Growth and Condition of Manitoba Maple When Planted With Mattock and Planting Bar On Waste Dump No. 7

	Survival (%)				Growth (cm)			
	SE[1]	SW[2]	Top[3]	AVG.	SE	SW	TOP	AVG
Swedish Tree Planting Mattock		15	19	17		-2	3	1
Planting Bar	6	13	20	12	0	-3	3	0
		Condition[4]						
	SE	SW	TOP	AVG.				
Swedish Tree Planting Mattock		1.8	1.9	1.8				
Planting Bar	1.0	1.7	2.0	1.5				

[1] Southeast section
[2] Southwest section
[3] Top section
[4] As described in appendix 9.4

Parameter values are quite low, indicating that perhaps some other factors are affecting seedling performance enough to mask any affect planting method might have. One factor might be that these seedlings were the very last to be planted, so would have the least favourable growing condition relative to other seedlings. Also, the size and vigour of the planting stock could have reduced the success of these trials. Many of the seedlings were less than 15 cm tall and did not have a very large root system thus putting them at a disadvantage when competing with other vegetation.

4.6 POSITION ON SLOPE TRIALS

The data in Appendix 9.8 was presented by section with each section being approximately 5 m long and representing 25 seedlings. Section number one is always located at the highest slope position of the plot and the highest numbered section at the bottom.

The data indicates that the performance of Basford willow was variable along the length of each slope tested. The pattern of this variance does not seem to be consistent between plots indicating that possibly other site factors are also playing a significant role in seedling performance. For example, plots 652 and 448 on the north side of the tailings dike had low survival rates in section one even though the growth and condition was the best for each plot concerned.

This shows that on a limited number of small sites seedlings were doing well. Typically, the sites the willows did well on were composed of drifting sand and sparse grass cover.

4.7 NATIVE CUTTINGS

Table 3 indicates the success of 400 spring planted cuttings of balsam poplar. Their survival is substantially lower than seedlings planted on the same site.

TABLE 3. Performance of Spring Planted Balsam Poplar Cuttings.

	Survival (%)		Growth (cm)		Condition[3]	
	Tailings Dike	Waste Dump No. 7	Tailings Dike	Waste Dump No. 7	Tailings Dike	Waste Dump No. 7
Large Cuttings	26[2]	12[1]	42	18[1]	2.2	1.8[1]
Small Cuttings (shove-ins)	6	0	12	0	1.0	0

[1] Significantly greater than shove-ins at 95% level of probability

[2] Significantly greater than survival on waste dump no.7 at 95% level of probability

[3] As described in Appendix 9.4

On both sites, the large size cuttings performed better than the smaller size shove-ins. One reason could be that the larger cuttings were planted at a greater depth than the shove ins providing better moisture conditions for root development. Kaszkurewicz (64) found that in central Louisiana, cottonwood cuttings (Populus deltoides Bartr.) showed optimum growth when planted 4 feet deep. Perhaps just as important is that large cuttings would have a greater reserve of energy for developing shoots and roots. Both cuttings and shove-ins were more successful on the tailings dike than on waste dump no. 7. This was probably because the tailings dike site was on the peat treatments which were as already mentioned, the most productive of all sites used.

4.8 SEED TRIALS

4.8.1 Coniferous Seed Germination Trial

Appendix 9.7 shows that only the Douglas fir, lodgepole pine and Jack pine seeds germinated and had significant numbers of seedlings survive. This was not suprising because these three species commonly act as pioneers on dry warm

sites. For the soaked seed treatment Jack pine (60-65) germinated and survived significantly better than Douglas fir and lodgepole pine. The difference between the two Jack pine seed lots was significant only at a 50% probability level. A considerably greater amount of erosion occurred on the unsoaked plots, no doubt biasing the results and making comparisions between the two treatments difficult.

The greatest amount of erosion was of the type where the top 1 to 2.5 cm of sand was removed by water thus exposing the roots of some seedlings and completely burying seedlings in lower slope positions. Many seedlings were observed germinating 0.1 to 0.8 m away from where they were originally planted indicating that seed displacement due to erosion was common.

Seeds were also disturbed by rodents or birds. The seed coats of the relatively large white-bark pine seeds were often observed scattered around the test site and it is probable other species of seed were eaten also.

It was not uncommon to find young seedlings surviving in locations shaded for at least part of the day by annual weeds which have invaded the sites. If, as it is suspected, soil surface temperatures are reaching a critical level for seeds and young germinants, shade will be an important microsite factor.

For the reasons just mentioned we suspect the low germination and survival rate of these seed trials will continue in the next growing season.

4.8.2 Deciduous Broadcast Seed Trials

Absolutely no germination was observed in the sample quadrates used for all species and seed treatment combinations. During the evaluation only 1 seedling was observed and it appeared to be green alder. On one of the plots, common wild rose seed shells were frequently observed indicating that rodents or birds were eating the seeds. A significant amount of site disturbance occurred in the form of water erosion, severe enough to dislodge seeds or young germinants. Another factor inhibiting the germination and seedling growth would be the high soil surface temperatures. The plot sites had a southeast exposure, 2.5:1 slope and very little vegetation cover. Soil surface temperatures taken for A.O.S.E.R.P. Project VE 4.1 during August 1976, at a similar site having grass cover, were often over 30^{o}C. These temperatures are far above the optimum for seed germination and seedling survival.

Only 1 method of stratification was used in this trial so other seed treatments should be considered if seed performance is to be improved.

5. CONCLUSIONS AND RECOMMENDATIONS

It should be emphasized again that the following conclusions are based on work completed in 1976 and will no doubt be revised as the program approaches completion.

1. Initial seedling survival, growth and condition can be significantly improved by mixing tailings sand with peat in a 1 to 1 ratio. How long this good performance can be maintained is not known.
2. Out of the 23 species planted this year many of the poplar clones received from the PFRA[1] Tree Nursery at Indian Head Saskatchewan, survived and grew the best. Their performance on the peat treated sites was very good and should continue to be monitored for long term performance.
3. A combination of seed, seed treatments, erosion, rodents and high soil surface temperature combined to make the seed trials intially unsuccessful. The most successful germinating coniferous seed was Jack pine. Other methods of stratification and scarification, different site preperations, the use of mice and bird repellents and a continued search for suitable species and provenances would probably increase the success of this revegetation method.
4. Large cuttings were more successful than small ones and performed best on the peat treatment sites. This work should be expanded to include native willow cuttings and other planting techniques.

[1] Prairie Farm Rehabilitation Administration

6. PROPOSED DIRECTION OF FURTHER STUDY

In the future this program should continue to monitor potentially successful species to determine the self sustaining nature of the communities being created. As already illustrated with the survival of white birch, the early success of a certain plant species does not ensure that they will help provide site stability and soil improvement on a long term basis.

Larger stands of trees and shrubs should be established for the purpose of:

a) studying the advantage of planting various mixtures of trees and shrubs.

b) conducting silvicultural treatments such as pruning and thinnings to see how stand performance and soil condition might be improved.

c) studying the transfer of forest stands composed of species having site amelioration properties, to stands more commercial or semi-commercial in composition.

d) creating permanent plots inside the stand to record changes in the planting medium as it developes towards a soil. This work would be in collaboration with other projects of the Vegetation Committee especially VE 4.

Species selection should remain as broad as possible with particular emphasis being placed on the propagation of native species. To date native seedlings from local seed source have comprised a relatively small part of this program and so should receive increased attention. This task will not be easy for several reasons. First, good seed production years for many local trees and shrubs are sporadic making collection planning difficult. Secondly, not a great deal is known about the nature and properties of non-commercial seeds. Lastly, up till now, nursery facilities for the growing of "specialty" seedlings have been difficult to obtain.

We have just begun to explore the possibilities of using native poplar and willow cuttings. This work should be continued and expanded to determine if this relatively inexpensive method of seedling production has merit for the Alberta oil sands area.

An area of study, this project should pursue further, in collaboration with other projects doing so now, is the nature of the planting mediums being revegetated. We are just now becoming aware of the kind of temperature and soil regimes affecting plant growth on the tailings dike. Further knowledge of major nutrient cycles and soil properties would aid in correlating species performance with site conditions and in identifying factors most limiting to growth. With this information a more informed selection of species and site treatments could be made.

Work should continue on developing site preparations and treatments which enhance seedling growth. Site amendments that offer long term benefits should be used. An examination of the types, timing and amount of fertilization, will be most essential if optimum performance is to be achieved on the nutrient poor materials being used. A larger variety of native and introduced nurse crops which improve the seedling's growing environment and at the same time provide for site stabilization and soil improvement should be considered. An examination of the technology and materials available for applying nurse crop species would improve the success and effectiveness of these crops. For example, many types of mulches and chemical soil binders are available for application on problem sites.

If direct seeding of tree and shrub species is going to be successful, more investigations on species selection, stratification and scarification treatments, rodent and bird repellents and site preparation will be needed to improve the success of this revegetation method.

7. AKNOWLEDGEMENTS

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APPENDIX # 9.1
NUMBER AND LOCATION OF 1976 PLANTING STOCK

Species	Nursery[1] Origin	Waste Dump No. 7[2]						Tailings Dike				Sum of Totals
		NW	NE	SE	SW	TOP	TO-TAL	Peat Treatments	N	SE	TOTAL	
Acer ginnala	IH		100				100					100
Acer negundo	0	750	525	1096	1500	1500	5371	319	500	500	1319	6690
Acer negundo	IH	300	300	300	300	300	1500	200		300	500	2000
Total		1050	825	1396	1800	1800	6871	519	500	800	1819	8690
Alnus crispa	0	100		150			250		100	150	250	500
Alnus tenuifolia	0			150			150					150
Betula papyrifera	0			150			150			150	150	300
Caragana arborescens	IH		200				200					200
Crataegus cerronis	IH	150					150		145		145	295
Elaeagnus angusti-folia	IH		193				193			190	190	383
Fraxinus pennsylvanica var. subintegerrima	0	127					127		150		150	277
Fraxinus pennsylvanica var. subintegerrima	IH							200	200	200	600	600
Total		127					127	200	350	200	750	877
Larix sibirica	IH									100	100	100
Lonicera tatarica	0	250	148				398			175	175	573
Picea glauca	IH								50	100	150	150
Picea pungens	IH									100	100	100
Pinus contorta	0								175		175	175
Populus balsamifera	Fort McMurray Area											

NUMBER AND LOCATION OF 1976 PLANTING STOCK

Species	Nursery[1] Origin	Waste Dump No. 7[2]						Tailings Dike				Sum of Totals
		NW	NE	SE	SW	TOP	TOTAL	Peat Treatments	N	SE	TOTAL	
spring cuttings			100				100	100			100	200
fall cuttings			100				100			100	100	200
spring shove-ins			100				100	100			100	200
fall shove-ins			100				100			100	100	200
TOTAL			400				400	200		200	400	800
Populus balsamifera	O	48	267				315	250			250	565
Populus sp. clones[3]	IH											
Acuminata	IH									89	89	89
Angulata	IH									186	186	186
Berolinensis[4]	IH									350	550	550
BNW #4	IH									270	270	270
Brooks #2	IH		100				100			250	250	350
Brooks #4	IH							200		249	449	449
Brooks #5	IH		77				77			60	60	137
C-regenerata	IH									99	99	99
Carolina #3	IH									170	170	170
D709 PA	IH									100	100	100
Eucalyptus	IH									220	220	220
Gelrica	IH							100			100	100
Jackii #18	IH							100			100	100
Nigra[5]	IH		100				100			131	131	231

NUMBER AND LOCATION OF 1976 PLANTING STOCK

Species	Nursery[1] Origin	Waste Dump No. 7[2]						Tailings Dike				Sum of Totals
		NW	NE	SE	SW	TOP	TOTAL	Peat Treatments	N	SE	TOTAL	
Northwest	IH							210		135	345	345
P38 P38	IH							185		125	310	310
44-55	IH		224				224	500		250	750	974
PV	IH									200	200	200
PX Grandis	IH		125				125			200	200	325
PX Mann	IH									300	300	300
Serotina de Selys	IH		284				284	200		500	700	984
Tristis #1	IH									100	100	100
unknown	IH		99				99					99
Walker	IH		250				250	350		150	500	750
Prunus padus	IH	300					300		250		250	550
Prunus virginiana	O	180					180		250	100	350	530
Prunus virginiana	IH		100				100					100
TOTAL		180	100				280		250	100	350	630
Pseudostuga menziesii	O	200					200					200
Salix fragilis var. 'Basfordiana'	IH	300	300	799	1305	1177	3881	200	500	577	1277	5158
Salix sp.	O	350				200	550					550
Syringa villosa	O	250					250		250		250	500
Syringa villosa	IH		100				100			100		200
TOTAL		250	100				350		250	100	350	700

NUMBER AND LOCATION OF 1976 PLANTING STOCK

Species	Nursery[1] Origin	Waste Dump No. 7[2]						Tailings Dike				Sum of Totals
		NW	NE	SE	SW	TOP	TOTAL	Peat Treatments	N	SE	TOTAL	
Syringa vulgaris	0	185					185		250		250	435
Ulmus americana	0	200	200	250			650		250	492	742	1392
Ulmus americana	IH		150				150	200			200	350
Total		200	350	250			800	200	250	492	942	1742
Ulmus pumila	0	250			250		500		250	250	500	1000
Ulmus pumila	IH		150				150			200	200	350
Total		250	150		250		650		250	450	700	1350
TOTALS		3940	4392	2895	3355		17759	3614	3320	8018	14952	32711

1 IH - seedlings received from P.F.R.A. Tree Nursery, Indian Head Sask.
0 - seedlings from Oliver Provincial Tree Nursery, Alta.

2 See Appendix 9.3 for location of each planting site on waste dump no. 7 and the tailings dike

3 For description of culture methods and parentage see Appendix 9.6

4 'Berolinensis femina' may be included under this name

5 Both Nigra #1 and Nigra viadri Rudiger

Appendix 9.2

PLOT DESCRIPTIONS

TAILINGS DIKE

Tailings Dike - Peat Treatments

Plot no.	Species	Age	Nur[1]	No.[2]	Date[3]	Comments
338	P. Walker	1-0	IH	50	4-30	
339	Populus balsamifera		G.C.O.S. lease	51	5-13	shove-ins
340	Populus balsamifera	1-0	O	100		
341	Fraxinus pennsylvanica var. subintegerrima	2-0	IH	50	5-1	
342	P. P 44-55	1-0	IH	75	4-30	
343	P. Walker	1-0	IH	50	4-30	
344	P. Berolinensis femina	1-0	IH	50	4-30	
345	P. Northwest	1-0	IH	50	4-30	
346	P. Walker	1-0	IH	50	4-30	
347	P. Brooks #4	1-0	IH	50	4-30	
348	Ulmus americana	2-0	IH	50	5-1	
349	Salix fragilis var. 'Basfordiana'	2-0	IH	50	5-1	
350	P. P 38 P 38	1-0	IH	50	5-1	
351	Fraxinus pennsylvanica var. subintegerrima	2-0	IH	50	5-1	
352	P. Walker	1-0	IH	50	4-30	
353	P. Berolinensis femina	1-0	IH	50	4-30	
354	P. Serotina de Selys	1-0	IH	50	4-30	
355	P. unknown					
356	Populus balsamifera	1-0	O	49	5-17	
357	P. Brooks #4	1-0	IH	50	5-1	
358	P. Serotina de Selys	1-0	IH	50	4-30	
359	P. Northwest	1-0	IH	50	4-30	
360	Acer negundo	2-0	IH	50	5-1	
361	Acer negundo	2-0	O	66	5-26	
362	P. P 44-55	1-0	IH	75	4-30	
363	P. P 38 P 38	1-0	IH	45	4-30	
364	Ulmus americana	2-0	IH	50	5-1	
365	P. P 44-55	1-0	IH	75	4-30	
366	Acer negundo	2-0	IH	50	5-1	
367	Salix fragilis var. 'Basfordiana'	1-0	IH	75	5-1	
368	P. P 44-55	1-0	IH	75	4-30	

Tailings Dike - Peat Treatments

Plot no.	Species	Age	Nur[1]	No.[2]	Date[3]	Comments
369	Populus balsamifera		G.C.O.S. lease	38	5-13	cuttings
370	P. Berolinensis femina	1-0	IH	53	5-1	
371	Fraxinus pennsylvanica var. subintegerrima	2-0	IH	50	5-1	
372	Acer negundo	2-0	IH	50	5-1	
373	Fraxinus pennsylvanica var. subintegerrima	2-0	IH	50	5-1	
374	P. Walker	1-0	IH	50	5-1	
375	P. Northwest	1-0	IH	50	5-1	
376	Salix fragilis var. 'Basfordiana'	1-0	IH	50	5-1	
377	P. P 44-55	1-0	IH	50	5-1	
378	P. Gelrica	1-0	IH	50	5-1	
379	P. Jackii #18	1-0	IH	50	5-1	
380	P. P 44-55	1-0	IH	75	4-30	
381	P. P 38 P 38	1-0	IH	45	4-30	
382	P. Walker	1-0	IH	50	5-1	
383	P. Brooks #4	1-0	IH	50	5-1	
384	Ulmus americana	2-0	IH	50	4-30	
385	Populus balsamifera		G.C.O.S. lease	53	5-13	cuttings
386	P. P 44-55	1-0	IH	85	5-1	
387	Populus balsamifera	1-0	0	50		
388	P. Berolinensis femina	1-0	IH	52	5-1	
389	P. Serotina de Selys	1-0	IH	50	5-1	
390	Acer negundo	2-0	0	153	5-26	
391	Salix fragilis var. 'Basfordiana'	1-0	IH	50	5-1	
392	P. Serotina de Selys		IH	48	5-1	
393	Populus balsamifera		G.C.O.S. lease	50	5-13	shove-ins
394	P. Serotina de Selys	1-0	IH	50	5-1	
395	P. Jackii #18	1-0	IH	17	5-1	
396	P. Walker	1-0	IH	50	5-1	
397	P. Northwest	1-0	IH	60	5-1	
398	Ulmus americana	2-0	IH	50	5-1	
399	P. Brooks #4	1-0	IH	49	5-1	

Tailings Dike - Peat Treatments

Plot no.	Species	Age	Nur[1]	No.[2]	Date[3]	Comments
400	Acer negundo	2-0		46		
401	Populus balsamifera	1-0	O	112	5-17	

[1] IH - seedlings received from P.F.R.A. Tree Nursery, Indian Head, Sask.
O - seedlings received from Oliver Provinical Tree Nursery, Alta.

[2] Number of seedlings planted

[3] Date seedlings planted

Tailings Dike - Southeast Section

Plot no.	Species	Age	Nur.[1]	No.[2]	Date[3]	Comments
212	P.Serotina de Selys	1-0	IH	100	5-2	
213	Salix fragilis var. 'Basfordiana'	1-0	IH	91	5-2	
214	P. Berolinensis	1-0	IH	50	5-2	
215	Acer negundo	2-0	IH	92	5-2	
216	Prunus virginiana	2-0	IH	50	5-2	
217	P. Walker	1-0	IH	49	5-2	
218	P. Serotina de Selys	1-0	IH	101	5-4	
219	P. Berolinensis	1-0	IH	100	5-4	
220	P. Northwest	1-0	IH	50	5-4	
221	P. Tristis #1	1-0	IH	49	5-4	
222	P.C. regenerata	1-0	IH	54	5-4	
223	P. Angulata	1-0	IH	50	5-5	
224	P. Brooks #5	1-0	IH	40	5-10	
225	P. P.V. 97	1-0	IH	51	5-10	
226	P. Angulata	1-0	IH	50	5-10	
227	P. Acuminata	1-0	IH	57	5-10	
228	P. Carolina #3	1-0	IH	50	5-10	
229	P. P 38 P 38	1-0	IH	50	5-10	
230	P. PX Mann	1-0	IH	100	5-10	
231	P. Carolina #3	1-0	IH	50	5-10	
232	P. Acuminata	1-0	IH	39	5-10	
233	P. P 44-55	1-0	IH	50	5-10	
234	P. Brooks #4	1-0	IH	50	5-10	
235	P. PX Grandis	1-0	IH	50	5-10	
236	P. Eucalyptus	1-0	IH	60	5-10	
237	P. PX Grandis	1-0	IH	50	5-10	
238	P. Brooks #4	1-0	IH	50	5-10	
239	P. BNW #4	1-0	IH	60	5-10	
240	P. P 38 P38	1-0	IH	25	5-11	
241	P. P 44-55	1-0	IH	50	5-11	
242	Salix fragilis var. 'Basfordiana'	1-0	IH	100	5-11	
243	P. Brooks #2	1-0	IH	50	5-11	
244	Salix fragilis var. 'Basfordiana'	1-0	IH	100	5-11	

Tailings Dike - Southeast Section

Plot no.	Species	Age	Nur.[1]	No.[2]	Date[3]	Comments
245	P. BNW #4	1-0	IH	50	5-11	
246	P. D 709 PA	1-0	IH	50	5-11	
247	P. Walker	1-0	IH	50	5-11	
249	P. Brooks #2	1-0	IH	50	5-11	
250	P. D 709 PA	1-0	IH	50	5-11	
251	P. BNW #4	1-0	IH	50	5-11	
252	Acer negundo	2-0	0	100	5-19	
253	Larix sibirica	2-0	IH	50	5-19	
254	Ulmus americana	1-0	0	50	5-19	
255	Acer negundo	2-0	0	91	5-19	
256	Ulmus americana	1-0	0	50	5-19	
257	Ulmus pumila	2-0	0	50	5-25	
258	Salix fragilis var. 'Basfordiana'	1-0	IH	185	5-25	
259	Ulmus pumila	2-0	0	50	5-25	
260	Salix fragilis var. 'Basfordiana'	1-0	IH	185	5-25	
261	Ulmus pumila	2-0	0	50	5-25	
262	Ulmus pumila	2-0	0	50	5-25	
263	Acer negundo	2-0	0	100	5-19	
264	Ulmus americana	1-0	0	42	5-19	
265	Acer negundo	2-0	0	100	5-19	
266	Larix sibirica	2-0	IH	50	5-19	
267	Ulmus americana	1-0	0	50	5-19	
268	Acer negundo	2-0	0	98	5-18	
269	P. Brooks #2	1-0	IH	40	5-11	
270	P. D 709 PA	1-0	IH	48	5-11	
271	Salix fragilis var. 'Basfordiana'	1-0	IH	100	5-11	
272	P. D 709 PA	1-0	IH	50	5-11	
273	P. BNW #4	1-0	IH	50	5-11	
274	P. Brooks #2	1-0	IH	50	5-11	
275	P. D 709 PA	1-0	IH	50	5-11	
276	P. PX Grandis	1-0	IH	50	5-11	
277	P. Brooks #2	1-0	IH	50	5-11	
278	P. Brooks #4	1-0	IH	50	5-11	

Tailings Dike - Southeast Section

Plot no.	Species	Age	Nur.[1]	No.[2]	Date[3]	Comments
279	P. Eucalyptus	1-0	IH	50	5-11	
280	P. BNW #4	1-0	IH	50	5-11	
281	P. Brooks #4	1-0	IH	49	5-11	
282	P. Brooks #2	1-0	IH	49	5-11	
283	P. PX Grandis	1-0	IH	49	5-11	
284	P. Nigra	1-0	IH	31	5-11	
285	P. Eucalyptus	1-0	IH	60	5-10	
286	P. P 44-55	1-0	IH	50	5-10	
287	P. Eucalyptus	1-0	IH	60	5-10	
288	P. BNW #4	1-0	IH	59	5-10	
289	P. Nigra	1-0	IH	52	5-10	
290	P. Brooks #4	1-0	IH	49	5-10	
291	P. P 44-55	1-0	IH	50	5-10	
292	P. Nigra	1-0	IH	50	5-10	
293	P. P 38 P 38	1-0	IH	50	5-10	
294	P. Carolina #3	1-0	IH	70	5-10	
295	P. Brooks #5	1-0	IH	20	5-10	
296	P. P.V. 97	1-0	IH	50	5-10	
297	P. PX Mann	1-0	IH	80	5-5	
298	P. Angulata	1-0	IH	50	5-5	
299	P. P.V. 97	1-0	IH	50	5-5	
300	P. Serotina de Selys	1-0	IH	100	5-4	
301	P. Tristis #1	1-0	IH	50	5-4	
302	P. Northwest	1-0	IH	37	5-4	
303	P. Berolinensis	1-0	IH	100	5-4	
304	Picea glauca	2-2	IH	44	5-2	
305	P. Serotina de Selys	1-0	IH	100	5-2	
306	Acer negundo	2-0	IH	100	5-2	
307	Salix fragilis var. 'Basfordiana'	1-0	IH	32	5-2	
308	Prunus virginiana	2-0	IH	50	5-2	
309	P. Walker	1-0	IH	50	5-2	
310	Fraxinus pennsylvanica var. subintegerrima	2-0	IH	100	4-29	
311	Salix fragilis var. 'Basfordiana'	1-0	IH	100	4-29	
312	Ulmus pumila	2-0	IH	100	4-29	

Tailings Dike - Southeast Section

Plot no.	Species	Age	Nur.[1]	No.[2]	Date[3]	Comments
313	Picea pungens	2-3	IH	50	4-29	
314	Fraxinus pennsylvanica var. subintegerrima	2-0	IH	100	4-29	
315	Elaeagnus angostifolia	2-0	IH	100	4-29	
316	Syringa villosa	2-0	IH	50	4-29	
317	Lonicera tatarica	2-0	IH	71	4-29	
318	Picea pungens	2-3	IH	50	4-29	
319	Ulmus pumila	2-0	IH	100	4-29	
320	Salix fragilis var. 'Basfordiana'	1-0	IH	100	4-29	
321	Lonicera tatarica	2-0	IH	100	4-29	
322	Elaeagnus angustifolia	2-0	IH	90	4-29	
323	Fraxinus pennsylvanica var. subintegerrima	2-0		50		
324	Salix fragilis var. 'Basfordiana'	1-0	IH	73	4-29	
325	P. P 44-55	1-0	IH	50	5-2	
326	Picea glauca	2-2	IH	50	5-2	
327	P. Berolinensis	1-0	IH	50	5-2	
328	Acer negundo	1-0	IH	100	5-2	
329	P. Berolinensis	1-0	IH	50	5-4	
330	P. Northwest	1-0	IH	50	5-4	
331	P. Serontina de Selys	1-0	IH	100	5-4	
332	P. C. regenerata	1-0	IH	49	5-4	
333	P. PX Mann	1-0	IH	101	5-5	
334	P. PV 97	1-0	IH	50	5-5	
335	P. Angulata	1-0	IH	36	5-5	
336	P. PX Mann	1-0	IH	100	5-5	
337	Ulmus pumila	2-0	O	50	5-25	
682	Alnus tenuifolia	1 8/12[4]	O	50	10-21	container
683	Alnus crispa	1 8/12	O	50	10-11	container
684	Ulmus americana	1 8/12	O	50	10-11	container
685	Betula papyrifera	1 8/12	O	50	10-11	container
686	Alnus tenuifolia	1 8/12	O	50	10-21	container
687	Alnus crispa	1 8/12	O	50	10-11	container
688	Ulmus americana	1 8/12	O	50	10-11	container

Tailings Dike - Southeast Section

Plot no.	Species	Age	Nur.[1]	No.[2]	Date[3]	Comments
689	Ulmus americana	1 8/12	O	50	10-11	container
690	Ulmus americana	1 8/12	O	50	10-11	container
691	Betula papyrifera	1 8/12	O	50	10-11	container
692	Alnus tenuifolia	1 8/12	O	50	10-11	container
693	Alnus crispa	1 8/12	O	50	10-11	container
694	Ulmus americana	1 8/12	O	50	10-11	container
695	Ulmus americana	1 8/12	O	50	10-11	container
696	Betula papyrifera	1 8/12	O	50	10-21	container
697	Populus balsamifera		A.F.S bomber base	50	10-10	cuttings
700	Populus balsamifera		G.C.O.S. lease area	50	10-10	shove-ins

[1] IH - seedlings received from P.F.R.A. Tree Nursery, Indian Head, Sask.
O - seedlings received from Oliver Provincial Tree Nursery, Alta.

[2] Number of seedlings planted

[3] Date seedlings planted

[4] 1 8/12 - number of years

Tailings Dike - North Section

Plot no.	Species	Age	Nur.[1]	No.[2]	Date[3]	Comments
402	Fraxinus pennsylvanica var. subintegerrima	2-0	IH	50	5-3	
403	Prunus virginiana	2-0	0	50	5-3	
404	Syringa vulgaris	2-0	0	50	5-3	
405	Syringa villosa	2-0	0	50	5-3	
406	Salix fragilis var. 'Basfordiana'	1-0	IH	100	5-3	
407	Prunus virginiana	2-0	0	50	5-3	
408	Syringa villosa	2-0	0	50	5-3	
409	Fraxinus pennsylvanica var. subintegerrima	2-0	IH	50	5-3	
410	Syringa vulgaris	2-0	0	50	5-3	
411	Syringa villosa	2-0	IH	51	5-3	
412	Prunus virginiana	2-0	0	50	5-3	
413	Syringa vulgaris	2-0	0	50	5-3	
414	Salix fragilis var. 'Basfordiana'	1-0	IH	100	5-3	
415	Acer negundo	2-0	0	100	5-19	
416	Ulmus pumila	2-0		50	5-19	
417	Fraxinus pennsylvanica var. subintegerrima	2-0	0	50	5-19	
418	Ulmus pumila	2-0		49	5-18	
419	Acer negundo	2-0	0	100	5-18	
420	Syringa villosa	2-0	0	50	5-3	
421	Prunus virginiana	2-0	0	50	5-3	
422	Fraxinus pennsylvanica var. subintegerrima	2-0	IH	50	5-3	
423	Fraxinus pennsylvanica var. subintegerrima	2-0	0	50	5-18	
424	Salix fragilis var. 'Basfordiana'	1-0	IH	100	5-3	
425	Ulmus pumila	2-0		50	5-18	
426	Acer negundo	2-0	0	99	5-18	
427	Crataegus cerronis	2-0	IH	45	5-19	
428	Prunus padus	2-0	IH	50	5-19	
429	Syringa vulgaris	2-0	0	50	5-3	

Tailings Dike - North Section

Plot no.	Species	Age	Nur.[1]	No.[2]	Date[3]	Comments
430	Syringa villosa	2-0	0	50	5-3	
431	Prunus virginiana	2-0	0	50	5-3	
432	Syringa vulgaris	2-0	0	50	5-3	
433	Fraxinus pennsylvanica var. subintegerrima	2-0		50	5-3	
434	Prunus padus	2-0	IH	50	5-19	
435	Salix fragilis var. 'Basfordiana'	1-0	IH	100	5-25	
436	Fraxinus pennsylvanica var. subintegerrima	2-0		50	5-18	
437	Acer negundo	2-0	0	94	5-18	
438	Crataegus cerronis	2-0	IH	47	5-19	
439	Prunus padus	2-0	IH	50	5-19	
440	Ulmus pumila	2-0		50	5-18	
441	Acer negundo	2-0	0	100	5-18	
442	Ulmus pumila	2-0		50	5-18	
443	Prunus padus	2-0	IH	50	5-19	
444	Crataegus cerronis	2-0	IH	50	5-19	
445	Prunus padus	2-0	IH	50	5-19	
446	Salix fragilis var. 'Basfordiana'	1-0	IH	100	5-25	
447	Salix fragilis var. 'Basfordiana'	1-0	IH	100	5-25	
448	Salix fragilis var. 'Basfordiana'	1-0	IH	235	5-25	
449	Salix fragilis var. 'Basfordiana'	1-0	IH	120	5-25	
652	Salix fragilis var. 'Basfordiana'	1-0	IH	203	5-25	
653	Salix fragilis var. 'Basfordiana'	1-0	IH	93	5-25	
675	Alnus crispa	1 8/12[4]	0	50	10-12	container
676	Ulmus americana	1 8/12	0	50	10-12	container
677	Ulmus americana	1 8/12	0	50	10-12	container

Tailings Dike - North Section

Plot no.	Species	Age	Nur.[1]	No.[2]	Date[3]	Comments
678	Ulmus americana	1 8/12	O	50	10-12	container
679	Alnus crispa	1 8/12	O	50	10-19	container
680	Ulmus americana	1 8/12	O	50	10-12	container
681	Ulmus americana	1 8/12	O	50	10-12	container

[1] IH - seedlings received from P.F.R.A. Tree Nursery, Indian Head, Sask.
O - seedlings received from Oliver Provincial Tree Nursery, Alta.

[2] Number of seedlings planted

[3] Date seedlings planted

[4] 1 8/12 - number of years

WASTE DUMP NO. 7

Waste Dump No. 7 - Southeast Section

Plot no.	Species	Age	Nur.[1]	No.[2]	Date[3]	Comments
450	Acer negundo	2-0	O	100	5-17	
451	Acer negundo	2-0	O	100	5-27	planting bar
452	Acer negundo	2-0	O	100	5-17	
453	Salix fragilis var. 'Basfordiana'	1-0	IH	99	4-28	
454	Acer negundo	2-0	IH	100	4-27	
455	Acer negundo	2-0	O	99	5-27	planting bar
456	Acer negundo	2-0	O	100	5-17	
457	Acer negundo	2-0	O	100	5-17	
458	Acer negundo	2-0	O	100	5-27	planting bar
459	Acer negundo	2-0	O	100	5-17	
460	Acer negundo	2-0	O	100	5-27	planting bar
461	Acer negundo	2-0	O	96	5-27	
462	Salix fragilis var. 'Basfordiana'	1-0	IH	100	4-28	
463	Acer negundo	2-0	IH	100	4-27	
464	Acer negundo	2-0	IH	100	4-27	
465	Salix fragilis var. 'Basfordiana'	1-0	IH	100	4-28	
466	Acer negundo	2-0	O	100	5-27	planting bar
660	Alnus crispa	1 8/12[4]	O	50	10-19	container
661	Ulmus americana	1 8/12	O	50	10-19	container
662	Betula papyrifera	1 8/12	O	50	10-22	container
663	Alnus crispa	1 8/12	O	50	10-19	container
664	Ulmus americana	1 8/12	O	50	10-19	container
665	Betula papyrifera	1 8/12	O	50	10-22	container
666	Alnus crispa	1 8/12	O	50	10-19	container
667	Ulmus americana	1 8/12	O	50	10-19	container
668	Ulmus americana	1 8/12	O	50	10-19	container
669	Betula papyrifera	1 8/12	O	50	10-22	container
670	Ulmus americana	1 8/12	O	50	10-19	container
671	Populus balsamifera		G.C.O.S. lease	50	10-8	shove-ins

Waste Dump No. 7 - Southeast Section

Plot no.	Species	Age	Nur.[1]	No.[2]	Date[3]	Comments
672	Populus balsamifera		A.F.S. bomber base	50	10-9	cuttings
673	Populus balsamifera		G.C.O.S. lease	50	10-8	shove-ins
674	Populus balsamifera		A.F.S. bomber base	50	10-9	cuttings

[1] IH - seedlings received from P.F.R.A. Tree Nursery, Indian Head, Sask.
O - seedlings received from Oliver Provincial Tree Nursery, Alta.

[2] Number of seedlings planted

[3] Date seedlings planted

[4] 1 8/12 - number of years

Waste Dump No. 7 - Southwest Section

Plot no.	Species	Age	Nur[1]	No.[2]	Date[3]	Comments
601	Salix fragilis var. 'Basfordiana'	1-0	IH	100	4-28	
602	Acer negundo	2-0	IH	98	4-27	
603	Acer negundo	2-0	O	100	5-26	mattock
604	Acer negundo	2-0	O	105	5-26	planting bar
605	Ulmus pumila	2-0		49	5-17	
606	Acer negundo	2-0	O	100	5-26	planting bar
607	Acer negundo	2-0	O	100	5-26	mattock
608	Acer negundo	2-0	O	100	5-16	
609	Ulmus pumila	2-0		50	5-17	
610	Acer negundo	2-0	IH	98	4-27	
611	Ulmus pumila	2-0		50	5-17	
612	Acer negundo	2-0	IH	100	4-27	
613	Ulmus pumila	2-0		50	5-17	
614	Salix fragilis var. 'Basfordiana'	1-0	IH	100	4-28	
615	Ulmus pumila	2-0		50	5-17	
616	Acer negundo	2-0	O	100	5-26	planting bar
617	Acer negundo	2-0	O	100	5-26	mattock
618	Acer negundo	2-0	O	101	5-16	
619	Acer negundo	2-0	O	100	5-26	planting bar
620	Acer negundo	2-0	O	100	5-26	mattock
621	Salix fragilis var. 'Basfordiana'	1-0	IH	100	4-28	
622	Acer negundo	2-0	IH	100	4-27	
623	Acer negundo	2-0	O	100	5-16	
624	Acer negundo	2-0	O	100	5-26	planting bar
625	Acer negundo	2-0	O	100	5-26	mattock
626B	Acer negundo	2-0	IH	100		

1 IH - seedlings received from P.F.R.A. Tree Nursery Indian Head, Sask.
O - seedlings received from Oliver Provincial Tree Nursery, Alta.

2 Number of seedlings planted

3 Date seedlings planted

Waste Dump No. 7 - Northeast Section

Plot no.	Species	Age	Nur[1]	No.[2]	Date[3]	Comments
467	Ulmus americana			50	5-14	
468	Prunus virginiana	2-0		50	5-14	
469	Elaeagus angustifolia	2-0	IH	50	5-12	
470	P. Walker	1-0	IH	50	5-12	
471	Ulmus pumila	2-0		50	5-14	
472	Salix fragilis var. 'Basfordiana'	1-0	IH	100	4-27	
473	Populus balsamifera		G.C.O.S. lease	50	5-13	shove-ins
474	Caragana arborescens	2-0	IH	50	5-14	
475	Elaeagnus angustifolia	2-0	IH	50	5-12	
476	Syringa villosa	2-0	IH	50	5-14	
477	P. Serotina de Selys	1-0	IH	84	5-12	
478	P. Walker	1-0	IH	50	5-12	
479	Acer negundo	2-0	IH	100	4-27	
480	Acer ginnala	2-0	IH	50	5-12	
481	Acer negundo	2-0		90		
482	Lonicera tatarica	2-0		50	5-12	
483	P. Walker	1-0	IH	50	5-12	
484	P. Serotina de Selys	1-0	IH	50	5-12	
485	Acer negundo	2-0		123		
486	Ulmus americana	1-0	O	50	5-14	
487	Ulmus americana	2-0	IH	50	5-14	
488	P. P. 42-55	1-0	IH	60	5-12	
489	P. PX Grandis	1-0	IH	75	5-12	
490	Populus balsamifera	1-0	O	50	5-17	
491	Ulmus pumila	2-0	IH	28		
492	Caragna arborescens	2-0	IH	50	5-14	
493	Populus balsamifera	1-0	O	50	5-17	
494	Acer negundo	2-0	IH	100	4-27	
495	Acer negundo	2-0		69		
496	Lonicera tatarica	2-0		48	5-14	
497	Ulmus americana	2-0	IH	50	5-14	
498	Caragana arborescens	2-0	IH	50	5-14	

Waste Dump No. 7 - Northeast Section

Plot no.	Species	Age	Nur[1]	No.[2]	Date[3]	Comments
499	Syringa villosa	2-0	IH	50	5-14	
500	Elaeagnus angustifolia	2-0	IH	50	5-12	
501	P. P42-55	1-0	IH	100	5-12	
502	Salix fragilis var. 'Basfordiana'	1-0	IH	100	5-28	
503	Elaegnus angustifolia	2-0	IH	50	5-12	
504	Prunus virginiana	2-0	IH	50	5-12	
505	Ulmus pumila	2-0	IH	50	5-12	
506	Caragana arborescens	2-0	IH	50	5-12	
507	Populus balsamifera	1-0	0	100	5-17	
508	Acer negundo	2-0		65		
509	Populus balsamifera		G.C.O.S. lease	50	5-13	Shove-ins
510	Ulmus americana	1-0	0	50	5-14	
511	P. Nigra	1-0	IH	50	5-12	
512	P. unknown	1-0	IH	49	5-12	
513	P. PX Grandis	1-0	IH	50	5-12	
514	P. Serotina de Selys	1-0	IH	50	5-12	
515	Acer negundo	2-0		50		
516	Ulmus americana	1-0	0	50	5-14	
517	Ulmus americana	2-0	IH	50	5-14	
518	Lonicera tatarica	2-0		50	5-12	
519	P. Nigra	1-0	IH	50	5-12	
520	unknown					
521	P. Walker	1-0	IH	50	5-12	
522	P. Brooks #5	1-0	IH	50	5-12	
523	Acer negundo	2-0	IH	100	4-27	
524	P. Brooks #2	1-0	IH	50	5-12	
525	P. Serotina de Selys	1-0	IH	50	5-12	
526	Acer ginnala	2-0	IH	50	5-12	
527	Ulmus pumila	2-0		50	5-12	
528	Acer negundo	2-0	0		5-17 or later	
529	P. P44-55	1-0	IH	50	5-12	
530	P. Brooks #2	1-0	IH	50	5-12	

Wast Dump No. 7 - Northeast Section

Plot no.	Species	Age	Nur[1]	No.[2]	Date[3]	Comments
531	P. P 44-55	1-0	IH	50	5-12	
532	Acer negundo	2-0	O	75	5-17 or later	
533	Salix fragilis var. 'Basfordiana'	1-0	IH	100	4-27	
534	P. Serotina de Selys	1-0	IH	40	5-12	
535	Populus balsamifera	1-0	O	67	5-17	
536	Populus balsamifera		G.C.O.S. lease	50	5-12	cuttings
537	Populus balsamifera		G.C.O.S. lease	50	5-12	cuttings
538	P. Brooks #5	1-0	IH	27	5-12	

[1] IH - seedling received from P.F.R.A. Tree Nursery, Indian Head, Sask.
O - seedlings received from Oliver Provincial Tree Nursery, Alta.

[2] Number of seedlings planted

[3] Date seedlings planted

Waste Dump No. 7 - Northwest Section

Plot no.	Species	Age	Nur.[1]	No.[2]	Date[3]	Comments
539	Ulmus pumila	2-0	O	50	5-15	
540	Acer negundo	2-0	IH	100	4-27	
542	Acer negundo	2-0	O	99	5-16	
543	Ulmus pumila	2-0	O	50	5-16	
544	Populus balsamifera	1-0	O	48	5-16	
545	Acer negundo	2-0	O	97	5-17	
546	Salix fragilis var. 'Basfordiana'	1-0	O	100	5-16	
547	Fraxinus pennsylvanica var. subintegerrima	2-0	O	50	5-16	
548	Acer negundo	2-0	O	50	5-16	
549	Syringa vulgaris	2-0	O	50	5-14	
550	Lonicera tatarica	2-0	O	50	5-15	
551	Prunus virginiana	2-0	O	50	5-14	
552	Syringa villosa	2-0	O	50	5-14	
553	Prunus padus	2-0	IH	50	5-15	
554	Pseudotsuga menziesii	4-0	O	50	5-15	
555	Crataegus cerronis	2-0	IH	50	5-16	
556	Acer negundo	2-0	O	100	5-17	
557	Syringa vulgaris	2-0	O	50	5-14	
558	Lonicera tatarica	2-0	O	50	5-14	
559	Salix fragilis var. 'Basfordiana'	1-0	IH	101	4-28	
560	Acer negundo	2-0	O	50	5-15	
561	Syringa villosa	2-0	O	50	5-14	
562	Prunus virginiana	2-0	O	50	5-14	
563	Acer negundo	2-0	IH	100	4-27	
564	Pseudotsuga menziesii	4-0	O	50	5-15	
565	Prunus padus	2-0	IH	50	5-15	
566	Lonicera tatarica	2-0	O	50	5-15	
567	Syringa vulgaris	2-0	O	50	5-15	
568	Acer negundo	2-0	O	50	5-15	
569	Prunus padus	2-0	IH	50	5-15	
570	Pseudotsuga menziesii	4-0	O	51	5-15	
571	Syringa vulgaris	2-0	O	37	5-15	
572	Lonicera tatarica	2-0	O	50	5-15	

Waste Dump No. 7 - Northwest Section

Plot no.	Species	Age	Nur.[1]	No.[2]	Date[3]	Comments
573	Salix fragilis var. 'Basfordiana'	1-0	0	50	5-16	
574	Prunus virginiana	2-0	0	30	5-15	
575	Syringa villosa	2-0	0	45	5-3	
576	Acer negundo	2-0	0	50	5-15	
577	Fraxinus pennsylvanica var. subintegerrima	2-0	0	50	5-16	
578	Salix fragilis var. 'Basfordiana'	1-0	0	100	5-16	
579	Salix fragilis var. 'Basfordiana'	1-0	IH	99	4-28	
580	Prunus virginiana	2-0	0	50	5-15	
581	Syringa villosa	2-0	0	50	5-15	
582	Ulmus pumila	2-0	0	50	5-16	
583	Acer negundo	2-0	0	100	5-16	
584	Prunus padus	2-0	IH	50	5-15	
585	Crataegus cerronis	2-0	IH	50	5-15	
586	Prunus padus	2-0	IH	50	5-15	
587	Pseudotsuga menziesii	4-0	0	49	5-15	
588	Acer negundo	2-0	0	49	5-15	
589	Lonicera tatarica	2-0	0	50	5-15	
590	Syringa villosa	2-0	0	50	5-15	
591	Pseudotsuga menziesii	4-0	0	50	5-15	
592	Crataegus cerronis	2-0	IH	50	5-16	
593	Acer negundo	2-0	0	100	5-16	
594	Ulmus pumila	2-0	0	50	5-16	
595	Syringa vulgaris	2-0	0	50	5-3	
596	Salix fragilis var. 'Basfordiana'	1-0	IH	100	4-28	
597	Acer negundo	2-0	IH	100	4-27	
598	Ulmus pumila	2-0	0	50	5-16	
599	Salix fragilis var. 'Basfordiana'	1-0	0	100	5-16	
600	Fraxinus pennsylvanica var. subintegerrima	2-0	0	27	5-16	
654	Ulmus americana	1 8/12[4]	0	50	10-20	container
655	Ulmus americana	1 8/12	0	50	10-20	container
656	Alnus crispa	1 8/12	0	50	10-20	container

Waste Dump No. 7 - Northwest Section

Plot no.	Species	Age	Nur.[1]	No.[2]	Date[3]	Comments
657	Ulmus americana	1 8/12	O	50	10-20	container
658	Alnus crispa	1 8/12	O	50	10-20	container
659	Ulmus americana	1 8/12	O	50	10-20	container

[1] IH - seedlings received from P.F.R.A. Tree Nursery, Indian Head, Sask.
O - seedlings received from Oliver Provincial Nursery, Alta.

[2] Number of seedlings planted

[3] Date seedlings planted

[4] 1 8/12 - number of years

Waste Dump No. 7 - Top Section

Plot no.	Species	Age	Nur.[1]	No.[2]	Date[3]	Comments
626A	Acer negundo	2-0	IH	100	4-28	
627	Salix fragilis var. 'Basfordiana'	1-0	IH	99	4-28	
628	Acer negundo	2-0	O	96	5-17	
629	Acer negundo	2-0	O	99	5-26	mattock
630	Salix fragilis var. 'Basfordiana'	1-0	O	100	5-	
631	Acer negundo	2-0	O	90	5-26	planting bar
632	Acer negundo	2-0	O	100	5-17	
633	Acer negundo	2-0	IH	100	4-28	
634	Salix fragilis var. 'Basfordiana'	2-0	IH	100	4-28	
635	Acer negundo	2-0	O	100	5-26	mattock
636	Acer negundo	2-0	O	90	5-26	planting bar
637	Acer negundo	2-0	O	100	5-17	
638	Salix sp.	1-0	O	99	5-18	
639	Acer negundo	2-0	O	100	4-28	
640	Salix fragilis var. 'Basfordiana'	1-0	IH	100	4-28	
641	Acer negundo	2-0	IH	98	5-17	
642	Acer negundo	2-0	IH	100	5-26	mattock
643	Salix sp.	1-0	O	100	5-	
644	Acer negundo	2-0	O	100	5-26	planting bar
645	Acer negundo	2-0	O	100	5-26	planting bar
646	Acer negundo	2-0	O	100	5-26	mattock
647	Acer negundo	2-0	O	98	5-26	planting bar
650	Acer negundo	2-0	O	100	5-17	
651	Acer negundo	2-0	O	100	5-26	mattock

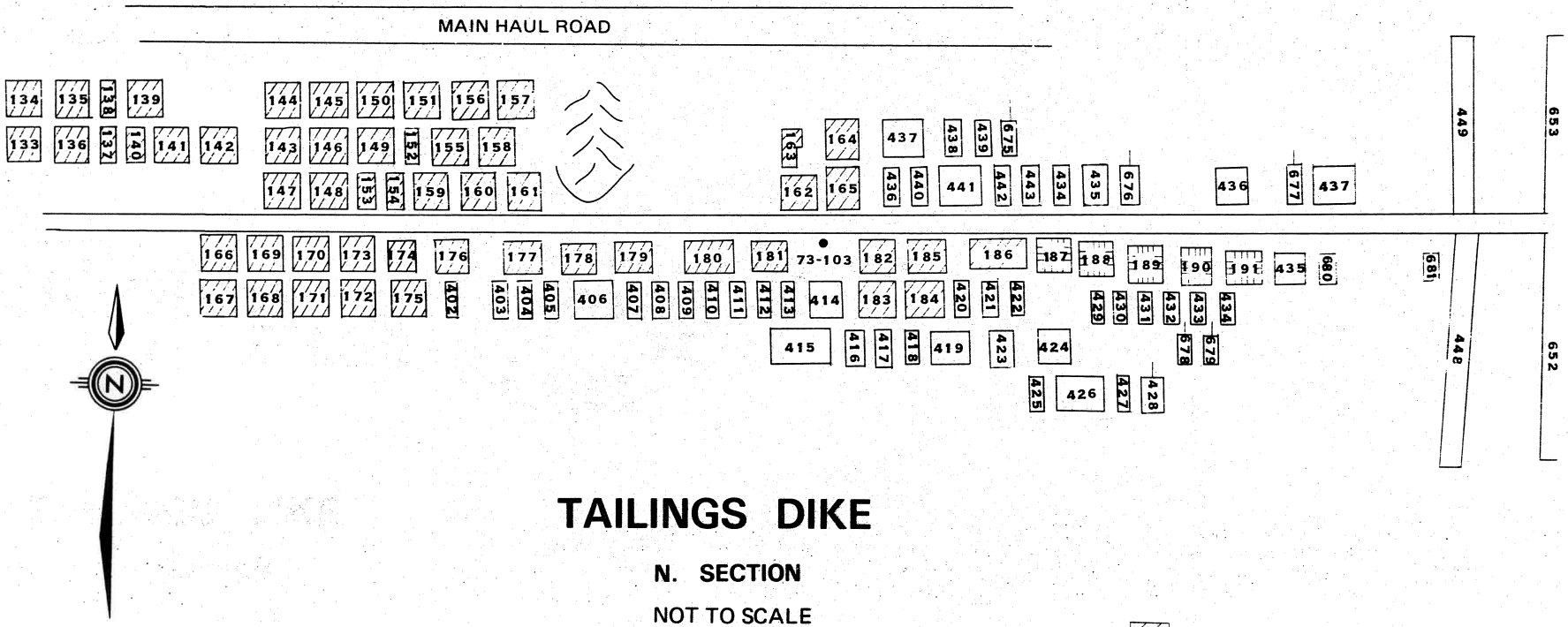
[1] IH - seedlings received from P.F.R.A. Tree Nursery, Indian Head, Sask.
O - seedlings received from Oliver Provincial Tree Nursery, Alta.

[2] Number of seedlings planted

[3] Date seedlings planted

Appendix 9.3

PLOT LOCATIONS ON PLANTING SITES



TAILINGS DIKE

N. SECTION

NOT TO SCALE

888 PLANTED SPRING '76

888 PLANTED FALL '75

888 PLANTED FALL '76

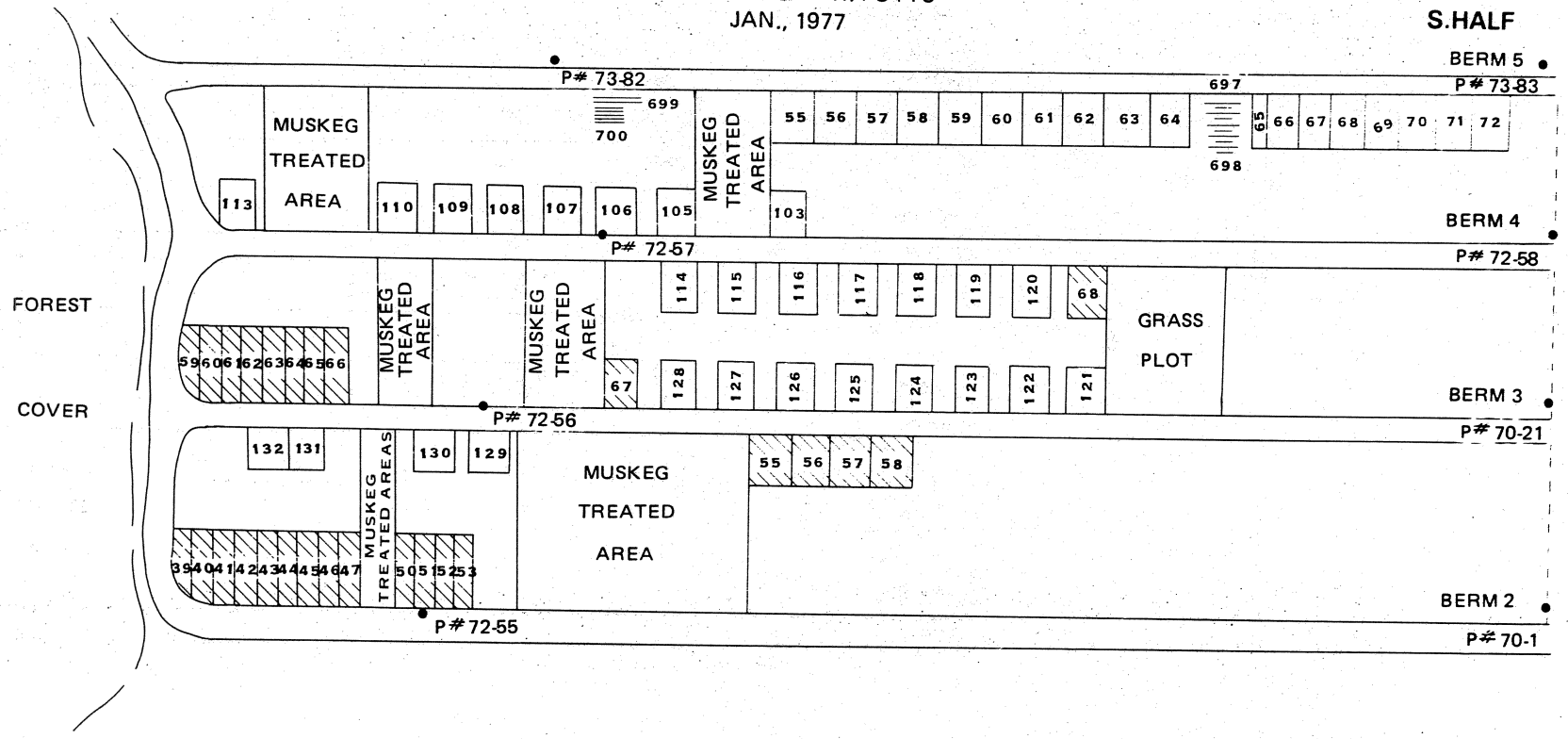
PREPARED BY: R. POTTS
JAN., 1977

TAILINGS DIKE

S.E.SECTION

NOT TO SCALE

PREPARED BY: R. POTTS
JAN., 1977

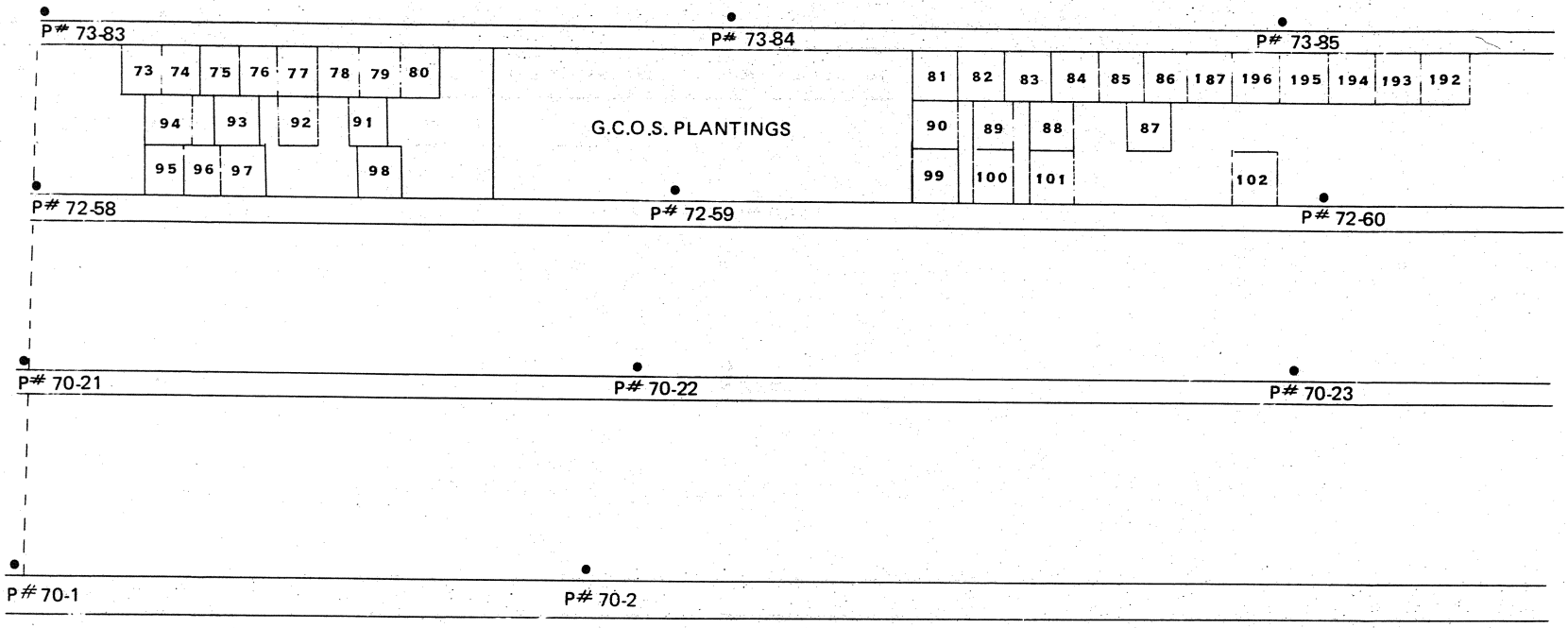


88 PLANTED '74

88 PLANTED SPRING '76

S. HALF N. HALF

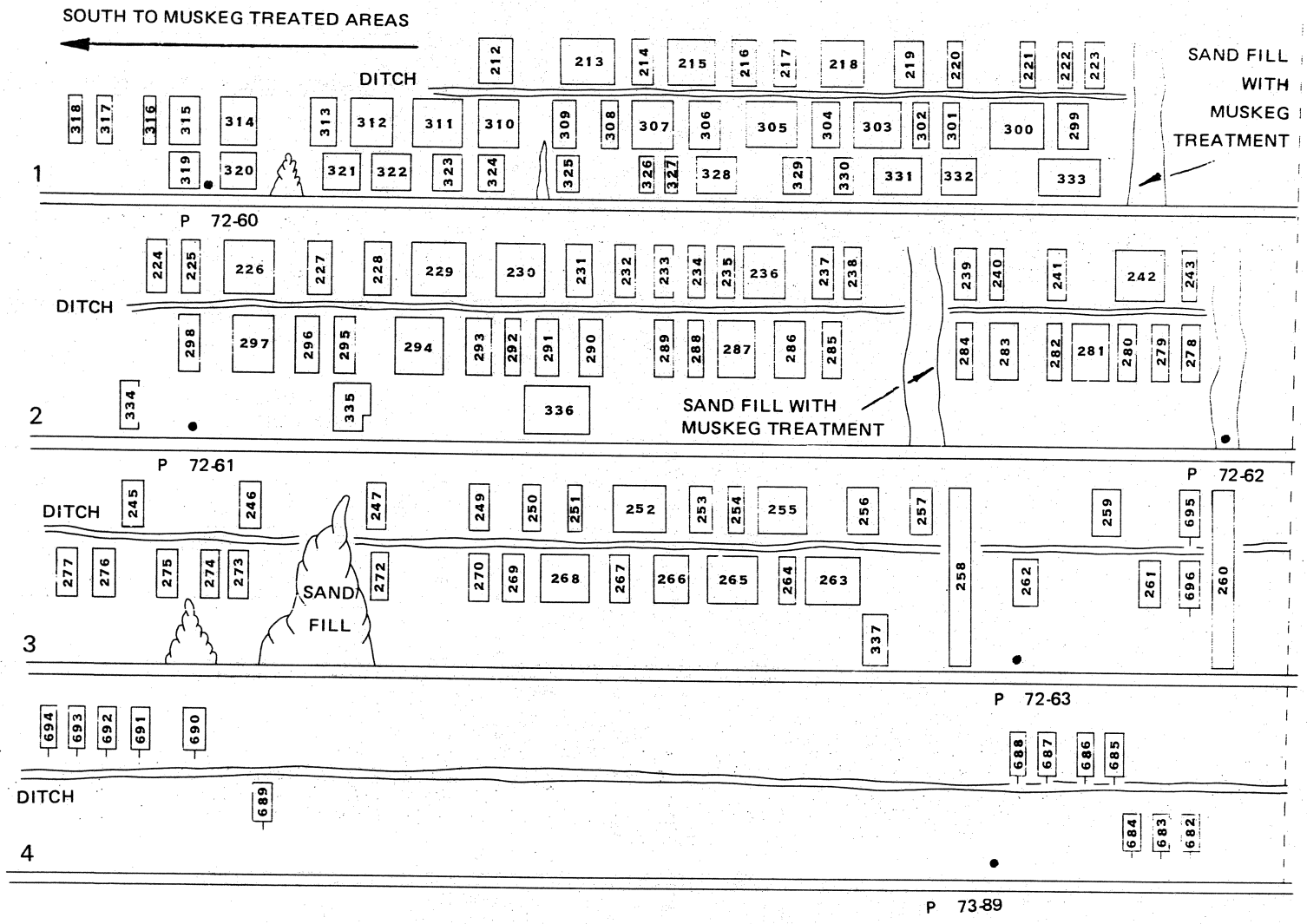
N.HALF



TAILINGS DIKE

S.SECTION

PREPARED BY: R. POTTS
JAN., 1977
NOT TO SCALE



NOT TO SCALE
PREPARED BY: R. POTTS
JAN., 1977

TAILINGS DIKE

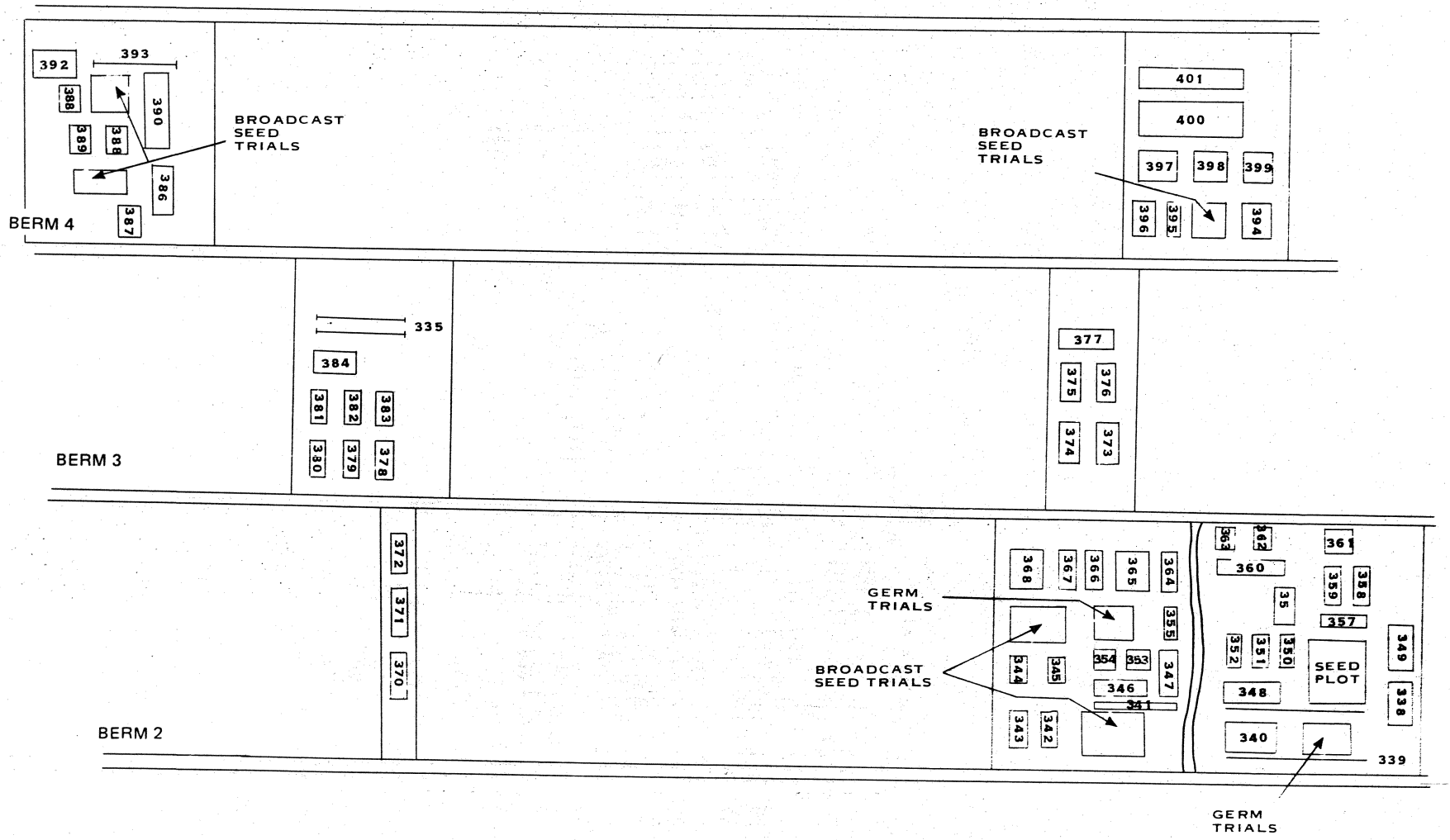
S.E.SECTION

TAILINGS DIKE

PEAT TREATED AREAS

PREPARED BY: R. POTTS
JAN., 1977

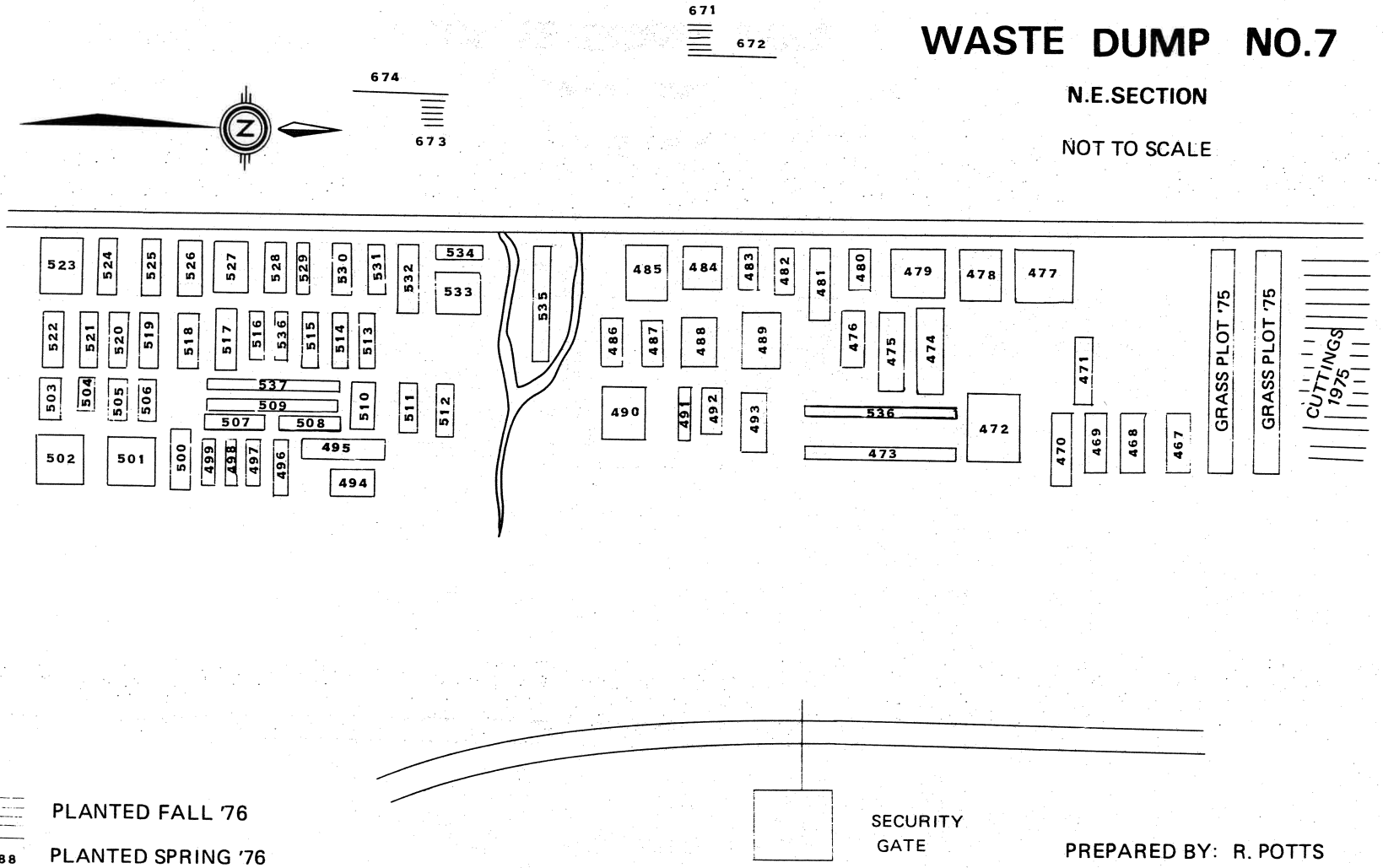
NOT TO SCALE



WASTE DUMP NO.7

N.E.SECTION

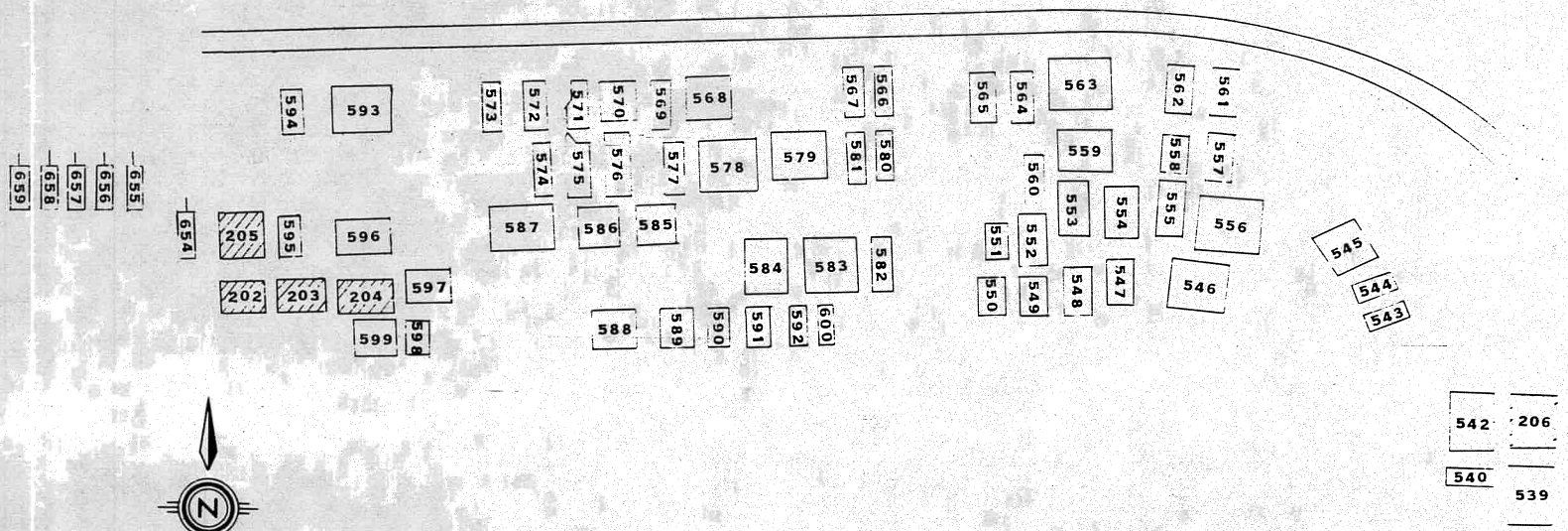
NOT TO SCALE



PLANTED FALL '76

888 PLANTED SPRING '76

PREPARED BY: R. POTTS
JAN., 1977



WASTE DUMP NO.7

N.W.SECTION

NOT TO SCALE
PREPARED BY: R. POTTS
JAN., 1977

888 PLANTED SPRING '76

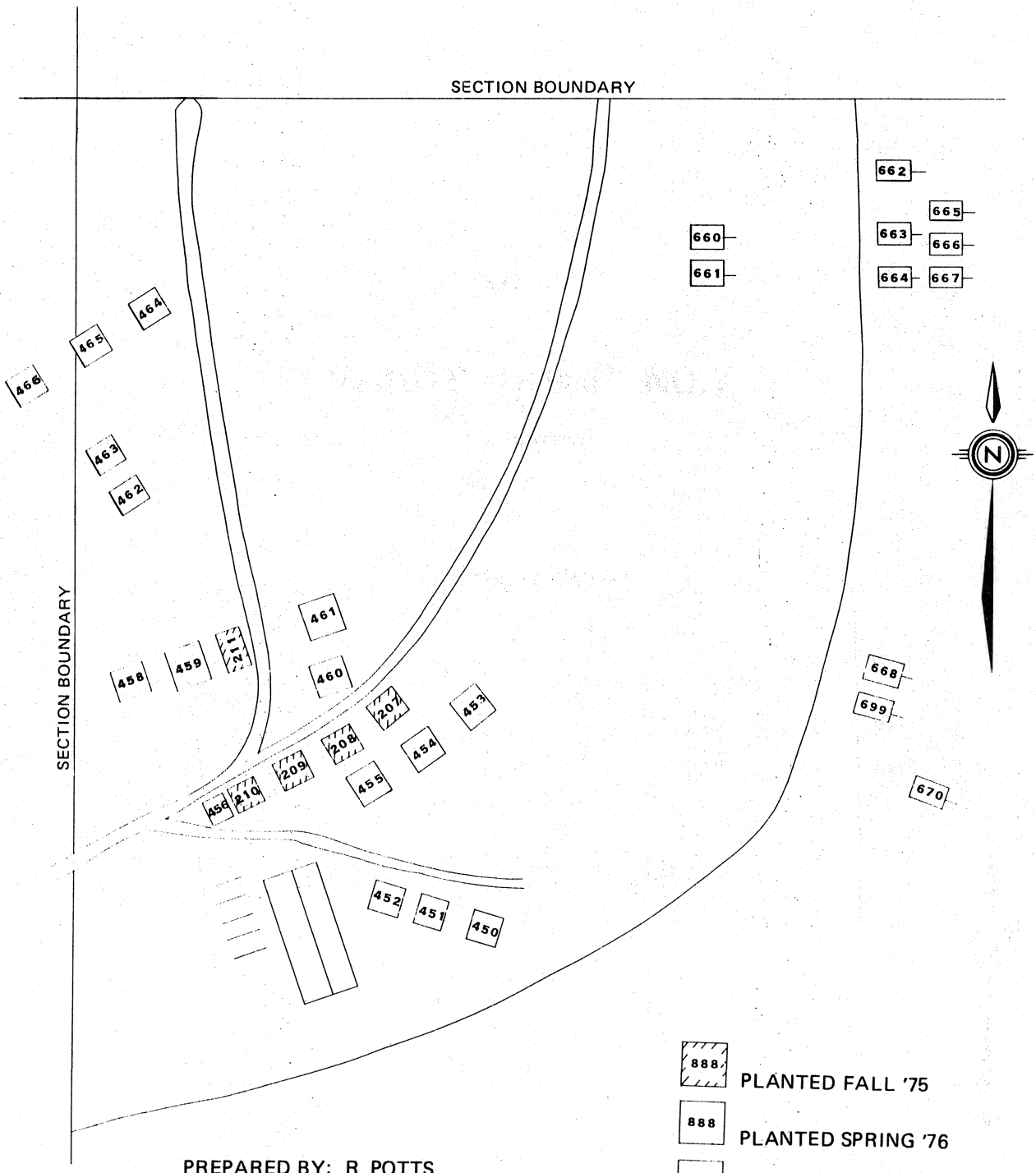
888 PLANTED FALL '75

888 PLANTED FALL '76

WASTE DUMP NO.7

S.E.SECTION

NOT TO SCALE

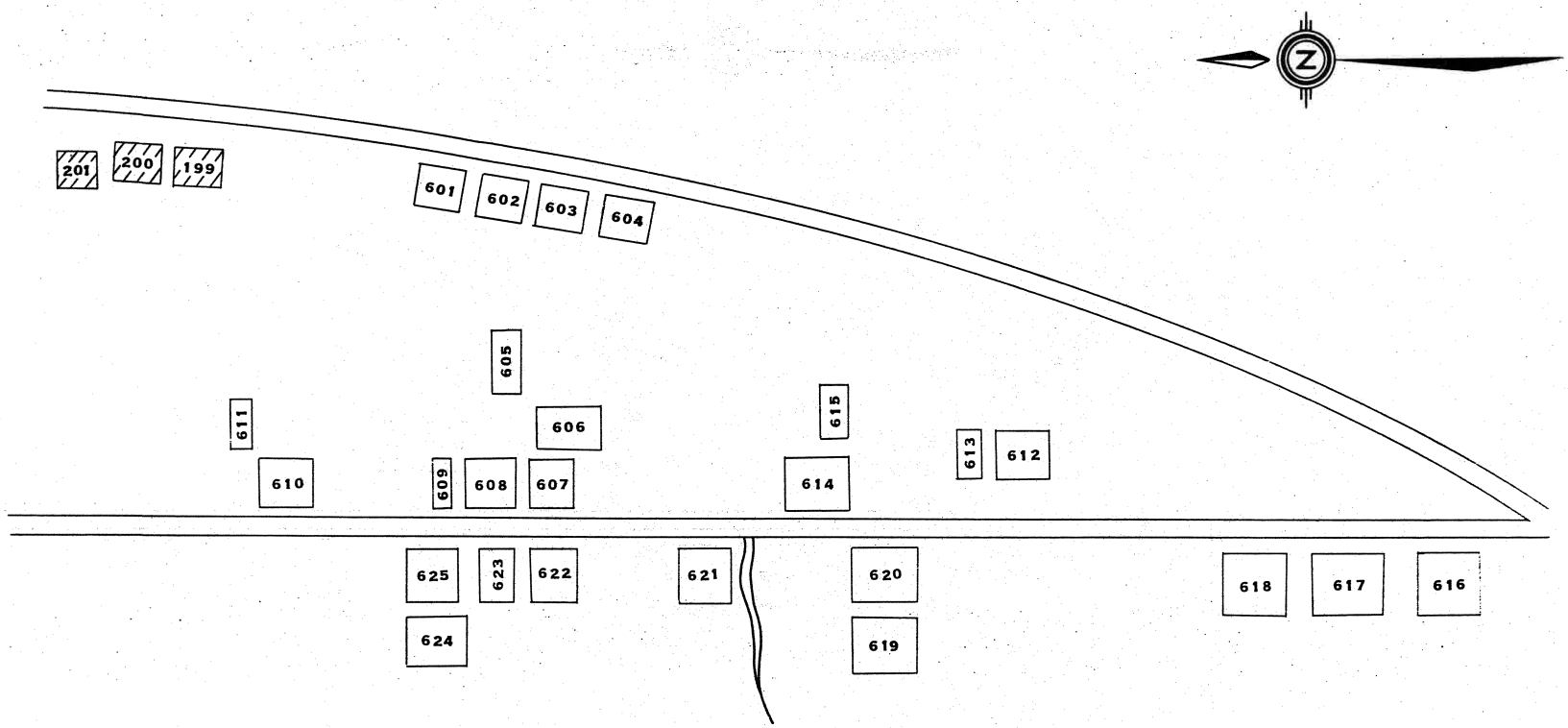


PREPARED BY: R. POTTS
JAN., 1977

WASTE DUMP NO. 7

S.W.SECTION

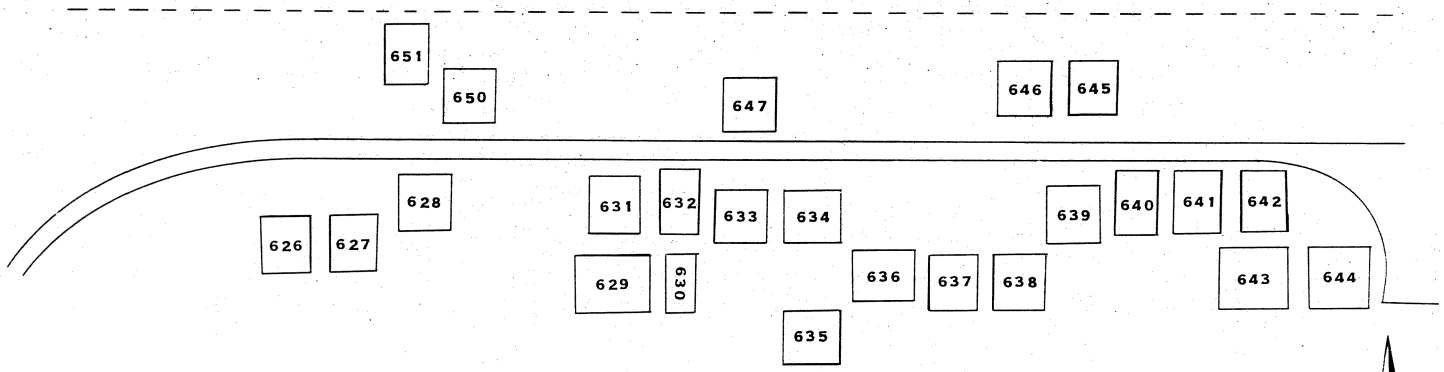
NOT TO SCALE



PREPARED BY: R. POTTS
JAN., 1977

888 PLANTED SPRING '76

888 PLANTED FALL '75



WASTE DUMP NO.7

TOP SECTION

NOT TO SCALE

PREPARED BY: R. POTTS
JAN., 1977

888 PLANTED SPRING '76

Appendix 9.4

EVALUATION METHODS

Summer Evaluation

An evaluation of seedling mortality and mouse damage incurred by 1974 and 1975 planted seedlings during the 75-76 winter was completed between June 21 and July 6, 1976. A 100% sampling intensity was used. An example of the data collection form is attached. The following is an explanation of the seedling description code used on this form.

The following codes were used if a dead seedling was observed:

C - Considerable soil movement or compaction most often due to earth moving equipment has taken place on the area occupied by the seedling.

E - Soil erosion or movement, severe enough that it probably effects seedling survival and vigour, has taken place. This is usually in the form of root exposure, but deposits of material covering all or a portion of a seedling might also be observed.

MD - Mice have been chewing on the seedling causing observable damage to the bark.

U - C,E and MD were not observed

The condition classes used for dead seedlings do not describe the cause of mortality, only some of the conditions existing at the time of evaluation. The relationship between these conditions and the dead seedling is not necessarily understood, but it will illustrate the number of seedlings around which these activities occurr.

The following numerical codes were used if a live seedling was observed.

1 - The seedling is in poor condition. It has very little to no growth, poor color and quite often dead branches or foliage. Its survival seems unlikely.

2 - The seedling is in fair condition. It has new growth but often has faded or chlorotic foliage. It may have some dead branches or foliage.

3 - The seedling is in good condition. It has good growth and most or all of it's foliage has healthy color. Dead branches and foliage are rarely observed.

4 - The seedling is in very good to excellent condition. It has very good growth and a healthy color.

When describing the condition of a living seedling, a letter code representing a dead seedling was often used in combination with one of the numbers described above. For example, if a class 2 tree had some mouse damage it would be recorded as 2,MD. If that same tree had some of its roots exposed due to erosion the proper symbol would be 2,MD,E. The order in which the letter codes follow does not indicate their relative importance.

The percentage of live and dead seedlings as well as the percentage of seedlings in each class was computed for each plot evaluated.

Fall Evaluation

Between August 18 and September 29 a second evaluation of tree and shrub seedlings was carried out. This time all seedlings planted in the spring of 1976, the fall of 1975 and 5,078 white spruce, black spruce, Jack pine and lodgepole pine planted in the spring of 1975 were evaluated. The sampling intensity was again 100%. The evaluation process was the same as that described for the previous evaluation however, one important addition was made. Change in seedling height over the last growing season was taken for each tree. Thus for each plot an estimate of seedling survival, condition and growth was made.

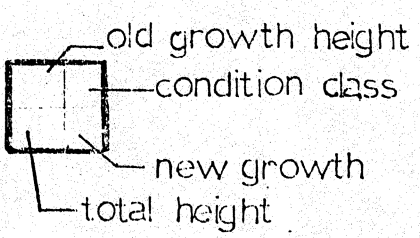
The growth was measured by subtracting the height of the plant at the end of the previous growing season from the height of the highest living terminal bud at the time of measurement. The measuring stick was placed as close as possible to the right hand side of the seedling stem, as one faces the plot sign. The measuring stick base was to rest on the ground unless observable erosion had occurred in which case it would be placed at the root collar level. In many cases, a negative change in growth was recorded. This does not mean that no growth occurred, it means that the seedling did not grow above its former living height. Dieback would be an example of this. It should be emphasized that this parameter is only a measurement of the change in the living height of the plant, not total plant growth. The change in height is at best, an indicater of the total increase in plant tissue.

Fall Evaluation

Plot No.: 808 Date Surveyed: August 21/76 Site: Waste Dump #1 SW Section

Species Planted: Acer negundo

40	2	47	2	26	1	32	2	24	2	30	2	29	3	30	2	30	2	46	2
28	2	38	4	24	2	31	1	20	4	32	2	27	2	28.5	1.5	36	6	40	6
40	2	32	2	20	2	22	3	34	2	20	2	32	2	42	2	30	2	48	2
25	1.5	33	1	8.5	1.5	23	1	32	2	21	1	30.5	1.5	34	5	28	3	52	4
12	2	23	2	28	2	34	2	27.5	2	28.5	2	37	2	34	1	34	2	36	2
17.5	2.5	20.5	2.5	3	2.5	30	4	28	.5	20	8.5	39	0	26	5	31	3	35	1
28.5	2	34	1	23	4	26	1	40	2	33	1	40	2	33	2	31.5	2	26	2
28	5	32	2	20	3	25	1	41	1	30	3	44	4	22	11	32	.5	27	1
34	2	34	2	21	2	36	2	27	2	20	2	27	3	11	2	31	3	33.5	3
6	28	29	3.5	20	1	18	18	26.5	.5	18	2	28	1	12	1	4	27	30	3.5
24	3	36	3	34	3	27	2	30	1	32	2	30.5	2	29	2	30	2	40	2
27	3	9	27	30	4	28	1	28	2	31.5	.5	32.5	2	30.5	1.5	32	2	41	1
44	2	22	2	34.5	2	33	2	16	2	33	2	40	1	33	2	27.5	3	34	2
39	5	20	2	28.5	6	30	3	15	1	13	20	29	11	30	3	28	.5	26	8
28.5	2E	23	2E	26	2	42	1	27.5	2	20	2	30	2	26	2	20	2	40	2
28	5	20	3	25	1	40	2	28	.5	19	1	32.5	2.5	25	1	8.5	11.5	38	2
E		E		24	2	29	2	31	2	26	2	20	2	34	2	32	2	26	2
				20	4	27	2	35	4	33	7	36	16	26	8	31	1	24	2
C		C		C		C		C		C		C		C		30	2	46	2
																28.5	1.5	40	6



Plant Condition Classes:

1. Poor-Very little to no growth, poor green color, has dead branches, survival unlikely.
2. Fair-New growth, some color loss, may or may not have dead branches.
3. Healthy-Obvious new growth, good green color, foliage in good condition.
4. Very Healthy-Outstanding growth and condition.

C-construction E-erosion MD-mouse damage U-unknown

Mortality		Survival		Growth
C	8	1.	9	
E	2	2.	12	
MD	—	3.	9	
U	—	4.	—	

Comments

Light grass cover, some erosion has taken place, leaves are somewhat discolored.

Appendix 9.5 SEEDLING PERFORMANCE ON PEAT TREATMENTS AND SOUTHEAST SECTION OF TAILINGS DIKE

Species or Clone	Survival %		Growth (cm)		Condition[1]	
	PT[2]	SE[3]	PT	SE	PT	SE
P. Brooks #4[4]	99	69	45	9	3.0	2.6
P. Walker	97	64	53	13	3.0	2.3
P. Serotina de Selys	97	70	59	10	3.2	2.2
P. 42-55	96	58	56	9	2.8	2.1
P. Northwest	96	59	46	9	2.9	2.2
P. P38 P38	96	72	43	9	2.7	2.1
P. Berolinensis	95	56	36	7	2.8	2.1
Ulmus americana	95	8	10	-2	2.1	1.3
Salix fragilis var. 'Basfordiana'	94	38	51	5	3.0	2.1
Fraxinus pennsylvanica var. subintegerrima	89	62	3	0	2.1	2.1
Acer negundo	78	35	7	-1	2.0	2.0
$\bar{X}$ =	94[5]	54	37[5]	6	2.7[5]	2.1

[1] See appendix 9.4 for description of condition codes

[2] Peat treatments

[3] Southeast section

[4] Name following "P" is name of poplar clone

[5] Difference between mean of two sites for survival, growth, and condition is significant at 99% level of probability.

Appendix 9.6

CULTURE METHODS FOR SEEDLINGS RECEIVED FROM P.F.R.A. TREE NURSERY AT INDIAN HEAD, SASKATCHEWAN

CULTURE METHODS

A. Poplar and Willow Clones

The Indian Head Tree Nursery maintains a cutting bed which contain a large number of poplar and willow clones, which act as a source of cuttings for clonal tests and as a reference collection in the event that the original source is lost. Poplar and willow shoots are harvested in the late fall, usually in October and early November. The shoots are cut into 6" lengths and stored over winter in sealed containers at 28°F. These cuttings are planted by machine the following spring, using a mechanical tree planter. Irrigation is applied as required as are controls for insects and diseases. In the fall the rooted cuttings are topped to 12", undercut to 9 inches and mechanically lifted, sorted to remove sub-standard material, tied in bundles of 10 and heeled-in outside in special plots for the winter. These 1 year old rooted cuttings are then forwarded to applicants in the spring.

B. Deciduous Species

Deciduous species such as Manitoba maple, Amur maple, green ash, Villosa lilac and Russian olive are fall sown in production fields, with germination occuring the following spring. American and Siberian elm, as well as caragana are sown in production fields in July and these species germinate in a few weeks. This mid-season planting is done to limit the size of plants obtained. The seedlings are too small to ship as 1-0 stock but too big if sown in the fall, so that they have a full two year growing season.

Asian rose, red elder, honeysuckly, dogwood, Saskatoon, buffaloberry and chokecherry are shown in late fall, and germinate the follwing spring. These species are sown in special fumigated seedbed areas, using a nursery designed shrub seeder. All species are irrigated as necessary.

In the fall of the second year the seedlings are mechanically topped to 12 inches, undercut to 9 inches and lifted by a harvest machine. All material

is sorted to remove undersized or damaged seedlings, tied in bundles, the size of which varies which species and heeled-in outdoors for winter storage until spring. Thus all the deciduous species in question are shipped as 2-0 stock.

C. Conifers

Seed of Siberian larch and white spruce are fall sown and Colorado spruce are sown in the spring, in special fumigated seedbeds, having wooden sides and a sun shade placed on top. Irrigation is provided as required. In the second year the wooden sides and sun shade are removed and the seedlings hardened off. In the fall of the second year the seedlings are undercut at 4 inches, lifted by hand and sorted, with undersized or damaged seedlings being discarded. The seedlings are then stored indoors overwinter in sealed containers at 33^{o}F and transplanted the following spring, using the transplant machine. Larch and white spruce are left in the Transplant plots for 2 years and Colorado spruce for three years. In the fall before harvest the stock is culled in the field to remove undersized or malformed stock. The material is usually lifted in the spring before bud break, although some material is stored overwinter indoors as space permits. All conifer stock is undercut to 8" prior to lifting by hand.

The age of conifer material supplied is: Colorado spruce 2-3, white spruce 2-2 and Siberian larch 2-2.

Clones and Parentage

Clone	Parentage
P. Acuminata Rydb.	species
P. Northwest	P. deltoides x balsamifera
P. 38 P 38	P. tacamahacca x Simonii
P. Walker	P. deltoides x Russian?
P. Serotina de Selys	P. x euramericana
P. P X Mann	unknown
P. Eucalyptus	P. xeuramericana
P. Berolinensis femina	selection of Berolinensis
P. D709 PA	P. petrowskiana
P. Carolina #3	P. x euramericana
P. BNW #4	P. berolinensis x P. Northwest
P. Brooks #2	P. deltoides x unknown
P. Brooks #4	P. deltoides x unknown
P. Brooks #5	P. deltoides x unknown
P. Nigra #1	species (selection)
P. Nigra viadri Rudiger	species
P. Berolinensis	P. laurifolia x Nigra
P. PV97	P. petrowskiana x caudina
P. Jackii #18	P. tacamahacca x deltoides?
P. Angulata Ait.	Syn. P. d. angulata
P. Tristis Fisch	species
P. 44-55	P. deltoides x Russian?
P. PX grandis	P. x euramericana
P. C. regenerata	P. x euramericana
P. Gelrica	P. x euramericana
P. Tristis #1	P. balsamifera x tristis

Appendix 9.7 CONIFEROUS SEED GERMINATION

	Soaked			Not Soaked			Mean	
	1	2	3	1	2	3	Soaked	Not soaked
Species								
white spruce (62-6)[2]	0	3	0	0	0	0	1	0
white spruce (94-2)	0	0	0	0	0	0	0	0
white spruce (100)	0	0	0	1	0	0	0	0
white-bark pine	0	0	0	0	0	0	0	0
Douglas fir	20	7	16	4	12	13	14*	10
alpine fir	0	0	0	0	0	0	0	0
Jack pine (93-10)	12	49	22	23	31	29	28	28
Jack pine (60-65)	41	40	33	24	3	4	38	10
lodgepole pine (65-7)	18	4	11	10	8	0	11*	6
Engelmann spruce	0	0	0	0	0	0	0	0
black spruce	0	0	0	0	0	1	0	0
tamarack	0	0	0	0	0	0	0	0

[1] Values given are percentage of potential germination

[2] Seed lot code - legal location of each seed lot given on next page

* Significantly different than Jack pine (60-65) value at 99% level of probability

Legal Location and Germination Potential of Seed Lots

Species	Seed lot no.	Twp.	R.	Mer.	GE.	
					%	yr.
white spruce	100	125	10	4	79	75
white spruce	94-11-4-75	94	11	4	87	75
white spruce	62-6-4-75	62	6	4	67	75
Jack pine	93-10-4-74	93	10	4	65	75
Jack pine	60-65	65	6	4	75	75
lodgepole pine	65-7	94	23	5	84	75
Dougals fir	2-2-71	8	4	5	75	74
black spruce	86-8-4-74	86	8	4	68	75
Engelmann spruce	60-13-6-74	60	13	6	79	75
alpine fir	60-13-6-74	60	13	6	37	75
white-bark pine	3-7-71	3	3	5	52	75
tamarack	94-11-4-75	94	11	4	56	75

Appendix 9.8 Performance of Basford Willow On Terraced Slopes of the Tailings Dike

Plot	Section	S[2]	Gr[3]	Con[4]	Plot	Section[5]	S	Gr	Con.
					Southeast Section				
258[1]	1	88	0	2.3	259	1	93	5	2.6
	2	88	7	2.3		2	72	11	2.9
	3	48	4	2.3		3	80	-1	1.9
	4	4	-39	2.0		4	52	11	2.5
	5	36	-8	1.7		5	40	1	1.5
	6	48	2	1.9		6	24	3	1.8
	7	77	1	2.0		7	40	0	1.7
	$\bar{X}$ =	55	-1	2.1		8	32	-4	1.6
						$\bar{X}$ =	54	3	2.1
					North Section				
Plot	Section	S	Gr	Con	Plot	Section	S	Gr	Con.
652	1	13	27	3.0	448	1	16	18	3.3
	2	4	-11	1.0		2	28	18	1.9
	3	40	2	1.8		3	64	5	1.9
	4	44	8	1.8		4	72	9	1.9
	5	12	6	1.7		5	52	3	2.0
	6	20	3	1.2		6	4	-4	1.0
	7	52	11	1.7		7	36	-6	1.7
	8	43	6	1.4		8	30	6	1.7
	$\bar{X}$ =	29	7	1.7		9	49	13	1.9
						$\bar{X}$ =	39	7	1.9
653	1	94	6	2.0	449	1	4	0	1.0
	2	68	11	2.0		2	52	2	2.0
	3	16	7	1.7		3	92	1	2.2
	4	8	-3	1.5		4	72	9	2.2
	$\bar{X}$ =	47	5	1.8		5	85	5	1.9
						$\bar{X}$ =	61	3	1.9

[1] For location of plots see appendix 9.3

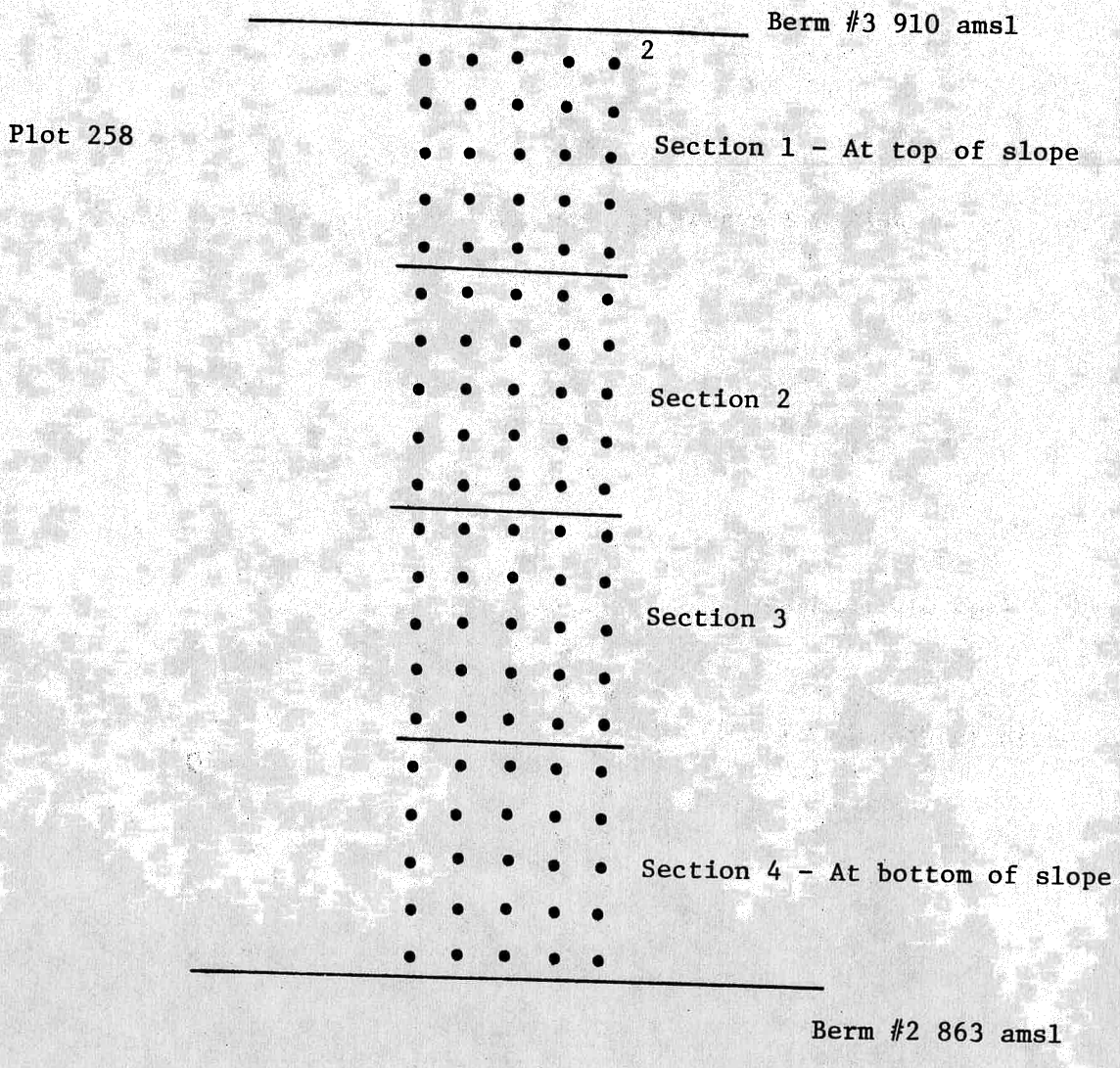
[2] Survival percentage

[3] Growth (cm)

[4] For explanation of condition codes, see appendix 9.4

[5] See attachment for description of section

Illustration[1] of How Plot Sections Illustrate Position On Slope



[1] [2] this is example only represents seedling

Appendix 9.9

SPECIES PERFORMANCE BY SITE

Tailings Dike - Southeast Section

Species	Survival %	Sx[1]	Growth (cm)	Sx	Con[2]	Sx	Index[3]	No. of Plots
P.[4] BNW #4	82	3.60	10	2.13	2.2	0.64	114	6
P. Tristis	83	1.88	9	0.99	2.0	0.00	112	2
P. D 709	78	2.47	9	0.98	2.4	0.57	111	5
P. Brooks #4	69	5.07	9	1.22	2.6	0.55	104	5
P. Serotina de Selys	70	4.13	10	2.07	2.2	0.67	102	5
P. P38 P38	72	4.53	9	1.56	2.1	0.34	102	3
Lonicera tatarica	79	2.22	3	0.27	2.0	0.00	102	2
P. Walker	64	5.51	13	2.33	2.3	0.78	101	3
Ulmus pumila	71	4.97	3	1.95	2.0	0.28	94	7
P. PX Grandis	65	4.05	7	1.16	2.1	0.42	93	4
P. Brooks #2	62	4.16	4	2.50	2.4	0.59	90	5
P. Northwest	59	3.62	9	1.05	2.2	0.46	90	3
P. Accuminata	59	4.90	9	4.90	2.1	0.46	89	2
P. P42-55	58	5.06	9	2.39	2.1	0.65	88	5
P. Brooks #5	47	6.24	11	2.55	2.8	0.65	86	2
Prunus virginiana	69	3.94	-3	1.33	1.9	0.27	85	2
P. Berolinensis	56	3.06	7	2.02	2.1	0.57	84	5
P. Eucalyptus	51	6.12	10	2.09	2.3	0.69	84	4
P. Angulata	54	4.53	6	1.03	2.4	0.55	84	4
P. Carolina #3	53	4.86	9	1.57	2.2	0.55	84	3
Fraxinus pennsylvanica var. subintegerrima	62	5.48	0	1.71	2.1	0.42	83	3
Picea pungens	54	3.76	2	0.99	2.5	0.53	81	2
P.C. regenerata	53	3.03	6	1.74	2.0	0.00	79	2
P. PX Mann	39	2.89	10	1.69	2.3	0.51	72	4
P. PV 97	48	4.68	4	2.92	1.9	0.47	71	4
P. Nigra	39	5.35	6	2.31	2.0	0.32	65	3
Salix fragilis var. 'Basfordiana'	38	4.45	5	2.71	2.1	0.27	64	8
Picea glauca	41	3.03	3	0.70	1.9	0.38	63	2
Elaeagnus angustifolia	47	1.46	-4	0.59	1.9	0.46	62	2

Tailings Dike - Southeast Section

Species	Survival %	Sx[1]	Growth (cm)	Sx	Con[2]	Sx	Index[3]	No. of Plots
Acer negundo	35	4.26	-1	1.74	2.0	0.49	53	8
Larix sibirica	21	4.03	-3	2.13	1.6	0.00	34	2
Ulmus americana	8	2.50	-2	1.41	1.3	1.00	19	4
$\bar{X}$ =	56	4.06	6	1.75	2.1	0.45	83	

[1] Standard error of the mean

[2] For description of condition codes see Appendix 9.4

[3] For description of index value see Results and Discussion section 4.4

[4] Species name beginning with "P" is name of cultivated poplar clone

Tailings Dike - North Section

Species	Survival %	Sx[1]	Growth (cm)	Sx	Con[2]	Sx	Index[3]	No. of Plots
Ulmus pumila	93	2.78	6	1.20	2.0	0.39	119	5
Syringa vulgaris	80	2.34	-2	1.18	2.0	0.20	98	5
Fraxinus pennsylvanica var. subintegerrima	74	5.12	-1	0.91	2.0	0.73	93	5
Syringa villosa	64	4.09	0	0.94	1.9	0.21	83	5
Acer negundo	54	4.60	0	2.25	2.0	0.30	74	5
Salix fragilis var. 'Basfordiana'	36	3.6	7	2.06	1.6	0.50	61	10
Prunus padus	31	4.64	1	0.85	1.5	0.93	47	5
Prunus virginiana	11	3.17	-1	1.13	1.6	0.65	27	5
Crataegus cerronis	1	1.07	1	0.93	0.3	0.76	5	3
$\bar{X}$ =	49	3.49	1	1.27	1.7	0.52	67	

[1] Standard error of the mean

[2] For description of condition codes see Appendix 9.4

[3] For description of index value see Results and Discussion section 4.4

Tailings Dike - Peat Treatment Sites

Species	Survival %	Sx[1]	Growth (cm)	Sx	Con[2]	Sx	Index[3]	No. of Plo
P.[4] Serotina de Selys	97	1.61	59	3.81	3.2	0.59	188	5
P. P 42-55	96	1.59	56	4.60	2.8	0.51	182	3
P. Walker	97	1.67	53	2.83	3.0	0.45	179	7
Salix fragilis var. 'Basfordiana'	94	1.67	51	4.33	3.0	0.65	175	4
P. Brooks #4	99	1.00	45	3.44	3.0	0.36	174	4
P. Northwest	96	2.35	46	3.16	2.9	0.36	171	4
P. Gelrica	100		38		3.0		168	1
P. P38	96	2.74	43	4.65	2.7	0.72	166	3
P. Jackii #18	96	2.38	41	3.75	2.8	0.37	165	2
P. Berolinensis	95	1.94	36	3.33	2.8	0.41	159	4
Ulmus americana	95	2.10	10	2.81	2.1	0.24	126	4
Fraxinus pennsylvanica var. subintegerrima	89	2.23	3	0.94	2.1	0.22	113	4
Acer negundo	78	3.86	7	4.22	2.0	0.54	105	6
Populus balsamifera	63	4.55	16	3.30	1.9	0.51	98	4
$\bar{X}$=	92	2.28	36	3.48	2.7	0.47	155	

[1] Standard error of the mean

[2] For description of condition codes see Appendix 9.4

[3] For description of index value see Results and Discussion section 4.4

[4] Species name beginning with "P" is name of cultivated poplar clone

Waste Dump No. 7 - Northeast Section

Species	Survival %	Sx[1]	Growth (cm)	Sx	Con[2]	Sx	Index[3]	No. of Plo
P.[4] Nigra	98	1.68	30	2.87	2.6	0.53	154	2
Salix fragilis var. 'Basfordiana'	93	2.14	31	3.30	2.2	0.39	146	3
P. Serotina de Selys	98	1.61	19	2.28	2.7	0.60	144	5
P. P42-55	96	2.38	21	2.68	2.4	0.69	141	4
P. Walker	96	1.82	23	2.08	2.2	0.41	141	4
P. Brooks #5	98		19		2.0		137	1
P. PX Grandis	98	0.84	12	1.76	2.6	0.65	136	2
P. Brooks #4	100		15		2.1		136	1
Elaeagnus angustifolia	94	1.43	14	1.95	2.4	0.46	132	4
Ulmus pumila	94	2.36	11	2.30	2.2	0.58	127	4
Caragana aborescens	97	1.86	5	1.47	2.5	0.62	127	4
Lonicera tatarica	98	1.41	4	1.63	1.9	0.23	121	3
Syringa villosa	96	2.38	1	0.99	2.3	0.59	120	2
P. Brooks #2	89	2.79	10	1.13	2.1	0.46	119	2
Prunus virginiana	92	2.38	-1	0.59	1.9	0.00	111	2
Acer ginnala	84	2.38	-1	1.74	2.2	0.21	105	2
Acer negundo	79	4.44	-3	2.36	1.9	0.14	95	10
Ulmus americana	64	5.33	2	2.30	2.0	0.66	86	7
Populus balsamifera	54	3.16	5	0.92	2.0	0.26	79	2
$\bar{X}$=	90	2.37	11	1.90	2.2	0.44	124	

1 Standard error of the mean

2 For description of condition codes see Appendix 9.4

3 For description of index value see Results and Discussion section 4.4

4 Species name beginning with "P" is name of cultivated poplar clone

Waste Dump No. 7 - Northwest Section

Species	Survival %	Sx[1]	Growth (cm)	Sx	Con[2]	Sx	Index[3]	No. of Plot
Salix fragilis var. 'Basfordiana'	89	3.09	11	1.97	2.3	0.62	123	3
Ulmus pumila	92	1.91	6	2.00	2.2	0.54	120	4
Fraxinus pennsylvanica var. subintegerrima	92	2.30	-1	0.57	2.6	0.65	117	3
Pseudotsuga menziesii	88	2.43	1	1.10	2.0	0.33	109	5
Syringa vulgaris	87	2.99	-2	1.37	2.0	0.00	105	4
Syringa villosa	76	2.03	0	0.74	2.0	0.22	96	6
Prunus padus	63	4.88	-2	1.39	2.0	0.20	81	5
Salix sp.	58	3.53	1	1.92	1.7	0.48	76	3
Populus balsamifera	48		2		2.0		70	1
Acer negundo	54	5.88	-5	2.19	1.9	0.54	68	13
Prunus virginiana	41	4.47	0	1.21	1.7	0.47	58	4
Lonicera tatarica	8	3.02	-2	2.42	1.0	1.00	16	5
Crataegus cerronis	1	1.07	1	1.07	0.7	1.07	12	3
$\bar{X}$ =	61	3.13	1	1.49	1.9	.51	81	

[1] Standard error of the mean

[2] For description of condition codes see Appendix 9.4

[3] For description of index value see Results and Discussion section 4.4

Waste Dump No. 7 - Southwest Section

Species	Survival %	Sx[1]	Growth (cm)	Sx	Con[2]	Sx	Index[3]	No. of Plot
Salix fragilis var. 'Basfordiana'	86	2.45	16	3.11	1.6	0.71	118	3
Ulmus pumila	94	2.17	5	2.37	1.9	0.30	118	5
Acer negundo	36	5.50	-3	1.74	1.8	0.58	51	18
$\bar{X}$ =	72	3.37	6	2.41	1.8	0.53	96	

[1] Standard error of the mean

[2] For description of condition codes see Appendix 9.4

[3] For description of index value see Results and Discussion section 4.4

Waste Dump No. 7 - Southeast Section

Species	Survival %	Sx[1]	Growth (cm)	Sx	Con[2]	Sx	Index[3]	No. of Pl
Salix fragilis var. 'Basfordiana'	40	6.58	13	2.81	1.5	0.62	67	3
Acer negundo	35	5.59	-3	1.82	1.3	0.87	45	14
$\bar{X}$ =	37	6.09	5	2.31	1.4	0.75	56	

[1] Standard error of the mean

[2] For description of condition codes see Appendix 9.4

[3] For description of index value see Resluts and Discussion section 4.4

Waste Dump No. 7 - Top Section

Species	Survival %	Sx[1]	Growth (cm)	Sx	Con[2]	Sx	Index[3]	No. of Pl
Ulmus pumila	98		17		1.9		134	1
Salix fragilis var. 'Basfordiana'	66	6.43	26	2.41	2.0	0.48	113	3
Acer negundo	45	5.74	3	1.35	1.9	1.40	67	18
Salix sp.	29	4.39	17	1.66	2.1	0.65	67	4
$\bar{X}$ =	59	5.52	16	1.81	2.0	0.84	95	

[1] Standard error of the mean

[2] For description of condition codes see Appendix 9.4

[3] For description of index value see Results and Discussion section 4.4

Appendix 9.10

SURVIVAL OF SEEDLINGS PLANTED IN

1974 AND 1975

Tailings Dike - North Section

Species	% Survival (July 1976)	Standard Error	Number of Plots	% Survival (Fall 1975)
Lonicera tatarica	75	5.45	2	75
Salix pentandra	50	4.71	3	63
Ulmus pumila	48		1	64
P.[1] Brooks	47	3.26	2	68
Pinus contorta	46	5.05	3	55
Prunus virginiana	40		1	60
Picea glauca	34	5.94	7	39
Pinus banksiana	33	5.46	7	44
Caragana arborescens	30	1.19	2	55
P. Griffin	21	3.67	2	22
Salix amygdaloides	20	3.94	2	29
Salix alba	18	4.12	2	35
Acer negundo	17	5.07	4	27
Populus balsamifera	15		1	22
Picea mariana	14	3.96	5	16
Fraxinus pennsylvanica var. subintegerrima	12		1	55
Ramnus davurica	12		1	38
Ulmus americana	8		1	56
Salix acutifolia	8	3.56	3	14
Alnus rugosa	4	1.79	3	24
Populus sp. (Russian)	1		1	
Quercus macrocarpa	0		1	54
Betula alba	0		1	74
Prunus padus	0		1	17
Cornus stolonifera	0		1	12
$\bar{X}$ =	22	4.08		41

[1] Any species name beginning with "P." is the name of a specific poplar clone.

Tailings Dike - Southeast Section

Species	% Survival (July 1976)	Standard Error	Number of Plots	% Survival (Fall 1975)
P. Brooks #10	96		1	
Acer negundo 74[1]	94		1	93
Caragana arborescens	83		1	74
Picea pungens	82		1	100
P.[2] Northwest	73		1	
Salix sp. 74	62		1	67
Pinus contorta 74	61	4.69	5	60
Populus tremuloides 74	60	3.94	2	61
Salix acutifolia	57	3.57	4	62
Pinus banksiana	56	4.97	12	54
Picea glauca 74	55	5.45	4	60
Pinus contorta	53	5.95	6	55
Acer negundo	53	5.42	3	65
Salix pentandra	52	4.90	4	52
Populus balsamifera 74	45	4.76	2	48
Populus balsamifera	37	4.69	6	51
Pinus banksiana 74	34	2.45	3	38
Picea glauca	32	4.99	13	38
Salix acutifolia 74	31	1.88	2	39
Salix alba	29		1	36
Picea mariana	27	4.75	21	38
Alnus rugosa	23	4.75	7	42
Salix amygdaloides	17		1	21
Poplus trichocarpa	17		1	26
Betula alba 74	5		1	13
Abies balsamea 74	0		1	4
Salix arctica 74	0	0	3	0
$\bar{X}$ =	46	4.48		48

[1] Planted in 1974, all others planted 1975

[2] Any species name beginning with "P" is the name of a specific poplar clone.

Waste Dump No. 5

Species	% Survival (July 1976)	Standard Error	Number of Plots	% Survival (Fall 1975)
Fraxinus pennsylvanica var. subintegerrima	77		1	92
Salix acutifolia	75	5.27	3	73
Salix alba	67	6.35	2	66
Pinus banksiana	66	4.15	7	81
Pinus contorta	65	3.40	4	94
Caragana arborescens	55		1	50
Acer negundo	54		1	62
Salix pentandra	49	4.20	2	49
Picea glauca	43	5.21	3	50
Picea mariana	39	3.34	6	54
Populus trichocarpa	35		1	43
Populus balsamifera	35	2.22	2	38
Salix amygdaloides	33	0	2	35
Rhamnus davurica	27		1	53
Alnus rugosa	21	4.92	3	45
$\bar{X}$ =	49	3.90		59

Appendix 9.11 Botanical and Common Names of Species Used for Sub-Project VE 7.1

Species	Common Names
Abies balsamea (L.) Mill	Balsam fir
Acer ginnala Maxim.	Amur maple
Acer negundo (Britt.) Sarg.	Manitoba maple
Alnus crispa (Ait.) Pursh	American green alder
Alnus rugosa (Du Roi) Spreng.	Speckled alder
Alnus tenuifolia Nutt.	Mountain alder
Betula alba L.	White birch
Betula papyrifera Marsh.	Paper birch
Caragana arborescens Lam.	Caragana
Cornus stolonifera Michx.	Dogwood
Crataegus cerronis A. Nels.	Chocolate hawthorn
Elaeagnus angustifolia L.	Russian olive
Fraxinus pennsylvanica Marsh. var. subintegerrima (Vahl) Fern.	Green ash
Larix sibirica Ledeb.	Siberian larch
Lonicera tatarica L.	Tatarian honeysuckle
Picea glauca (Moench) Voss	White spruce
Picea mariana (Mill.) BSP.	Black spruce
Picea pungens Engelm.	Colorado spruce
Pinus banksiana Lamb.	Jack pine
Pinus contorta Dougl. var. latifolia Engelm	Lodgepole pine
Populus balsamifera L.	Balsam poplar
Populus tremuloides Michx.	Trembling aspen
Populus trichocarpa Torr. & Gray	Black cottonwood
Prunus padus L.	Mayday
Prunus virginiana L.	Chokecherry
Pseudotsuga menziesii (Mirb.) Franco	Douglas fir
Quercus macrocarpa Michx.	Bur oak
Rhamnus davurica Pall.	Buckthorn
Salix acutifolia Willd.	Acute leaf willow
Salix alba L.	Golden leaf willow
Salix amygdaloides Anderss.	Peach leaf willow
Salix arctica Pall.	Arctic willow
Salix fragilis var. 'Basfordiana' Redher	Basford willow

Species	Common Names
Salix pentandra L.	Laurel leaf willow
Syringa villosa Vahl.	Late lilac
Syringa vulgaris L.	Common lilac
Ulmus americana L.	American elm
Ulmus pumila L.	Manchurian elm