ENVIRONMENTAL SERVICES

REVEGETATION PLAN

SUBMISSION 4-7

NOVEMBER, 1981

Foothills Pipe Lines (South Yukon) Ltd.

REVEGETATION PLAN

SUBMISSION 4-7

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ADDENDUM
TO
THE ENVIRONMENTAL IMPACT STATEMENT
FOR
THE YUKON SECTION
OF
THE ALASKA HIGHWAY GAS PIPELINE

THE ALASKA HIGHWAY GAS PIPELINE PROJECT

Foothills Pipe Lines (South Yukon) Ltd.

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This document is one of a series of addenda prepared to meet information requirements placed on Foothills Pipe Lines (South Yukon) Ltd. by the Federal Environmental Assessment and Review Office. Addenda within the series are divided into seven sets of submissions dealing with separate subject areas:

1. Introduction to Addenda Submissions.

2. Project Description and Update for Addenda Submissions.

3. Alternative Routes.

4. Geotechnical, Hydrological, Design Mode and Revegetation Issues.

5. Fisheries, Wildlife and Scheduling Issues.

6. Issues Related to Pipeline Facilities.

7. Other Issues.

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1.0 INTRODUCTION

At the time Foothills Pipe Lines prepared and submitted its application to the National Energy Board for permission to construct the Alaska Highway Gas Pipeline large scale revegetation in northern areas had not been attempted. Preliminary evidence from limited revegetation efforts in the north indicated that the use of commercially available agronomic seed often led to failure because the varieties of plants involved were not adapted to northern conditions. In view of these two factors Foothills proposed a program of revegetation for areas disturbed by pipeline activity which involved the use of so called "native species". In fact, the plant materials involved in the proposal could more accurately be described as "northern varieties" as many of the plants involved were species with circumpolar distributions which, as species, were available commercially. The proposal put forward involved testing and field production of northern varieties in the quantities required by the pipeline. After review of the 1976 application, the Environmental Assessment and Review Panel noted that a complete revegetation plan was required as extensive induced revegetation by native species was not a proven method.

In 1979, Foothills submitted an Environmental Impact Statement for the Alaska Highway Gas Pipeline in Yukon which: made brief mention of revegetation with regard to erosion control, presented revegetation as a Project undertaking and included as an Annex to the EIS a report dealing with existing vegetation along the pipeline route. The latter report placed emphasis on disturbed sites and invader species. Revegetation plans were discussed during hearings arising from the EIS but a revegetation plan was not submitted, as such a plan required the results from field experiments which were underway at that time.

As a result of the review of the EIS and discussions at hearings in 1979, the Panel requested a comprehensive revegetation and erosion control plan that would include: the results of revegetation field research, a description of long-term vegetation management, the identification of problem areas (for revegetation) and a discussion of the effects of forest fires on the revegetation program.

After joint review of the Panel's report by Panel members, Northern Pipeline Agency representatives and project personnel the Panel clarified its requirements by noting that a satisfactory outline for a revegetation plan had been introduced at the 1979 hearings and by requesting a revegetation plan based on that outline. A request for examples of solutions for different terrain types was also made.

This addenda submission is being forwarded by the Project in response to the Panel's most recent request. The submission is in fact a preliminary draft of a revegetation plan prepared for submission to the Northern Pipeline Agency. The plan presents the Projects overall approach (philosophy) to revegetation, reviews the legal and regulatory requirements related to revegetation and discusses technical aspects of the regions traversed, plant materials available and methods of application. Final sections of the plan, not included in the preliminary draft, will present kilometre by kilometre details of materials and methods, based on final pipeline design decisions. These sections of the plan will be submitted in support of final design to the NPA and will be approved by the NPA prior to construction.

2.0 ALASKA HIGHWAY GAS PIPELINE REVEGETATION PLAN

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REVEGETATION PLAN

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REVEGETATION PLAN

1.0 INTRODUCTION

1.1 Purpose

This document has been prepared by the Environmental Services Department of Foothills Pipe Lines (South Yukon) Ltd. in compliance with the requirement of Section 179 "Submission and Implementation of Environmental Plans" of the Northern Pipeline Agency's Environmental Terms, Conditions and Related Guidelines. It is one of a series of Protection Planning documents issued for the purpose of providing environmental input into the design and construction of the Alaska Highway Gas Pipeline.

This document provides general information, guidelines and specifications pertaining to the revegetation of the Alaska Highway Gas Pipeline project in Yukon and the Swift River segment in northern British Columbia. They have been developed to:

(1) comply with the Environmental Terms and Conditions;

(2) comply with other regulatory requirements established for the protection of the environment; and

(3) prevent, mitigate or remedy adverse environmental impacts that might result from the construction of the pipeline.

1.2 Background

Foothills Pipe Lines (South Yukon) Ltd. upon initiation of efforts to build the Alaska Highway Gas Pipeline in Yukon, adopted a revegetation approach founded upon the re-establishment of the vegetative cover and the primary utilization of seed varieties indigenous to the southern

Yukon, northern British Columbia and Alberta. The difficulties of such a course of action, were recognized. The advantages, however, of using native varietal selections adapted to the climatic and edaphic conditions of northern regions, were assessed to outweigh the disadvantages of developing and testing new seed types and sources.

The following excerpts from the Foothills application to the National Energy Board in 1976 describes the concept and planned revegetation approach as presented during the application.

> ..."The applicant intends to help nature restore the self-supporting eco-system through rehabilitation of disturbed areas, wherever necessary. In the long term, revegetation will assist in erosion control and will reduce soil temperature regime changes which occur when vegetation cover is removed. In this program, ecotypes of native species will be used as much as possible...."
>
> ..."Species selected for the revegetation program must possess different characteristics than those of species used for agronomic or horticultural programs. Forage yield and quality are not the most desirable characteristics in selection for reclamation purposes. Longevity, cover production, erosion control capability, resistance to disease, and aesthetic value are some factors important in selection of species for reclamation...."
>
> ..."The revegetation techniques described will be applied in those areas where natural revegetation by re-invasion of local species will not be adequate...."
>
> ..."A prime concern will be the revegetation of river and stream crossing slopes and other potentially unstable slopes."

..."Revegetation in these areas will be designed to assist in long term erosion control. Consequently, the areas will be reseeded; but, if necessary, vegetative propagation techniques will be implemented and the hand planting of stem and rooted cuttings will be undertaken...."

..."Areas such as road crossings which are highly visible will be revegetated to reduce the visual impact of the pipeline construction...."

..."Other disturbed areas such as stockpile sites, borrow areas, construction camps and land adjacent to compressor stations will be considered on a site-specific basis. If deemed necessary, they will be revegetated; but this decision will depend on the proposed future use of each site, its location, and the assessed potential for natural rehabilitation. Where immediate revegetation is not necessary to protect the integrity of the pipeline and of the physical environment and where aesthetic considerations are not an overriding factor, the Applicant will allow natural revegetation to take place..."

Revegetation work undertaken since 1976 has, in general, followed the basic commitments outlined above and has included field tests of both northern and agronomic varieties in the southern Yukon. The results of these studies are presented in the following reports:

Vaartnou & Sons Enterprises Ltd. 1978. Pipeline revegetation research: Haines Junction test site. Progress Report - 1977. Prepared for Foothills Pipe Lines (Yukon) Ltd., Calgary, Alberta. 41 pp.

Vaartnou & Sons Enterprises Ltd. 1978. Pipeline revegetation research: Northern British Columbia test sites. Progress report - 1977. Report prepared for Foothills Pipe Lines (Yukon) Ltd., Calgary, Alberta, Alberta Gas Trunk Line Ltd., Calgary, Alberta and Westcoast Transmission Ltd., Vancouver, British Columbia. 56 pp.

Vaartnou & Sons Enterprises Ltd. 1978. Pipeline revegetation research: Grasses, Legumes and Shrubs adjacent to the Alaska Highway of Yukon Territory. Report prepared for Foothills Pipelines (Yukon) Ltd., Calgary Alberta. 47 pp.

Vaartnou & Sons Enterprises Ltd. 1979. Chemical and Physical Properties of some soils proximal to the Alaska Highway, Yukon Territory. Report prepared for Foothills Pipe Lines (Yukon) Ltd., Calgary, Alberta. 41 pp. and appendices.

Vaartnou & Sons Enterprises Ltd. 1979. Pipeline revegetation research: Alaska Highway test sites - Progress report - 1978. Prepared for Foothills Pipe Lines (South Yukon) Ltd., Calgary, Alberta. 135 pp.

Vaartnou & Sons Enterprises Ltd. 1979. Pipeline revegetation research: Haines Junction test site - Progress report - 1978. Report prepared for Foothills Pipe Lines (South Yukon) Ltd., Calgary, Alberta. 54 pp.

Vaartnou & Sons Enterprises Ltd. 1979. Pipeline revegetation research: Northern British Columbia test sites - Progress report - 1978. Report prepared for Foothills Pipe Lines (South Yukon) Ltd., Calgary, Alberta and Westcoast Transmission Company Limited, Vancouver, British Columbia. 44 pp.

Vaartnou & Sons Enterprises Ltd. 1980. Pipeline revegetation research: Northern shrubs propagation. Prepared for Foothills Pipe Lines (South Yukon) Ltd., Calgary, Alberta. 32 pp.

Vaartnou & Sons Enterprises Ltd. 1980. Pipeline revegetation research: Alaska Highway test site - Progress report - 1979. Report prepared for Foothills Pipe Lines (South Yukon) Ltd., Calgary, Alberta. 66 pp.

Vaartnou & Sons Enterprises Ltd. 1980. Pipeline revegetation research: Haines Junction test site - Progress report - 1979. Report prepared for Foothills Pipe Lines (Yukon) Ltd., Calgary, Alberta. 57 pp.

Vaartnou & Sons Enterprises Ltd. 1981. Pipeline revegetation research: Alaska Highway test sites - Progress report - 1980. Report prepared for Foothills Pipe Lines (South Yukon) Ltd., Calgary, Alberta. 83 pp. + appendices.

Vaartnou & Sons Enterprises Ltd. in prep. Pipeline revegetation research: Alaska Highway test sites - Progress report - 1981. Report prepared for Foothills Pipe Lines (South Yukon) Ltd., Calgary, Alberta.

Vaartnou & Sons Enterprises Ltd. in prep. Pipeline revegetation research: Northern British Columbia test sites - Progress report - 1978. Report prepared for Foothills Pipe Lines (South Yukon) Ltd., Calgary, Alberta and Westcoast Transmission Company Limited, Vancouver, British Columbia.

In addition, information from previous revegetation programs as reported in literature, in government and industry reports, and from experienced individuals was utilized to develop the concept, and derive criteria by which revegetation work could be planned and evaluated on a site-specific basis. This document presents the conclusions founded upon the research undertaken.

1.3 Scope and Objectives

The scope of the Revegetation Plan is restricted to project-related activities which disturb or alter the terrain within or immediately adjacent to the lands authorized by the regulatory agencies for use during the construction and operation of the Alaska Highway Gas Pipeline Project in Yukon and the Swift River area of British Columbia.

The Revegetation Plan provides the specifications and the guidelines utilized in their development to ameliorate the impact of the Alaska Highway Gas Pipeline Project upon the bio-physical environment. In pursuing this general objective, it is recognized that lands involved have been committed to the transport of natural gas. Revegetation plans therefore are designed to support this primary land-use while simultaneously limiting adverse effects upon secondary land-uses.

The specific objectives of this revegetation program are:

1. to encourage the re-establishment of a self-sustaining native vegetative cover;

2. to assist temporary and long-term erosion control;

3. to rehabilitate the aesthetic appearance of the landscape; and

4. to ensure continued compatible secondary land-uses.

1.4 Definitions and Criteria

Revegetation is defined as action(s) taken to assist the re-introduction of vegetative cover to areas denuded or disturbed by pipeline activity. Emphasis in the definition is placed on the words "assisted re-introduction" as surrounding vegetation will in virtually all cases re-invade disturbed areas without encouragement over the course of time.

Also, for purposes of definition, revegetation efforts are viewed as falling into two categories termed "passive" and "active." Passive revegetation involves surface preparation and the addition of soil amendments to encourage re-introduction of vegetation from adjacent undisturbed areas; whereas, active efforts involve the artificial introduction of plant material as well as soil modification techniques to accelerate the revegetation process.

Both approaches foster the re-establishment of a self-supporting vegetative cover to the Yukon and Swift River segments of the Alaska Highway Gas Pipeline. However, the passive approach will be employed as the standard treatment to encourage wherever feasible the re-establishment of a native vegetative cover analogous to the adjacent undisturbed areas. Active revegetation efforts will be implemented only if one or a combination of the following conditions exist:

1. actual or probable hydraulic, thermal or wind erosion;
2. disturbance of scenic (aesthetic) conditions;
3. disturbance of existing or future land-uses related to vegetative cover; and
4. harsh environmental conditions which cause low growth potential.

The techniques to be employed for any given site will be specified to compliment the site-specific conditions. The success of these efforts in assisting the re-establishment of an adequate vegetative cover will be assessed utilizing the criteria defined on Table 4.19.

To determine the revegetation approach to be utilized on a site-specific basis, criteria have been established for areas subject to erosion, aesthetic and land-use disturbance and harsh environmental conditions. These are described below. If any criteria is satisfied, the active approach will be employed to accelerate the revegetation process.

The data base required to apply the criteria is provided in the following documents:

Foothills Pipe Lines (South Yukon) Ltd. in prep. Soil Types and Distribution along the Alaska Highway Gas Pipeline, Calgary, Alberta.

Foothills Pipe Lines (South Yukon) Ltd. in prep. Geotechnical Atlas, Calgary, Alberta.

Foothills Pipe Lines (Yukon) Ltd. 1981. Aesthetic Plan, Submission 7-1. The addendum to the Environmental Impact Statement for the Yukon Section of the Alaska Highway Gas Pipeline, Calgary, Alberta.

Foothills Pipe Lines (Yukon) Ltd. in prep. Terrain Protection Plan, Calgary, Alberta

Pacific Forestry Research Centre. 1980. Vegetation Types and Environmental Factors Associated with the Foothills Gas Pipeline Route, Victoria, B.C.

Erosion:

Erosion involves the physical and chemical weathering of rock and the transport and deposition of unconsolidated materials by the action of water and wind, by gravity and by thermal processes. A distinction is made between "geological" and "accelerated" erosion. Geological erosion is the process by which the land would normally be eroded without disturbance through human activity. Accelerated erosion is the increased rate of erosion that arises when man alters the natural system by various land use practices. Erosion and its control as addressed in this plan refers to accelerated surface erosion.

The rate of erosion is affected by numerous variables, of which soil characteristics, climate, vegetation, length and steepness of slopes, and drainage density are considered to be the most important. Other factors imposed by construction activities such as clearing, excavation of ditches, side and through cuts, diversion and concentration of flow, embankment construction and disposal of waste material, are the major causes of accelerated erosion.

To assess the susceptibility of terrain conditions to erosion and determine those areas requiring active revegetation efforts, a Terrain Erodibility Index has been developed[1].

The Terrain Erodibility Index (T.E.I.) is based on three parameters:

1. soil erodibility
2. slope of the terrain (topography)
3. thaw settlement susceptibility of the terrain.

The effect of each of the above parameters is evaluated by the use of indices as obtained from Tables 1.1, 1.2 and 1.3. The indices are summed to give a total between 2 and 10 and the result is the T.E.I. The T.E.I. is classified as follows:

T.E.I.	Class
2 - 4	Low
5 - 7	Medium
8 - 10	High

In Table 1.1, the soil erodibility index is based on maximum allowable velocities (MAV) for different soil types. The MAV is the maximum flow velocity that the soil can sustain without eroding. The greater the MAV, the lower the soil erodibility index. In Table 1.2, the topography index is based on the concept that the steeper the slope of the terrain, the greater the erodibility. Table 1.3 gives the thermal erosion index according to the potential for more than 0.6 m (2 ft.) of settlement to occur as the result of thermal degradation. (The thaw settlement analyses carried out by Hardy Associates for the Foothills pipeline were used to provide the thaw settlement potential of the various terrain groups.)

[1] Letter June 10, 1981, "Drainage and Erosion Control For Foothills Pipelines, Hardy Associates (1978) Ltd.

TABLE 1.1
SOIL ERODIBILITY INDEX

Bare Soil Erodibility Index	Permissible Velocity Range	Typical Soil Type
1 (low)	greater than 1 m/sec	gravel, peat, compacted clay soils
2 (moderate)	0.5 - 1 m/sec	medium to coarse sand, clay till
3 (high)	less than 0.5 m/sec	silt, silty sand, fine sand

TABLE 1.2
SLOPE INDEX

Topographic Index	Slope	Topography Description
1	0 - 5%	flat to gentle slopes
2	5 - 10%	gentle to moderate slopes; gently rolling relief; or gently sloping terrain with occasional short steep slopes
3	> 10%	frequent steep slopes

TABLE 1.3
SCALE OF THERMAL EROSION INDICES

Thermal Erosion Index	Thaw Settlement Range
0	no settlement
1	less than 10% of data indicates more than 0.6 m of settlement)
2	10-30% of data indicates more than 0.6 m of settlement
3	30-60% of data indicates more than 0.6 m of settlement
4	more than 60% of data indicates more than 0.6 m of settlement

Active revegetation efforts will be employed wherever the T.E.I. exceeds 4 or site-specific conditions warrant accelerated revegetation. These areas may include temporary disturbances such as spoil stockpile sites which will subsequently be recontoured and reseeded prior to completion and areas subjected to unanticipated disturbance. These sites will be assessed during construction and measures will be developed accordingly. In addition, active measures will be employed in conjunction with erosion and drainage control structures (e.g. diversion dykes and mound breaks).

Areas subject to wind erosion are generally highly localized in terms of surface disturbance; however, dry clay or dry cohesionless fine sand and silt will be assumed to be wind erosion prone and treated accordingly.

Revegetation techniques will be employed to assist surface erosion control and supplement physical measures in stabilizing disturbed areas. However, revegetation is a very slow process which cannot be relied upon to solve stability problems.

Aesthetics:

The region through which the route passes is predominantly one of scenic wilderness. The diversity and quality of the wilderness experience afforded by the varied landscape features provides a considerable attraction for visual appreciation.

In considering aesthetics in the context of this plan, two interrelated elements come into play. These are, firstly, the presence of resources of visual interest and, secondly, access which permits the perception of these resources.

Although aesthetics is subject to the vagaries of individual interpretation, persons visiting the region do so to enjoy the scenic wilderness experience it offers. Thus, in the assessment of project induced aesthetic impacts and subsequent amelioration, emphasis is

placed upon those features of the pipeline project which could diminish the scenic wilderness value of the region to significant numbers of people (i.e., travellers along the Alaska Highway).

Construction and operation of the pipeline through the Yukon will add the following features to the landscape:

1) Pipeline right-of-way
2) Compressor station sites
3) Mainline construction camps. (Compressor station camps will be located at the stations and so are not considered separately.)
4) Access roads
5) Stockpile sites
6) Borrow pits
7) Block valves

The travelling public and the majority of Yukon residents will not, however, have direct "on-site" exposure to most of these features unless they deliberately seek them out. Thus, these do not generally require special measures to reduce the disturbance for aesthetic reasons.

The visual impacts of the pipeline and ancilliary facilities will differ in the project's construction and operational phases. The activity of construction crews, vehicles and heavy equipment will make any view of the right-of-way or facility sites highly conspicuous during the short-term construction phase. However, no revegetation efforts will be undertaken to reduce this visual impact during construction. Long-term effects, even though not as pronounced will be mitigated, in part, utilizing active revegetation efforts: reseeding and vegetative propagation techniques.

Areas for which active revegetation efforts will be undertaken to reduce visual impact are documented in the Aesthetics Plan (Foothills Pipe Lines (Yukon) Ltd. 1981). They include pipeline right-of-way and

all ancillary facilities directly visible from and adjacent to primary roadways, navigable waterbodies and viewpoints.

Land Use:

In cooperation with regional management authorities, all legally encumbered lands and waterbodies which directly interact with the Yukon and Swift River segments of the Alaska Highway Gas Pipeline project have been identified. They include:

- parks and game reserves;
- International Biological Program sites;
- public campgrounds;
- mining claims;
- community water intakes and wells; and
- agricultural and grazing leases.

Special measures will be implemented which reflect the site-specific requirements. All work in these areas will be undertaken in cooperation with the appropriate agencies and interested parties.

Growth Potential:

Growth potential is a reflection of the ability of a site to provide adequate moisture, nutrients and favourable microclimate for plant growth. To encourage the re-establishment of a native vegetative cover upon sites with a low growth potential active revegetation efforts will be undertaken. Such areas include alkaline soils (pH > 8), acid soils (pH < 5), dry peaty soils, subalpine soils (> 1000 masl) and arid soils (precipitation < 150 mm during the growing season).

Even though granular soils (with less than 20% fines), and rock outcrops reflect harsh environmental conditions and have a low growth potential, these normally barren surfaces will not be actively revegetated.

1.5 Organization

The planning document provides general information and guidelines in Sections 1.0 to 4.0 Factors considered in the development of the program are briefly identified and discussed. Sections 5.0 to 7.0 are the applied portions of the document, intended to provide the practical applications of the material and procedures according to Revegetation Management Areas (Sections 5.0 and 6.0) and specific locations (Section 7.0). Section 7.0 will be incorporated directly into the construction specifications.

Section 1.0, Introduction, sets forth the purpose, objectives, background, revegetation definitions and criteria, and organization.

Section 2.0, Regulations, outlines the legal and/or regulatory requirements placed upon the Project which will be adhered to by the company during project development.

Section 3.0, Revegetation Management Areas, defines segments along the route with similar biophysical characteristics. Those environmental features influencing the development of the revegetation plan are summarized.

Section 4.0, Revegetation Material and Methods, summarizes the varieties of plant material available, seed mixes, general fertilizer requirements, mulches and tackifiers, topsoil salvage and replacement, cultivation requirements and application methods.

Section 5.0, Revegetation Plans, stipulates the seeding standards which are to be incorporated into the project design and implemented during all phases of the project. They are categorized according to Revegetation Management Areas, and their implementation is based upon construction mode,

erosion potential, soil type and edaphic conditions. Planning Sheets for Revegetation Management Area 2 are provided as an example of the approach being utilized.

Section 6.0, Planting Standards and Special Measures, stipulates the general planting standards which will be implemented following the construction of the pipeline to limit erosion and to ameliorate aesthetic and land-use disturbances. Standards are characterized according to vegetation community type and facility type. This section is in preparation and is not included in the present "draft protection plan".

Section 7.0, Specific Actions Taken, itemizes actions taken or specified in contracts to revegetate areas disturbed by pipeline-related construction. This final section is also not included in the present "draft protection" report but will form part of the "final protection plan" developed to support final design submissions to the Northern Pipeline Agency. A set of specification sheets; however, are provided as examples of the approach being utilized.

2.0 REGULATIONS

Regulations which affect revegetation efforts in the Yukon Territory are as follows: Northern Pipeline Socio-Economic and Environmental Terms and Conditions for the Yukon Territory and for the Swift River segment in British Columbia prepared by the Northern Pipeline Agency, National Energy Board Regulations Respecting Gas Pipelines, and Territorial Land Use Regulations. Additional regulations which will apply to the Foothills Pipe Lines (South Yukon) project area are those of the British Columbia Government. These will relate to the Swift River section of the route which is located in the Province of British Columbia.

In the development of the revegetation plan every effort was made to comply with the stipulations set forth by the Northern Pipeline Agency. Those regulations set forth by other agencies have been considered and incorporated into the plan if compatible with the overall objectives of the program. The applicable stipulations documented in the relevant legislation are presented below:

2.1 Northern Pipeline Socio-Economic and Environmental Terms and Conditions

93. Foothills shall implement such measures as are satisfactory to the designated officer to rehabilitate land disturbed by the construction or operation of the pipeline.

94. Foothills shall, to the satisfaction of the designated officer, take measures to revegetate land, other than agricultural land, disturbed by the construction or operation of the pipeline in a manner that complements any other measure Foothills takes to control drainage and erosion.

95. Where land is to be rehabilitated pursuant to section 93 or revegetated pursuant to section 94, Foothills shall give priority to the following objectives:

(a) the control of erosion and its impact,
(b) the re-establishment of vegetation native to the Yukon Territory on the land, and
(c) the restoration of the aesthetic appearance of the land, and such priority shall be given in the order set out in paragraph (a) to (c).

96. Where Foothills has backfilled any part of the pipeline under construction, Foothills shall, unless otherwise authorized by the designated officer, commence as soon as practicable but, in any event, within one year of the backfilling, the erosion control measures referred to in section 91. the rehabilitation measures referred to in section 93 and the revegetation measures referred to in section 94.

97. (1) Foothills shall monitor, to the satisfaction of the designated officer, the effectiveness of the erosion control measures referred to in section 91, the rehabilitation measures referred to in section 93, the revegetation measures referred to in section 94.

(2) Where, in the opinion of the designated officer, the measures referred to in subsection (1) are ineffective, Foothills shall implement such remedial measures as are satisfactory to the designated officer.

2.2 National Energy Board - Gas Pipeline Regulations

Section 6 (1) This section applies to a company that intends to use the below grade method of installation of a pipeline.

(2) The company shall

(c) stabilize and vegetate the surface of the backfill and the surface of the ground adjoining the ditch, where plant growth is disturbed by excavation.

(3) Where the condition of the ground is such that adequate bearing support will not be provided to the pipe after it is installed or the condition of the backfill is such that soil subsidence will occur after the pipe is installed, the company shall employ adequate measures to achieve bearing support and to correct slumping or erosion and, where practicable, shall

(a) use an alternative ditch padding or backfill material that is not susceptible to instability, slumping, or erosion after installation;

(b) modify the thermal regime in the ground and in the fill material surrounding the pipe by such means as

(iii) the placement of vegetation, fill materials or other cover so as to alter the flow of heat conducted to the ground from the surface

Section 7 (1) This section applies to a company that intends to use the below grade method of installation of a pipeline.

(2) Where practicable, the company shall

(d) vegetate the berm surface and the surrounding ground, where plant growth is disturbed.

(3) Where the berm is subject to deterioration by erosion, the company shall employ measures to prevent the erosion and to ensure adequate cover to protect the pipeline and, where practicable shall:

(a) vegetate the berm surface.

(4) Sub-sections 6 (2) and (3) apply in respect to the below grade method of installation.

Section 25(1) Where disturbances of the ground occur in the construction work the company shall restore the disturbed ground to prevent erosion or slumping and, where practicable, shall:

(c) leave all disturbed areas in a stabilized condition by means of vegetation, seeding, planting or mulching or by the placement of mat binders, soil binders, rock or gravel blankets or structures where necessary.

(2) Where a pipeline right-of-way has been stabilized or restored, the company shall employ measures to protect the right-of-way from subsequent damage.

Section 30 A company shall, where possible, plant trees and shrubs between roads and its pipeline facilities so that the facilities do not present an untidy or unsightly view from the road.

2.3 Territorial Land-Use Regulations (Applied Through Land-Use Permits)

Section 18 Subject to the terms and conditions of this permit, every permitee shall, after completion of the land-use operation, restore the permit area as nearly as possible

to the same condition as it was prior to the commencement of the land-use operation.

2.4 British Columbia - Soil Conservation Act

This act is applicable only to agricultural land reserves.

Section 6 (1) An applicant for a permit shall sign as a part of the application, an undertaking which shall be deemed to be a term and condition of the permit if one is issued,

(b) that before the expiry of the permit, he will

(i) restore the land to a condition fit and suitable for agriculture to a standard approved by the local authority and the commission (commission refers to the Provincal Land Use Commission), or

(ii) restore the land to such condition, and at such time and in such manner, as the local authority and the commission may require.

3.0 REVEGETATION MANAGEMENT AREAS

To facilitate the implementation of the revegetation plan, the Alaska Highway Gas Pipeline route in Yukon and the Swift River segment of British Columbia has been subdivided into six regions; hereinafter referred to as Revegetation Management Areas. The Management Areas reflect climatic extremes, soil and geologic conditions and species composition of natural revegetation along the route and to the extent practicable planned construction sections.

This section defines the six Revegetation Management Areas along the route. A brief description of the dominant environmental characteristics of each management area is presented. The approximate location of each of the areas is shown on Figure 3.1. Comparison of physical factors in each of the Management Areas related to potential revegetation difficulties is summarized in Table 3.1. Botanical and common names used in this plan are provided in Appendix A.

The detailed environmental information required to develop the site specific aspects of the Revegetation Plan are not provided in this section; however, the data are compiled in the following documents:

> Foothills Pipe Lines (South Yukon) Ltd. in prep. Geotechnical Atlas, Calgary, Alberta
>
> Foothills Pipe Lines (South Yukon) Ltd. in prep. Soil Type and Distribution along the Alaska Highway Gas Pipeline, Calgary, Alberta.
>
> Pacific Forest Research Centre. 1980. Vegetation Types and Environmental Factors Associated with the Foothills Gas Pipeline Route, Yukon Territory, Victoria, B.C.

In addition, description of physical conditions and existing vegetation along the route is presented in Vaartnou (1977), Foothills Pipeline (South Yukon) Ltd. (1979) and Orloci (1980). Vegetation of

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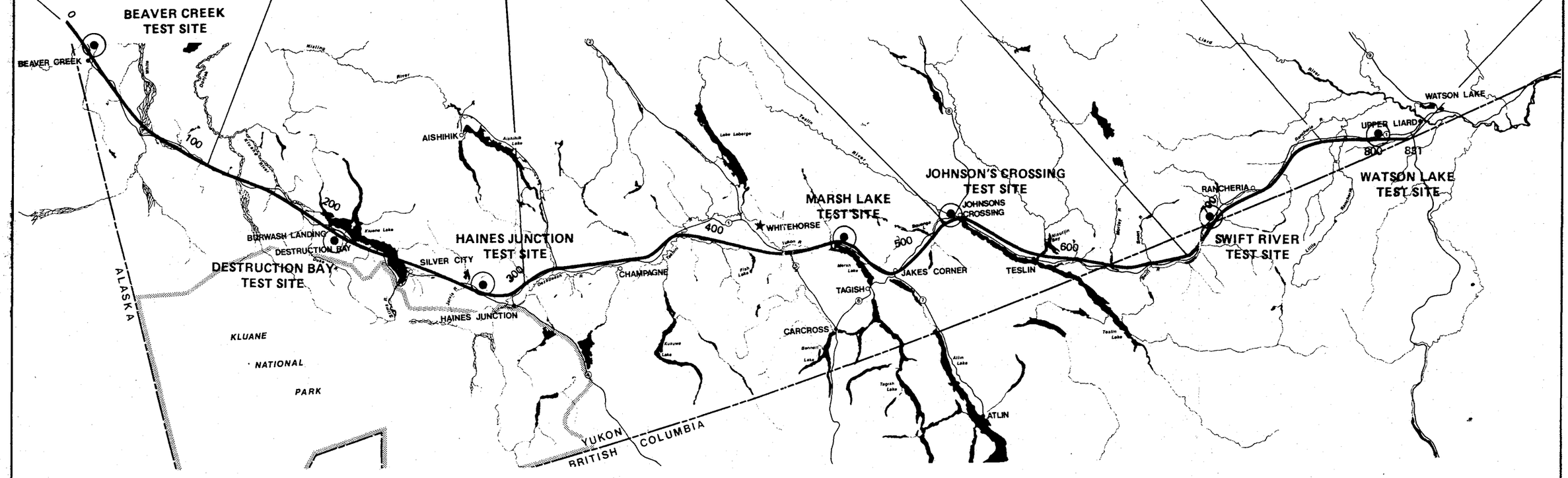
SECTIONS 1, 2	SECTIONS 3, 4, 5	SECTIONS 6, 7, 8	SECTIONS 9, 10	SECTIONS 11, 12a	SECTIONS 13a, 12b, 13b	
MANAGEMENT AREA ONE	MANAGEMENT AREA TWO	MANAGEMENT AREA THREE	MANAGEMENT AREA FOUR	MANAGEMENT AREA FIVE	MANAGEMENT AREA SIX	
ALASKA BORDER TO PICKHANDLE LAKE	PICKHANDLE LAKE TO PINE LAKE	PINE LAKE TO SQUANGA LAKE	SQUANGA LAKE TO MORLEY LAKE	MORLEY LAKE TO BOULDER CREEK	BOULDER CREEK TO BRITISH COLUMBIA BORDER	



REVISIONS					
NO.		DATE	APPR.	BY	CHKD.

Foothills Pipe Lines (Yukon) Ltd.

	DRAWN	CHECKED	APPROVED	APPROVED
BY	N.G.B			
DATE	81-07-31			

TITLE

THE ALASKA HIGHWAY GAS PIPELINE PROJECT

MAP 3.1

REVEGETATION MANAGEMENT AREAS & REVEGETATION TEST SITES

SCALE

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TABLE 3.1

COMPARISON OF PHYSICAL CONDITIONS
IN THE REVEGETATION MANAGEMENT AREAS ALONG THE
ALASKA HIGHWAY PIPELINE ROUTE

	LENGTH OF FROST FREE PERIOD	MEAN DAILY TEMPERATURES JANUARY	TOTAL PRECIPITATION	PRECIPITATION DURING GROWING SEASON (MAY TO SEPT. INCL.)	RIGHT-OF-WAY ELEVATION	RIGHT-OF-WAY SOIL SALINITY
	(days)	(°C)	(mm)	(mm)	(masl)	
Area One - Alaska Border to Pickhandle Lake	51	-28.2	359.7	228.8	greater than 700	normal
Area Two - Pickhandle Creek to Pine Lake	21	-21.6	282.4	136.1	greater than 800	high
Area Three - Pine Lake to Squanga Lake	87	-18.9	260.0	140.6	greater than 700	high
Area Four - Squanga Lake to Morley Lake	60	-20.2	326	153.3	greater than 700	normal
Area Five - Morley Lake to Boulder Creek	n/a	n/a	n/a	n/a	greater than 900	normal
Area Six - Boulder Creek to British Columbia Border	95	-25.3	432	210.8	800	normal

n/a = not available.

the southwest Yukon has been studied by Douglas (1974), Grieve (1974), Nielsen (1968, 1972), Price (1970), Porsild (1966) and Scotter (1973). Also Hoefs, Cowan and Krajina (1975) completed a quantitative study on Sheep Mountain. Vegetation of southeast Yukon has been studied by Scotter and Henry (1977), Marsh and Scotter (1976, 1975), Fletcher, Doyle and Brink (1973) and Porsild (1951).

Halliday (1937), LaRoi (1967), Oswald and Senyk (1977) and Rowe (1972) have investigated the pipeline route as part of larger studies. Floras by Hulten (1968) and Welsh (1974) include the Yukon, and Annas (1974) studied the grasslands of the Yukon.

The Revegetation Management Areas and construction spreads correlate to the ecoregions of Oswald and Senyk (1977) as follows:

Management Area	1	KP 0 - 110; construction spread 1,2 corresponds to the Wellesley Lake Ecoregion.
Management Area	2	KP 110 - 300; construction spread 3,4,5 corresponds to the Ruby Range Ecoregion.
Management Area	3	KP 300 - 537; construction spread 6,7,8 consists of an area made up of portions of both the Dawson Range and Lake Laberge Ecoregions.
Management Area	4	KP 537 - 661; construction spread 9,10 includes a southeastern section of the Lake Laberge Ecoregion.
Management Area	5	KP 661 - 760; construction spread 11,12a approximates the Pelly Mountains Ecoregion.
Management Area	6	KP 760 - 831; construction spread 13a,12b,13b approximates the Liard River Ecoregion.

3.1 Management Area One - KP 0 - 110

The generally low lying terrain, at elevations of about 700 m.a.s.l.; is characterized by a cold continental climate and widespread permafrost. Growing season precipitation exceeds that recorded in the other parts of the route (Table 3.1). Moraines, tills, glaciofluvial, glaciolacustrine and thick buried organic deposits are common.

Cryosols occur with the highest frequency. Brunisols, are less common and are confined to warm sites. Regosols are even less frequent, occurring on rock outcroppings and recent alluvium. The soils tend to be course textured, low in silt and clay. In June, seasonally frozen ground is close to the soil surface, increasing in depth until September. Permafrost tends to be ice-rich. The modal slope angle is near zero, and soil drainage tends to be impeded.

Vegetation within this Area consists primarily of woodlands or scrub forests with occasional areas of grassland occurring on very well-drained hillsides and willow-sedge areas on mesic alluvial mineral soils. Riparian and wetland communities dominated by shrubs are common. Sedge tussock and black spruce bogs are found throughout the Area.

On disturbed sites in Area One, slender and purple wheatgrass, bluegrass, foxtail barley and alkali grass are the dominant recolonizing plant species. Secondary invaders include shrubs such as willows, buffaloberry, shrubby cinquefoil, prickly rose, Labrador tea and shrub birch. The first legumes to colonize disturbed areas are Mackenzie's hedysarum and lupine.

Other species commonly present on disturbed areas are sage in very dry areas; Gorman beard tongue, and Jacob's ladder.

3.2 Management Area Two - KP 110 - 300

This is the most heterogenous of the Management Areas and it has the longest intercept with the Alaska Highway. Moderate elevations, foothill conditions and a severe rainshadow effect are characteristic. The climate is harsh, continental and substantially drier than in Area One (Table 3.1). Consequently, severe drought during the growing season may retard germination and make seedling survival difficult in some years. Winter temperatures are very low.

Intrusive and metamorphic rocks are widespread, sometimes exposed, but most often covered under deep mantles of morainal, glaciofluvial, or lacustrine deposits. Colluvial and alluvial deposits affect local areas. West of Kluane Lake extensive deposits of buried organic material exist, averaging one to two metres thick. East of Kluane Lake these deposits are limited in distribution. Brunisols and Cryosols are the most frequent soil types. Regosols and Gleysols are sparse. In contrast to Area One, the soils tend to be coarser and better drained, organic matter content appears to be lower and the organic horizons tend to be shallower. The incidence of soils without permafrost increases drastically. Southerly exposures are more frequent and level terrain is less common.

Open canopy forests are the characteristic vegetative cover throughout Area Two with white spruce stands being most common. West of Kluane Lake black spruce stands are present. Mixed wood stands are uncommon and occur only on some hill sides. Non-forest communities include willow-sedge meadows and grasslands. The latter, while uncommon, occur more frequently than in the Area One.

Vegetation east of Kluane Lake consists mainly of closed canopy white spruce forests which are often mixed with aspen or paper birch scrublands. Mixed wood forests representing the seral stage prior to climax spruce stands are not common. Non-forested areas include occasional willow-sedge meadows, some of which occur on alkaline soils, as well as occasional grassland areas.

On disturbed sites with mineral soils, purple wheatgrass is the dominant invader. Hairgrass, bluegrasses, sweetgrass, ticklegrass, alkali grass and fescue are also early invaders. These same species are the first to colonize disturbed areas in peat bogs, if the peat layer is mixed with the underlying mineral soil. Another fescue, along with hairgrass, are the first to establish on drier parts of peat bogs, if the organic layer is not mixed with the subsoil. Grasses are frequently accompanied on disturbed sites by common invaders such as fireweed, northern bedstraw, Jacob's ladder and goldenrod. Locoweed, milk vetch and lupine are the first legumes to recolonize disturbed warmer, mineral soils. Hedysarum also invades disturbed areas, especially those which are semi-shaded. Legumes do not commonly occur on disturbed moist, cold, organic soils. Woody species follow the primary invaders on disturbed sites. Willows are frequently the first shrubs to return although rose, shrubby cinquefoil and buffalo berry may also become important species.

3.3 Management Area Three - KP 300 - 537

Area Three is the driest of the six Management Areas. Sandy soils and the possibility of frequent summer droughts present probably the most severe conditions related to revegetation. The landscape is characterized by dissected plateaus, flat-rolling hills, generally low elevations, rainshadow effect and harsh winter temperatures. Elevations along the route range between 600 m and 900 m, with the exception of the Ibex Pass and Squanga Lake alternatives with elevations of 1450 m and 1200 m, respectively. The soils tend to be coarser than in Area Two, but are variable with medium-textured tills overlain by coarser materials in the northwestern section and silty and sandy soils occurring in the southeastern section.

Brunisols are the most prevalent soil type, but Regosols are also frequent. Cryosols, Gleysols and Organic soils occur with low frequency. The silt and clay content is low. The active layer tends to be deeper than in Area Two. Most soil profiles have no permafrost within the upper metre. The slopes tend to be moderately steep. The

erosion potential is medium to low and is generally less sensitive than Area Two.

Vegetation in Area Three is characterized by drought-resistant communities. White spruce forests in northern portions of the region give way quickly to lodgepole pine stands interspersed with grassy slopes in the south. Riparian communities, while present, tend to be restricted as a result of more stable streambeds cut deeply into finer-grained substrates.

Grasses, such as bluegrasses, wheatgrasses, fescues and foxtail barley rapidly invade disturbed sites. Legumes such as lupine, locoweed and milk vetches are also relatively abundant. Other plants which commonly occur on disturbed sites are yarrow, fireweed, flax, dandelion and tall lungwort. Secondary successional species include shrubs such as rose and willow. White spruce, lodgepole pine and aspen are early invaders to the west of the Ibex alternative; whereas, lodgepole pine is more dominant to the east of the Ibex area.

3.4 Management Area Four - KP 537 - 661

The landscape from Squanga Lake to Morley Lake is characterized by rolling hills and dissected plateaus. Terrain at lower elevations consists of morainal and glaciofluvial deposits. Fine textured sands and silty soils in the region are susceptible to wind erosion. Temperatures are moderate compared to adjacent areas and precipitation tends to be higher than Area Three. Summer droughts can be severe, but higher snowfall may increase the moisture available in spring for seedling germination and emergence.

Similiar to Area Three, Brunisols and Regosols are the most common soils. Crysols, Gleysols and Organic Soils occur with lower frequency.

Vegetation in the area consists mainly of open stands of lodgepole pine and relatively frequent willow-sedge meadows with grassland areas

on southern slopes. Riparian communities are dominated by willows and alders to a greater degree than in areas to the north and west.

The early successional patterns on disturbed areas are also similar to those previously discussed in Areas Two and Three. Lodgepole pine is the primary tree species in the early stages.

3.5 Management Area Five - KP 661 - 760

Whereas the relief in Area Five is dominated by the Cassiar Mountains and the Dease Plateau, the route is generally below 1000 m.a.s.l. Intrusive, volcanic and metamorphosed sedimentary rocks underlie the terrain in the mountains. The plateau is mainly of sedimentary rocks. Deep deposits of glacial origin cover much of the surface. Alluvial and colluvial deposits are localized.

The mean annual precipitation is estimated to lie between 375 and 625 mm, varying according to elevation and aspect. In general, this is higher than in Areas Three and Four, but the area still experiences severe summer drought. The mean annual temperature is believed to be between -4° and -6°C at low elevations; however, the growing season and frost free periods vary considerably as to when early fall and/or late spring frosts occur.

Compared to Area Four, soil texture is generally finer and the organic horizon depth greater. Slopes tend to be steep.

The area is characterized by immature stands of lodgepole pine and spruce, a situation apparently resulting from widespread fires in the past. Grassland areas are much less common than in the Areas to the north, tending to occur only on well-drained, south facing slopes.

As in the case of previously described Management Areas, a variety of grasses and forbs initially colonize disturbed areas. The most dominant grass is foxtail barley, although the wheatgrasses, bluegrasses, fescues and reedgrasses also play an important recolonization role. Legumes, such as hedysarum, locoweed and lupine,

and other forbs, such as yarrow, fireweed, pussytoes and sage, are also prominent invader species. Secondary invading species are shrubs, such as rose, willow, wolf willow, raspberry and alder. This is followed by a gradual succession to a forest with lodgepole dominating early stages.

3.6 Management Area Six - KP 760 - 831

Area Six includes the Liard Plain and Dease Plateau at elevations of about 800 m. The bedrock is mainly sedimentary or metamorphic. Deep deposits of glacial origin cover the terrain. Locally, rock outcroppings occur, and some areas are affected by alluvial deposits. The climate is cold continental; however, the growing season is longer than the other Areas. Total precipitation is greatest in this Area, with more than half being received during the non-growing season.

In comparison with Areas Four and Five, the soil texture tends to be finer, the organic matter content higher and the depth of the organic horizon thicker. Exposures are more frequently northerly, and slopes are generally more gentle than Area Five. Brunisolic soils continue to be the most dominant soil type.

Vegetation within Area Six consists essentially of continuous forest stands broken only on rare occasions by meadows and grasslands. Pine dominates the area, a reflection of repeated forest fires, but stands of white spruce are common. Black spruce and mixed black and white spruce stands occur occasionally.

Colonization of disturbed areas follows a similar pattern to Areas Four and Five. Foxtail barley is usually the most prominent of the invading grasses, but, depending upon conditions, initial colonizers may also include the wheatgrasses, bluegrasses, ticklegrass, fescue, alkali grass and introduced species such as timothy and smooth brome. Other primary invaders include legumes such as milk vetch, hedysarum,

locoweed and lupine, and other forbs such as yarrow, sage, fireweed, northern bedstaw, tall lungwort, and Jacob's ladder. The early stages are followed by reinvasion of shrubs, such as alder, rose, willow, wolf willow and raspberry. Subsequently, aspen, poplar and pine enter the successional sequence to the climax white spruce forest.

4.0 MATERIALS AND METHODS

This section outlines the materials and methods which will be utilized for the Alaska Highway Gas Pipeline revegetation program in the Yukon and Swift River segment. The criteria for selection of a seed mix, fertilizer, mulch or tackifier as well as the application method is in part based upon the defined objectives at the specific site: to encourage the re-establishment of a self-supporting native vegetative cover; to assist long term or temporary erosion control; to mitigate aesthetic disturbance or to ensure compatible secondary land-use conditions. The material and method selection criteria also reflect the local conditions: temperature regime, permafrost, soil type, elevation, aspect, season, wind conditions. In the final selection process, material and methods will be modified to accommodate material availability, site accessibility and program complexity.

4.1 Revegetation Materials

4.1.1 Seed Varieties

Seed varieties of grasses and legumes indigeneous to the southern Yukon and northern British Columbia will be utilized wherever possible in the revegetation program. The material to be seeded has been specifically selected to foster the establishment of a self-supporting plant community upon disturbed sites. Based upon the results of the Revegetation Test Sites established along the Alaska Highway Gas Pipeline within each of the Revegetation Management Areas (Map 3.1) and available government, industry and academic reports, twenty-one varieties have been selected. These varieties are adapted to the environmental conditions found in the southern Yukon and northern British Columbia. The varieties can be effectively multiplied utilizing standard field techniques to satisfy the revegetation objectives. In addition, Alsike clover and Anik alfalfa are included because of their capacity to fix nitrogen. Table 4.1 identifies the species selected and their relevant characteristics.

TABLE 4.1
CHARACTERISTICS CONSIDERED IN THE SELECTION OF SPECIES FOR REVEGETATION OF THE ALASKA HIGHWAY GAS PIPELINE PROJECT

	Bunch Growth Habit	Creeping Growth Habit	Rapid Emergence	Early Spring Growth	Late Fall Growth	Low Growth Habit	Potential Fire Hazard	High Root:Shoot Ratio	High Ground Cover Production	Good Biocompetitive Ability
Agropyron cristatum	●		●	●			●			
A. pauciflorum	●		●	●	●		●	●		
A. riparium		●	●		●				●	●
A. violaceum	●		●	●	●			●	●	●
Agrostis gigantea		●	●	●	●				●	●
Alopecurus pratensis	●		●	●	●		●		●	●
A. arundinacea		●	●	●	●			●	●	●
Bromus inermis		●	●	●	●		●		●	
Deschampsia caespitosa	●				●				●	●
Festuca ovina	●					●				
F. rubra		●	●	●	●				●	●
F. saximontana	●			●		●		●		●
Medicago sp.		●		●	●		●		●	
Phleum pratense	●		●	●	●		●		●	
Poa alpina	●					●		●		
P. ampla	●				●					●
P. compressa		●		●		●		●	●	
P. glauca	●			●		●		●		●
P. palustris	●		●	●				●		●
P. pratensis		●		●	●				●	●
Puccinellia Nuttalliana	●		●	●		●				
Trifolium hybridum	●			●		●			●	●

TABLE 4.1
CHARACTERISTICS CONSIDERED IN THE SELECTION OF SPECIES FOR REVEGETATION OF THE ALASKA HIGHWAY GAS PIPELINE PROJECT

	Low Nutrient Tolerance	Alkalinity Tolerance	Acidity Tolerance	Salinity Tolerance	Organic Soil Tolerance	Permafrost Tolerance	Drought Tolerance	High Altitude Tolerance	Resistant to Northern Diseases	Adapted to Hydric Soils
Agropyron cristatum							●			
A. pauciflorum	●	●								
A. riparium										
A. violaceum	●	●				●	●	●	●	
Agrostis gigantea			●		●	●				●
Alopecurus pratensis			●		●	●				●
A. arundinacea			●		●					●
Bromus inermis										
Deschampsia caespitosa	●		●			●		●	●	●
Festuca ovina	●		●				●			
F. rubra						●		●	●	
F. saximontana	●						●		●	
Medicago sp.		●								
Phleum pratense			●		●					
Poa alpina	●					●		●	●	
P. ampla	●	●		●						
P. compressa	●									
P. glauca	●	●				●	●	●	●	
P. palustris	●		●			●			●	●
P. pratensis										
Puccinellia Nuttalliana	●	●		●		●	●	●	●	
Trifolium hybridum			●							

The native ecotypes, naturalized land races and agronomic cultivars selected possess characteristics which may differ significantly from those important to varieties utilized for agronomic and horticultural purposes. Forage yield and quantity were not considered the primary criteria, but rather the adaptability to local environments, cover production, growth habit, aesthetic quality and biocompetitive ability.

Adaptability to Local Environments

A species must be compatible with the local climatic conditions. The temperature in an area, the moisture regime, and the effects of photo period and light intensity must all be considered in selecting particular species. The species selected must be tolerant to physical and chemical properties of the soil and must not be susceptible to local diseases.

Cover Production

In rehabilitation work, the amount of ground cover provided by a species is important in providing temporary and long-term erosion control.

Growth Habits

Grass species used in a revegetation seed mix must provide a diversity in growth habit. Planting a variety of species which differ in root habit optimizes the use of nutrients at various levels in the soil profile. The depth to which the roots penetrate in a particular soil is often a species characteristic. Fibrous, taproot, or creeping root systems, or combinations thereof, will be advantageous for erosion control and establishment on sites with severe edaphic conditions.

Aesthetic Considerations

In locations where pipeline disturbance is proximal to areas of aesthetic importance, active revegetation efforts will be used in part to decrease the visual impact. Such locations will be replanted with vegetation which is compatible with the local environment and, plant communities. Diverse forms of plant life such as shrubs, trees, grasses and legumes will be incorporated into the site, if such were present prior to the disturbance. The vegetative material available to mitigate visual disturbances is shown in Table 4.20.

Land-Use Considerations

In areas where project related activities disturb legally encumbered land, active revegetation efforts will be employed to ensure future compatible land-use. Materials and methods which will be utilized in the revegetation program for these areas will be developed in consultation with the appropriate resource management authorities and interest groups.

Bio-Competitive Ability

A single plant species may seem well suited for use in a particular environment; but, monocultures are unstable and the greater the diversity in species within a stand the greater is the stability of the stand. In the selection of a mixture of species, each must be considered for its competitive ability. In many ways, this aspect is a cumulative effect of all other selection factors, for the plant must be able to survive and reproduce within the plant community. Competition between species for water and nutrients, as well as tolerance to shading and crowding by other plants, are considered in the final species selection process.

Seed Development and Availability

The native ecotypes and naturalized land races which are being utilized in this program were initially hand collected from parts of northern Canada, then tested and multiplied specifically for Foothills Pipe Lines (Yukon) Ltd. Collection locations and propagation methods are presented in Table 4.2.

All of the proposed varietal selections are available in limited quantities and are being multiplied on a contract basis with growers in northern British Columbia and Alberta.

Agronomic cultivars in general are not as well adapted as native varieties; however, those cultivars which showed good results at the Alaska Highway Gas Pipeline Test Sites or at similar test sites in Alaska, Yukon and NWT are included as potential sources of seed material. These varieties include boreal creeping red fescue, meadow foxtail, Durar hard fescue, sheep fescue, arctared fescue, timothy, and smooth brome.

4.1.2 Seed Mixtures

Utilizing a diverse mixture of selected varieties, a vegetative cover will be established which is less vulnerable to pests, disease, and climatic extremes. Each mix includes varieties which are adaptable to the broadest range of anticipated microenvironments, and thus offer the greatest assurance of success. Mixes have been developed for each of the Revegetation Management Areas and a variety of special soil types which exist along the route (Table 4.3 - 4.16).

An additional mix (Table 4.17) has been developed specifically to provide temporary erosion control. This mix would be employed immediately following construction on erosion prone soils to minimize the loss of fine grained sediment. It would only be utilized during suboptimal seeding periods. The site will be reseeded with the appropriate permanent mix at the optimal time period.

TABLE 4.2

SOURCE AND BREEDING METHODS
OF VARIETAL SELECTIONS

VARIETIES	COLLECTION LOCATION	STOCK SEED SOURCE	BREEDER SEED SOURCE
Agropyron pauciflorum Native ecotype	Teslin	seed from 200 selected plants	stock seed planted - 1/4 acre
Agropyron riparium Naturalized land race	Beaverlodge	seed from 200 veg. prop. plants	stock seed planted - 1/4 acre
Agropyron sp. (violaceum) Native ecotype	Kluane Lake	seed from 200 selected plants	stock seed planted - 1/4 acre
Agrostis gigantea Naturalized land race	High Level	seed from 200 veg. prop. plants	stock seed planted - 1/4 acre
Alopecurus pratensis Naturalized land race	Smithers	seed from 200 veg. prop. plants	stock seed planted - 1/4 acre
Bromus inermis Naturalized land race	Fort St. John	seed from 200 veg. prop. plants	stock seed planted - 1/4 acre
Deschampsia caespitosa Native ecotype	Haines Junction	seed from 200 selected plants	stock seed planted - 1/4 acre
Festuca rubra Naturalized land race	Haines Junction	seed from 200 veg. prop. plants	stock seed planted - 1/4 acre
Festuca saximontana Native ecotype	High Level	seed from 200 selected plants	stock seed planted - 1/4 acre
Medicago falcata cv. Anik Agronomic cultivar			
Phleum pratense Naturalized land race	High Level	seed from 200 veg. prop. plants	stock seed planted - 1/4 acre
Poa alpina Native ecotype	Cassiar Mtn.	seed from 200 selected plants	stock seed planted - 1/4 acre
Poa ampla Native ecotype	Kleskum Hills	seed from 200 selected plants	stock seed planted - 1/4 acre
Poa compressa Naturalized land race	High Level	seed from 200 veg. prop. plants	stock seed planted - 1/4 acre
Poa glauca Native ecotype	Whitehorse	seed from 200 selected plants	stock seed planted - 1/4 acre
Poa palustris Native ecotype	Teslin	seed from 200 selected plants	stock seed planted - 1/4 acre
Poa pratensis Naturalized land race	Haines Junction	seed from 200 veg. prop. plants	stock seed planted - 1/4 acre
Puccinellia sp. (nuttalliana) Native ecotype	High Level	seed from 200 selected plants	stock seed planted - 1/4 acre
Trifolium hybridum cv. Dawn Agronomic cultivar			

[1]VARIETAL SELECTION CLASSIFICATION:

AGRONOMIC CULTIVAR: A commercially available strain of a species selected by man for any of several specific traits such as forage quality, drought resistance or cold tolerance.

NATIVE ECOTYPE: A naturally occurring variety of a species which has evolved genetically in response to its environment. This contrasts with exotic varieties introduced directly or indirectly by man into any given area.

NATURALIZED LAND RACE: Intermediate between native and exotic varieties. A species introduced sufficiently long ago that it now has completely established itself in a given area and behaves similarily to a native species.

VARIETY: Variety denotes a general term encompassing the native ecotypes, naturalized land races and agronomic cultivars which have been used as the revegetation candidate entires in this program.

The application rates for each seed mixture varies according to Revegetation Management Area, terrain conditions and the nature of the revegetation objectives. A minimum seeding rate will be applied to ensure vigorous plant growth without limiting reinvasion from adjacent undisturbed areas or creating excessive interspecific competition. The rates are documented in Section 5.0.

Revegetation Management Area One	Seed Mix A
Revegetation Management Area Two	Seed Mix B
Revegetation Management Area Three	Seed Mix C
Revegetation Management Area Four	Seed Mix D
Revegetation Management Area Five	Seed Mix E
Revegetation Management Area Six	Seed Mix F
Special Soil Types	
Alkaline (pH > 8)	Seed Mix I
Acid (pH < 4)	Seed Mix J
Course Textured Soils	Seed Mix K
Fine Textured Soils	Seed Mix L
Sub-Alpine	Seed Mix N
Peat (xeric)	Seed Mix O
Temporary	Seed Mix P

TABLE 4.3

RECOMMENDED SEED MIXTURE A
REVEGETATION MANAGEMENT AREA ONE

KP 0 - 110

SPECIES	COMMON NAME	PERCENT BY WEIGHT
- Agropyron pauciflorum	slender wheatgrass	20
- Agropyron riparium	streambank wheatgrass	5
- Agropyron sp. (violaceum)	purple wheatgrass	10
- Agrostis gigantea	red top	5
- Alopecurus pratensis	meadow foxtail	10
- Festuca rubra	red fescue	15
- Phleum pratense	timothy	10
- Poa palustris	fowl bluegrass	15
- Poa pratensis	Kentucky bluegrass	5
- Trifolium hybridum	alsike clover	5

Agropyron pauciflorum, Agropyron sp. (violaceum) and Poa palustris are among the first colonizers on disturbed areas in this region. All three emerge rapidly and will provide early erosion control. Agropyron riparium will also provide early ground cover while Phleum pratense, Alopecurus pratensis and Agrostis gigantea are more adapted to provide ground cover on moist acidic areas. The Festuca rubra and Poa pratensis will provide long term cover once established while the Trifolium hybridum will help provide nitrogen through its symbiotic relationship with Rhizobium sp. bacteria.

TABLE 4.4

RECOMMENDED SEED MIXTURE B
REVEGETATION MANAGEMENT AREA TWO

KP 110 - 300

SPECIES	COMMON NAME	PERCENT BY WEIGHT
- Agropyron riparium	streambank wheatgrass	5
- Agropyron sp. (violaceum)	purple wheatgrass	35
- Festuca rubra	red fescue	20
- Phleum pratense	timothy	5
- Poa glauca	glaucous bluegrass	10
- Poa palustris	fowl bluegrass	10
- Poa pratensis	Kentucky bluegrass	5
- Trifolium hybridum	alsike clover	5

Agropyron sp. (violaceum) is the dominant invading grass on disturbed sites in this region. It will provide rapid ground cover on coarse soils and on the slightly alkaline soils which exist in this region. Agropyron riparium will also provide early erosion control. Poa palustris, Phleum pratense and Festuca rubra will provide rapid ground cover on mesic areas on fine soils. Poa pratensis will provide long term cover on mesic soils while Poa glauca will be the permanent ground cover on xeric soils. The Trifolium hybridum is included because of its nitrogen fixation.

TABLE 4.5

RECOMMENDED SEED MIXTURE C
REVEGETATION MANAGEMENT AREA THREE

KP 300 - 537

SPECIES	COMMON NAME	PERCENT BY WEIGHT
- Agropyron riparium	streambank wheatgrass	10
- Agropyron sp. (violaceum)	purple wheatgrass	40
- Festuca rubra	red fescue	10
- Phleum pratense	timothy	10
- Poa glauca	glaucous bluegrass	20
- Poa palustris	fowl bluegrass	5
- Poa pratensis	Kentucky bluegrass	5

Agropyron sp. (violaceum) is the primary invader on dryer, slightly alkaline soils in this region. This species and Agropyron riparium will provide rapid ground cover on disturbed sites. Poa palustris is included to provide rapid cover on mesic microsites. On mesic sites long term cover will be provided by Festuca rubra and Poa pratensis. However, of all the management areas, this area receives the least precipitation and Poa glauca will be necessary to provide long term cover for most of this area. These latter two species are major components of the grasslands of this area.

TABLE 4.6

RECOMMENDED SEED MIXTURE D
REVEGETATION MANAGEMENT AREA FOUR

KP 537 - 661

SPECIES	COMMON NAME	PERCENT BY WEIGHT
- Agropyron pauciflorum	slender wheatgrass	10
- Agropyron riparium	streambank wheatgrass	5
- Agropyron sp. (violaceum)	purple wheatgrass	30
- Agrostis gigantea	red top	5
- Festuca rubra	red fescue	20
- Festuca saximontana	native fescue	5
- Poa palustris	fowl bluegrass	15
- Poa pratensis	Kentucky bluegrass	5
- Trifolium hybridum	alsike clover	5

Agropyron sp. (violaceum), Agropyron pauciflorum and Poa palustris are the primary invaders of disturbed sites in this area. They will provide the rapid emergence and growth for early erosion control on coarse and medium textured soil. Agropyron riparium is included to provide early cover on heavier soil while Agrostis gigantea will provide cover on more acidic organic soils. Permanent cover will be provided by Festuca rubra and Poa pratensis on mesic soils and by Festuca saximontana on sandy and xeric soils. The Trifolium hybridum is included because of its nitrogen fixation capability.

TABLE 4.7

RECOMMENDED SEED MIXTURE E
REVEGETATION MANAGEMENT AREA FIVE

KP 661 - 760

SPECIES	COMMON NAME	PERCENT BY WEIGHT
- *Agropyron riparium*	streambank wheatgrass	5
- *Agropyron sp.* (violaceum)	purple wheatgrass	30
- *Alopecurus pratensis*	meadow foxtail	5
- *Bromus inermis*	smooth brome	10
- *Festuca rubra*	red fescue	15
- *Phleum pratense*	timothy	10
- *Poa palustris*	fowl bluegrass	15
- *Poa pratensis*	Kentucky bluegrass	5
- *Trifolium hybridum*	alsike clover	5

In this area the primary invading grasses are *Bromus inermis*, *Phleum pratense*, *Agropyron sp.* (violaceum) and *Poa palustris*. Thus these species and *Agropyron riparium* are included to provide early emergence and rapid growth for initial erosion control. *Alopecurus pratensis* is included for revegetation of moist microsites. Long term cover will be provided by the rhizomatous species *Poa pratensis* and *Festuca rubra*. *Trifolium hybridum* is included for its initial nitrogen fixation ability. Also, this latter species may survive as long term cover in this region.

TABLE 4.8

RECOMMENDED SEED MIXTURE F
REVEGETATION MANAGEMENT AREA SIX

KP 760 - 831

SPECIES	COMMON NAME	PERCENT BY WEIGHT
- Agropyron pauciflorum	slender wheatgrass	20
- Agrostis gigantea	red top	5
- Alopecurus pratensis	meadow foxtail	5
- Bromus inermis	smooth brome	10
- Festuca rubra	red fescue	10
- Phleum pratense	timothy	15
- Poa palustris	fowl bluegrass	20
- Poa pratensis	Kentucky bluegrass	5
- Trifolium hybridum	alsike clover	5

In this region Agropyron pauciflorum, Poa palustris, Bromus inermis and Phleum pratense are the primary invaders of disturbed sites. These four species will provide the early emergence and rapid development needed for initial erosion control. Agrostis gigantea and Alopecurus pratensis will provide cover on mesic microsites. Long term cover will be provided by Festuca rubra and Poa pratensis. Trifolium hybridum is included because of its nitrogen fixation capability.

TABLE 4.9

RECOMMENDED SEED MIXTURE O
FOR DRY PEAT

SPECIES	COMMON NAME	PERCENT BY WEIGHT
- Agropyron sp. (violaceum)	purple wheatgrass	25
- Alopecurus arundinacea	creeping foxtail	15
- Alopecurus pratensis	meadow foxtail	20
- Agrostis gigantea	red top	10
- Deschampsia caespitosa	hairgrass	10
- Poa palustris	fowl bluegrass	10
- Poa pratensis	Kentucky bluegrass	10

On predominantly peat soils early development and initial erosion control will be provided by Agropyron sp. (violaceum) and Poa palustris. Agrostis gigantea and Deschampsia caespitosa are included in the mixture to provide some acid tolerant species. Long term cover will be provided by Alopecurus arundinacea and Alopecurus pratensis and by Poa pratensis if this latter species can successfully establish itself.

TABLE 4.10

RECOMMENDED SEED MIXTURE I FOR ALKALINE SOILS

SPECIES	COMMON NAME	PERCENT BY WEIGHT
- Agropyron cristatum	crested wheatgrass	25
- Agropyron sp. (violaceum)	purple wheatgrass	20
- Festuca saximontana	native fescue	15
- Poa ampla	bluegrass	15
- Poa glauca	glaucous bluegrass	10
- Puccinellia Nuttalliana	alkaligrass	15

On alkaline soils, Agropyron sp. (violaceum) and Agropyron cristatum will provide early emergence and rapid development. Poa ampla, on fine soils and Puccinellia Nuttalliana, on coarse soils, are the most alkaline resistant species. Poa glauca will provide plant resistance to drought and alkalinity on fine-textured soils while Festuca saximontana can survive on sandy soils.

TABLE 4.11

RECOMMENDED SEED MIXTURE J FOR ACID SOILS

SPECIES	COMMON NAME	PERCENT BY WEIGHT
- Agrostis gigantea	red top	10
- Alopecurus pratensis	meadow foxtail	25
- Deschampsia caespitosa	hairgrass	20
- Festuca ovina	sheep fescue	10
- Phleum pratense	timothy	15
- Poa palustris	fowl bluegrass	20

Poa palustris, Alopecurus pratensis and Phleum pratense are included for early emergence and development. Agrostis gigantea and Deschampsia caespitosa are acid tolerant on fine textured moist soils while Festuca ovina can survive on xeric, sandy soils.

TABLE 4.12

RECOMMENDED SEED MIXTURE K FOR COURSE TEXTURED SOILS*

SPECIES	COMMON NAME	PERCENT BY WEIGHT
- Agropyron sp. (violaceum)	purple wheatgrass	20
- Agropyron riparium	streambank wheatgrass	10
- Festuca ovina	sheep fescue	20
- Festuca saximontana	native fescue	20
- Poa compressa	Canada bluegrass	20
- Poa glauca	glaucous bluegrass	10

On low fertility, coarse textured sandy slopes, Agropyron sp. (violaceum) and Agropyron riparium are included to provide rapid first year cover. Poa compressa is included because of its low nutrient requirements and rhizomatous growth form. Long term cover will be provided by Poa glacua, Festuca saximontana and Festuca ovina as these species have relatively low nutrient requirements and considerable drought tolerance.

* course textured soils include sand and loamy sand

TABLE 4.13

RECOMMENDED SEED MIXTURE L FOR FINE TEXTURED SOILS*

SPECIES	COMMON NAME	PERCENT BY WEIGHT
- Agropyron cristatum	crested wheatgrass	15
- Agropyron sp. (violaceum)	purple wheatgrass	20
- Agropyron riparium	streambank wheatgrass	10
- Agrostis gigantea	red top	10
- Festuca ovina	sheep fescue	10
- Poa ampla	bluegrass	10
- Poa glauca	glaucous bluegrass	10
- Poa palustris	fowl bluegrass	10
- Puccinellia Nuttalliana	alkaligrass	5

Silty-clay slopes vary considerably in their chemical and physical soil properties, aspect and soil moisture. Therefore, the seed mixture must cover a wide spectrum of possible conditions. Agropyron cristatum, Agropyron sp. (violaceum) and Agropyron riparium will provide early ground cover in xeric to mesic sites while Poa palustris is adapted to wetter sites. Agrostis gigantea can survive in mildly acidic soils while Poa ampla and Puccinellia Nuttalliana have some alkali resistance. Poa glauca and Festuca ovina are included for their drought tolerance and potential as long term ground cover.

* fine textured soils include clay, silty clay, silty clay loam and silt

TABLE 4.14

RECOMMENDED SEED MIXTURE N FOR SUB-ALPINE AREAS

SPECIES	COMMON NAME	PERCENT BY WEIGHT
- *Agropyron sp.* (violaceum)	purple wheatgrass	25
- *Deschampsia caespitosa*	hairgrass	10
- *Festuca ovina*	sheep fescue	10
- *Festuca saximontana*	native fescue	15
- *Poa alpina*	alpine bluegrass	25
- *Poa glauca*	glaucous bluegrass	15

In subalpine areas *Agropyron sp.* (violaceum) and *Poa alpina* are often primary invaders of disturbed sites. Thus these species will be used to provide initial cover for early erosion control. *Deschampsia caespitosa* is included to provide an acid tolerant component to the mixture. *Poa glauca*, *Festuca ovina* and *Festuca saximontana* provide drought resistant species for sandy and coarse textured soils. All six entries are tolerant of the cold temperatures found in the subalpine.

TABLE 4.15

RECOMMENDED SEED MIXTURE P FOR TEMPORARY SEEDING

SPECIES	COMMON NAME	PERCENT BY WEIGHT
- Agropyron pauciflorum	slender wheatgrass	30
- Agropyron sp. (violaceum)	purple wheatgrass	25
- Festuca rubra	red fescue	15
- Phleum pratense	timothy	30

The primary goal of temporary seeding is the rapid establishment of ground cover. Thus the majority of species in a temporary seeding mixture must emerge quickly and develop rapidly. In this category are Agropyron pauciflorum, Agropyron sp. (violaceum) and Phleum pratense. The Festuca rubra is included to provide a slower developing rhizomatous component to the mixture.

4.1.3 Planting Materials

A prime objective of the program will be the revegetation of river and stream crossing slopes and other steep slopes. Revegetation in these areas will be designed to assist in long term erosion control. The area will be reseeded and vegetatively propagated materials and container-grown seedlings planted to ensure deeper root penetration. The vegetative propagation will include shredding (see below), the hand planting of rooted and unrooted cuttings and wildlings (shrubs transplanted from southern Yukon).

Areas such as road crossings which are highly visible will also be reseeded and revegetated with shrubs and in some cases small trees to reduce the visual impact of the pipeline right-of-way after construction. Other disturbed areas such as stockpile sites, borrow areas, camp sites and compressor station sites will be considered on a site-specific basis.

All shrubs and tree varieties that will be utilized are indigenous to the southern Yukon and northern British Columbia. The species and the techniques to be employed are presented on Table 4.20.

Shredding

A shredding technique will be used to revegetate some wet sloughs and peat bogs. This technique will be used in locations where local native groundcover can re-establish through viable roots and rhizomes but where reseeding of grasses is difficult or impossible. The shredding technique can be used in botanically unique areas. In such regions the introduction of ecotypes which are not indigenous is not desirable and thus local ecotypes must be used to re-establish vegetative cover.

The rhizosphere will be ripped to a depth of 20 centimeters. Subsequently the rhizosphere material, consisting of soil, rhizomes, seeds and rootstalks, will be collected and stored adjacent to the area needing revegetation. Upon completion of disturbance the collected material will be shredded with machinery comparable to a compost shredder and spread on the surface wherever necessary with equipment comparable to manure spreaders. The plant propagules will then be incorporated into the soil with a disc or rototiller and the area will be rolled to improve soil-root contact.

This technique will facilitate the return of indigenous species such as bluejoint, sedge, northern fescue, lingonberry, cloudberry, Labrador tea, and fireweed.

Unrooted Cuttings

The planting of unrooted stem cuttings directly to a disturbed site is the least expensive method for establishment of some shrub species. However, it is also the least reliable method. The ability to root, survive initially and establish permanently is dependent upon species used, soil moisture, temperature, methods of collecting and handling the cuttings and season of planting. The high failure rates reported even in more favourable micro-environments suggest that extensive use of this technique for northern pipeline revegetation will not be productive. Thus, it will be limited to species prone to rooting and on ideal microsites which have sufficient soil moisture. Therefore, use of unrooted cuttings (primarily willows) will be restricted to highly favourable environments such as moist riverbank slopes.

Rooted Cuttings

Nursery Beds

Some stem cuttings will be rooted in nursery beds where moisture can be controlled at the time of root establishment. This method will be

Table 4.16

Plant Material Propagation

Methods and Applications

Species	Common Name	Method of Propagation	Application	Spacing (m)
Arctostaphylos uva-ursi	Bearberry	i) container grown cuttings	aesthetic mitigation	1 x 1
Vaccinium vitis-idea	Lingonberry	i) wildling transplants ii) container grown cuttings iii) container grown seedlings	aesthetic mitigation aesthetic mitigation aesthetic mitigation	5 x 5
Rosa acicularis	Prickly Rose	i) wildling transplants ii) container grown seedlings	erosion control aesthetic mitigation erosion control	1.5 x 1.5
Potentilla fruticosa	Shrubby Cinquefoil	i) container grown seedlings	erosion control aesthetic mitigation	1.5 x 1.5
Elaeagnus commutata	Wolfwillow	i) wildling transplants ii) container grown seedlings	aesthetic mitigation erosion control	2 x 2
Sherpherdia canadensis	Buffaloberry	i) wildling transplants ii) container grown seedlings	aesthetic mitigation erosion control	2 x 2
Betula glandulosa	Shrub Birch	i) container grown seedlings	aesthetic mitigation	2 x 2

Table 4.16 - cont'd

Plant Material Propagation

Methods and Applications

Species	Common Name	Method of Propagation	Application	Spacing (m)
Salix sp.	Willow	i) wildling transplants ii) cuttings rooted in nursery iii) unrooted cuttings iv) container grown cuttings v) container grown seedlings	aesthetic mitigation erosion control erosion control erosion control erosion control	2 x 2
Viburnum edule	High Bush Cranberry	i) container grown seedlings	aesthetic mitigation	1.5 x 1.5
Alnus crispa	Green Alder	i) container grown seedlings	erosion control aesthetic mitigation	2 x 2
Populus tremuloides	Quaking Aspen	i) container grown seedlings	aesthetic mitigation	3 x 3
Populus balsamifera	Balsam Poplar	i) container grown seedlings ii) cuttings rooted in nursery	aesthetic mitigation	3 x 3
Pinus contorta var. latifolia	Lodgepole Pine	i) container grown seedlings	aesthetic mitigation	5 x 5
Picea glauca	White Spruce	i) container grown seedlings	aesthetic mitigation	5 x 5

utilized when larger, two to four year old plants of poplar and willow are required for aesthetic purposes.

Containers

When more rapid root development and faster early growth is required some stem cuttings will be rooted in containers in greenhouses. The plants, which will be initially rooted in Spencer-Lemaire containers in a greenhouse, will be acclimatized at the Yukon nursery. If small plants up to one year old are required then the stock will remain in the containers. If larger plants from three to four years old are required then the young rooted cuttings will be transplanted into a nursery bed at a Yukon nursery. This will be the principal propagation technique of uniform clonal material of poplar, willows and bearberry.

Container Grown Seedlings

The principal method of obtaining native shrub and tree stock for pipeline revegetation purposes will be growth from seed in containers. The seed will be collected from selected plants in Yukon Territory and British Columbia and germinated in Spencer-Lemaire containers in a greenhouse. After four months the young plants will be moved with their containers to an outdoor nursery to acclimatize the plants. After one year the plants will be handled using one of the three following methods:

i. Planted out onto the disturbed site as one year old seedlings. This is only possible with species which develop rapidly in the first year (e.g., wolfwillow and poplar).

ii. Transplanted into a Yukon nursery bed, if large bare-root plants are required.

iii. Transplanted into larger containers if larger containerized material is required for outplantings to control erosion or for aesthetic purposes.

This method will be used to grow wolfwillow, buffaloberry, resin birch, willow, alder, highbush cranberry, aspen, poplar, lodgepole pine, white spruce, shrubby cinquefoil and blueberry.

Wildlings

Larger plants required during the early stages of construction will be obtained by collecting small wildlings of rose, willow, wolfwillow, buffaloberry, shrubby cinquefoil and spruce from local disturbed areas. The plants will be lifted with soil attached to the root system and transplanted to a nursery bed in the Yukon. The stem will be pruned to balance the stem-root ratio and aid establishment in the nursery. The maintenance program will be directed at the encouragement of root growth prior to movement of the plants to their permanent location.

If soil moisture is adequate (hydric to mesic) at any time when shrub transplanting is necessary then some larger wildlings can be lifted and transplanted directly to the disturbed site. This latter technique is site-specific and will only be used if conditions are favourable.

4.1.4 Fertilizer

In general, grass grown in agriculture for hay or pasture purposes requires fertilization each year to achieve maximum productivity, however, for reclamation, a low maintenance self-maintaining vegetative cover rather than high annual productivity is the objective. Therefore, fertilization will be limited to the season of seeding.

In addition, because native species and naturalized land races are often better adapted to lower amounts of nutrients and may be more efficient in the extraction of available nutrients than agronomic cultivars, they may grow and remain healthy with less fertilizer and may be less susceptible to local diseases. Thus, they do not require heavy fertilization in the spring to help them recover from winter damage or initiate vigorous growth.

A minimum rate of fertilization will be applied to keep the seedlings growing vigorously. The fertilization program is designed to promote vigorous root growth without limiting reinvasion from adjacent undisturbed areas or creating excessive interspecific competition. Therefore, a slow release nitrogen fertilizer will be distributed at the time of seeding or immediately following to ensure hardy, well established plants. The rate of application will vary according to the soil texture, nutrient deficiencies, surface soil salvage requirements, and erosion potential.

The fertilizer will consist of a blend of sulphur coated urea and triple superphosphate mixed to obtain an approximate formulation of 19-26-0. This will be applied to obtain nitrogen at the rate of 57 to 95 kg/ha urea and phosphorous between 78 and 130 kg/ha P_2O_5. Potassium, in the form of Potassium Sulfate, will be included in the fertilizer mix in select areas were a deficiency has been identified. The inclusion of micro-nutrients has not been identified as being necessary to provide vigorous growth.

Calcium carbonate in the form of agricultural lime will be used to reduce acidity in areas where the soil pH is below 3.0. The lime will be applied where required in amounts sufficient to raise the pH to levels greater than 4.0.

Additional soil samples will be taken before and after construction, but before seeding of the line. The data obtained by analyzing the

chemical and physical properties of the samples will be utilized to further assess specific nutrient deficiencies and site-specific fertilizer requirements, site treatment and plant species selection.

4.1.5 Mulches and Tackifiers

A mulch cover helps retain soil moisture, protect the surface soil from erosion by wind or water, holds seed in place and helps stabilize surface soil temperatures. The addition of mulch is not necessary to re-establish a vigorous vegetative cover on favourable sites; however, application is essential in obtaining a satisfactory catch on harsh sites, such as xeric soils, subalpine slopes and arid regions with precipitation during the growing season less than 150 mm. Because mulches conserve substantial soil moisture to a depth of 300 mm or more, mulch will also be used to prevent the desication of the Peat Radiation Barrier[1] and assure a greater number of established seedlings and a denser vegetative cover.

Where available, on-site materials such as peat moss can be used to stabilize surface soils. Where these materials are not suitable, straw or hay applied at a rate of 3000 kg/ha bound with a tackifier will be utilized. The straw or hay will be harvested from sloughs in the southern Yukon or northern Alberta, stockpiled and utilized as required. The seed present in the hay harvested from the southern Yukon will be an additional source of native stock. Straw blowers will be used to apply straw and hay mulch. In order of preference, the following products are being considered as alternatives to hay and straw mulch, if required.

1.	Weyerhaeuser	- wood cellulose fibre - green; dye non-toxic
2.	Conwed Hydromulch	- wood cellulose fibre - green; dye unknown toxicity
3.	Conwed Hydromulch 2000	- as Conwed Hydromulch above plus added organic tackifier

[1] Peat Radiation Barrier is a 50 cm insulative layer composed of peat which will be employed at the interface between undisturbed terrain and embankments in areas of ice rich thaw susceptible terrain.

Organic or acrylic tackifiers are generally used to hold woodfibre, straw or woodchips and seed in place. As well, they serve to retain moisture and thus promote germination. Some tackifiers are applied on top of the mulch (particularly for holding straw or woodchips) while others may be mixed with woodfibre, seed and fertilizer in the hydroseeder. Table 4.17 provides a list of commercially available tackifiers. They are listed in order of preference for use. A hydroseeder will be used to apply the tackifiers.

Under severe site conditions where the Soil Erodibility Index exceeds 1 and slopes exceed 50%, the erosion potential may warrant the use of erosion control mats. These mats are stronger and longer lasting than mulches and tackifiers under severe site conditions. Erosion control mats have been used very successfully along waterways and other highly erodible areas. In general, they will be used only on critical areas and application will be decided in the field. Good surface contact is essential, therefore preliminary seedbed preparation is important. The products listed below are in order of preference. The erosion control measures are presented in greater detail in the Terrain Protection Plan.

Trade Name	Description
Curlex Blankets	- Amxco soil retention blanket of interlocking, curled, barbed aspen fibres - form: rolls 4 ft x 180 ft., weight/roll = 64 lbs. - staples required
Hold Grow	- synthetic netting interwoven with paper - form: rolls 360 ft x 5 ft or 10 ft. - staples required
Conwed Netting	- plastic mesh - form: rolls 2500 ft. x 7 1/2 ft, 12 ft, 15 ft. - staples required

TABLE 4.17

POTENTIALLY SUITABLE TACKIFIERS

PRODUCT TRADE NAME	TYPE OF MATERIAL	FORM	APPLICATION RATE AS MULCH ANCHORER	COMMENTS
Terra Tack II	plant gum	powder	110 kg/ha	- applied as an overspray with a small amount of woodfibre primarily to anchor straw or hay - applied with 6600 l/ha water
Terra Tack III	plant gum	powder	60 kg/ha	- used alone with woodfibre primarily - seaweed extract - applied with 7000 to 8800 l/ha water
Ecology Controls M-Binder	plant gum	powder	120 kg/ha	- low-cost material - used along or with hay, straw or woodfibre - applied with 3200 l/ha water
Aquatain 'C'	natural organic	powder	60 kg/ha	- applied to hay, straw or woodfibre - requires more water than most: 8800 to 11000 l/ha
Curasol All	polyvinyl acetate	liquid	2000 l/ha	- used alone or with hay, straw or woodfibre - not as effective after freezing, storage therefore a problem - applied with 4400 to 60000 l/ha water

4.1.6 Herbicides

Herbicides will only be employed to control vegetation where essential for pipeline maintenance and operation and to control the introduction of annuals, biannuals and perennials exotic to the Yukon and Swift River segments of the Alaska Highway Gas Pipeline. Any vegetation control program will be undertaken in cooperation with the appropriate agencies and/or land owners. All chemical applications will be applied by or under the supervision of qualified licensed operators. All regulations set forth in legislation regarding the use of herbicides will be followed.

Choice of the best herbicide for a particular weed problem is complex and depends upon the target species, numerous soil factors, and climatic variations. Therefore, no attempt is herein undertaken to specify the types and rate of herbicide that may be utilized.

4.2 Revegetation Methods

Revegetation methods to be employed along the Yukon and Swift River segments of the Alaska Highway Gas Pipeline will be undertaken to ensure success of the program. Methods and equipment to be utilized for surface preparation, spreading seed, fertilizer, mulch and tackifer, and transplanting shrubs and trees will vary according to site-specific conditions, aerial extent, and weather conditions. The preferred methods will be specified in Section 7.0, Specific Actions Taken.

In general, the passive revegetation approach will involve the following sequence of events: recontouring the disturbed terrain, replacement of 20 to 40 cm of salvaged topsoil, scarification as required and soil amendment with a light application of fertilizer. Treatments that will be involved in the active approach include: recontouring the disturbed terrain and replacement of salvaged topsoil as required. Following surface preparation, seed and fertilizer will

be broadcast from a fixed wing aircraft or ground based vehicle, depending on weather and access. In areas of low growth potential or high erosion potential, seed may be incorporated into the soil using standard harrows and covered with a mulch and tackifier. The timing and type of scarification to be employed will vary according to terrain conditions.

Implementation of the program will commence as soon as possible and no later than one year following clean-up of any disturbed area. All revegetation activities will be scheduled to ensure seed is distributed during the recommended time period to minimize potential winter kill and to take maximum advantage of the growing season and available moisture.

4.2.1 Surface Preparation

Surface preparation will be undertaken to ensure that the soil substrate can support plant growth and the re-establishment of a self-supporting plant community. Measures will be utilized which modify the soil bulk density, increase moisture retention capability, increase nutrient supply and availability and provide an optimum seed bed for seed germination.

Recontouring

Recontouring will be implemented during clean-up: (1) to blend the disturbed area into the surrounding landscape; and (2) to alter the slope angle and length to reduce the erosion potential. The general erosion risk, maximum allowable velocities, and associated slope ratios for different soil types along the route will be addressed in the Terrain Protection Plan. The degree of recontouring required to mitigate aesthetic disturbance and blend the disturbed area into the

surrounding landscape will be determined in the field and will not be specified in the protection plan.

Scarification

Scarification techniques will vary for each site depending upon level of compaction, and depth of topsoil salvaged and redistributed over the site.

Compacted soils along abandoned roadbed sections or those subjected to heavy equipment traffic will be chisel plowed to a depth of 20 to 30 cm and disced or cultivated. On sites which have not been as severely compacted, shallow cultivation of the surface (20 cm) may be adequate to loosen and roughen the seedbed and provide sufficient microsites for the seed. On sites with uncompacted disturbed material, the impressions left by bulldozer tracks will provide sufficient microsites for the seed.

Where greater than 30 cm of topsoil will be redistributed, neither ripping, discing nor cultivation will be required. If 15 to 30 cm of topsoil is to be respread over the disturbed area, discing or cultivation will be required to a depth of 20 cm prior to redistribution of topsoil. If less than 20 cm of topsoil is redistributed, topsoil will be incorporated into the spoil (20 cm) either with a ripper or cultivator.

Surface preparation will produce a loose, moderately rough seedbed. Grading to a smooth surface will not be undertaken as potential for runoff, erosion, crusting and saltation is increased as well as reducing the quality of the seed bed.

Soil Salvage and Replacement

Soil salvage and replacement will generally provide a better medium for revegetation than seeding into the underlying soil parent

material. Soil salvage is most practical in concentrated areas of construction such as borrow pits where soil hauling distances during stripping and replacement can be minimized and there is sufficient area in which to manoeuvre equipment. However, where designated 20 - 40 cm of surface soil will be salvaged along the route, replaced and contoured prior to reseeding.

Subterrestial peat harvested during trenching may be salvaged and stockpiled to be utilized either as a Radiation Barrier at the embankment-soil interface or as an amendment to the spoil material, to provide an optimal growth medium. In the later case, peat will be amended to the spoil at a ratio of approximately 1:3. The amended soil will then be replaced and contoured, as required.

4.2.2 Seeding and Fertilizing Methods

Seed and fertilizer can be applied either by broadcasting or drilling. Drilling is generally preferred to broadcasting if the terrain condition allows operation of machinery and the seed requires a uniform depth of placement. Because of the generally rough terrain and diverse nature of the seed mix, even rugged drills such as the Nobel are not amendable to the Alaska Highway Gas Pipeline Revegetation Program. Therefore, seed and fertilizer will be applied utilizing standard broadcast methods.

Any method that scatters the seed directly upon the soil surface is termed broadcasting. This method includes fan or air blast seeders from aerial or ground vehicles and hydroseeders which apply the seed in a water based slurry.

Where access by vehicles is not limited, truck, tractor, or ATV mounted broadcast seeders will be utilized. In some cases, on extremely rough terrain or on small areas broadcasting will be applied by a hand cyclone seeder.

Broadcasting the seed mix in the mulch and tackifier using a hydroseeder is a common practice where annual precipitation is high and the mulch is frequently moistened for seed germination. However, such practices in arid regions are generally unsatisfactory unless spring moisture will be sufficient to keep the mulch constantly moist for two or three weeks. The seeds must be in a continuously moist environment for a sufficent period of time to germinate and establish as seedlings. Only in cases of limited access or on steep slopes where adequate moisture is available will this method be used.

The fastest method of application of seed and fertilizer is via aerial means. Fixed wing application of seed and fertilizer is perhaps the fastest, however, accuracy in hilly or treed areas is reduced, thereby increasing the possibility of having to return for "touch-ups". Helicopters have advantages over fixed wing aircraft in being able to operate from a small cleared area, and have greater manoeuvrability and thus control over seed placement.

Once broadcast, the seed can be covered with a mulch and binder or covered with soil to encourage germination and establishment. This is particularly necessary in arid and subalpine areas and unfavourable sites such as south and west facing slopes at higher elevations. On favorable sites with salvaged topsoil, covering the seed is not necessary, even though catch may be improved.

Seed can be covered with harrows, disks, or other similar devices. Moving a small tracked vehicle over the area after seeding will cover the seed and compact unstable loose or freshly tilled soil.

4.2.3 Mulch and Tackifier Application

To assist surface stabilization of highly erodible areas, or the improvement of conditions for seed emergence in arid terrain or on xeric soils, hydromulching or straw/hay mulch will be utilized. Both methods involve the application of a mulch material and tackifier to the disturbed area.

In the hydromulching operation, seed and fertilizer are mixed with water into a slurry with the mulch and tackifier and then applied in a pressurized spray. Mulch, tackifier and water are mixed in proportions dependent on the site conditions and the degree of protection required from the mulch. The slurry is often applied to steep slopes, such as the road cuts to stabilize the surface, but can also be used on other areas, if as mentioned, there is a plentiful supply of water. The application rate of the hydro mulch generally ranges from 1200 to 1800 kg/ha. A hydroseeder similar to "Bowie Imperial 2500-1500" or Reinco Model HB8(A) will be used to apply the cellufiber mulch and tackifier, if required.

The preferred method is to apply straw by blowing or hand spreading over the seeded surface at approximately 3000 kg/ha. A binder mixed in water is oversprayed to hold the straw or hay in place. If mulch is used in conjunction with broadcast seeding, best results can be obtained by broadcasting the seed, covering with topsoil, and then applying the mulch. The major disadvantage of using straw compared to hydromulching is that straw necessitates a multi-stage operation, whereas, hydromulching is a one stage application of all materials. Equipment such as the Reinco Power Mulcher Model TM7-30(X) will be used for applying hay and straw mulch. Crimped straw/hay mulch will be utilized on steep sandy/silty soils or areas subject to wind erosion. Mulch will be crimped along the contour.

4.2.4 Scheduling

The time of seeding is critical in assuring optimal germination, seedling growth and the success of the revegetation program. In general, the best results will be achieved, if seeding commences immediately prior to the period of maximum precipitation or during dormancy. The period of maximum precipitation is of particular importance in the arid regions of Revegetation Management Area Two and Three between Congdon Creek and Squanga Lake. As a result of the hot dry conditions characteristic of these areas, high seedling mortality could occur if seeding is undertaken significantly prior to or following the rainy season.

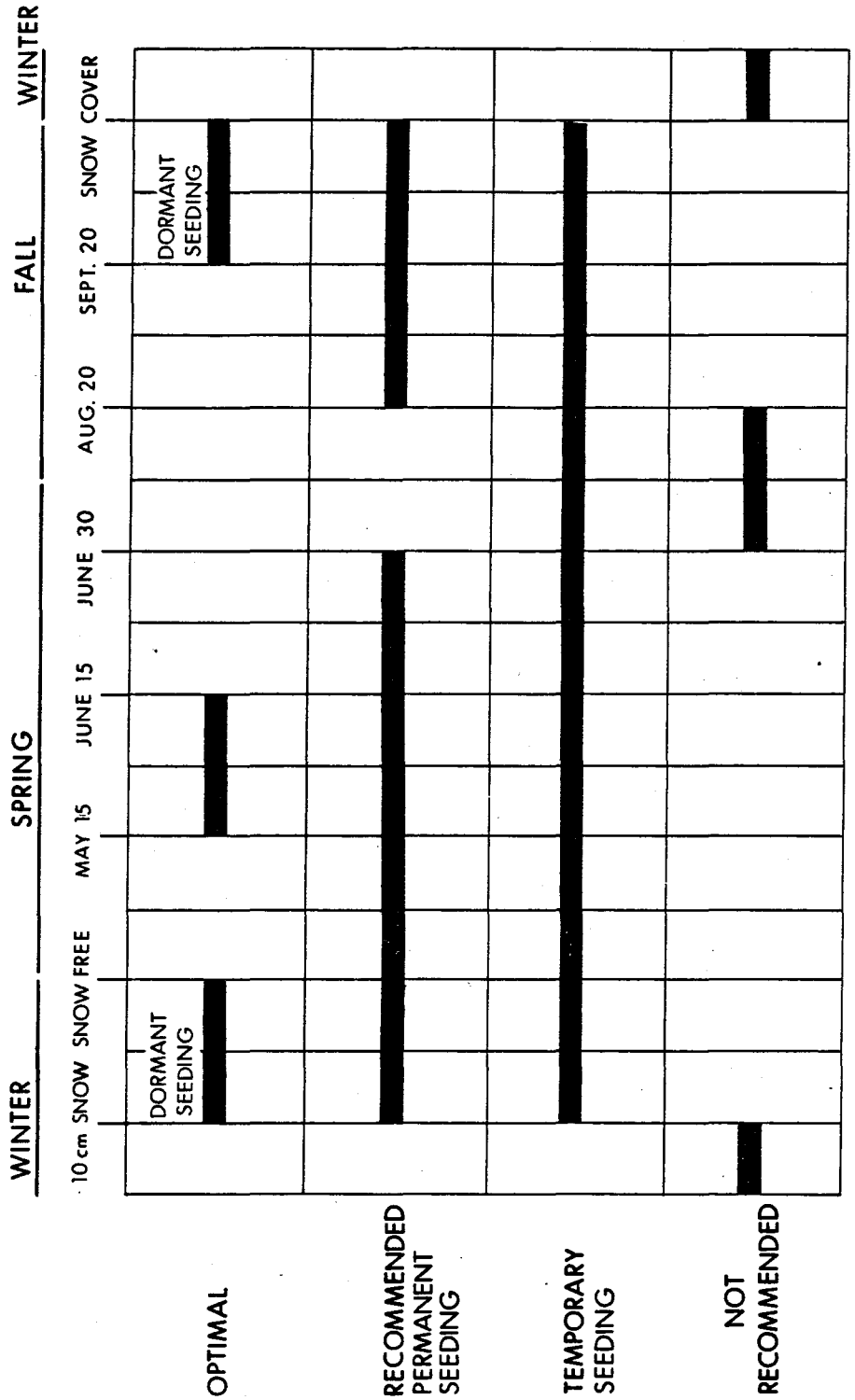
For this reason optimal and recommended seeding windows have been established. Seeding should be undertaken following the completion of each construction spread during the first appropriate seeding window (Table 4.18). The only exception to the windows defined is in erosion prone areas where temporary revegetation measures are necessary. In these areas a temporary seed mix will be applied whenever appropriate. These areas will be reseeded during the application of seed for the remainder of the section.

4.2.5 Shrub and Tree Planting Methods

As discussed in Section 4.1.3 the bare-root and containerized shrub cuttings will be utilized for pipeline revegetation. Also, many species of shrubs and trees will be grown from seed. The following section includes discussion relating to advantages and disadvantages of each technique.

Bare-Root System

In general, bare-root techniques will be used to produce larger plants for aesthetic and erosion control purposes. The use of bare-root plants has shown that the growth of secondary or tertiary tissue



Foothills Pipe Lines (South Yukon) Ltd.

TITLE

THE ALASKA HIGHWAY GAS PIPELINE PROJECT

TABLE 4.18
SEEDING TIME CRITERIA

	DRAWN	CHECKED	APPROVED	APPROVED	SCALE NTS	PREPARED BY M. L ESKY
BY	E.R.K.					
DATE	81-08-17					

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improves the probability of survival. Within limits, the survival of shrubs is dependent upon their size and age as larger plants can better survive the rigours of drought, vegetative competition and browsing by native fauna. The optimal size and age are governed by the economics of land rental, maintenance and planting costs and by a decline in manual transplanting efficiency as the size of the plants increases.

The use of bare-root techniques minimizes transportation costs by reducing bulk and weight to a minimum. Growth rates in the preparatory stage are within limits dictated by the local climate but can be optimized by maintenance of clean fertile soil and controlled irrigation. Also, while the plants are in the nursery roots can be undercut, wrenched or laterally pruned. If done correctly these techniques will enhance survival by producing a compact fibrous root structure. As a consequence, plant vigour will often be sufficient to overcome stress induced upon torn roots when the plants are lifted or dessicated during transit and planting.

Space-Root System (Containerization)

Spencer-Lemaire containers (folding book planters) will be used for the growth of seedlings and some cuttings. The objective of this system is to shape, protect and control the egress of roots from the container.

A major advantage of this technique is the higher planting quality obtained through use of containers with a constant shape and size. Human planting errors are reduced and there is a greater probability of obtaining good root contact with moist subsurface soil. Also the protection offered the roots during transit and outplanting confers definite biological advantages to the young plant and thus the plants can be used under a wide array of conditions.

A second advantage is the possible extension of the planting season to earlier and later dates than is possible with the bare-root system. Thirdly, the use of the space-root system allows control of root form and size. Containers will be used to guide roots into a pre-determined shape with minimal spiralling or cross-over of lateral roots, and ensure the proper top-root ratio. However, regardless of size or design of the container there is a time limit beyond which plants can not be confined without risk of "pot-binding".

In general, the plants will be repotted in large containers (1 gal. pots) for the second growing season. If the plants will not be required within two years, they will be outplanted in the Yukon nursery. The plants which are repotted will also be moved to the Yukon nursery and all plants will be grown there until needed for planting out to the disturbed sites.

4.3 Monitoring and Maintenance

An integral component of the revegetation program is monitoring: the data gathering, data analysis and interpretation and data presentation to determine the magnitude and character of environmental change.

All aspects of the revegetation program will be monitored to assess the performance of material and methods utilized along the Alaska Highway Gas Pipeline. Success of active and passive revegetation efforts will be annually monitored, compared to previous results as well as a predefined set of performance criteria (Table 4.19). This approach will: (1) ensure the detection of vegetation not re-establishing as anticipated and provide adequate lead time to implement corrective action; (2) allow refinement of revegetation plans to be implemented on subsequent sections of the pipeline route; and (3) ensure compliance with stipulations set forth by regulatory agencies.

Table 4.19
Revegetation Performance Criteria

Criteria[1]	Year 1	Year 2	Year 3
Ground Cover %	15 - 25	30 - 40	30 - 60
Species (number)[2]	6	5	4
Vigor (1-5)[3]	3	3-4	3-5
Productivity (% seed production)	0	20%	40%

1 For assessment purposes the standard area to be considered will be 1000 square metres. This guideline will be decreased if warranted for aesthetic, land-use, erosion control or environmental reasons.

2 Species refers to the number of species which have established as a result of active revegetation measures.

3 The vigour rating is based upon the vigour of each variety and proportion of the total cover. The 1 to 5 vigour ratings are subjective assessments of each variety's development. The ratings are based upon the gross morphology and phenology of each variety. Plant characteristics considered include leaf colour, leaf width, and length, tillers, signs of disease and rhizomatous development. The numerical 1,2,3 and 4 values correspond to the ratings poor, fair, average and strong. The 5 rating denotes successful phenological development of the variety, with seed production on a minimum of 50% of extant plants.

4.3.1 Method

To achieve the desired monitoring objectives, two complementary programmes will be undertaken: low level aerial remote sensing and detailed field oriented investigations. The remote sensing programme will meet a number of monitoring requirements of which revegetation performance is only one. The programme will involve periodic coverage beginning July 1, 1982 and continuing on an annual basis until two years after completion of the Yukon portion of the Alaska Highway gas pipeline or the vegetative cover is well established and satisfies predefined performance criteria. Three sensors will be flown at a scale of 1:15000: colour infra Red (CIR) and colour photography; and a Thermal Scanner. Prints and transparencies will be produced and utilized for interpretation and demonstration.

Field investigation will be undertaken to check and calibrate the remotely sensed interpretations. Special emphasis will be focused on actively revegetated areas which posess erosion susceptible soils, aesthetic and land-use concerns or harsh environmental conditions and low growth potential.

The traits selected for monitoring the revegetation program are percent cover and species composition, plant vigour as expressed through gross morphology, and phenological development as expressed through production of seed. Long-term monitoring of the disturbance is essential because survival is frequently dependent upon climatic extremes which only occur occasionally.

4.3.2 Time Variability

The early emerging and rapid developing species are expected to provide the most cover in the first and second years. The rhizomatous species and species adapted to site specific conditions are expected to dominate from the third growing season. It is expected that the number of species seeded in a mix will decline up to the third growing

season, but should stabilize after that time period. The number of plants making up the community will decline with time. The vigour of early developing and short living species will be highest in the first and second growing seasons and will start to decline after the second year. The vigour of slow developing species should increase and should rate at least 4 (see Table 4.19) in third growing season.

The importance of viable seed production will be assessed according to the primary regeneration habit of the species. Specifically, viable seed production of non-rhizomatous species will be valued more than that of rhizomatous species which are able to increase and maintain their presence in the community by vegetative means.

In addition, the rate of cover establishment will vary considerably between the active and passive approaches. Active measures will ensure 30 - 60% vegetative cover within the first three years; whereas, the passive approach will require approximately five years to achieve the same results.

4.3.3 Management Area Variability

The performance of seeded or planted species will depend on the climatic and edaphic conditions which exist in the various management areas. Climatic extremes in the first or second years will often curtail success and cause establishment failure. The most serious problem which may be expected is drought conditions at the early developmental stage. The upper levels of performance are expected in management areas 1 and 6, and the lowest in management area 3. The performance is largely dependent upon moisture in each region and roughly corresponds to the amount of native cover found on mesic and xeric sites, respectively.

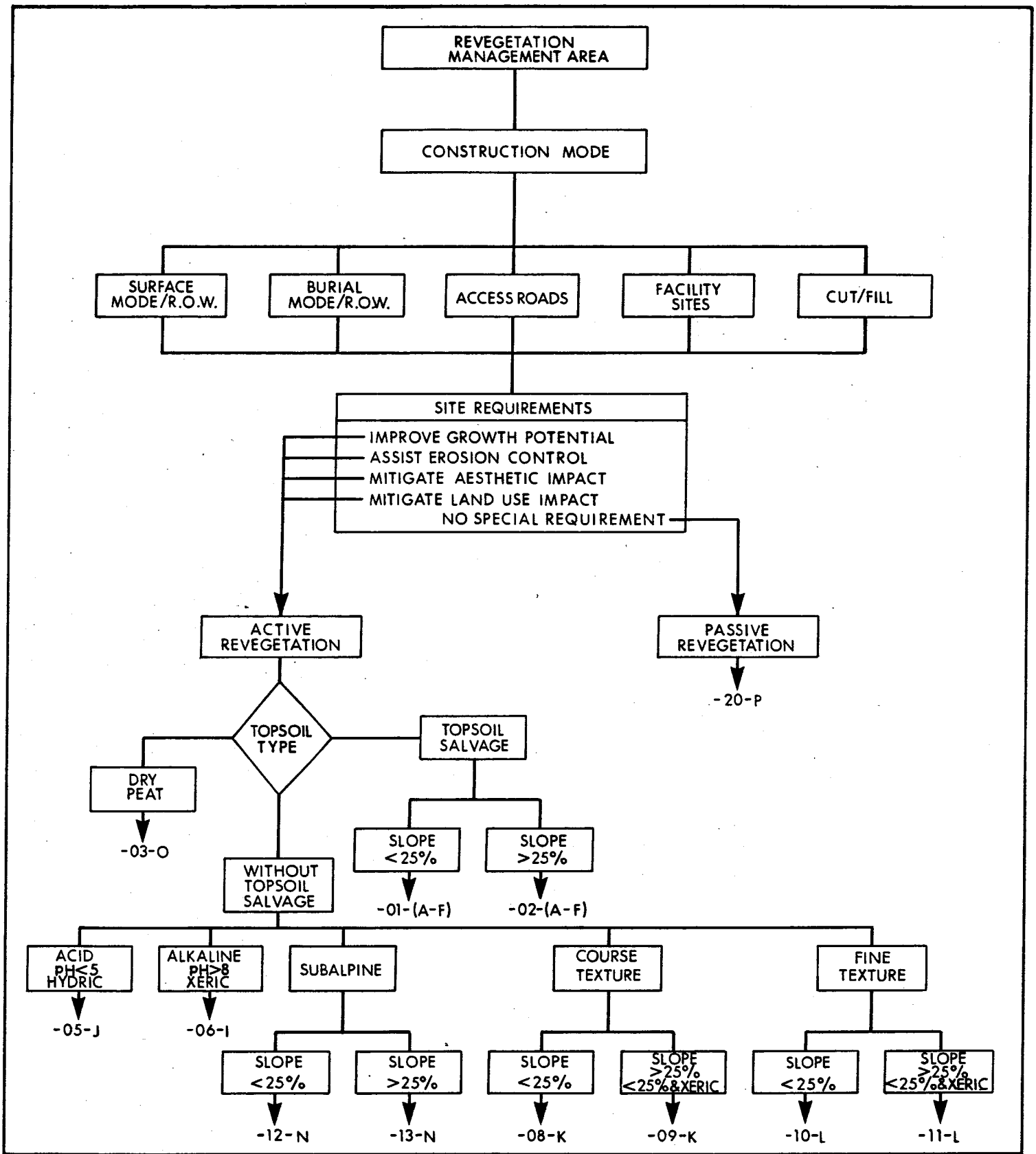
5.0 REVEGETATION PLANS

The following revegetation plans stipulate the material and methods which are to be incorporated into the project design and implemented during all phases of the project for both active and passive approaches. The active approach will be applied in those areas where natural revegetation by invasion of local species will not be adequate to re-establish a native vegetative cover, to assist in the control of erosion, or mitigate aesthetic and secondary land use impact. A description of the criteria utilized to select the revegetation approach are provided in Section 1.4, Definitions and Criteria.

The rehabilitation of a specific site will depend on the existing ecological and physical conditions of that site as well as the projected land-use for the site after construction is completed. No single property of a site can be used to determine the appropriate rehabilitation methods; therefore, a combination of natural attributes of the landscape will be used to determine the preferred revegetation approach.

Table 5.1 presents the criteria for selection and implementation of revegetation materials and methods. The flow chart is designed to demonstrate the decision making process in selecting the appropriate materials and methods required for a given condition along the right-of-way. The flow chart incorporates all anticipated site conditions within each Revegetation Management Area. Utilization of the decision making flow chart requires the following site-specific data:

Revegetation Management Area
Site Requirements
Construction Mode
Soil Type
pH
Slope
Moisture Gradient



Foothills Pipe Lines (Yukon) Ltd.

TITLE

THE ALASKA HIGHWAY GAS PIPELINE PROJECT

TABLE 5.1
REVEGETATION PLAN
SELECTION CRITERIA

	DRAWN	CHECKED	APPROVED	APPROVED	SCALE N/A	PREPARED BY M. LESKY
BY	D.K.M.					
DATE	81/12/07					

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With this data it is feasible to determine the applicable reference plan number and access the site-specific revegetation plan which specifies the material and methods to be implemented.

Table 5.1 is applicable to each Revegetation Management Area and a separate set of plans has been developed for each Area (1 to 6). The plans are referenced with a three segment alphanumeric code (eg. 3-04-M). The first segment of the code (not shown on the flow chart) refers to the Management Area (1 - 6). The second segment refers to the soil type and the third segment refers to the seed mix. Plans have been developed only for those conditions anticipated within an Area and therefore only the relevant plans are included for each Management Area.

To clarify the utilization of the flow chart two case examples are presented below. In both cases, familiarity with the construction techniques and final right-of-way configuration is mandatory. This data is provided on the alignment sheets and in construction specification documents. The first example is located at Station 173 + 500 within a segment of the pipeline which will be constrained by the above ground mode of construction. A granular embankment will be constructed of non-erodible material with a Peat Radiation Barrier to reduce thermal degradation placed at the embankment toe. The second example is located at Station 177 + 200 within a segment of the pipeline which will be buried and constructed off of an ice aggregate workpad. In this case only the ditch line area will be subjected to terrain disturbance. The spoil replaced over the ditch will be an excellent growth media, composed of peaty loam.

Case 1: 173 + 500

Revegetation Management Area	2
Construction Mode	Above ground mode

Site Requirements	Peat Radiation Barrier requires revegetation to assist control of wind erosion and improve growth potential
Revegetation Approach	Active
Topsoil Type	Dry Peat
Plan #	2 - 03 - 0

Case 2: 177 + 200

Revegetation Management Area	2
Construction Mode	Burial Mode
Site Requirements	Ditch line requires revegetation to assist erosion control (TEI 6)
Revegetation Approach	Active
Topsoil Type	Salvaged topsoil
Slope	< 25%
Plan #	2 - 01 - B

The reference number and related information will be specified for the entire Yukon segment in Section 7.0, (Actions Taken). The equipment and mode of application (e.g. aerial, hydroseeder, etc.), being dependent upon the practical consideration of accessibility and areal continuity of the programme will also be specified in Section 7.0 (Specific Actions Taken).

These plans are restricted to passive and active revegetation of the disturbed area. Planting standards for shrubs and trees and special measures such as shredding are addressed in Section 6.0.

FOLLOWING ARE SAMPLE PLANS FOR REVEGETATION MANAGEMENT AREA TWO.

ALASKA HIGHWAY GAS PIPELINE PROJECT
REVEGETATION PLANNING SHEET

PLAN No.:	2-01-B
MANAGEMENT AREA:	2, Pickhandle Lake to Pine Lake.
SECTION:	3,4,5
STATION:	110-165
FACILITY TYPE:	Burial mode/R.O.W., access roads, facility sites, cut/fill
SOIL TYPE AND CONDITION:	Topsoil salvaged and replaced, slope less than 4:1

SPECIFICATIONS

SURFACE PREPARATION:	If less than 15 cm of topsoil available, redistribute and incorporate into spoil 20 cm with a ripper or cultivator; if 15 to 30 cm of topsoil available, disc or cultivate right-of-way to a depth of 20 cm prior to redistribution; if greater than 30 cm of topsoil redistributed, no scarification is required
FERTILIZATION:	19-26-0 sulfur coated urea and triple super phosphate blend; applied at 57 kg/ha nitrogen, 78 kg/ha phosphate; rate may be modified following soil analysis
SEED MIX:	Seed Mix B applied at 30 kg/ha
MULCH AND TACKIFIER:	No mulch or tackifier
SPECIAL CONSIDERATION:	

ALASKA HIGHWAY GAS PIPELINE PROJECT
REVEGETATION PLANNING SHEET

PLAN No.:	2-02-B
MANAGEMENT AREA:	2, Pickhandle Lake to Pine Lake
SECTION:	3,4,5
STATION:	110-165
FACILITY TYPE:	Burial mode/ROW, access road, cut slopes
SOIL TYPE AND CONDITION:	Topsoil salvaged and replaced, slope greater than 4:1

SPECIFICATIONS

SURFACE PREPARATION:	If less than 15 cm of topsoil available, redistribute and incorporate into spoil 20 cm with a ripper or cultivator; if 15 to 30 cm of topsoil available, disc or cultivate right-of-way to a depth of 20 cm prior to redistribution; if greater than 30 cm of topsoil redistributed, no scarification is required
FERTILIZATION:	19-26-0 sulfur coated urea and triple super phosphate blend; applied at 76 kg/ha nitrogen, 104 kg/ha phosphate, no potassium requirements anticipated
SEED MIX:	Seed Mix B applied at 40 kg/ha
MULCH AND TACKIFIER:	Straw mulch to be applied at 3000 kg/ha with tackifier
SPECIAL CONSIDERATION:	If slopes greater than 2:1, roughen seedbed and broadcast seed and fertilizer from fixed-wing aircraft or hand held cyclone seeders or equivalent

ALASKA HIGHWAY GAS PIPELINE PROJECT
REVEGETATION PLANNING SHEET

PLAN No.:	2-06-I
MANAGEMENT AREA:	2, Pickhandle Lake to Pine Lake
SECTION:	3,4,5
STATION:	110-165
FACILITY TYPE:	Burial mode / R.O.W., access roads, facility sites
SOIL TYPE AND CONDITION:	Alkaline xeric soils, pH>8

SPECIFICATIONS

SURFACE PREPARATION:	If compacted, chisel plow 20 to 30 cm and disc or cultivate; if lightly compacted, cultivate 20 cm; if uncompacted, roughen surface
FERTILIZATION:	19-26-10, sulfur coated urea and triple super phosphate blend; applied at a rate of 76 kg/ha nitrogen 104 kg/ha phosphate and 40 kg/ha potassium sulphate
SEED MIX:	Seed Mix I applied at 45 kg/ha
MULCH AND TACKIFIER:	Straw mulch applied at 2000 kg/ha and tackifier
SPECIAL CONSIDERATION:	Application of plan will be dependent upon site-specific soil analysis

ALASKA HIGHWAY GAS PIPELINE PROJECT
REVEGETATION PLANNING SHEET

PLAN No.:	2-08-K
MANAGEMENT AREA:	2, Pickhandle Lake to Pine Lake
SECTION:	3,4,5
STATION:	110-165
FACILITY TYPE:	Burial mode/R.O.W., access roads, facility sites
SOIL TYPE AND CONDITION	Course textured soils, slope less than 4:1

SPECIFICATIONS

SURFACE PREPARATION:	If compacted, chisel plow 20 to 30 cm and disc or cultivate; if slightly compacted, cultivate 20 cm; if uncompacted, roughen surface
FERTILIZATION:	19-26-20 sulfur coated urea and triple super phosphate blend; applied at 76 kg/ha nitrogen, 104 kg/ha phosphate
SEED MIX:	Seed Mix K applied at 40 kg/ha
MULCH AND TACKIFIER:	Straw mulch (3000 kg/ha) and tackifier to conserve moisture and create a favourable microenvironment
SPECIAL CONSIDERATION:	Crimp mulch if area is subject to wind erosion

ALASKA HIGHWAY GAS PIPELINE PROJECT
REVEGETATION PLANNING SHEET

PLAN No.:	2-09-K
MANAGEMENT AREA:	2, Pickhandle Lake to Pine Lake
SECTION:	3,4,5
STATION:	110-165
FACILITY TYPE:	Cut slopes
SOIL TYPE AND CONDITION:	Course textured soils, slopes greater than 4:1

SPECIFICATIONS

SURFACE PREPARATION:	Recontour and roughen surface
FERTILIZATION:	19-26-0 sulfur coated urea and triple super phosphate blend; applied at 95 kg/ha nitrogen, 130 kg/ha phosphate; rate may be modified following soil analysis
SEED MIX:	Seed Mix K applied at 45 kg/ha
MULCH AND TACKIFIER:	Straw mulch (3000 kg/ha) and tackifier to conserve moisture, reduce seed loss and create a favourable micro environment
SPECIAL CONSIDERATION:	If slope subject to wind erosion, crimp mulch; if slope greater than 1.5:1, terracing may be required; under select conditions erosion control mats may be required (e.g. Curlex blankets or Jute Mesh)

ALASKA HIGHWAY GAS PIPELINE PROJECT
REVEGETATION PLANNING SHEET

PLAN No.:	2-11-L
MANAGEMENT AREA:	2, Pickhandle Lake to Pine Lake
SECTION:	3,4,5
STATION:	110-165
FACILITY TYPE:	Burial mode, Access Roads, Facility sites
SOIL TYPE AND CONDITION:	Fine textured soils, xeric slopes less than 4:1, and fine textured soils slopes greater than 4:1

SPECIFICATIONS

SURFACE PREPARATION:	On slopes less than 4:1, if compacted, chisel plow 20 to 30 cm and disc or cultivate; if lightly compacted, cultivate 20 cm; if uncompacted, roughen surface; On slopes greater than 2:1, recontour and roughen surface
FERTILIZATION:	19-26-0 sulfur coated urea and triple super phosphate blend; applied at a rate of 76 kg/ha nitrogen, 104 kg/ha phosphate
SEED MIX:	Seed Mix L applied at 45 kg/ha
MULCH AND TACKIFIER:	Straw mulch applied at 3000 kg/ha and tackifier
SPECIAL CONSIDERATION:	

ALASKA HIGHWAY GAS PIPELINE PROJECT
REVEGETATION PLANNING SHEET

PLAN No.:	2-10-L
MANAGEMENT AREA:	2, Pickhandle Lake to Pine Lake
SECTION:	3,4,5
STATION:	110-165
FACILITY TYPE:	Cut Slopes
SOIL TYPE AND CONDITION:	Fine textured soils, mesic slopes less than 4:1

SPECIFICATIONS

SURFACE PREPARATION:	If compacted, chisel plow 20 to 30 cm and disc or cultivate 20 cm; if lightly compacted, cultivate 20 cm; if uncompacted, roughen surface
FERTILIZATION:	19-26-0 sulfur coated urea and triple super phosphate blend; applied at a rate of 57 kg/ha nitrogen, 78 kg/ha phosphate
SEED MIX:	Seed Mix L applied at a rate of 40 kg/ha
MULCH AND TACKIFIER:	Straw mulch applied at 3000 kg/ha and tackifier
SPECIAL CONSIDERATION:	

ALASKA HIGHWAY GAS PIPELINE PROJECT
REVEGETATION PLANNING SHEET

PLAN No.:	2-03-0
MANAGEMENT AREA:	2, Pickhandle Lake to Pine Lake
SECTION:	3,4,5
STATION:	110-165
FACILITY TYPE:	Above ground mode/R.O.W., cut slopes
SOIL TYPE AND CONDITION:	Peat Radiation Barrier

SPECIFICATIONS

SURFACE PREPARATION:	redistribution of peat; no ripping, cultivation or discing required
FERTILIZATION:	19-26-0 sulfur coated urea and triple super phosphate blend; applied at 76 kg/ha nitrogen and 104 kg/ha phosphate; may be modified following soil analysis; broadcast fertilizer with cyclone seeders or equivalent
SEED MIX:	Seed mix 0 applied at 45 kg/ha; broadcast seed with cyclone seeders or equivalent
MULCH AND TACKIFIER:	Straw mulch and tackifier may be applied to conserve moisture while seedlings are establishing. Rates to be determined (approximately 3000 kg/ha)
SPECIAL CONSIDERATION:	On slopes greater than 2:1, erosion control mats may be required

ALASKA HIGHWAY GAS PIPELINE PROJECT
REVEGETATION PLANNING SHEET

PLAN No.:	2-20-P
MANAGEMENT AREA:	2, Pickhandle Lake to Pine Lake.
SECTION:	3,4,5
STATION:	110-165
FACILITY TYPE:	Burial mode/R.O.W., cut/fill access roads, facility sites
SOIL TYPE AND SLOPE:	Topsoil development greater than 10 cm or topsoil salvaged and replaced and/or favourable edaphic conditions

SPECIFICATIONS

SURFACE PREPARATION:	If less than 15 cm of topsoil available, redistribute and incorporate into spoil 20 cm with a ripper or cultivator; if 15 to 30 cm of topsoil available, disc or cultivate right-of-way to a depth of 20 cm prior to redistribution; if greater than 30 cm of topsoil redistributed, no scarification is required
FERTILIZATION:	19-26-0 sulfur coated urea and triple super phosphate blend; applied at 57 kg/ha nitrogen, 78 kg/ha phosphate; rate may be modified following soil analysis
SEED MIX:	none
MULCH AND TACKIFIER:	none
SPECIAL CONSIDERATION:	none

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APPENDIX A

BOTANICAL* AND COMMON NAMES

Botanical Names	Common Names
Agropyron cristatum (L.) Gaertn.	Crested Wheatgrass
Agropyron pauciflorum (Schwein.) Hitchc.	Slender Wheatgrass
Agropyron riparium Scribn. & Smith	Streambank Wheatgrass
Agropyron violaceum (Hornem.) Lange	Purple Wheatgrass
Agropyron Gaertn.	Wheatgrass
Agrostis gigantea Roth	Red Top
Agrostis scabra Willd.	Tickle Grass
Alopecurus pratensis L.	Meadow Foxtail
Anemone parviflora Michx.	Anemone
Antennaria Friesiana (Trautv.) Ekman	Pussytoes
Arctostaphylos uva-ursi L.	Bearberry
Betula glandulosa Michx.	Shrub Birch
Bromus inermis Leyss.	Smooth Brome
Calamagrostis canadensis (Michx.) Beauv.	Bluejoint
Calamagrostis purpurascens R.Br.	Purple Reedgrass
Carex L.	Sedge
Deschampsia caespitosa (L.) Beauv.	Hairgrass
Dryas Drummondii Richards.	Drummond's Dryas
Dryas octopetala L.	Eight-petalled Mountain Aven
Empetrum nigrum L.	Crowberry
Epilobium angustifolium L.	Fireweed

APPENDIX A (cont'd)

BOTANICAL* AND COMMON NAMES

Botanical Names	Common Names
Festuca altaica Trin.	Fescue
Festuca ovina L.	Sheep Fescue
Festuca rubra L.	Red Fescue
Festuca saximonta	Native Fescue
Festuca L.	Fescue
Hedysarum alpinum L.	American Hedysarum
Hedysarum Mackenzii Richards.	Mackenzie's Hedysarum
Hierochloe alpina (Sw.) Roem. & Schult.	Alpine Sweetgrass
Ledum groendlandicum Oeder	Labrador Tea
Ledum palustre L.	Labrador Tea
Lupinus arcticus S. Wats.	Arctic Lupine
Oxytropis nigrescens (Pall.) Fisch.	Locoweed
Petasites sagitatus (Banks) Gray	Colt's Foot
Phleum pratense L.	Timothy
Picea glauca (Moench) Voss	White Spruce
Picea mariana (Mill.) Britt., Sterns & Pogg.	Black Spruce
Poa alpigena (E. Fries) Lindm.	Bluegrass
Poa alpina L.	Alpine Bluegrass
Poa ampla Merrill	Sherman Bluegrass
Poa compressa L.	Canada Bluegrass
Poa glauca M. Vahl	Glaucous Bluegrass
Poa palustris L.	Fowl Bluegrass
Poa pratensis L.	Kentucky Bluegrass
Poa L.	Bluegrass
Puccinellia Nuttalliana (Schult.) Hitchc.	Nuttall's Alkaligrass

APPENDIX A (cont'd)

BOTANICAL* AND COMMON NAMES

Botanical Names	Common Names
Rhododendron lapponicum (L.) Wahlenb.	Lapland Rosebay
Rosa acicularis Lindl.	Rose
Rubus chamaemorus L.	Cloudberry
Salix L.	Willow
Vaccinium uliginosum L.	Blueberry
Vaccinium vitis-idaea L.	Lingonberry

* Nomenclature after E. Hulten "The Flora of Alaska and Neighbouring Territories", Stanford University Press, Stanford, California, 1968.