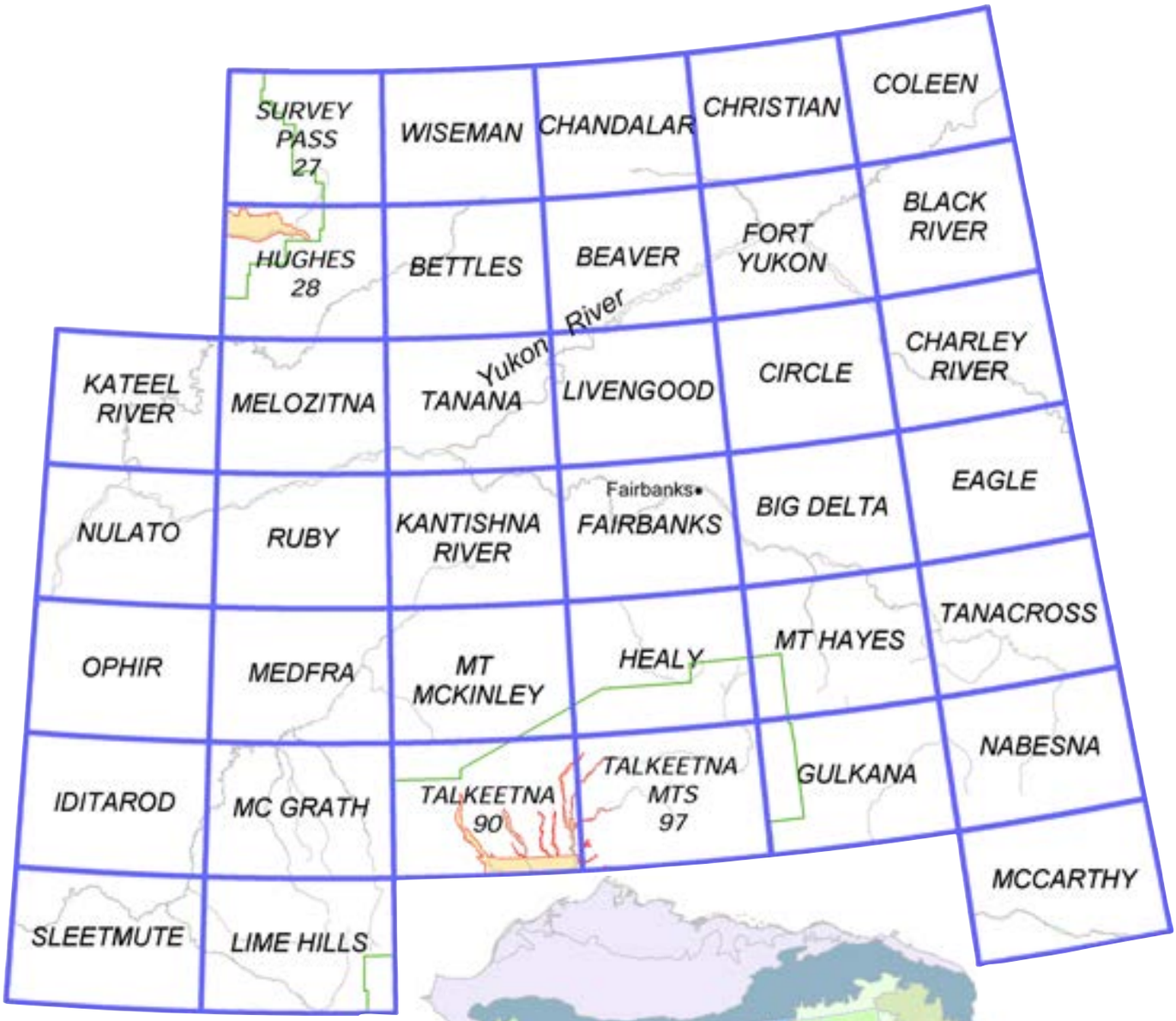
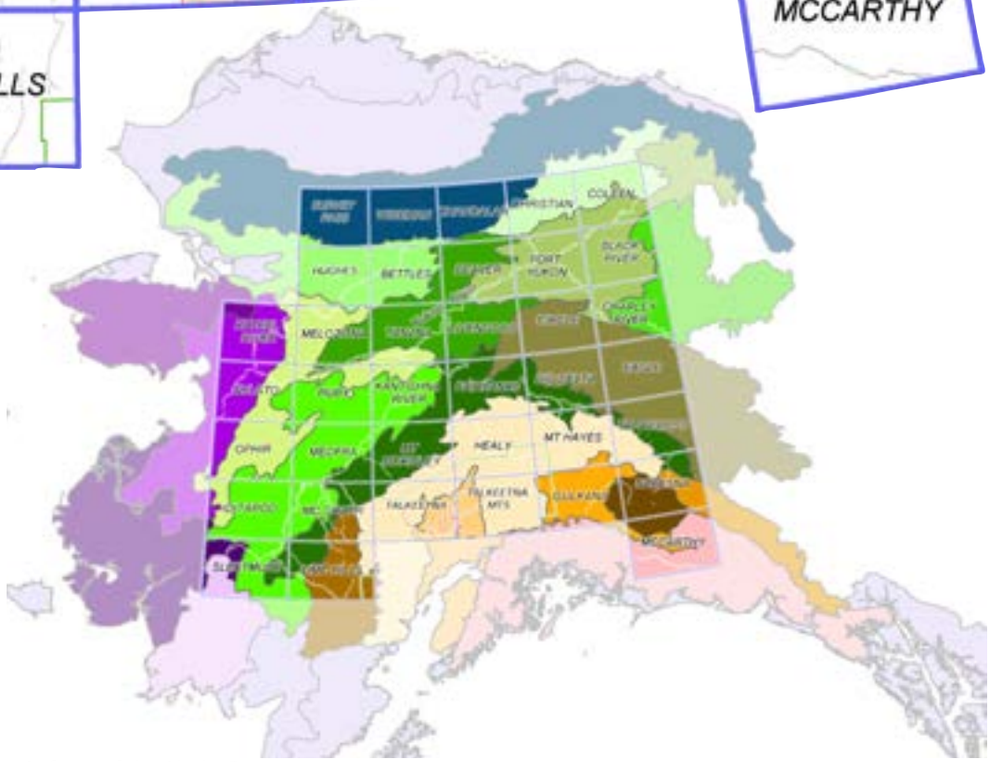
Interior Alaska Revegetation & Erosion Control Guide



Interior Alaska, for the purposes of this guide, is defined as the 37 USGS quads shown above. These quads span several unique eco-regions, further detailed on page 49.



Front Cover: The Chulitna River meanders in front of the Alaska Range

Cover Photo: Phil Czapla (AK PMC)

Interior Alaska Revegetation & Erosion Control Guide

By
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and
Stoney J. Wright

Editing | Layout | Design: Brennan Veith Low

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Alaska Plant Materials Center logo: '*Germinate*' - Original artwork by Sheila Wyne, used with permission

Foreword

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February 22, 2012

Dear Readers;

It is with great personal pleasure that I introduce the Interior Alaska Revegetation and Erosion Control Guide and recognize the great efforts of the Alaska Plant Materials Center's professional staff in preparing this information. Trained in landscape architecture, I am very familiar with the uses for which vegetation may be applied to assist in restoring and stabilizing the natural environment and to control erosion. Living systems can serve as a buffer between the constructed and natural environments, and should be considered as integral parts of development projects in Interior Alaska. Erosion control through vegetation is a valuable construction technique, and can represent significant cost savings over hard approaches, when circumstances allow.

I have been actively involved in working to design and implement large projects in Interior Alaska for many years. Soil conservation, erosion control and stream-bank protection are always an important concern. Solutions utilizing vegetative techniques were implemented in these development projects, to assist with soil stabilization, restoration and reclamation.

Throughout my many years in land and water management, project management and on a broader scale as Deputy Commissioner of the Alaska Department of Natural Resources, I dealt with remediation and reclamation issues quite a bit. Interior Alaska plays host to a large percentage of the mines in Alaska; each mine must have a detailed reclamation plan and post a bond before operations begin.

The case studies and best practices in this manual serve to advance the science of revegetation and erosion control in Alaska. Had these materials been available during some of the larger projects I oversaw during my tenure, they would have been a useful planning tool. The information about and emphasis on the use of native Alaskan plants is also valuable, as the use of introduced species is one of the largest vectors for invasive weeds. I appreciate the efforts of those at the Alaska Plant Materials Center for the work they have done to bring this information to a larger audience. I look forward to applying this information in my current work.

Like many crafts, when done well, revegetation blends into the natural background. This publication serves to highlight this complex and nuanced work. The Interior Alaska Revegetation and Erosion Control Guide is a useful reference that covers the use of natural materials to recreate an ecosystem after a disturbance. While human hands may guide the process, the living roots of plants themselves are largely in control of revegetation, a reminder of who is really in charge.

Yours truly,

SRK Consulting (U.S.) Inc

Richard LeFebvre

Author's Preface

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The publishing of the Interior Alaska Revegetation and Erosion Control Guide marks my thirty-third year with the Alaska Plant Materials Center. Much of the early off-site plot evaluation work and revegetation studies during my career took place in Alaska's Interior. A shift to work on coastal regions occurred after roughly eight years, in part due to the increasing amount of construction activity in the coastal areas of Alaska, and the availability of federal funds for coastal projects.

Another reason revegetation and restoration activities in Alaska's Interior subsided was the fact that many disturbances self-restore. On non-fill disturbances, natural revegetation was fast and generally reliable. Revegetation in the Interior was required only when erosion potential was high and there was insufficient time to rely on natural revegetation. Highway and airport construction activities over the past two decades have kept the Plant Materials Center involved in the other revegetation efforts in the Interior.

Although the Interior allows for greater use of natural revegetation than other areas of Alaska, the region is not immune to the problems associated with surface disturbances. Permafrost poses unique and interesting problems when disturbed by construction and mining. The massive forest fires so common in the Interior also present water quality issues if erosion occurs after the fire and before natural revegetation can occur.

Working on projects in the Interior has left me with a number of great memories of successful projects and the outstanding summers in the region. Interior Alaska is a unique place. Hopefully this guide will assist others in their efforts to use vegetation to control erosion problems and restore disturbed lands to a natural condition.

The science of revegetation in Alaska's Interior is moving forward in a new direction. The seeding practice may be different, but erosion control and storm water issues remain important and must be accommodated during the entire process. This new seeding approach will be cautiously introduced so the techniques can be adapted to the rest of Alaska, advancing the science even more. May the effort begin!

Stoney J. Wright

"Responsibly develop Alaska's resources by making them available for maximum use and benefit consistent with the public interest."

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The distinct qualities of Interior Alaska are a great platform to introduce the next evolution of revegetation in Alaska. The shift away from standardized bulk seeding rates (lbs/acre) to the more nuanced art of seed mixes based on seed size/weight and a prescribed number of seed per given area is ongoing.

Steering away from the bulk (lbs/acre) seeding rate is necessary for a few reasons. Seeding rates based on weight per unit area, such as the standard bulk seeding rate, tend to over-emphasize small seeded species and under-emphasize large seeded species. As different species have differently weighted seeds, reliance upon this method can influence the species composition of the seeded area.

A general bulk seeding rate of 43 pounds Pure Live Seed (PLS) /acre has for many years been the recommended 'catch-all' revegetation seeding rate for sites across Alaska. This rate was developed for a 3-5 species composition mixture, applied by broadcast seeding. This recommendation has yielded many successful plantings, and is still made for revegetation sites in the Interior.

Lower seeding rates are becoming the norm in the revegetation field. Referencing the number of seeds per given area, instead of the weight, can make it easier to visualize bulk density, especially for smaller projects. Factors like seed cost and commercial availability also play a role in this shift to lower seeding rates. Lower seeding rates leave more ground space available and can create a ground surface microclimate suitable for natural colonization.

Further research and test plot evaluation is necessary to properly document the effect of changed seeding rates on indicators like percent ground cover, species composition, vigor, and survival. The goal of revegetation seeding has always been to reduce or prevent erosion and protect soil surfaces. A lower seeding rate does not change this goal.

The Alaska Plant Materials Center will recommend seeding rates based on bulk density. Weight-per acre bulk seeding rates will still be provided while further research is conducted. These will be phased out over time, with emphasis given to a newer method of determining seeding rates. It is my hope that these more efficient seeding methodologies can be adopted across Alaska, advancing the art and science of revegetation in the last frontier.

Phil Czapla

Philip K. Czapla

"Responsibly develop Alaska's resources by making them available for maximum use and benefit consistent with the public interest."

Acknowledgements

This guide was written to assist land owners, land managers, engineers and environmental professionals in making decisions regarding revegetation and the use of vegetation in soil erosion control and soil conservation. The information contained in the guide builds upon past revegetation manuals including:

2001 Alaska Highway Drainage Manual - *Chapter 16: Erosion and Sediment Control*. (2001) State of Alaska, Department of Transportation and Public Facilities.

Wright, Stoney J. (2008) - A Revegetation Manual for Alaska. Edited by Peggy Hunt. State of Alaska, Department of Natural Resources, Division of Agriculture, Alaska Plant Materials Center.

Wright, Stoney J. & Czapla, Philip K. (2011) - Alaska Coastal Revegetation and Erosion Control Guide, 2nd Edition. Edited by Brennan Veith Low. State of Alaska, Department of Natural Resources, Division of Agriculture, Alaska Plant Materials Center.

The authors would like to thank the individuals named below for their participation in this project.

Dean Brown with the Alaska Department of Natural Resources (DNR), Division of Forestry, **Casey Dinkel** with the Alaska DNR, Division of Agriculture, Alaska Plant Materials Center, **Lee McKinley** with the Alaska Department of Fish & Game and **Anne Brown** with the Alaska DNR, State Pipeline Coordinator's Office.

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Photo: Casey Dinkel (AK PMC)

The Trans-Alaska Pipeline winds through mixed hardwood and spruce forest in Interior Alaska.

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Section 2: Project Implementation

Section 3: Species Selection

Section 4: Case Studies

Section 5: Further Information

Background

Photo: Phil Czapla (AK PMC)

Interior Alaska is dominated by boreal spruce forests, with wetlands present throughout. The Alaska Range is visible in the background of this photo, taken near Talkeetna.

Section 1:

Introduction

- *Geography*
- *History*
- *Impacts*
- *Purpose*

Introduction

Photo: Brianne Blackburn (AK PMC)

Spruce, willow and fireweed are present in this Brooks Range vegetation community.

Geography

Interior Alaska is a region defined by three mountain ranges; the Brooks Range to the north, the Chugach to the south, and the Alaska Range in between. "[Interior Alaska] includes North America's highest mountain, permanently snow covered peaks, glaciers, rivers and streams, lakes, a diverse geology and vegetation that ranges from Alpine tundra to boreal forest and wetlands, and a rich flora and fauna" (Laursen & Seppelt, 2009).

Alaska is by far the largest state within the United States of America; having more than twice the area of its nearest largest state. Indeed, Alaska by itself covers 1% of the land mass on Earth, and is larger than all but 19 countries on the planet. For the purposes of this book, Interior Alaska is defined by the 37 USGS quadrangle maps included on the inside front cover.

History

Interior Alaska was first populated by indigenous Athabascan cultures and tribes. The Yukon river and its tributaries provided access and means of travel, communication and trade between peoples. Ancestral peoples followed the spawning salmon into the Interior, lived with the seasonal migration patterns of the caribou herds, and learned the habits of the moose, bear and other furbearing animals. Villages and individuals established rights to specific territory, land use, and water which were generally respected and guarded against foreign encroachment. Almost all villages were occupied in the winter and periodically in summer (Selkregg, 1976).

The search for gold in Alaska is what gave many Interior communities their start. Gold was first discovered in Southeast Alaska during the 1870s; continued exploration through the years expanded the findings northwards. Fairbanks came into existence largely due to the discovery of gold in the creeks of Tanana hills by Felix Pedro in 1902. Prospectors flocked to the interior with gold fever, hoping to strike it rich. Development soon followed with a trading post and other buildings being built to support the new mining district. Today the Fort Knox mine, northeast of Fairbanks produces a large amount of gold.

The military presence in interior Alaska is significant. Ladd Field, a US Air Force base, was constructed in 1939. It served as a cold weather experimental station where soldiers tested clothing and equipment. With the onset of World War II, Ladd Field expanded its role to serve as a transfer station for soviet aircraft. American crews delivered approximately 8,000 aircraft to the Russians for their war effort under a lend-lease agreement. Planes were flown from Great Falls, Montana to Fairbanks. Russians accepted the planes at Ladd Field, then flew them to Siberia for use in the war effort against Germany (Pike, 2011).

In 1961 the Army assumed control of Ladd Air Force Base and renamed the base Fort Wainwright after General Jonathan Wainwright, a decorated officer. Today Fort Wainwright is home to about 7,700 soldiers. It also encompasses Fort Greely and the Donnely Training Area (wainwright.army.mil).

Fort Greely is home to the US Army's largest training area.

Fort Greely is a military installation situated in Delta Junction. This army base is part of the United States's Ballistic Mission Defense Systems (BMDS), charged with destroying threat missiles mid-course. Fort Greeley also hosts the Cold Regions Test Center and the Northern Warfare Training Center. Fort Greely plays a unique role in the Department of Defense, encompassing about 7,200 acres of training lands.

Impacts

Impacts to Interior Alaska have many causes. The region supports industries including mining, logging, tourism, and oil and gas production. Production industries, such as mining, can have significant impacts on the environment, and these effects must be mitigated. Mining, road-building, and tourism all take a toll on the natural environment. Human-caused impacts such as these have disrupted natural ecosystems and resulted in significant changes. Proper stewardship dictates that these human-caused impacts to Interior Alaska's ecosystem be minimized.

Purpose

This guide was developed to aid in the process of revegetation. The intended audience is private property owners, local and government agencies, environmental engineers, resource extraction companies, and anyone else that may encounter a need for erosion control or revegetation.

For the purpose of this document, revegetation is defined as:

> ***The re-establishment of plant cover by means of seeding or transplanting on a site disturbed by natural or man-caused actions.***

Impacts, both large and small, will continue to disrupt interior Alaska. Recovery (defined as the presence of self-sustaining vegetative cover and limited erosion) of most sites can be expedited and impacts minimized with human intervention to correct limitations and guide the ecosystem towards a desired end state. Material presented in the manual focuses on the "soft approach" to erosion control, using vegetation as opposed to the "hard approach" which utilizes engineered structures.

Numerous methods for reintroducing vegetation on a site are available. This manual details a logical sequence of surface preparation, fertilization, and seeding. When followed on a project site, this sequence will usually result in a self-sustaining native plant community that requires minimal management input.

When conditions allow, most disturbed sites will naturally be re-colonized with plants from the surrounding area, though it may take several years before a plant community becomes established. Natural reinvasion, as this technique is known, is at times used in Interior Alaska. This approach tends to be more acceptable in areas that are not highly visible and do not have immediate erosion control needs or regulatory time lines.

The latter portion of this manual is dedicated to case studies, highlighting past revegetation projects that have occurred throughout Interior Alaska. These projects expose the realities of revegetation in the field, including successes, challenges, and lessons learned. It is our hope that these case studies will become a useful resource for future projects. These reports, as well as case studies from the Alaska Coastal Revegetation & Erosion Control Guide are available from the Alaska Plant Materials Center's website, at plants.alaska.gov/reveg.

Project Implementation

Photo: Will Menheere (Fairbanks Gold Mining Inc.)

A well prepared seedbed along the slope contour creates an ideal environment for seed germination, while the furrows limit down-slope water flow.

Section 2:

Planning

- *Goal Setting & Preparation*
- *Identify Site Conditions*
- *Seeding Methods*
- *Transplanting*
- *Planting Choices*
- *Planting Time*
- *Selection of Species*
- *Mulch & Erosion Matting*

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- *Charged Overburden Veneer*
- *Sod Clumps*
- *Vegetation Mats*
- *Natural Reinvasion*
- *Enhanced Natural Reinvasion*
- *Imprinting*
- *Scarification*
- *Dormant Seeding*

Wild Seed Collection

Potential Sources of Erosion

- *Wildfire*
- *Agriculture*
- *Transportation*
- *Riverbank Erosion*
- *Mining*

Conservation and Protection

- *Protecting Wetland Areas*
- *Invasive Plants*
- *Permafrost Conservation*

Planning

Photo: Gordy Schlosser (Great Northwest Inc.)

Emergent grass species are evident on this reclaimed landfill a few weeks after seeding.

Planning should be the first step for any project. The revegetation/ restoration process requires careful planning and management, as the designer is working with biological processes that have specific timing and environmental requirements. When multiple stakeholders are involved in a restoration project, design decisions should be coordinated. This allows restoration goals to be implemented effectively.

Goal-Setting & Preparation

The planning phase of a restoration project encompasses several steps. These include:

- Gathering baseline data,
- Identifying site problems,
- Collecting reference plot information, and
- Setting goals.

Goals tell managers about the desired state of the ecosystem, as compared to a reference ecosystem. Objectives are measures taken to attain the goals, and are evaluated on the basis of performance standards (SER 2002). Without clear goals, objectives and performance standards, a restoration project should not move forward.

Performance standards come from an understanding of the reference ecosystem and the realization that the trajectory of the degraded site should progress towards the desired state of recovery comparative to the reference site.

If data collected and interpreted during monitoring shows that performance standards have been met, then project objectives have been reached. Revegetation goals may include erosion control, visual enhancement, weed control, or other desired outcomes. Often the goal is erosion control.

Baseline Environmental Data Collection

After determining the revegetation objectives, take note of factors influencing the site. These include climate, soils, topography and vegetation. Climate includes temperature, precipitation, and wind, as well as other factors. Climate records can be obtained online, through resources such as the National Oceanographic and Atmospheric Administration's National Climate Data Center, at ncdc.noaa.gov.

A soils inventory involves identification of soil types and characterization of the soil types, as well as distribution. Soil surveys have been completed by the Natural Resource Conservation Service (NRCS) and are accessible online at soils.usda.gov. If feasible, a sample of soil from the site should be sent to a soil testing lab. There, a lab analysis will check the physical (texture, density), chemical (pH, salts, organic matter) and biotic (activities of organisms) characteristics of the soil. All of this information aids in developing a seed and fertilizer mix.

Mapping of vegetation types and characterization of the vegetation types in regards to production, cover and density will be part of an in-depth vegetation analysis. Review available regional data prior to creating a revegetation plan.

Reference Sites

A reference ecosystem serves as a model for planning a revegetation/restoration project, allowing for measurement of the progression of an ecosystem towards its desired end-state (SER, 2002). It's important to note that a restored ecosystem can never be identical to the reference. A reference system is best assembled from multiple reference sites to account for the possibility that one particular site may be biased.

Many sources of information are useful in describing a reference site, such as lists of species present, maps of the site prior to damage, and aerial and ground-level photography (SER, 2002). Reference ecosystems should have high production and species composition in order for managers to evaluate the progress of the ecosystems towards its desired state of recovery. Eventually the restored ecosystem should emulate or closely resemble the attributes of the reference site (SER, 2002).

Collecting information from a reference site can be costly, and is often limited by available funds.

Permitting

Permits may be required for some projects. Regulations are always changing, however, so consult appropriate agencies to make sure that you have any permits necessary. A list of agencies is included as Appendix B.

Projects that disturb an acre or more, discharge storm water into a municipal separate storm sewer system (MS4), or into the surface waters of the United States require an Alaska Pollutant Discharge Elimination System Permit (APDES). This permit is issued by the Alaska Department of Environmental Conservation (DEC), in accordance with the Federal Clean Water Act. APDES permits are issued as either a phase one or phase two permit depending on the size of the area disturbed and nearby population. More information about the APDES program can be found at the DEC website, at dec.state.ak.us/water/npdes.

A dewatering permit is necessary if the total discharge volume is equal to or greater than 250,000 gallons and wastewater discharge is located less than one mile from a contaminated site. Other permits are necessary for projects that affect fish habitat, historic properties, endangered species, and other concerns. The regulations above were those in force at the time of printing. Please be aware of current regulations before beginning a project.

Identify Site Conditions

Potential limiting factors that will affect revegetation establishment are extensive, and a complete discussion is beyond the scope of this guide. This publication focuses on limiting factors that have been observed regularly on interior sites, and other parameters important for revegetation success.

Plant growth depends on water availability. The amount of water a type of soil can hold and how easily roots can penetrate the soil depend on the texture and structure of the soil.

Soil Texture

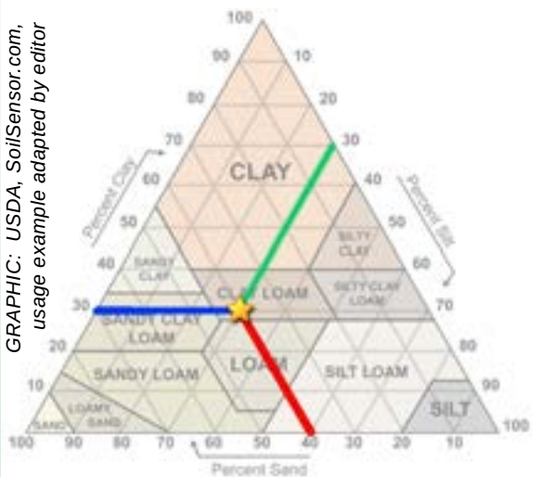
Soil is made up of mineral particles, organic matter, air, and water. Soil texture is determined by the composition of soil expressed as % sand, % silt, and % clay in which the total composition equals 100%. Seven classes of particle size are acknowledged with sands being the largest (2.0-.05 mm), silts (.05-.002 mm) intermediate in size, and clays (<.002 mm) being the smallest.

The Agronomic Soil Textural Triangle is a tool used to determine the textural type of a soil. Field analysis of soil texture can also be done using the "By Feel Method". This qualitative method is quick, easy, and fairly reliable. Testing procedure involves wetting a sample of the soil and working the soil between one's fingers. Water is often used to moisten the soil, but saliva is also suitable. Texture cannot be determined accurately when the soil is dry. Quantitative measures to determine soil texture are also available. Contact the Alaska Plant Materials Center for more information about testing and analysis of soils.

Some characteristics of clay soils are that they restrict air and water flow, have high shrink-swell potential, and are highly absorptive. Sand, in contrast, has a low water holding capacity (due to large pore spacing) and limited absorptive capability for substances in solution.

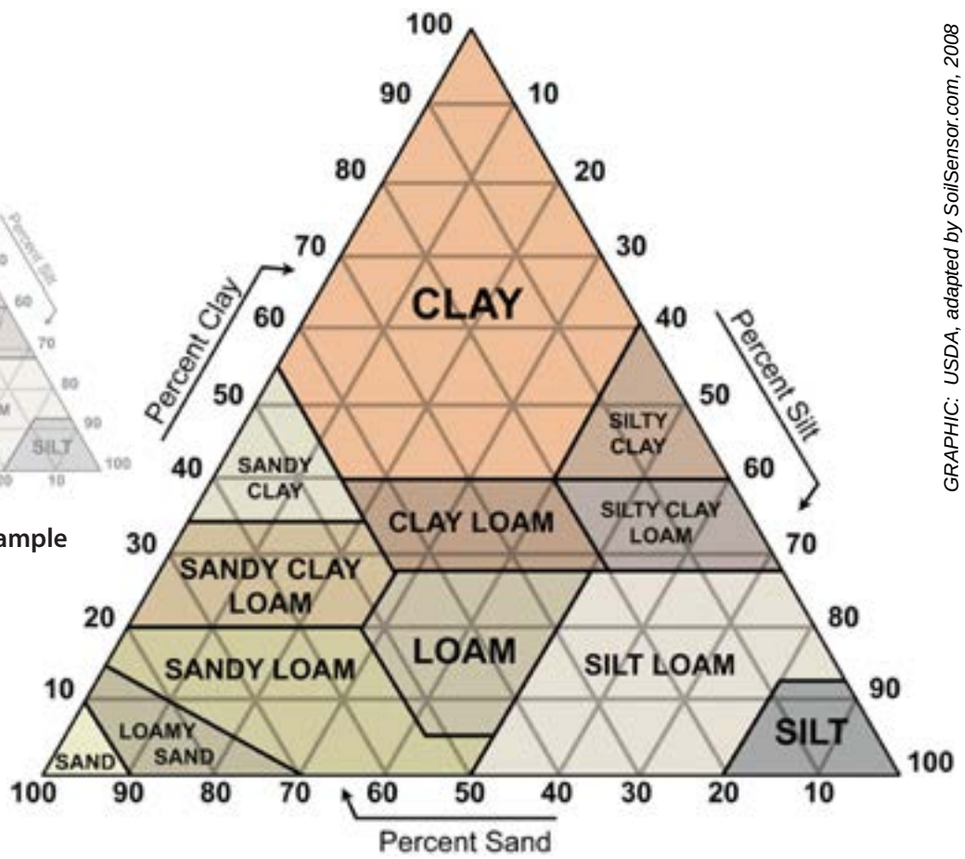
The remainder of this section refers to conservation activities on agricultural soils or undisturbed native soils. Details on construction site considerations are presented later in this chapter.

GRAPHIC: USDA, SoilSensor.com, usage example adapted by editor



Soil Textural Triangle usage example

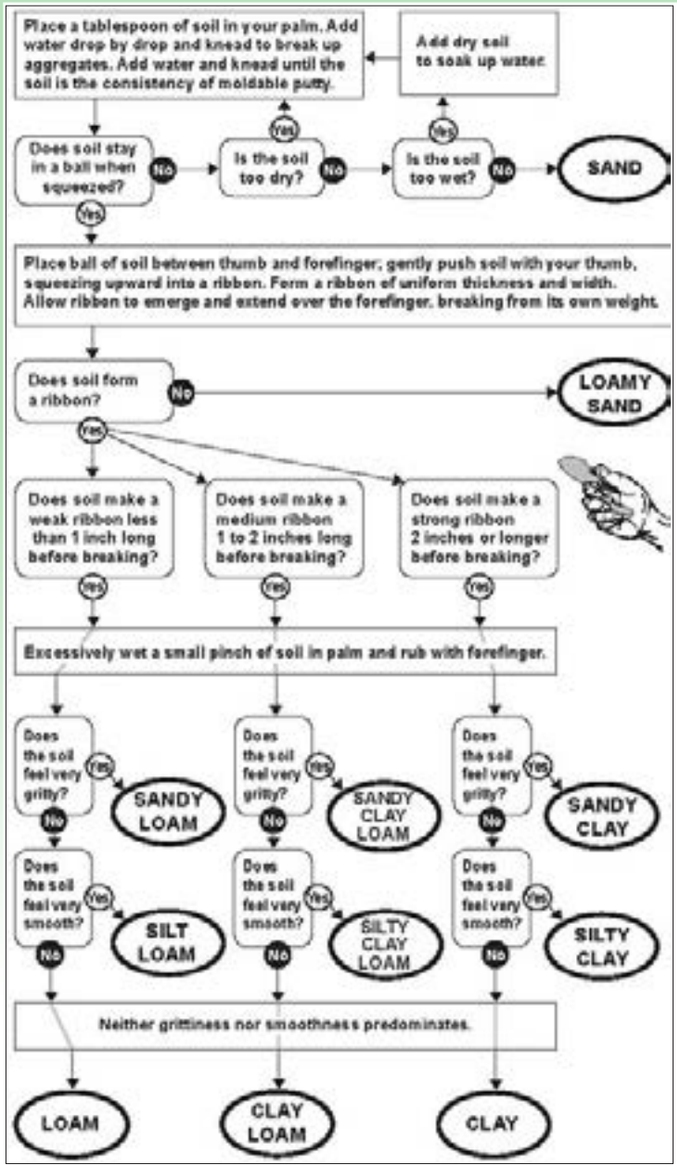
In the example above, the soil consisted of 40% Sand (red line), 30% Clay (blue line), and 30% Silt (green line). Thus, the soil can be classified as clay loam (indicated by the intersection of the three lines).



USDA Agronomic Soil Textural Triangle

GRAPHIC: USDA, adapted by SoilSensor.com, 2008

GRAPHIC: NRCS Irrigation Guide, USDA 1997



'By Feel' method of Soil Texture Analysis

Soil Structure

The aggregation of mineral soil particles (sand, silt, clay) is referred to as soil structure. The arrangement of soil particles create varying pore spaces allowing different quantities of moisture to be retained. This is referred to as the porosity of the soil, and will be noted on a soils test. Soil compaction refers to the reduction in the pore space of the soil by pressure applied to the soil surface. Compaction destroys the soil structure (compresses micropores and macropores), affects uptake and movement of water and inhibits plant and microbial growth.

Breaking up compacted layers can be accomplished by mechanical tillage equipment. Equipment should be operated on the contour to reduce the potential of water entering furrows and creating soil erosion problems.

Topography - Slope and Aspect

Slope angle and aspect can vary significantly at a site. Both of these factors influence the plant communities present. Slope angles are usually expressed as the ratio of the difference in height (*Vertical rise*) over the difference in length (*Horizontal run*). As an example: a 3:1 slope indicates three units of rise per unit of horizontal distance. Steep slopes are most prone to erosion and may require some form of surface stabilization, such as matting or mulch.

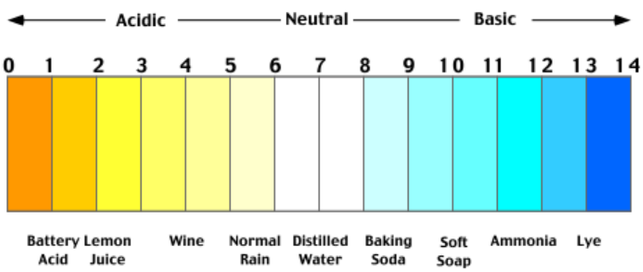
When a wetland is being restored, elevation gradients along the slope are very important. Many wetland species can only tolerate a certain level of water inundation. Plant loss can occur when planting in areas that receive too much or too little water; the result is an unsuccessful outcome from plant loss. Also, as one moves up in elevation the growing season declines because of lower air and soil temperatures.

Aspect is the direction a slope faces. North facing generally receives less sun and has wetter soils. Higher solar radiation, warmer air and soil temperatures, and drier soils are characteristic of south-facing slopes.

Soil pH - Acidity and Alkalinity

Soil pH is a measurement of soil acidity and/or alkalinity and has a major effect on nutrient availability. It is based on a logarithmic scale from 0 to 14. A number less than 7 represents an acidic soil, with the acidity increasing as the pH value gets closer to 0. Basic or alkaline are characterized by pH values greater than 7. A pH value of 7 indicates a neutral soil.

Basic soils contain high amounts of bases (calcium, magnesium, potassium, sodium, phosphates) and have generally developed in arid and



semi-arid climates. Acidic soils are formed in wetter climates where the bases have been leached through the soil profile. Having an idea of the pH value of the soil will help with plant selection, as some species prefer more acid soils and others prefer more alkaline soils. To correct acidic (low pH) soils a limestone application is used, and to mitigate overly basic (high pH) soils, sulfur is applied.

Electrical Conductivity

The electrical conductivity of a soil is determined by the amount of soluble salts in the soil. Plants grow best when the electrical conductivity (amount of salt) of a soil is low. Almost all plant species are endangered by high salt levels, particularly young seedlings. High salt concentrations can be found in arid climates where there is not enough rainfall to leach salts out of the plant root zone. Incorporating Gypsum into the soil may help to correct this.

PHOTO: Brennan V. Low (AK PMC)

A portable pH / Electrical Conductivity meter is used to identify site conditions in the field

Organic Matter

Organic matter consists of partially decayed and decomposed plant and animal matter, such as roots, branches, needles, bark and insects. In general, organic material makes up from 1 to 6% of the soil and is very important for water and nutrient retention. Revegetation potential is higher in soils with more organic matter.

Nutrients

In most forms of revegetation, application of fertilizer at the time of seeding is necessary. Most commercial fertilizers meet minimum standards for quality. When problems do arise, they can usually be traced to the product becoming wet during storage or shipment.

Fertilizer should be selected based on soil tests and the needs of the vegetation to be planted. Fertilizer is described using the percentages of three macro-nutrient elements: nitrogen (N), phosphorus (P), and potassium (K). For example, 20-20-10 fertilizer contains 20% nitrogen, 20% phosphorus, and 10% potassium by weight.

If possible, fertilizer should be applied concurrent with or prior to seeding. Once the seed has been applied no additional traffic should be allowed on the site. This is to avoid compaction and unnecessary disturbance of the seed bed.

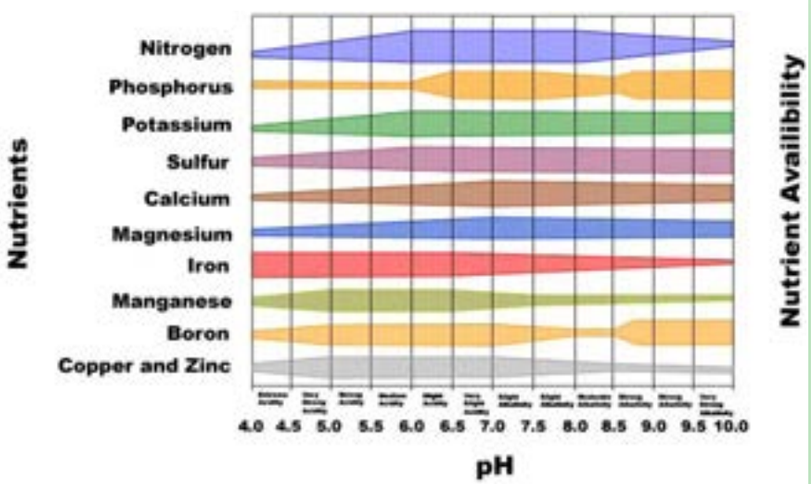
Topsoil

The topsoil layer in undisturbed areas in Alaska is often very thin, and therefore expensive and impractical to salvage. However, this layer is a source of native seed, plant propagules, organic matter, and soil microbes which can enhance the quality of the substrate being revegetated.

Topsoils tend to have lower salt content than subsoils. When topsoil is removed during construction, the remaining soils can be very high in salts and pH (Steinfeld et al., 2007). Topsoil is a valuable resource in revegetation, and should be salvaged when possible.

Many construction sites in Alaska have exposed surfaces of gravel or gravely soils. Gravelly sites tend not to be highly erodible. If some fine particles are present in the gravelly soil, adapted species will grow without additional topsoil. In fact, the addition of a layer of topsoil on a gravel surface can increase erosion potential.

Influence of pH on Availability of Plant Nutrients



GRAPHIC: S.S.S.A.P, 1946 11:305, Redrawn by K. Williams; extension.org

Construction Site Considerations

Construction and mining sites rarely have intact soil horizons. The preceding discussion on soil profiles does not apply to most disturbed land. More basic measures of soil particle size, elasticity, and water holding capacity are usually applied to construction and mining sites. The uniform soil classification table is the best means of determining soil characteristics for revegetation purposes.

The **Unified Soil Classification System** (chart included below) describes both the texture and grain size of a soil. Symbols are composed of two letters; the first represents primary grain size division (>50% of soil). The second letter refers to the uniformity or plasticity of a soil, or to a second major soil type (>12% fines present).

Seeding Methods

The objective of seeding is to place the seed where it is needed and in proper contact with the soil. The method used depends upon the plant species being seeded, equipment availability and site characteristics such as soil type and topography.

Drill Seeding

Drill seeding is a method whereby the seed is placed in a soil furrow and covered with a relatively precise amount of soil. Drill seeders are used most often in agricultural settings. One type of drill seeder, the Brillion-style, is often used for revegetation of mine and construction sites. This seeder has been successfully used on most soil types, except very gravelly soils.

Fertilizer cannot be applied with all drill seeders, however, the drill seeder delivers the seed into the soil, packs the seed in place, and applies seed with high accuracy. This method is considered by many to be the best method of distributing seed, however the need for specialized equipment may be impractical at many sites in Alaska.

Broadcast Seeding

The broadcast method scatters seed on the soil surface and relies on natural processes or harrowing to cover the seed. The recommended seeding rate for broadcasting is double that of drilling due to the lack of application control, seed

Major Divisions			Group Symbol	Group Name
Coarse grained soils - more than 50% retained on No. 200 (0.075 mm) sieve	gravel > 50% of coarse fraction retained on No. 4 (4.75 mm) sieve	clean gravel <5% smaller than #200 Sieve	**GW**	well graded gravel, fine to coarse gravel
			GP	poorly graded gravel
		gravel with >12% fines	**GM**	silty gravel
			GC	clayey gravel
	sand ≥ 50% of coarse fraction passes No.4 sieve	clean sand	**SW**	well graded sand, fine to coarse sand
			SP	poorly-graded sand
		sand with >12% fines	**SM**	silty sand
			SC	clayey sand
Fine grained soils - more than 50% passes No.200 sieve	silt and clay liquid limit < 50	inorganic	**ML**	silt
			CL	clay
		organic	**OL**	organic silt, organic clay
	silt and clay liquid limit ≥ 50	inorganic	**MH**	silt of high plasticity, elastic silt
			CH	clay of high plasticity, fat clay
		organic	**OH**	organic clay, organic silt
Highly organic soils			**Pt**	peat

Chart: American Society for Testing & Materials D 2487-83

Unified Soil Classification System (USCS)

An Ideal Seedbed Should :

1. Be free of construction debris;
2. Have relatively few large rocks or objects;
3. Be free of ruts and gullies;
4. Have the top two inches in a thoroughly tilled, friable, non-compacted condition (allowing a 170 pound person heel print to make a ¼ to ½ inch impression);
5. Be scarified to a depth of 6 to 8 inches, if soil is heavily compacted;
6. Devoid of non-native established weeds. Competition from weeds is can be a cause of seeding failure; and
7. Without a significant seed-bank of weedy species. Seed stored in the soil as hard or dormant seed may be viable and will germinate if the conditions are right. The presence of a nearby seed-bank often accounts for the surprise of a weedy species showing up on a site.

predation, and potential reduction in seed establishment and germination.

Broadcasting includes aerial seeding, hydroseeding, and hand-held methods. Hand-held and hand-operated spreaders are used due to their portability, increased speed, lower costs, and suitability to both seed and fertilizer application.

Hydroseeding

Hydroseeders are well suited for seeding steep slopes and rocky areas, as they apply mulch, seed, and fertilizer in a single step. Hydroseeders come in truck-mounted and trailer forms. Major contractors either have a hydroseeder or can easily subcontract one.

Hydroseeder manufacturers have claimed that hydroseeding promotes vigorous plant growth. Grass growth can be inhibited, however, if too much mulch is applied.

Hydroseeding has also been portrayed as the most effective means for revegetating an area, though this claim is debated. The primary disadvantage of hydroseeding is the requirement for large quantities of water, which can result in numerous passes across the land that is being revegetated. The equipment is also complex, and mechanical problems can cause costly delays.

Hydroseeders are also useful as supplemental watering trucks once seed has been applied. Additional water applications increase project costs and are not always necessary to produce

Photo: Casey Dinkel (AK PMC)

A drill seeder, in this case a Brillion ©, is often used for planting revegetation species. The large drum in the background is an imprinter, used to firm the seedbed as well as create furrows into which the seed will settle.

Photo: Brennan V. Low (AK PMC)

A drill seeder drops seed into a row prepared by the spinning discs.

a good stand of vegetation. Even without additional water application, seed will remain dormant until rainfall provides sufficient moisture for germination.

A hydroseeding contract should state that seed will not remain in the hydroseeder for more than one hour. This will prevent seed from absorbing excess water and being damaged by the dissolved fertilizer.

Aerial Seeding

Aerial seeding uses an aircraft to place seed and fertilizer onto a site. This method is used to:

1. Broadcast seed over very large areas (50+ acres),
2. Apply seed rapidly to an area,
3. Apply seed in remote locations inaccessible to other seeding equipment.

Aerial seeding is used often after wildfires to stabilize slopes quickly and prevent erosion.

Seeding Rates

The revegetation suggestion chart on page 52 lists broadcast seeding rates for revegetation species. In this publication, hydroseeding is considered broadcast seeding with regard to seeding rates. Note that the rates provided should be halved when drill seeding.

Site Preparation

Seedbed preparation is the primary concern of most revegetation projects, since it is the most labor-intensive, energy consumptive, and often determines success or failure (Vallentine, 1989). The objectives of site preparation are to create several safe sites or micro-environments that provide favorable conditions for seed germination and seedling growth.

The surface of the prepared seedbed should be relatively smooth for drilling and rough for broadcasting. Germination and survival increase with proper site preparation.

If traditional surface preparation equipment such as disks and/or chisel plows are available, the conditions required for adequate surface preparation are the same as previously noted.

Note: If hydroseeding is chosen as a method of seed application, surface preparation as described in this section may not be applicable.

Photo: Gary Antoni (AK PMC)

Hydroseeding is used to revegetate slopes that are not easily accessed by traditional seeding equipment

Photo: Glenn Air / Northern Reclamation Services

Aerial seeding can be used for revegetating large, linear or remote sites.

Transplanting

Transplants, cuttings, and sprigs are all a form of planting where some portion of a live plant is placed directly into the soil. This is a labor intensive process; however there are times when it is the most appropriate revegetation method. Planting transplants, sprigs or cuttings is a way to jump-start vegetation growth, as the transplanted species has already reached a certain state of development.

Planting Choices

After a species or species mixture has been selected, a decision needs to be made about which form of plant to use. Cost, revegetation objectives and availability of equipment are a few of the factors that influence this decision (Whisenant, 2005).

Seed

Seed is commonly used for revegetating disturbed areas. Seed is easy to collect, clean, store, transport, mix and apply to a site by drill or broadcast methods. Grass and forb species are usually directly seeded onto disturbed sites.

Seed Specifications

Quality seed is a critical component to success. Specifying "certified" seed assures quality germination and purity; certification also provides some assurance of genetic quality.

Some native seed species are not available as certified seed. Seed quality can still be ascertained by examining percent germination and percent purity; information that will be clearly labeled for any seed sold in Alaska. This labeling is required by 11 AAC, chapter 34: Seed Regulations (*included as Appendix A*).

The true cost of seed can be determined by the Pure Live Seed calculation. To calculate Pure Live Seed (PLS), use the following equation:

$$PLS = \left[\frac{\text{Germination \%} \quad x \quad \text{Purity \%}}{100} \right]$$

The true price of seed, then, can be determined using the equation below:

$$\text{Price}_{PLS} = \left[\frac{\text{Bulk cost of seed / lb} \quad x \quad 100}{PLS} \right]$$

These calculations can increase the accuracy of bid comparisons. PLS price is a good method of comparing different seed lots at purchase.

All seed sold or used in the state of Alaska must also be free of noxious weeds (11 AAC 34.075). This is noted on seed tags, along with germination and purity.

Seed stored on site should be kept cool, dry, and in rodent-free areas. Remember seed is a living commodity; always buy seed based on the PLS calculation.

Certified Seed

The term "certified seed" can cause confusion because it is used to describe two conditions:

The official use of the term Certified seed (with a capital C) is to describe seed grown under the rules of the Seed Certification Program. Its ancestry can be traced back to Registered Class or Foundation Class seed. In addition, the Certified seed must meet standards of purity and germination. These standards are a means of verifying authenticity of a seed source. All the Alaska developed seed varieties or cultivars can be sold as either Certified or common.

Seed can also be certified (without a capital C) to be free of weeds or as meeting a minimum germination standard (11 AAC 34.075). This has nothing to do with variety identification - it simply indicates the quality of the seed.

Alaska Certified seed tags

Pre-certified Class seed tags

Seed produced in Alaska is easy to trace to its origin. It may be common (uncertified) 'Arctared', but it is still 'Arctared'. Minimum purities and germination should always be stated with orders. Certified seed should be used when available, although common seed is a usable product and may also be used to meet demands.

Common seed should meet Certified standards with regard to germination and purity, although these standards may need to be relaxed to acquire sufficient material for a large job. Lower germination rates can be overcome by increasing the seeding rate. Avoid lower purities of seed.

Other Certification Classes

Many new native seed sources are being developed in Alaska. For the most part, these will not be sold as Certified seed. They may carry the following designations: **Source Identified**, **Tested Class**, or **Selected Class**. These classes will be in keeping with the standards of germination and purity of the Certification system, but the term Certified seed will not apply. These classes are referred to as being Pre-certified Class.

Transplants

Transplants are plants that were/are growing in their native habitat and are transplanted directly into a restoration site or nursery to be cultured for future use. Large transplants provide visual prominence to a site and have the ability to establish and spread quickly (Hoag, 2003).

Transplanting shock is a problematic and common occurrence, whereby the transplanted species fails to become established. Care should be exercised and appropriate horticultural practices used to prevent transplant shock.

Sprigs

Sprigging is a method of transplanting whereby a plant clump is divided into individual sprigs, each of which is capable of growing into a new plant. Sprigs can be harvested from wild stands of vegetation, and planted without special equipment. A sprig does not need to have well-developed roots at planting time, only a portion of the below ground crown. The above ground portion of a sprig may die back after transplanting, however this is not cause for concern. New growth will start from the below ground portion. Sprigs become established faster than seeded grass.

Bare-root stock

Bare–root stock is commonly used to establish woody plants. Seedlings are grown in outdoor nurseries, lifted from the soil when dormant, and then stored in a cool and moist environment until transplanted (Munshower, 1994). Hardening, which induces dormancy, is often done in a 6-8 week period prior to transplanting, in order to acclimate the seedlings to their new environment.

Container-grown stock

Container stock is grown in artificial growing media in a controlled environment, usually a greenhouse. When harvested, the root system forms a cohesive plug (Steinfeld, 2007). Containers come in a variety of sizes and shapes. Container-grown plants are able to tolerate harsher conditions more easily than bare-root transplants (Eliason & Allen, 1997).

Cuttings

The use of willow cuttings is the most common used method of vegetative planting in Alaska, both historically and today. The use of willow cuttings has proven successful in all areas of Alaska where willow occurs naturally. Because timing is critical to both collection and planting, prior planning is an absolute necessity.

For detailed instructions on the use of willow cuttings, please refer to Streambank Revegetation and Protection, a guide published by the Alaska Department of Fish & Game. This publication can be found online, at www.adfg.alaska.gov/index.cfm?adfg=streambankprotection.main.

Photo: Andy Nolen (AK PMC)

Willow stakes, planted while dormant, will grow again in the spring.

Planting Time

Timing is crucial to revegetation success. The optimum planting season is just before the longest period of favorable conditions. Spring planting is ideal where the primary growing season occurs in the late spring and/or summer. The end of the planting season for Interior Alaska generally falls between August 15th and 31st.

If you are planning a revegetation project after the end of the planting season, refer to the dormant seeding section of the Techniques chapter for further information.

Selection of Species

After receiving a project contract, assess the availability of potential species. If seed and plant materials are available at the correct time and an acceptable cost, the purchase should be made immediately. Buying seed early ensures that the product will be available as needed. Care needs to be taken to assure the seed and plant materials are properly stored in a dry, cool environment to prevent loss of viability.

One of the most important criteria for successful revegetation is species selection. A restoration project seldom relies on a single species, however.

A classic definition states:

"Species selection strategies that emphasize diversity assume species-rich ecosystems are more stable and less susceptible to damage from unusual climactic events, disease or insects" (Whisenant, 2005).

Several characteristics are important in choosing a seed mixture, including: reliable establishment, ability to survive changing conditions, and ease of propagation (Coppin & Stiles, 1995). The Alaska Plant Materials Center recommends including at least three species in a planting mixture. Plant species should be chosen based on their adaptation to the project site and whether or not it is native to the area being revegetated.

Species is Adapted to site

The harsh environments of Alaska limit species growth and production potentials. Therefore, it is imperative that species chosen are able to survive and thrive in the local environment. Climatic, topographic, and soil conditions all influence plant performance, and should all be taken into account when selecting species.

Species is Native to the area

Native species, already adapted to Alaska, generally perform better than introduced materials. However, prices may be higher for native plants or seed. Availability is currently the primary obstacle to using native species in Alaska, although in-state production is increasing, due in part to state and federal mandates requiring the use of these species.

A list of commercially available native plant species is available in the Native Plant Directory,

Photo: Brennan Low (AK PMC)

Seeding should be accomplished using high quality seed that has been properly stored and is free of weeds.

which can be found at the Alaska Plant Materials Center website, at plants.alaska.gov/native. A discussion of non-native and invasive plants can be found in the Conservation and Protection chapter, on page 43.

Mulch and Erosion Matting

If soil has a high erosion potential, consideration should be given to using a soil cover such as mulch or erosion matting. Using a soil cover can conserve soil moisture, moderate soil surface temperature and increase germination. When deciding a soil cover method to use (i.e. mulch or erosion matting), several factors should be considered. Erosion potential due to wind or water is the first and primary consideration.

If the soil does not have a high erosion potential, then mulch and/or matting may be skipped. The second consideration is cost. Application of mulch and matting add significant costs to a project; not only in materials, but also in labor. An additional consideration is that straw may introduce unwanted weeds.

The above concerns do not apply to wood and paper fiber or similar products used in hydroseeders. When hydroseeders are used, mulch is obligatory. The mulch fiber forms a slurry that acts as a carrier for the seed and fertilizer. Without mulch, seed and fertilizer would not suspend properly or efficiently in solution, and uniform distribution would be impossible. Mulch also serves as a visual indicator of areas that have been treated.

Photo: Phil Czapla (AK PMC)

Geotextile fabric is a popular and effective type of erosion control matting. It is both inexpensive and resistant to weather extremes.

Photo: Sam Lamont (AK DOT&PF)

Seeded grasses become established through jute erosion control matting

Techniques


Photo: Don Ross

Many techniques exist for revegetation, including pre-prepared vegetation mats

In a number of situations, revegetation through seeding is not practical. There are several alternative methods that can be used to revegetate an area, in place of seeding. The different approaches highlighted in this chapter provide for greater flexibility to various site conditions and available materials.

Charged Overburden Veneer:

This technique promotes growth by spreading overburden (usually topsoil taken from a nearby work site) over an area to be revegetated. Seed, roots, nutrients, and microorganisms already present in the soil constitute the 'charge', and are relied upon to establish vegetation. The drawback to this revegetation technique is that it may involve placing an erodible material on the site.

An additional step to this revegetation approach consists of pushing the vegetative cover aside into debris piles, and then removing the topsoil layer and setting it aside as well. Upon completion of excavation, the site is re-contoured and the topsoil and vegetative debris is spread back over the area. The vegetative debris and 'charged' topsoil promote the growth of vegetation and increase the likelihood of a successful revegetation outcome.

Special measures must be taken if the overburden material has the potential to be transported into storm sewer systems and / or surface waters. Numerous Best Management Practices (BMPs) exist to limit soil sediment transport. For more information, view Appendix F of the Alaska Storm Water Pollution Prevention Plan Guide, available at www.dot.alaska.gov/stwddes/dcspubs/manuals.shtml.

Photo: Steve McGroarty (AK DOT&PF)

Vegetative debris was spread over a re-contoured waste rock dump at the Illinois Creek Gold Mine.

Topsoil being gathered onsite - November, 2005

Spreading charged overburden - May, 2006

Heavy equipment used to spread topsoil - May, 2006

Photos: James Bowers (AK DOT&PF)

Vegetation growth after 2 seasons - August, 2008

Vegetation cover fully established, using charged overburden technique - August, 2008

Sod Clumps:

The use of sod clumps is a form of transplanting whereby natural vegetation stands are harvested in block form. Dimensions of these blocks vary from one to several feet square (Muhlberg & Moore, 1998). Using sod clumps provides immediate vegetative cover on a site, and species are able to establish on a large area more quickly than with other forms of transplanting (i.e. using sprigs or individual plants).

Photos: AK DEC, Spill Prevention and Response

Transplanted tundra plugs

Placement of sod clumps

Harvesting sod clumps using a Bobcat

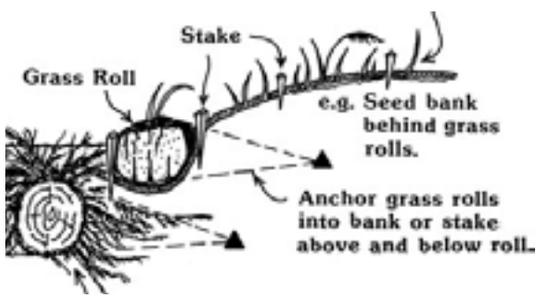


Photo: Nancy Moore (AK PMC)

A prepared grass roll, consisting of sod clumps wrapped in a biodegradable fabric, with slits cut in the top for the shoots

Sod clumps are also used in the restoration of erodible stream banks. Grass rolls use sod clumps wrapped in biodegradable fabric to stabilize river banks and quickly establish vegetation cover. For further explanation of this technique, refer to the ADF&G publication: 'Streambank Vegetation and Protection, a Guide for Alaska', or visit www.adfg.alaska.gov/index.cfm?adfg=streambankprotection.main.

Vegetation Mats:

If clumps of sod are not readily available, a vegetative mat can be prepared in a nursery or greenhouse, and later transported to the site. In this technique, plantings are grown in a controlled environment until roots and rhizomes have established.

Vegetation mats provide many of the same benefits of a sod clump, however at a greater cost in time, materials and labor. Prior planning is necessary when using vegetation mats, as the preparation of a mat will take at least one growing season. Some seeds may require stratification, while others may require scarification. All of these factors should be taken into account if you are using this technique.

Photos: Peggy Hunt (AK PMC)

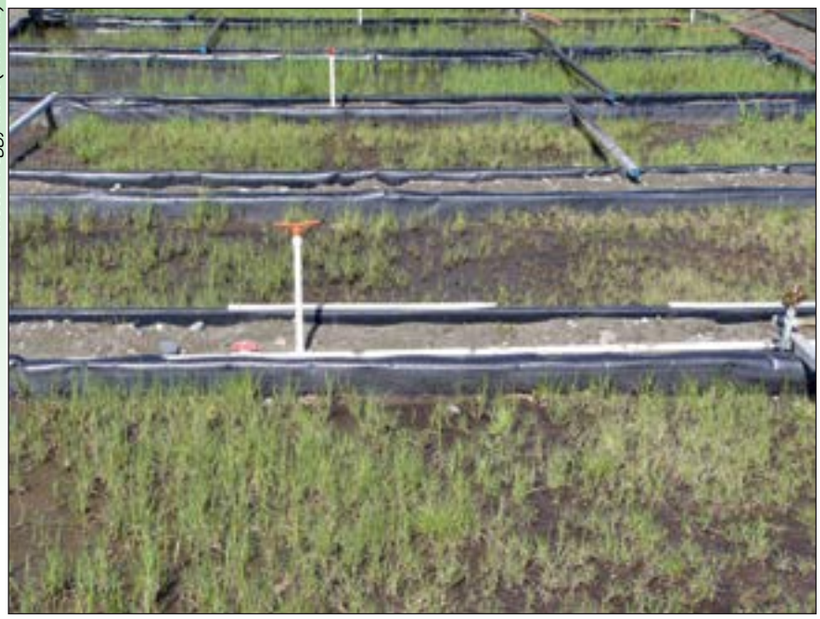
Soil spread on erosion control fabric provides a binding medium for roots.

10′ x 3′ constructed mats framed with dimensional lumber, with thick plastic and erosion control matting used for the base. Only the biodegradable erosion control matting will remain once the mat is deployed.

Photo: Peggy Hunt (AK PMC)

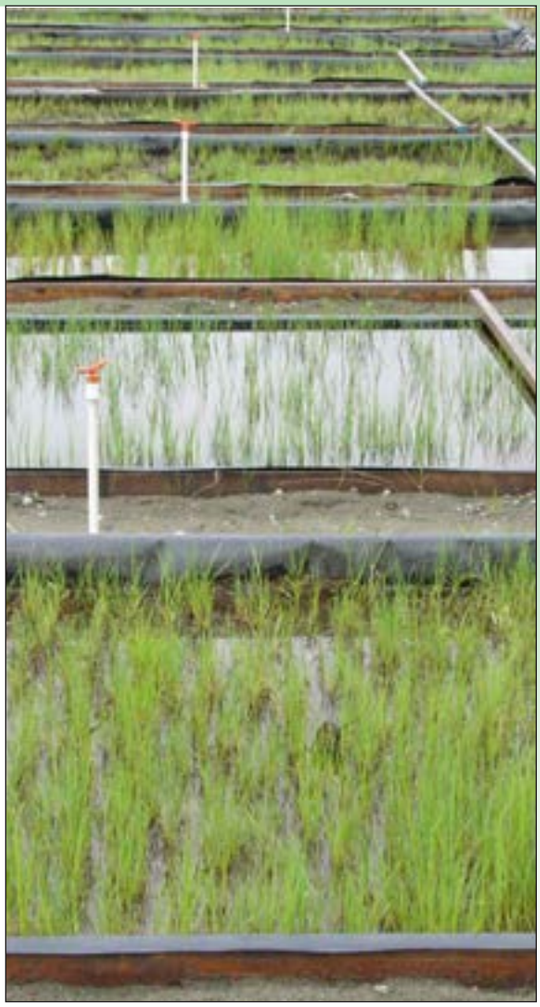
Stratified seeds are sown on a vegetation mat, using hand seeders and a constructed grid to seed at a rate of 1 seed per 2 inch square.

Photo: Peggy Hunt (AK PMC)



Germinated seeds take root in the constructed vegetation mats

Photo: Peggy Hunt (AK PMC)



In situ irrigation allows wetland species to thrive in the constructed vegetation mat.

Photo: Don Ross

Underside of vegetation mat, showing developed roots inter-twined with erosion control fabric

Photo: Don Ross

Established water sedge mats, ready for transport to site

Vegetation mats should be sized to fit available methods of transportation.

Heavy plastic sheeting facilitates on-site transport of the vegetation mats.

A line of vegetation mats, ready for placement

Vegetation mats being installed along the waters edge

Photos: Don Ross

Vegetation mats, one year after transplanting

Natural Reinvasion:

This technique relies on natural processes to revegetate a site. It is a slow process with unpredictable results. Management is not required because neither seedbed preparation nor planting is done. Species from the surrounding areas arrive through natural processes, usually by wind dispersal. Though it may take many years for a plant community to become established, this method can be highly effective and is often used at sites that are out of view. When communities are concerned with initial aesthetic and visual appeal, or a regulatory timeline applies, this technique should be avoided.

Photo: Steve McGroarty (AK DOT&PF)

Natural invasion is evident at this materials borrow site, four years after the closure of the Illinois Creek Gold Mine. The borrow site is being colonized nicely by species from the surrounding area.

Enhanced Natural Reinvasion:

Natural reinvasion can be assisted or enhanced with any combination of surface preparation or modification techniques, fertilizers, and soil amendments. This technique is infrequently used in the field, as few sites offer ideal conditions. Additionally, the regulatory process precludes methods that cannot give specifics of final vegetative cover and/or composition.

The enhanced natural reinvasion method of revegetation is dependent upon seed to arrive at the site by natural processes. This method is faster than natural reinvasion, but still has a relatively low success rate. Anyone wishing to apply this technique must understand the potential for failure and be willing to move to an active form of revegetation if the process does not perform well or other problems emerge.

Photo: Phil Czapla (AK PMC)

Using a tow-behind broadcast seeder to apply fertilizer can ensure uniform distribution.

Photo: Stoney Wright (AK PMC)

Fertilizer should be applied to edge of existing vegetation.

Photo: Stoney Wright (AK PMC)

The effect of surface scarification on plant establishment and growth after two growing seasons. No seed was applied to the site, but it was fertilized with 20N-20P-10K at a rate of 500 pounds per acre.

Imprinting:

Land imprinting is a method of seedbed preparation that uses heavy rollers to make a depression in the soil surface, creating basins in the soil that reduce erosion, increase water infiltration and captures runoff (Dixon, 1990). Imprinting can be accomplished with heavy equipment such as a compactor with a 'sheeps-foot' attachment. A broadcast seeder is often attached to the back of an imprinter to apply seed.

When the soil has been imprinted, uncovered seeds in the basin areas will tend to be covered by natural processes such as wind and rain. Imprinting creates micro-climates suitable for plant germination and growth. 'Track-walking' is a method of imprinting whereby the cleats on a tracked vehicle leave depressions on a soil surface. This technique is commonly used on sloping sites, before seeding. The equipment should be operated so as to leave depressions that will intercept runnoff as it flows downslope. When using the track-walking technique, the surface area of the treated site is increased by approximately 20%; application rates of materials should be adjusted accordingly.

The wheels of this landfill compactor imprint the surface area, creating basins of micro relief in the seedbed

Photo: Gordon Scholsser (Great Northwest, Inc)

If operating on a slope, tracked vehicles should be driven up and down to the slope such that the cleat marks left after track-walking are roughly perpendicular to the slope

Photo: Stoney Wright (AK PMC)

Imprinting creates pockets in the soil, each with a favorable micro-climate for vegetation growth

Photo: Phil Czapla (AK PMC)

Surface imprinting accomplished using the 'track-walking' technique.

Photo: Stoney Wright (AK PMC)

Vegetation grows first in the depressions created by the cleats of a tracked vehicle.

Photo: Stoney Wright (AK PMC)

***Puccinellia nutkaensis* grows in the depressions created by bulldozer tracks.**

Scarification:

Soil is scarified on almost all sites in preparation for seeding and fertilizer.

A harrow is a tool used to roughen the soil surface and kill shallow-rooted weeds. This process, called 'harrowing', may also break the compaction layer within the first few inches of the surface. When used after broadcast seeding a harrow will help to cover the seed with soil.

Heavy equipment, such as graders and front-end loaders, are frequently used for scarification on highly compacted rocky soils. A dozer blade can be modified with 'tiger teeth' at regular intervals and used for scarifcation.

Photos: Stoney Wright (AK PMC)

Deep scarification of the soil surface can be accomplished using a grader with a 'ripper shanks' tool bar.

A bulldozer, modified with 'Tiger-Teeth' attached to the blade, is an effective means of surface modification that promotes root growth by reducing soil compaction .

Dormant Seeding:

Dormant seeding is the process of planting seed during late fall or early winter when soil temperatures are too cold for seed germination to occur; so that seed germination occurs the following spring.

Facts to consider when choosing Dormant Seeding:

Choosing dormant seeding as a revegetation approach will allow for an extended planting season. The planting window for revegetation projects can be extended by several months when the dormant seeding method is part of a revegetation plan.

Seeds in flats for cold / moist stratification over the winter. During the stratification process, seeds are placed in cloth bags, with a layer of peat beneath and above them. The cloth around the seeds provide a steady source of moisture.

Planting seed later in the season can naturally overcome seed dormancy mechanisms. Some native species require exposure to cold and moisture (overwintering) to break internal and external dormancy. In these species, the winter season allows for stratification and scarification processes to take place. Breaking seed dormancy in a spring/summer planting schedule may require that these winter conditions be artificially recreated in a controlled environment. Most grasses used for revegetation in Alaska do not require this treatment. Forbs are more likely to require stratification.

Another benefit of dormant seeding is the head-start it provides against weeds. Seed present in the soil at the start of the growing season will face less competition from weeds for resources like oxygen and water.

Dormant seeding can also result in significant and unanticipated problems. Unseasonably warm temperatures after seed placement can trigger germination, and the possible failure of the seeding effort due to seedling mortality. Also, seed predation by rodents or birds can become a concern if seed was not adequately protected. Seed can also be transported away from the intended site by wind during the winter, or by water erosion during spring break-up.

Remember that dormant seeding cannot be counted as an active measure on the Storm Water Pollution Prevention Plan (SWPPP) without some other physical measure that protects the soil surface overtop of the seed bed. Dormant seeding is not an immediately effective Best Management Practice (BMP).

Site Preparation & Planting

Seeding methods become more limited with dormant seeding. The ground should be frozen with a soil temperature below 40 degrees so that the seed will not germinate. Seeds must remain un-germinated and in place until after the next growing season starts.

Dormant seeding is a roll of the dice and requires a high degree of confidence. The user is essentially becoming a farmer.

Late season planting restricts the type of site preparation equipment that can be used, as well as the method used to apply the seed mix. Frozen soil on a project site is harder to manipulate, and this can affect the viability of the seedbed. A mechanical implement such as a drill seeder is not as adaptable to frozen soil. Broadcasting and hydroseeding are effective methods for distributing seed on frozen ground. If hydroseeding, a dark colored mulch should not be used in the slurry. Dark mulches may raise the soil temperature promoting early germination.

Planting Time & Rate

As a general rule dormant seeding should only be undertaken after the first hard killing frost, but not after four inches of snow. This will prevent premature germination and allow good seed-to-soil contact. Dormant seeding should never be attempted on crested snow.

Mulch application may necessary for unprotected and windy sites, to protect the seed and prevent it from blowing offsite. The type of mulch used and application rates will be determined by the project engineer or Storm Water Pollution Prevention Plan (SWPPP) for the project site. Application rates are usually in accordance with manufacturer specifications.

Higher application rates are recommended for dormant seeding because seed mortality rate is higher. A 15-25% increase is appropriate. Dormant seeding is not temporary seeding and should include both annual and perennial species.

Seeding schedules tend to be location specific. As rule of thumb, seed as soon as you can in the spring (i.e. when no crusty snow remains on the ground). Temperature in the spring has no effect on seed dormancy.

Wild Seed Collection

Photo: Andy Nolen (AK PMC)

A pull-type seed stripper is an effective means of harvesting wild seed without damage to the surrounding environment.

An alternative to obtaining seed commercially is to collect seed in the wild. Wild seed can be harvested from native grass, forbs, shrubs, and trees found at or near the project site (Steinfeld,Riley,Wilkinson, Landis, Riley, 2007). If seed collection occurs at a considerable distance from the project site, make sure the species is adapted to the site conditions before using it in a revegetation project.

Collection of wildland seed is a lengthy process that benefits from prior planning. Seed collection, processing and increase are all steps that must be followed to make plant materials available. Seed collection includes locating donor plant communities, collecting seed, and choosing a method of harvest. When determining where to harvest, remember that there is no un-owned land in Alaska; collecting seed from any property, unless it is your own, requires the permission of the owner. If the potential seed collection site is state, federal, or tribally owned land, permits may be required. For a list of agencies and large land holders in Alaska, refer to **Appendix B: Partner Agencies**.

Proper timing in the season is critical for successful seed collection. A number of field visits may be required in order to collect seed that is ripe and mature. Seeds go through different stages of maturity; being able to recognize these stages allows one to collect seed in the proper ripening window. This collection window may vary from a few days to several weeks. Additional collection trips in the following year may be required if this window is missed. Also, some species may not produce enough seed in a single year, requiring multiple collection trips before planting can commence.

Recognizing seed maturity depends upon several factors, and differs for grasses, trees, and shrubs. Color, taste, and hardness should be considered when determining if a seed is mature. Plants with fruits start green and change to red, blue, white, or varying colors with maturity. The sour, bitter taste in plant fruits indicates an immature plant. With time, higher sugar content in the fruit signals maturity, giving it a sweet taste when eaten. The hardness of the fruit will also change when mature. When fruit becomes soft and pulpy, it is usually mature.

Photo: USDA Forest Service

Cut stem just below the seed-head when harvesting seed by hand.

Seed pods are another indication of maturity. If rattling can be heard when the pod is shaken, then the seeds are ready to collect. Cracks or breakage of the seed pod is another indicator of readiness. Lupine is a good species to hear and see those traits.

Grass seed maturity can be determined by how the seed responds when pressed between the fingers. The stages of grass seed maturity are summarized below (Steinfeld, et al, 2007):

- **Milk stage**: A milky substance is secreted when pressure is applied, indicating an immature seed lacking viability.
- **Soft-dough stage**: Seed has a doughy texture, indicating it will have low germination and viability if collected.
- **Hard-dough stage:** No excretion of dough or milky substance when squeezed. Seeds are collected at this stage. Seeds can be collected at the transition between soft-dough and hard-dough stages. If collection occurs between these stages, seed should not be stripped from the plant. Instead, seed heads should be cut and placed in collection bags where seeds will continue to mature.
- **Mature:** Seed in this stage are usually too hard to bite. Collection should begin immediately, because the seeds can dislodge from the stem at any time.

Weather conditions at the collection site are another variable to consider. Seed collection should commence during dry weather with little wind. High wind can make collecting difficult and blow the seed off site.

Seed collection methods are dependent upon the species being collected, where collection occurs, and the scale of the project. Grass seed is often harvested by hand, usually by shaking it off the stem or cutting off the seed head with a knife or scissors. Shrub seed can be picked by hand or lightly shaken into a tarp or bucket for collection. Large-scale harvesting is usually accomplished by mechanical means. Collection bags should allow airflow; cloth bags are often used.

Terrain is another factor that determines how the seed is collected. Steep slopes may limit access by mechanical equipment, necessitating alternate means of collection. For large, flat sites a combine or Woodward Flail-Vac © type seed stripper can be used. A pull type seed stripper can be mounted to an all terrain vehicle (ATV), facilitating collection on less flat ground.

Project scale is another consideration when collecting. The quantity of seed needed will often determine how seed is collected. Small quantities can be collected by hand but large-scale projects requiring large amounts of seed will benefit from using mechanical implements.

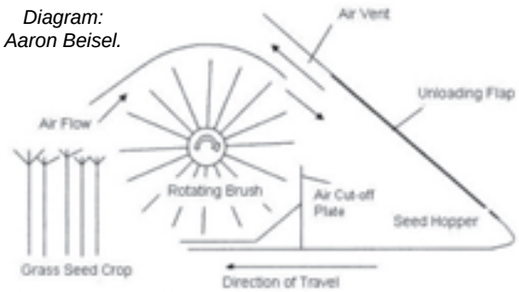
Photo: Stoney Wright (AK PMC)

Combine harvesting wild Bluejoint reedgrass (*Calamagrostis canadensis*)

Photo: Stoney Wright (AK PMC)

Collected fireweed stays in the seed stripper until removed for processing.

Diagram: Aaron Beisel.



Schematic of Woodward Flail-Vac © seed stripper

Photo: Prarie Habitats Inc.

A hand-held seed stripper is a solution for medium volume collections in inaccessible sites.

For inaccessible sites that are too large for hand harvesting, consider using a portable seed collector, such as a hand-held seed stripper or a commercial leaf vacuum. A push-type chipper shredder can also be used to collect seed, however some damage to the seed may occur due to the nature of the equipment. Regardless of the method of collection, processing is required before the seed can be used for revegetation.

Seed processing involves separating weeds, chaff, dirt, stems, and other inert matter from the seed. This is generally done by specialized equipment, but seeds can also be processed by hand for smaller field collections. After cleaning, the seed is tested at a seed lab for purity and germination.

Seed increase involves taking cleaned wild seed and planting it in a nursery field. The field is then cultured for heavy seed production, which involves weeding and fertilization, amongst other treatments. When sufficient quantities of seed are available, the increased seed must be collected and processed, as previously described, before planting can begin.

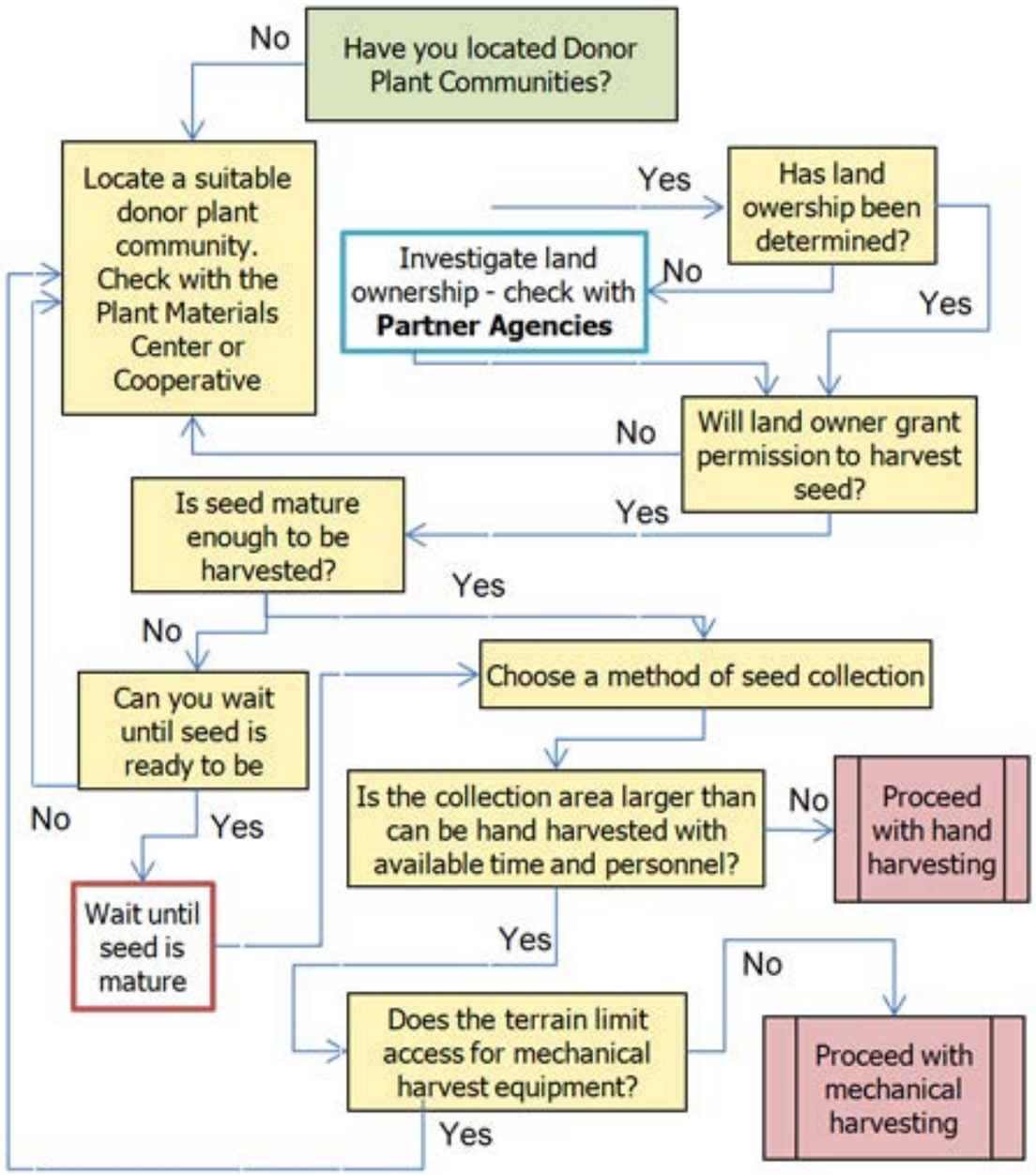
Harvested seeds from tree and shrub species are often started at a nursery and grown in nursery beds (bare-root stock) or containers (container-grown stock) in a greenhouse. Seedlings are then transplanted to the site when ready.

Photo: Troy-Bilt USA

A leaf blower with a vacuum function can be used to collect seeds in the wild.

Photo: Andy Nolen (AK PMC)

Using a seed stripper leaves the inflorescence (seed-head) intact, allowing for multiple equipment passes.



Wild seed harvest decision chart

Potential Sources of Erosion

Photo: National Parks Service

The 2005 Highpower Creek fire burned 115,000 acres of Denali National Park

There are many industries and activities that affect the soils and vegetation of Interior Alaska. Erosion or sedimentation from wildfire, agriculture, transportation, and resource development industries needs to be monitored. This chapter will address notable and typical impacts to Interior Alaska.

Following best management practices from the beginning of a project is an effective way to ensure a successful outcome and minimize the potential for erosion. If questions arise in the development of a revegetation / restoration plan, contact the Alaska Plant Materials Center for assistance.

Wildfire

Natural events, such as wildfire, can have a large effect on the landscape. Wildfires originating from lightning strikes, up to 4000 in a single day, are common throughout the summer months. In 2004 and 2005, Alaska recorded its worst burn years to date. Over six and half million acres were burned in 2004, and another four million acres in 2005.

Fire is a natural part of the landscape, resulting in uneven age distribution of trees in the forest, increased wildlife habitat and improved forest health. Hot burns down to mineral soil are essential for the regeneration of Black Spruce forests. Land managers identify lands that will benefit from natural fire. Fires in these areas are monitored, but left to burn until ended by weather, lack of fuel, topography or until threats to other resources justify suppression action.

Photo: National Parks Service

The process of succession takes place after wildfire. Here, cottongrass grows in the nutrient rich soil left after a burn.

Fire can be a major threat to life and property. It can potentially melt permafrost and be a source of erosion problems. Fire can result in the need for revegetation, slope stability and mitigation measures.

Wildfire can greatly affect species composition and age distribution of trees. Burned landscapes must go through transitional stages (succession) over time, as different tree species become established earlier and are replaced by other species over time. A diverse age and species distribution benefits not only forest health, flora and fauna, but creates natural barriers to wildland fire spread.

Natural reforestation and regeneration are successful in abating erosion in many areas, but with steep terrain, permafrost, or during certain seasonal weather conditions, the effects of fire can require remediation. Timing between fire occurrence and weather factors, such as thunderstorms, flooding or the onset of winter, can greatly influence the role of erosion.

Spruce Bark Beetles and Other Dangers

Another factor that can play a role in the intensity and frequency of wildfire is the Spruce bark beetle. In the 1990's, southcentral Alaska experienced a beetle outbreak that killed millions of acres of spruce trees (Ross, Daterman, Boughton & Quigley, 2001). Although most devastating in Southcentral and the Copper River Valley, other natural, extensive insect infestations have created more localized problems in Interior Alaska. Tree mortality caused by the spruce bark beetle has increased the potential for large, intense wildfires, changing vast areas to grassland made impenetrable with wind-thrown dead trees.

This beetle attacks spruce trees by boring through the bark and laying eggs directly into the phloem tissue, the transport mechanism that distributes food throughout the tree. When this layer is destroyed, the tree will die. When spruce beetle populations increase, they will begin to shift from dead, dying, and stressed trees into healthy trees nearby (USFWS).

A method to reduce the fire hazard caused by bark beetles is the removal of trees killed by beetles and wildfire. This management strategy removes host trees or logs suitable for beetle colonization (Reynolds & Holsten. 1994; Schmid, 1981). Salvaging burned material also reduces surface fuel loads on the forest floor. Large woody debris on the forest floor after spruce beetle outbreaks is prime "fuel" for wildfires. Wildfires that occur in affected forests could be intense and difficult to control (Ross et al., 2001).

Photo: Ned Rozell | UAF Geophysical Institute

Spruce bark beetle damage evident on White Spruce, *Picea glauca*

Agency policies concerning the removal of trees differ. The Alaska Department of Natural Resources, Division of Forestry and U.S. Forest Service remove diseased, dead, and dying trees in areas that are accessible, while the U.S. Fish and Wildlife Service encourages trees to be left in place to serve as nesting habitat and cover for wildlife. The U.S. Bureau of Land Management encourages harvest of diseased, dead, and dying trees on most lands under their oversight (USFWS).

Agriculture

Agriculture can be a source of erosion. Land clearing and grading (tillage) disturbs native vegetation and wildlife habitat. Application of chemical fertilizers and pesticides can affect soil nutrient cycles and groundwater. Soil erosion can lead to declining agricultural productivity and loss of topsoil. Understanding these dangers can help producers to avoid damage to the ecosystem.

The biggest dangers associated with agriculture are:

- Damage to soil, including erosion; and
- Contamination of water and soil from fertilizers & pesticides.

Ten times as much soil erodes on average from American agricultural fields as is replaced by natural soil formation processes. Since the formation of just one inch of agricultural topsoil can take up to 300 years, soil that is lost is essentially irreplaceable (Troutmann, Porter & Wagenet, 2008). Surface soils have the greatest water holding capacity and the highest density of plant nutrients. Cover crops, windbreaks and terracing are methods of limiting erosive threats to a soil.

Surface runoff carries manure, fertilizers, and pesticides into streams, lakes, and wetlands. Groundwater can also become contaminated by percolation of water and dissolved chemicals downward through the soil. Nitrogen from fertilizer is also a concern because of its high solubility in the nitrate form. Leaching from agricultural fields can elevate nitrate concentrations in underlying groundwater to levels unacceptable for drinking water (Troutmann et al., 2008). The use of conservation buffers and cover crops can minimize potential soil erosion and the leeching of harmful chemicals into surface and groundwater.

In the last 50 years, the State of Alaska has transferred over 80,000 acres of land into private ownership for agricultural development. The majority of this land is in the Delta area, approximately 100 miles southeast of Fairbanks.

In August 1978, the State of Alaska started the Delta Barley Project, a large scale commercial agriculture initiative, with the lottery sale of 22 parcels of land with an average size of over 2,700 acres (Davies, 2007). An additional land release of 15 parcels totaling 25,000 acres took place in early 1982, and the state has continued to release land for agricultural development. The State of Alaska occasionally makes agricultural parcels available for sale. For further information, check with the Alaska DNR, Division of Agriculture.

Photo: Casey Dinkel (AK PMC)

Fertilizer used in agricultural production may increase nitrate concentrations in ground and surface waters

Transportation

Alaskans depend on roads and railways for travel and transport of goods and services. These transportation corridors are common places for erosion to occur. Repeated activity may remove or limit vegetation growth while also increasing surface compaction. An established vegetative cover helps to bind the soil together, limiting erosion and sediment losses. It is prudent to make erosional observations on an ongoing basis, and take corrective actions when necessary. Rilling, sloughing, gullies, and sediment deposition are signs of erosion and may indicate a need for mitigation.

Another major project affecting the natural environment was the creation of the Alaska Highway, which starts in Dawson Creek, BC and terminates at Delta Junction. Today the Alaska Highway is fully paved, although frost-heaving and seasonal wear and tear ensures it is constantly under maintenance. Disturbances associated with the road require frequent revegetation to restore natural conditions. This helps with erosion, improves aesthetics and insulates the permafrost layer from warmer temperatures associated with bare ground.

Photo: Sid Richards (AK DOT&PF)

Riverbank erosion exposes a culvert along the Taylor Highway

The Dalton Highway (also called the "*haul road*"), was constructed in 1974. This 414 mile highway traverses an undulating landscape, creating a large, linear disturbance. The Dalton highway starts at the Elliot Highway and ends at Deadhorse, on the Arctic Coastal Plain. Truckers drive this route daily to supply the oil facilities in Prudhoe Bay. Continual road use requires ongoing maintenance to ensure that roads are passable.

Best Management Practices (BMPs) exist to address erosion hazards, and should be considered during construction. Selected BMPs can be found at the Alaska Department of Transportation & Public Facilities's website, at dot.state.ak.us/stwddes/desenviron/pop_swppp.shtml.

Riverbank Erosion

For communities and projects located along rivers, erosion is a predictable occurrence. Riverbank erosion is a natural process whereby high-flow events degrade embankments and can change the course of the river system. This threat is greatest during the spring break up, when water levels are high and flow is rapid. Ice jams that occur during spring melt are a major concern of many communities along rivers.

River systems are natural transportation corridors, and development along their banks is common. Roadways are sometimes located along rivers, presenting unique challenges for erosion and sediment control. The shoulders of

Photo: Alaska DOT&PF

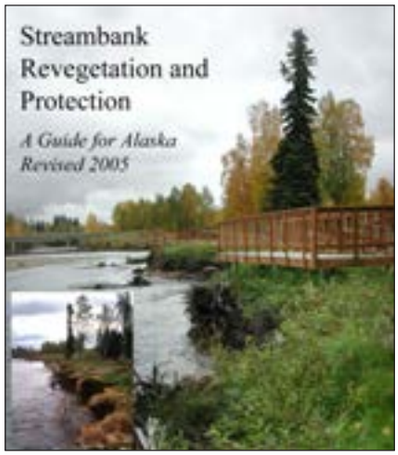
The town of Eagle, Alaska was hit with a major flood event in the summer of 2009

roads can become waterlogged and unstable during high-flow events. The Chistochina River Wetland Restoration project, in the case studies section, dealt with some of these issues.

Rivers are important for subsistence and cultural reasons, even though the erosion potential is high. Flooding happens very quickly along rivers, and can cause a great deal of damage. This occurred in May, 2009 in the town of Eagle, on the Yukon River. About 30 houses were destroyed by flooding, and a major cleanup effort followed.

An ambitious project to control river flooding and limit potential damage was developed 40 miles upriver of Fairbanks. The Chena River Lakes Flood Control Project (CRLFCP) was put in motion after an August, 1967 flood left a swath of water in downtown Fairbanks, along with $180 million in damages. The 20,000 acre flood control complex consists of four 30-ton floodgates, Moose Creek dam and the Tanana River levee.

The CRLFCP takes water from the Chena River during periods of high flow and sends it toward the Tanana River. The complex can hold a volume of water equivalent to 224,000 football fields, each covered with one foot of water. Very rarely does water have to be released into the Tanana River.



Streambank Revegetation and Protection, a guide published by the Alaska Department of Fish & Game is a comprehensive resource which details the use of erosion control mats, coir logs, and willow revetments, among other technologies. This publication can be found online, at www.adfg.alaska.gov/index.cfm?adfg=streambankprotection.main.

Additionally, case studies of some significant projects affecting river and streambanks can be found in the Alaska Coastal Revegetation & Erosion Control Guide, also by the Alaska Plant Materials Center. You can find this publication at plants.alaska.gov/reveg.


Photo: J.K. Brooks

Wreckage is cleared from the Beaver Creek floodgate after a 2008 flood event in the Tanana valley

Mining

Mining operations disturb the natural landscape and are potentially a major source of erosion. Consequently, the mining industry is heavily involved in reclamation and revegetation. Extracting natural resources from the earth has an environmental cost. In Alaska, industrial processes are managed to minimize the damage caused by resource development. Laws and regulations exist to promote responsible resource development.

A federal law, the Surface Mining Control and Reclamation Act (SMCRA) of 1977, regulates surface coal mining and reclamation nationwide. Enforcement of this law was taken over by Alaska in 1983, with the passage of the Alaska Surface Coal Mining Control & Reclamation Act. Alaska law now provides for the oversight of mining operations, from exploration through to final reclamation activities.

An additional program created through this legislation is the Abandoned Mine Lands Program. This program provides for the reclamation of eligible lands that were mined and abandoned, or inadequately restored. Funding for this program comes from a fee assessed on each ton of coal, presently 31.5 cents/ton for surface mines and 13.5 cents/ton for underground mines. The Alaska DNR, Division of Mining, Land, & Water (DMLW) has jurisdiction over abandoned mines in Alaska. Lasting disturbances to the landscape are minimized through reclamation.

Interior Alaska Mining Operations

Producing Mines	Land Status	Mineral Deposits
Usibelli Coal	State	Coal
Fort Knox	State/Mental Health Trust	Gold
Pogo	State	Gold
Advanced Exploration Project	**Land Status**	**Mineral Deposits**
Donlin Creek Project	Private	Gold
Livengood	State/Mental Health Trust	Gold
Ambler	State	Copper, lead, zinc, silver, gold
Nixon Fork	Federal	Gold

Mining Presence in the Interior

The mining industry is very important to Alaska's economy and provides thousands of job opportunities for people living in rural and urban areas. Additionally, mining brings in millions of dollars for local and state government through taxes. Mineral deposits are heavily concentrated in the Interior, and as a result most exploration, mine development and mineral production occurs in this part of Alaska. The Interior has three active producing mines, one development project and numerous advanced exploration projects. Driving exploration is the global demand for minerals, notably from countries such as Canada, China, India, South Korea and Japan.

Well in advance of mining operations, many qualitative and quantitative studies are conducted. These studies assess the economic feasibility and environmental impact of a project, and identify potential problems, such as threats to human health, critical habitat, and toxic materials. Information collected and analyzed may include climate, historical, archeological, hydrologic, geologic, and soil data. It should be noted that exploration projects do not always culminate in operating mines.

DMLW hosted a Northern Latitudes Mine Reclamation Workshop in May of 2011 which addressed several topics relating to revegetation. Abstracts and presentations can be downloaded from dnr.alaska.gov/mlw/mining/aml/nlmrws2011/.

The Usibelli coal mine is the only operating coal mine in Alaska. The active Two Bull Ridge mine is in the foreground, with the partially reclaimed and inactive Poker flats development in the background.

Conservation & Preservation

Photo: F. Golet (US FWS)

A wetland is an area innundated with water with emergent vegetation, such as this area in the Yukon Kuskokwim delta.

Protecting Wetland Areas

Wetlands are an important resource as they provide a number of functions such as wildlife habitat, passive and active recreational opportunities like photography and hunting, subsistence hunting, fishing, trapping, and aesthetic appreciation. Wetlands are defined as those lands: “inundated or saturated by water at a frequency and duration to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions” (Alaska Department of Environmental Conservation, n.d.).

Wetlands are transitional lands, between terrestrial and deepwater habitats, where the water table usually is at or near the surface or the land is covered by shallow water (Cowardin, Carter, Golet & LaRoc, 1979). Vegetation observed in wetlands is hydrophytic, meaning it grows in water or is found growing in a substrate that is periodically deficient in oxygen.

Alaska has an abundance of wetlands, more so than any other region of the United States. According to the National Wetland Inventory, wetlands account for more than 174 million acres and comprise more than 43 percent of Alaska’s surface area (Hall, Frayer & Wilen, 1994). Interior Alaska consists of 41 percent wetlands - approximately 71 million acres. The largest wetlands in the region are the Kanuti flats and Tanana-Kuskokwim lowlands. North-facing slopes are common wetland areas, where shallow permafrost is conducive for trapping water. Vegetation in the Interior consists of millions of acres of Black Spruce muskeg and floodplain wetlands, dominated by deciduous shrubs and emergents (Hall et al., 1994).

Wetlands are ideal habitat for many waterfowl species.

Wetlands may be subject to regulation, under section 404 of the Clean Water Act (33 U.S.C. 1344) or Section 10 of the Rivers and Harbors Act (33 U.S.C 403). These laws are designed to slow the loss of wetland areas. The Clean Water Act is the law most often used to protect wetlands. The Rivers and Harbors Act requires a permit for work in navigable waters. Regulated activities include diking, deepening, filling, excavating, and the placing of structures. The Army Corps of Engineers regulates the discharge of dredged or filled material into wetlands. Corps staff issue permits relating to wetlands, and will assist applicants with the process of obtaining a permit.

Farming, ranching, and silviculture activities do not fall under section 404 regulations. The U.S. Department of Agriculture (USDA) has jurisdiction for areas that produce or could produce an agricultural commodity, including wetlands. Under the Food Security Act of 1985, the Natural Resource Conservation Service (NRCS) has the sole responsibility for wetland determinations and delineations affecting these USDA programs.

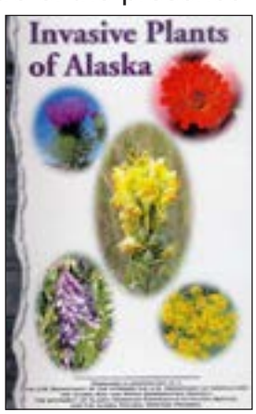
The Food Security Act of 1985 contains wetland conservation (also called "Swampbuster") provisions designed to discourage the conversion of wetlands into non-wetland areas and deny federal farm program benefits to producers who converted wetlands after December 23, 1985. A person who has produced an agricultural commodity on newly converted wetland is ineligible for certain benefits provided by the USDA, including commodity price support or production adjustment payments, farm storage facility loans, disaster payments and federal crop insurance.

Invasive Species

Invasive species are typically recognized as non-native species that, once introduced, spread beyond control to affect natural and agricultural resource or human health. Not all non-native species are invasive, and many are highly beneficial for agricultural or ornamental purposes.

Invasive plants and agricultural pests cause significant economic losses to agriculture and wild lands across North America. In Alaska, many notorious invasive agriculture and wildland weeds are not present, have a very limited distribution or have yet to invade natural areas. Some invasive weeds have become established in Alaska, however, and are impacting agricultural and wildlands.

It is important to be aware of the presence of invasive weeds in your project area, and the vectors through which invasives can be transported to new areas. Invasive Plants of Alaska is a guide for identification, management and risk assessment posed by each species. This guide can be found at www.fs.fed.us/r10/spf/fhp/invasiveplants.htm.



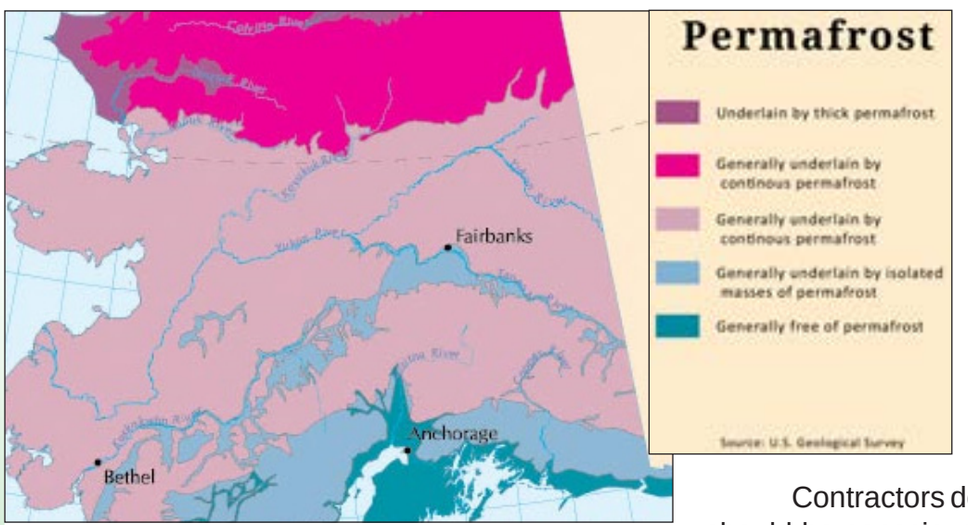
The University of Alaska's Alaska Natural Heritage Program maintains an information clearinghouse for data on non-native species in the state. Location and management information is collected each year from agencies and organizations and is available in a database and mapping application at aknhp.uaa.alaska.edu/botany/akepic/.

The Alaska DNR, Division of Agriculture (DOA) has responsibilities pertaining to the prevention and regulation of invasive plants, including the authority to declare pests, inspect infested areas, enforce quarantines and eradicate pests. The State of Alaska's Plant Health and Quarantine laws (11 AAC 34) include a list of prohibited and restricted noxious weeds, as well as labeling and transportation requirements for seed sold in Alaska. DOA maintains a Strategic Plan for Invasive Weed and Agricultural Pest Management, used by the DOA and partners to prioritize and man-

age invasive plant infestations in Alaska. Detailed information about prohibited & restricted noxious weeds is available on the Alaska Plant Materials Center Website, at plants.alaska.gov/invasives/

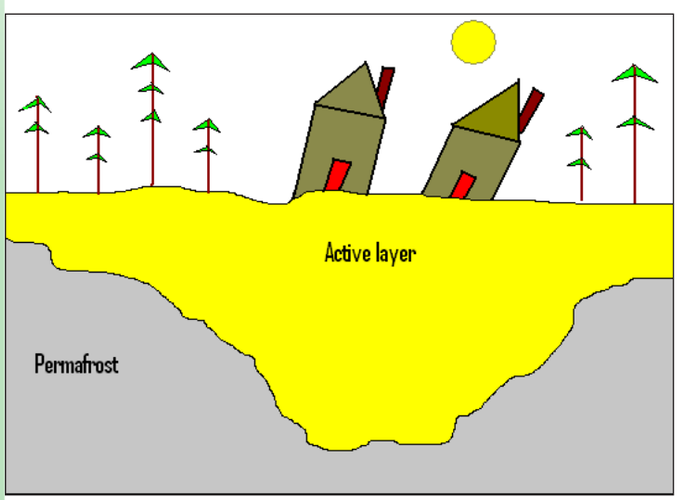
Permafrost Conservation

Permafrost, ground that remains frozen for two or more years, is common in interior regions of Alaska. The minimum of two years is meant to exclude the overlying surface layer that thaws every summer and freezes again every winter (Alyeska Pipeline Service Company, 2008) Two zones of permafrost are *continuous* and *discontinuous*. In the far north, the continuous zone is underlain by thick permafrost everywhere except for large bodies of water that do not freeze completely.



Permafrost distribution in Alaska

Graphics: Phil Czapla (AK PMC), Adapted from U.S. FWS Illustration



Thawing permafrost has expanded the active layer underneath these buildings. The removal of vegetative cover during construction allowed the soils to warm.

Discontinuous permafrost is commonly found on northerly aspects, where the average air temperature is only slightly below freezing (32 °F) and the annual soil surface temperature is between 23 and 32 °F.

Scattered pockets of unfrozen ground are found intermittently throughout the landscape in the Interior. The active layer of soil is limited to the depth that roots can penetrate. The permafrost zone is found beneath the active soil layer. The arctic and subarctic conditions of the Interior cause the ground to remain frozen for much of the year. The sun does not provide enough warmth to thaw the surface layer. In summer, vegetation growing on the surface acts as insulation, protecting the permafrost from melting under the sun's warmth.

Construction on permafrost

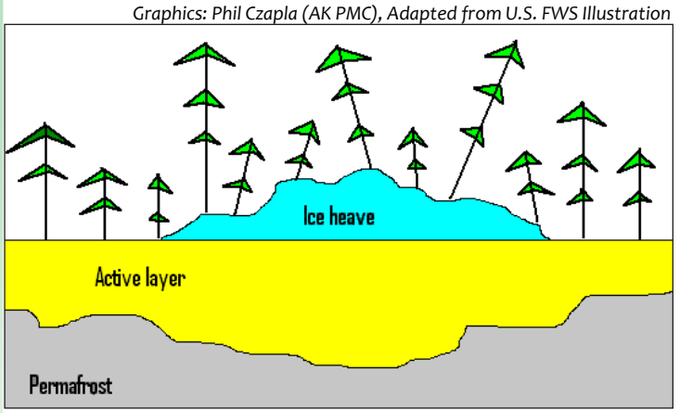
There are several variables to consider when building on permafrost. The distinct conditions associated with "frozen ground" must be considered when buildings, roadways, and other facilities are built. Understanding permafrost as a dynamic system necessitates that proactive measures be taken to minimize potential for damage.

Contractors developing buildings and roads should be conscious of the amount of vegetation removed. Removal of a vegetative layer on the surface will allow the sun to penetrate deeper into the soil, and may cause the permafrost to thaw. The heat of a building and associated utility lines may cause thawing.

Infrastructure developed in the presence of thawing permafrost sometimes requires engineered responses in place of or in addition to revegetation. One such response involves placing a thick layer of gravel under a roadbed or building structure. This gravel substrate acts as an insulation barrier between the surface layer and permafrost. An additional procedure is to construct foundations on pilings, limiting their heat transfer to the ground.

An additional area of concern for Interior Alaska is frost heaving. Seasonal melting of snow and rain water cannot infiltrate beyond the permafrost zone creating a saturated surface condition conducive to marsh, tundra, and wetland ecosystems. When cold weather traps the water between the soil and permafrost layer, it freezes and expands upwards creating a Pingo.

Graphics: Phil Czapla (AK PMC), Adapted from U.S. FWS Illustration



A "pingo" is created when water pooled in the active layer freezes, creating an ice heave above ground.

Trans Alaska Pipeline System

The construction of the Trans Alaska Pipeline System (TAPS) required the use of several distinct design methods to protect the permafrost. Approximately 75% of the pipeline traverses through permafrost soils (alyeska-pipe.com). Some problems resulting from permafrost include frost-heaving (pushing the ground upwards), frost-jacking (the structure on the ground pushed upwards along with the ground surface), and thaw settlement (structures settling into the ground caused by heat from structures) (alyeska-pipe.com). In light of these issues, three design solutions were developed and applied based on the soil conditions encountered.

- **Thaw-unstable permafrost conditions:**

  In warm areas and where oil in the pipeline might cause thawing, the pipeline was placed above ground on special support structures called Vertical Support Members (VSMs). Each support leg has two, 2 inch pipes called "heat pipes," containing anhydrous ammonia. A heat pipe is a heat transfer mechanism. Anhydrous ammonia, a compound formed by two gases, nitrogen and hydrogen, is a refrigerant put in the VSMs to reduce the soil temperatures underground.

- **Unfrozen or thaw-stable permafrost:**

  The pipeline was buried beneath ground using conventional methods. A ditch 8 ft. to 16 ft. deep was dug with the pipe underlain with a fine bedding material and covered with gravel padding and fill.

- **Thaw unstable permafrost & buried pipe:**

  Certain portions of the pipeline had to be buried to account for animal crossings, rockslides, and avalanche areas. Permafrost protection from the heat of oil flowing through the pipeline was provided by insulation wrappings. In some areas the pipe was insulated and buried in a refrigerated ditch lined with 6 inch diameter pipe. Chilled brine is circulated through the pipe to maintain the soil in a frozen state.

The Trans-Alaska Pipeline system uses ammonia driven "heat pipes" to ensure that permafrost underground remains frozen.

Photos: Phil Czapla (AK PMC)

Thawing Permafrost

Freezing and thawing of the active layer in permafrost soil may cause erosion and impact vegetation. The frozen soil limits the amount of ground water accessible to the plants, and the depth of roots. Species growing on permafrost are only able to access the top few inches of the soil. Thawing soil also creates thermokarst; uneven surface topography recognized by pits, mounds, and depressions. These unstable soil formations are susceptible to wind and water erosion carrying sediment away from its origination point. If sediment moves into river systems a slew of additional concerns arise. A major objective of most revegetation projects is to include a vegetative cover that will protect and stabilize the soil surface. This protective layer keeps the suns rays from warming the frozen subsurface.

Photo: Stoney Wright (AK PMC)

Thermal degradation, resulting from thawed permafrost

In areas underlain by permafrost, travel is often restricted to the winter months - when snow cover insulates the ground and prevents damage to the tundra. Construction activity in permafrost areas is sometimes unavoidable. In these instances, following accepted practices to minimize the negative effects of thawing is advisable. The Alaska DOT&PF has a research paper entitled Documenting Best Management Practices for Cutslopes in Ice-rich Permafrost, which is available at dot.state.ak.us/stwddes/research/assets/pdf/fhwa_ak_rd_09_01.pdf.

Photo: S. Lamont & J. Russell (AK DOT&PF)

Advanced thawing on a cutslope causing silty runoff to flow into a ditch created using a gravel berm at the edge of the roadway. For further detail on this technique, refer to Alaska DOT Publication No. FHWA-AK-RD-09-11.

Species Selection

Photo: Phil Czapla (AK PMC)

American Sloughgrass (*Beckmannia syzigachne*) at the Kanuti pit materials site on the Dalton Highway

Section 3:

Adapted Plants

- *Eco-regions of Interior Alaska*
- *Vegetation Communities*
- *Revegetation Suggestions*

Plant Species

Adapted Plants

Selecting an appropriate species mixture

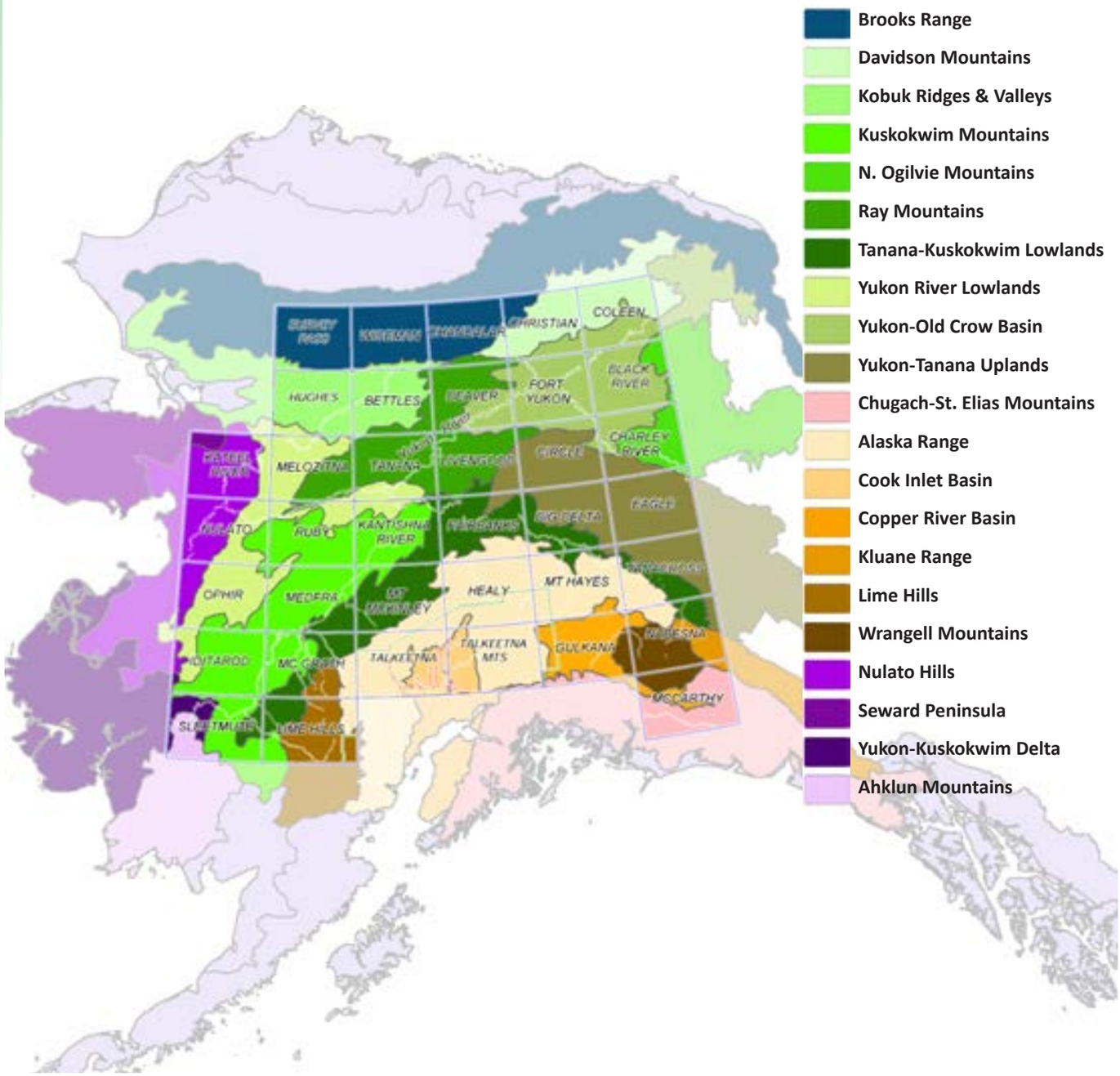
Photo: Stoney Wright (AK PMC)

A stand of sedge established on a rocky slope.

Species diversity is a critical component of successful revegetation. Predicting which species will grow at a site is an inexact science. Native plant varieties which are adapted to the region and the specific characteristics of the site are most likely to become established. The use of several different plant species increases the diversity of the stand, and increases the ability of the vegetated area to withstand unforeseen complications or changing site conditions. It is always prudent to use more than one species in a seed mix. The chart within this section can be used to develop adapted planting mixtures appropriate for Interior Alaska.

Eco-regions of Interior Alaska:

Alaska contains thirty-one unique eco-regions, defined as large areas of land and waters containing vegetation communities that share ecological dynamics, environmental conditions, and interactions that are critical for their long-term persistence. (Nowaki et. al., 2001). Sixteen of these regions are represented in Interior Alaska. Each eco-region of Alaska has a dominant vegetation community, and it is necessary to address the issue of revegetation in the context of these communities, as this will effect species selection and other planting requirements.



Map adapted from work by Nowaki et. al., 2001

Vegetation Communities:

INTERIOR ALASKA

Photo: Phil Czapla (AK PMC)

This taiga landscape near Coldfoot is dominated by Spruce forest, characteristic of Interior Alaska

Interior Alaska ecosystem is classified as a boreal forest, or taiga. The climate is continental with extremes of temperature common. Long, cold winters can drop temperatures to -40°F, although this rarely lasts long. The summers, while short, are generally warm with a few 90°F days common around Fairbanks. Annual precipitation for the region is approximately 10-15 inches. There is little evaporation in summer due to melting snow, relatively low temperatures, and a permafrost layer. Marshes, wetlands, fens, and bogs are prevalent.

Vegetation in the Interior is dominated by conifer species of White and Black spruce. On river bars and recently burned areas with south facing slopes, broadleaf deciduous species of Alaskan Paper Birch, Balsam Poplar, and Quaking Aspen are common. North facing slopes and low lying areas tend to be wetter. Black Spruce and Tamarack, a deciduous conifer, are common trees growing in this poorly drained permafrost environment. Black Spruce is common after fire because the cones open and spread abundant seed. Heat is needed for Black Spruce cones to open and disperse seed. Grasses, sedges, mosses, lichens, and ericaceous (adapted to acidic soils) shrubs are also present. (Viereck & Little, 2007). Several shrub thicket types are also common in the Interior. Shrubs of willow and alder are found on the river floodplains across the region. Closer to the treeline, thickets consisting of birch, alder, and willow are prevalent (Viereck & Little, 2007).

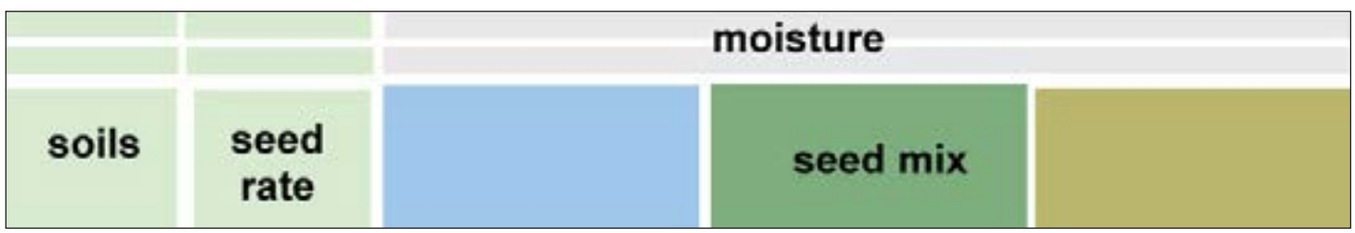
Revegetation Suggestions:

How to use the Species Chart :

1. Estimate soil moisture conditions. (**Saturated, Average, Very Dry**)
2. Select the soil type based on the Uniform Soil Classification engineering soil classification table. For more information about the Uniform Soil Classification System, refer to the 'Construction Site Considerations' section on page 11.

Uniform Soil Classification Table	
Symbol	**Soil Type**
GW	well-graded gravel
GP	poorly-graded gravel
GM	silty gravel
GC	clayey gravel
SW	well-graded sand
SP	poorly-graded sand
SM	silty sand
SC	clayey sand
ML	silt
MH	elastic silt
CL	lean clay
CH	flat clay
OL	organic clay/silt - low plasticity
OH	organic clay/silt -high plasticity
PT	peat - high organic

3. Select an effective seed mix from the primary and secondary species lists for the region.
4. **Primary Species**, selected from the primary species list, should account for 80–100% of the seed mix (relative weighting is indicated by a '**1**' or '**2**' preceding the species name on chart). If soil conditions at the site are uniform, a two or three species mix composed of exclusively primary species will suffice. Conversely, if soil conditions vary considerably, secondary species should be included as well.
5. **Secondary Species** represent the smallest percentage of a seed mix, often species that are costly or in short supply (indicated by a '**3**' on chart). Secondary material adds a degree of variability to the mix and is recommended to address special environmental concerns, such as stream crossings. Material for a given secondary species should not exceed 5% of the total mix.
6. Seeding rates for the entire mix are listed in the column "Seed Rate". This number is interchangeable for either lbs / acre or kg / hectare.
7. If the site is determined to be an erosion hazard, add no more than 10% Annual Ryegrass to the previously developed mix. This species, while giving temporary erosion protection, competes for nutrients with long-term perennial species. Also, Annual Ryegrass is a highly palatable forage species that can attract wildlife. Annual Ryegrass cannot be used in conjunction with Alpine Bluegrass (*Poa alpina*). The allelopathic effects of Annual Ryegrass will kill Alpine Bluegrass.



Revegetation Suggestion Chart Structure

Revegetation Suggestions:

INTERIOR ALASKA

Primary Species:

- 'Alyeska' **Polargrass**, *Arctagrostis latifolia*
- 'Kenai' **Polargrass**, *Arctagrostis latifolia*
- 'Egan' **American Sloughgrass**, *Beckmannia syzigachne*
- 'Nortran' **Tufted Hairgrass**, *Deschampsia caespitosa*
- Wainwright **Slender Wheatgrass**, *Elymus trachycaulus*
- 'Arctared' **Red Fescue**, *Festuca rubra*
- 'Boreal' **Red Fescue**, *Festuca rubra*
- 'Gruening' **Alpine Bluegrass**, *Poa alpina*
- 'Tundra' **Glaucous Bluegrass**, *Poa glauca*

Soil Group *(Refer to Soil Type Chart)*	Seed Rate *(Refer to Directions)*	Species/Cultivar Selection *(Refer to Species/Cultivar Characteristic Chart For Category Ratings)*		
High Organic		Suggest fertilizer only. If seeding is stipulated use suggestions for MH, CH, OH Mesic or Xeric depending on site.		
GW, GP		Suggest scarification and fertilizer only. If seeding is stipulated use suggestions for GM, GC soils and soil moisture.		
		Soil Moisture Characteristics		
		Saturated (Hydric)	**Average (Mesic)**	**Very Dry (Xeric)**
GM, GC	20	1 'Egan' American Sloughgrass 1 'Norcoast' Bering Hairgrass 1 'Alyeska' Polargrass 1 'Arctared' Red Fescue 2 'Nortran' Tufted Hairgrass 2 'Boreal' Red Fescue 2 'Kenai' Polargrass 2 'Gruening' Alpine Bluegrass 3 'Sourdough' Bluejoint Reedgrass	1 Wainwright Slender Wheatgrass 1 'Arctared' Red Fescue 1 'Gruening' Alpine Bluegrass 1 'Nortran' Tufted Hairgrass 2 'Alyeska' Polargrass 2 'Boreal' Red Fescue 2 'Norcoast' Bering Hairgrass 3 'Egan' American Sloughgrass 3 'Sourdough' Bluejoint Reedgrass	1 Wainwright Slender Wheatgrass 1 'Arctared' Red Fescue 1 'Gruening' Alpine Bluegrass 1 'Nortran' Tufted Hairgrass 2 'Boreal' Red Fescue 2 'Norcoast' Bering Hairgrass 3 'Sourdough' Bluejoint Reedgrass
SW, SP, SM, SC	40			
ML, CL, OL				
MH, CH, OH	30	1 'Norcoast' Bering Hairgrass 1 'Egan' American Sloughgrass 2 'Alyeska' Polargrass 2 'Gruening' Alpine Bluegrass 2 'Arctared' Red Fescue 3 'Sourdough' Bluejoint		

Revegetation Suggestions for Interior Alaska

Revegetation Suggestions:

INTERIOR ALASKA

'Sourdough' Bluejoint Reedgrass, *Calamagrostis canadensis*

Interior Alaska is largely a temperate continental climactic zone. Mountainous eco-regions include the Davidson, Kuskowkim, North Ogilvie, Ray, and Wrangell Mountains, as well as the Brooks Range to the north and the Alaska Range to the south. Notable lowland areas include the Yukon River lowlands, Yukon - old crow basin, Tanana-Kuskokwim lowlands, and the Copper River basin. Additional eco-regions of the Interior are the Kobuk ridges and valleys, Yukon-Tanana uplands and the Lime hills.

The Alaska range is a barrier to north-south air movements and precipitation from maritime influences to the south, thus creating a transitional climate. Areas on the south side of the range receive precipitation amounts at least twice those measured on the north side. Temperatures on the south side of the Alaska range exhibit less seasonal temperature variation, tending to be warmer in winter and cooler in summer (Laursen & Seppelt, 2009).

Secondary Species:

- Twenty Mile **Boreal Yarrow**, *Achillea millefolium*
- 'Caiggluk' **Tilesius' Wormwood**, *Artemisia tilesii*
- 'Sourdough' **Bluejoint Reedgrass**, *Calamagrostis canadensis*
- Pioneer Peak **Nootka Reedgrass**, *Calamagrostis nutkaensis*
- Kobuk **Dwarf Fireweed**, *Chamerion latifolium*
- Jakutsk **Snowparsley**, *Cnidium cnidiifolium*
- Solomon **Thickspike Wheatgrass**, *Elymus macrourus*
- Safety **Viviparous Fescue**, *Festuca viviparoidea*
- Paxson **Alpine Sweetvetch**, *Hedysarum alpinum*
- Knik **Wild Iris**, *Iris setosa*
- Cantwell **Downy Wildrye**, *Leymus innovatus*
- **Annual Ryegrass**, *Lolium multiflorum*
- Black Rapids **Field Oxytrope**, *Oxytropis campestris*
- Franklin Bluffs **Nodding Locoweed**, *Oxytropis deflexa*
- Teller **Alpine Bluegrass**, *Poa alpina*
- Council **Arctic Bluegrass**, *Poa arctica*
- Nome **Glaucous Bluegrass**, *Poa glauca*
- Butte **Beautiful Jacob's Ladder**, *Polemonium pulcherrimum*
- Nelchina **Spike Trisetum**, *Trisetum spicatum*

Plant Species

for use in Interior Alaska

Plant species listed in this section are known to be useful in revegetation. Each species is listed with the most commonly available varieties and cultivars. Primary species; those which should compose the bulk of a seed mixture, are labeled with a tab on the outer edge of the page.

Boreal Yarrow,
Achillea millefolium

Boreal Yarrow does well in coastal settings, but has sufficient adaptability to be useful in inland areas also. Yarrow has the ability to create the appearance of a natural meadow stand in reseeded areas; the presence of the white/cream flowers breaks up the usual homogeneity of grass plantings.

Boreal Yarrow is a colonizer, found in meadows and fields, in both wet and dry areas. It grows on soil and gravel. It is a long lived perennial.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Twenty Mile selected class germplasm

Twenty Mile **Boreal Yarrow**, *Achillea millefolium*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Sod	24 in.	6.0-8.0	Poor	Good	Good	Strong

Polargrass,
Arctagrostis latifolia

Polargrass is a species that is ideal for forage and revegetation in Alaska (Mitchell, 1987). Polargrass is adapted to moderately wet areas (Wright, 1992). It is tolerant of low temperatures and acidic soils. Polargrass is a pioneer species in disturbed areas, especially those that are moist and acidic (Walkup, 1991). Polargrass does not grow well with competition.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Kenai' is from southern Alaska, and should be planted appropriately.

'Alyeska' is suitable for revegetation in western and arctic Alaska (Mitchell, 1980).

'Alyeska' **Polargrass**, *Arctagrostis latifolia*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Fair	Sod	24 in.	4.9-6.8	Poor	Poor	Good	Weak

- **Hultén, E.** 1968. Flora of Alaska and Neighboring Territories. Stanford University Press, Stanford, CA
- **Mitchell, W.** 1987. Notice of Release of 'Kenai' Polargrass. Agroborealis Vol. 19, No. 1, p.5.
- **Walkup, C.** 1991. Arctagrostis latifolia. *In*: Fire Effects Information System, [Online]. USDA, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. www.fs.fed.us/
- **Mitchell, W.** 1980. Registration of 'Alyeska' Polargrass, Crop Science Vol. 20, 671.

Tilesius' Wormwood,
Artemisia tilesii

Tilesius' Wormwood is a broadleaf forb with a wide range of adaptations throughout Alaska (Wright, 1991). Tilesius' Wormwood is a perennial, non-woody sagebrush species. It has been found on many different soil types. Tilesius' Wormwood prefers full sun. The common name, stinkweed, refers to its smell when the leaves of *Artemisia tilesii* are crushed.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Caiggluk'

'Caiggluk' **Tilesius' Wormwood**, *Artemisia tilesii*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	20 in.	4.0-8.5	Poor	Excellent	Good	Strong

- **Wright, S.** 1991. Registration of 'Caiggluk' Tilesy Sagebrush. Crop Science 31: 1380.

American Sloughgrass,
Beckmannia syzigachne

American Sloughgrass has a high potential for wetland reclamation (Wright, 1991). Additionally, the species benefits wildlife by providing forage and seed for waterfowl. Revegetation and erosion control plantings in seasonally wet places between 60 degrees north latitude and the Arctic Circle will benefit from including Sloughgrass as part of the seed mix (Wright, 1991).

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Egan'

'Egan' **American Sloughgrass**, *Beckmannia syzigachne*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Good	Bunch	18 in.	5.5-7.5	Good	Poor	Excellent	Moderate

- **Wright, S.** 1991. Registration of 'Egan' American Sloughgrass. Crop Science 31, pp. 1380-1381.

Bluejoint Reedgrass,
Calamagrostis canadensis

Bluejoint Reedgrass is found throughout Alaska on both dry and wet sites. Commercial availability can be limited, and the seed expensive. Bluejoint provides good erosion control because of its aggressive rhizomes and root structure. It can be used to successfully reclaim strip mine sites and oil spills. Bluejoint Reedgrass can thrive in very cold conditions.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Sourdough'

'Sourdough' **Bluejoint Reedgrass**, *Calamagrostis canadensis*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Fair	Sod	36 in.	4.5-8.0	Poor	Good	Good	Strong

- **Mitchell, W.** 1980. Registration of 'Sourdough' Bluejoint Reedgrass, Crop Science Vol. 20, Sept.–Oct., 1980.

Nootka Reedgrass,
Calamagrostis nutkaensis

Nootka Reedgrass is appropriate for revegetation throughout southeast, southcentral, and southern portions of Interior Alaska. Nootka Reedgrass is a perennial, tufted grass with short rhizomes. It grows in clumps, and requires wet soil (NRCS, 2007). This reedgrass species is found in bogs, marshes, and freshwater swamps.

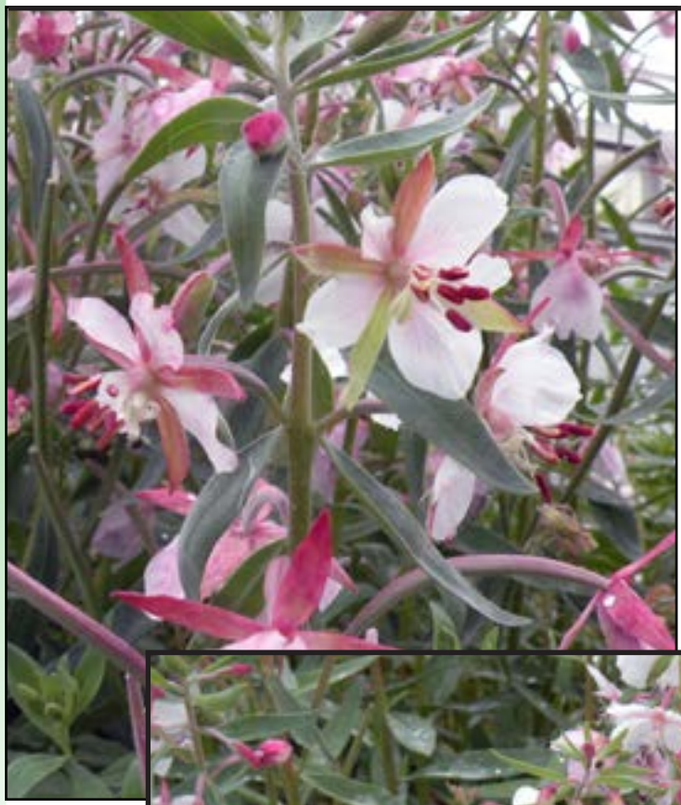
ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Pioneer Peak selected class germplasm

Pioneer Peak **Nootka Reedgrass**, *Calamagrostis nutkaensis*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Sod	24 in.	5.5-8.0	Good	Poor	Excellent	Strong

- **USDA, NRCS**. 2007. *Calamagrostis nutkaensis* - Pacific reedgrass
The PLANTS Database (plants.usda.gov). National Plant Data Center, Baton Rouge, LA



Dwarf Fireweed,
Chamerion latifolium

Dwarf Fireweed is a common species found on river gravel bars throughout Interior Alaska; hence it's other common name - river beauty. Dwarf Fireweed grows on sandy riverbars, roadsides, and foothills (Hunt & Moore, 2003). It prefers soil that is dry to medium-wet. Dwarf Fireweed is a natural perennial colonizer; it will live for several years and helps stabilize the soil.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Kobuk selected class germplasm

Kobuk **Dwarf Fireweed**, *Chamerion latifolium*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	12 in.	4.8-7.0	Poor	Poor	Good	Weak

- **Hunt, P. and Moore, N.J.** 2003. Propagation protocol for production of container *Chamerion latifolium* (L.) *Holub* plants; State of Alaska, Department of Natural Resources, Division of Agriculture, Palmer, Alaska. *In:* Native Plant Network., www.nativeplantnetwork.org (accessed 9 June 2004). Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery.

Jakutsk Snowparsley,
Cnidium cnidiifolium

Jakustk Snowparsley is a colonizer found in meadows, hillsides, and riverbanks. It grows well on gravel and is adapted to arctic conditions, tundra and taiga (USDA, 2000). The plant is named "Jakutsk" after the capital city of Russia's Sakha Republic - one of the coldest cities in the world, built on continuous permafrost.

The Alaskan swallowtail butterfly uses snowparsley as a host plant on which to lay its eggs (Murphy, 2004). When using Jakutsk Snowparsley for revegetation, animals which eat swallowtail caterpillars may become attracted to the project.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Tok selected class germplasm is native to Interior Alaska.

Tok **Jakutsk Snowparsley**, *Cnidium cnidiifolium*

Availability	Growth Form	Average Height	PH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	24 in.	6.6 - 8.4	Good	Good	Good	Strong

- **USDA, NRCS**, 2000. *Cnidium cnidifolium* - Jakutsk snowparsley. The PLANTS Database (plants.usda.gov). National Plant Data Center, Baton Rouge, LA

Tufted Hairgrass,
Deschampsia caespitosa

Tufted Hairgrass grows well throughout Interior Alaska. Tufted Hairgrass is a cool season bunch grass. It will grow in most any soil. Tufted Hairgrass is found in moist or boggy areas. An arctic species, Tufted Hairgrass is well suited for many of Alaska's harshest environments. *Deschampsia caespitosa* is not recommended for revegetation of streambank areas, however, since the tufted fibrous roots provide limited bank stabilization (Mitchell, 1986).

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Nortran'

'Nortran' **Tufted Hairgrass**, *Deschampsia caespitosa*

PRIMARY

Availability	Growth Form	Average Height	PH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Good	Bunch	20 in.	4.8-7.2	Poor	Good	Good	Strong

- **Mitchell, W.** 1986. Notice of Release of 'Nortran' Tufted Hairgrass. Agroborealis, July, 1986.

Thickspike Wheatgrass,
Elymus macrourus

Thickspike Wheatgrass is a long lived perennial grass species, a colonizer and considered an indicator of site disturbance (Tsvelev, 1983). It is drought tolerant and well adapted to dry soils. Thickspike Wheatgrass can be found growing on open slopes, gravel or sand bars, and earth embankments in tundra and woodlands (Hultén, 1968). Thickspike Wheatgrass is quick to germinate and become established, allowing it to serve as a nurse plant for slower growing species (Sullivan, 1993).

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Solomon selected class germplasm

Solomon **Thickspike Wheatgrass**, *Elymus macrourus*

Availability	Growth Form	Average Height	PH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	24 in.	6.6 - 8.4	Good	Good	Good	Strong

- **Tsvelev, N.N.** 1983. Grasses of the Soviet Union. Oxonian Press Pvt. Ltd. New Delhi, India
- **Hultén, E**. 1968. Flora of Alaska and Neighboring Territories. Stanford University Press, Stanford, CA.
- **Sullivan, J.** 1993. *Elymus macrourus*. *In:* Fire Effects Information System, USDA, www.fs.fed.us/database/feis.

Slender Wheatgrass,
Elymus trachycaulus

Slender Wheatgrass is a natural colonizer, adapted to dry, rocky and gravelly soil. Slender Wheatgrass is the largest commercially produced perennial grass in Alaska, both in volume and in the number of producers. This species can be found on moist to dry soils, under trees and in full sun. Slender Wheatgrass grows on either alkaline or acidic substrate. Although it is short lived, Slender Wheatgrass can colonize and stabilize an area, thereby allowing other plants to subsequently become established.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Wainwright selected class germplasm

Wainwright **Slender Wheatgrass**, *Elymus trachycaulus*

Availability	Growth Form	Average Height	PH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Excellent	Bunch	20 in.	5.6-9.0	Excellent	Excellent	Good	Strong

Red Fescue,
Festuca rubra

Red Fescue is outstanding for erosion control, although the overly aggressive, sod-forming nature of this species often makes the species unacceptable in reclamation. Red Fescue's aggressive nature may be utilized to prevent the invasion of native shrub species such as alder and willow.

Red Fescue is a colonizer of disturbed areas, and it provides long-term stabilization as well. It needs little maintenance, establishes quickly, and survives for many years. Red Fescue will survive in sun and shade; in cold and hot; in dry and moist; and in both acidic and alkaline soils.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Arctared' is the most winter-hardy Red Fescue variety. It is especially well adapted to the harsh arctic environment.

'Boreal' is adapted for use across Alaska.

'Arctared' **Red Fescue**, *Festuca rubra*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor - Excellent	Sod	14 - 18 in.	5.0-7.5	Poor	Good	Good	Strong

Viviparous Fescue,
Festuca viviparoidea

Viviparous Fescue reproduces by an asexual means called vivipary. Instead of producing seed, Viviparous Fescue produces small plantlets where the seed heads would be in other grasses. When these plantlets are sufficiently developed, they separate from the parent to fall to the ground. If the plantlet finds a suitable habitat, it will grow. Viviparous Fescue can be a colonizer in mountainous country. It may be found on alpine tundra and rocky slopes. If the purpose of a revegetation project is to stabilize soil in an arctic to subarctic area, then Viviparous Fescue could be a good choice.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Safety selected class germplasm

Safety **Viviparous Fescue**, *Festuca viviparoidea*

Availability	Growth Form	Average Height	PH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	6 in.	6.0-7.5	Poor	Excellent	Poor	Strong

Alpine Sweetvetch,
Hedysarum alpinum

Alpine Sweetvetch is an easily recognized and frequently encountered legume. This species is most often found on dry, gravelly soils, especially near rivers. It is suspected of being a nitrogen-fixing species.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Paxson selected class germplasm

Paxson **Alpine Sweetvetch**, *Hedysarum alpinum*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	24 in.	6.0-8.0	Poor	Poor	Good	Strong

Wild Iris,
Iris setosa

Wild Iris is best used on wet soil and in seed mixes with non-competitive grasses. Wild Iris can be found throughout most of Alaska in bogs, meadows, and on lake shores. It is also found in drier areas where the seed has taken hold.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Knik selected class germplasm

Knik **Wild Iris**, *Iris setosa*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Sod	12 in.	5.0-7.5	Good	Poor	Excellent	Strong

Downy Wildrye,
Leymus innovatus

Downy Wildrye is a perennial found in low mountainous areas. It prefers sandy to gravelly soil that is moderately basic (Burton and Burton, 2003). Downy Wildrye's deep spreading rhizomes allow it to be a good soil binder. Its true value shows when used for revegetation on dry mine sites and south-facing cut and fill slopes. Lab tests have shown that Downy Wildrye grows well on soils saturated with oil, so it should be considered when revegetating disturbances where hydrocarbons have been spilled (Burton and Burton, 2003).

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Cantwell selected class germplasm

Cantwell **Downy Wildrye**, *Leymus innovatus*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	24 in.	5.8-8.5	Good	Excellent	Good	Strong

- **Burton, C.M. and Burton, P. J.**, 2003. A Manual for Growing and Using Seed from Herbaceous Plants Native to the Northern Interior of British Columbia. Symbios Research & Restoration, Smithers, British Columbia, pp. 63-66.

Annual Ryegrass,
Lolium multiflorum

Annual Ryegrass provides a quick, temporary cover. It should be limited to 10% or less of a seed mix, because Annual Ryegrass uses nutrients intended for the perennial species in the mix. Also, a heavy plant cover can slow the growth of perennial species. Annual Ryegrass is very attractive to herbivores, which can increase the potential for vehicle / animal conflicts.

Annual Ryegrass, *Lolium multiflorum*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Excellent	Annual	16 in.	5.0-7.9	Excellent	Poor	Good	Moderate

- **Hultén, E**. 1968. Flora of Alaska and Neighboring Territories. Stanford University Press, Stanford, CA.

Field Oxytrope,
Oxytropis campestris

Field Oxytrope is a legume adapted to rocky and gravelly dry soils. Field Oxytrope is an early colonizer of disturbed sites. As with most legumes, Field Oxytrope fixes nitrogen, and may increase soil fertility.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Black Rapids selected class germplasm

Black Rapids **Field Oxytrope**, *Oxytropis campestris*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	8 in.	5.5-8.5	Poor	Excellent	Poor	Strong

Nodding Locoweed,
Oxytropis deflexa

Nodding Locoweed is highly adapted to gravelly sites, and it is often used in reclamation and re-vegetation in Alaska. Nodding Locoweed is a perennial legume found growing along riverbanks, meadows, and waste places in nature (Hultén, 1968). It is a natural colonizer of dry, rocky soils. Many of its characteristics are common to many arctic plants; low-growth habit, taproot, hairy leaves, and prolific flowering.

Large seeds enable Nodding Locoweed to survive in inhospitable environments. Since it is a legume, it fixes nitrogen in the soil, helping other plants to survive and creating a healthy ecosystem. Arctic plant studies of nitrogen fixing plants in Alaska have found that rhizobia are associated with locoweed (Allen et. al., 1995).

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Franklin Bluffs selected class germplasm

Franklin Bluffs **Nodding Locoweed**, *Oxytropis deflexa*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	8 in.	6.5-8.0	Poor	Excellent	Poor	Weak

- **Hultén, E**. 1968. Flora of Alaska and Neighboring Territories. Stanford University Press, Stanford, CA.
- **Allen, E.K., Allen, O.N. & Klebesadel L.J.** 1995. An Insight into Symbiotic Nitrogen-Fixing Plant Associations in Alaska. *In:* Dahlgren, G., ed., Science in Alaska. Proceedings of the 14th Alaskan Science Conference. 54-63.

Alpine Bluegrass,
Poa alpina

Alpine Bluegrass is found in the northern, southern and eastern portions of Interior Alaska (Hultén, 1968). As the name implies, the species is adapted to high elevation areas. It also performs well on drier sites and has low nutrient needs. Seed availability is limited. Availability of seed should be researched before Alpine Bluegrass is included in a planting plan.

Alpine Bluegrass grows in a wide range of habitats and soil conditions. Some of these are: dry slopes, gravelly sites, rocky sites, alpine and sub-alpine sites, and meadows. *Poa alpina* is a perennial grass that can serve as the pioneer species for a revegetation project. Once established, other plants can follow. *Poa alpina* is tolerant to a wide variety of climatic, soil, fire, and drought conditions. This flexibility makes the species important for high altitude revegetation.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Gruening' is a variety that can be established on dry soil as long as there is some irrigation.

Teller selected class germplasm is a native collection of *Poa alpina* intended for general revegetation projects throughout Alaska.

'Gruening' **Alpine Bluegrass**, *Poa alpina*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor - Fair	Bunch	6 - 8 in.	5.0-7.2	Poor	Good	Poor	Weak

- **Hultén, E**. 1968. Flora of Alaska and Neighboring Territories. Stanford University Press, Stanford, CA.

Arctic Bluegrass (viviparous form), *Poa arctica*

Arctic Bluegrass (viviparous form) is unique in that it reproduces via asexual reproduction. This variety of Arctic Bluegrass produce small plantlets in the seedhead in place of true seed. Viviparous Arctic Bluegrass performs best on dry upland sites.

Viviparous Arctic Bluegrass is found as raised clumps on gravel, wet meadows, and soils near wetlands. It is a cosmopolitan species, being able to grow on both acidic outcrops and calcareous substrate. Viviparous Arctic Bluegrass can be found on rocks, gravel, soil, moss, sand, silt, and clay (Aiken, et. al., 1995). Geese graze specifically on *Poa arctica*, which means that, in terms of restoration, viviparous Arctic Bluegrass will attract geese to the project-thus creating a more diverse habitat (Aiken et. al., 1995).

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Tin City selected class germplasm

Tin City **Arctic Bluegrass** (viviparous form), *Poa arctica*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	12 in.	5.0-7.8	Good	Good	Good	Strong

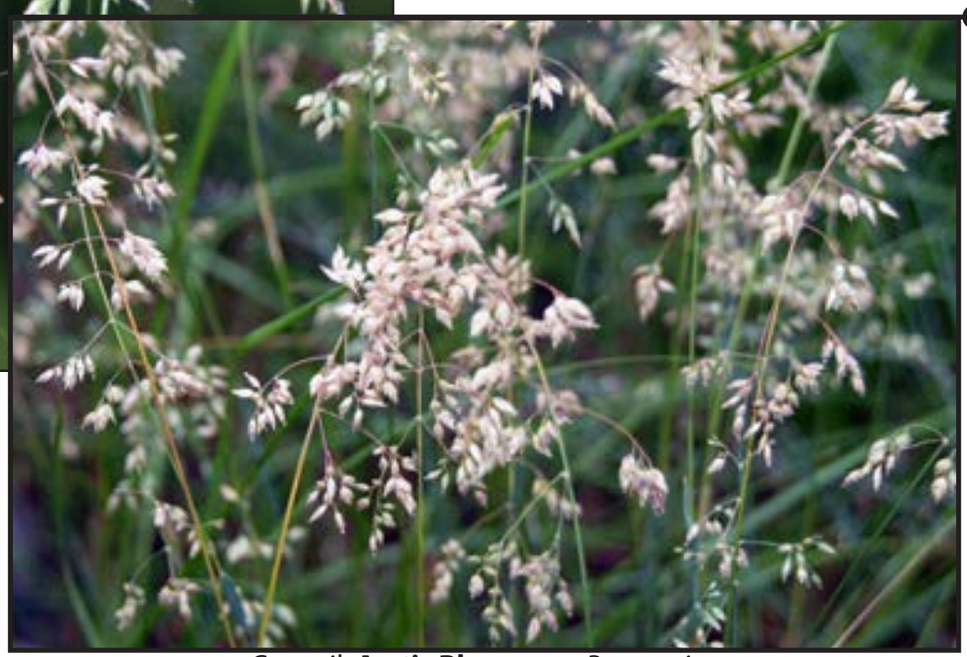
- **Aiken, S.G, Consaul, L.L. and Dallwitz, M.J.** 1995 onwards. Poaceae of the Canadian Arctic Archipelago. www.mun.ca/biology/delta/arcticf.

Arctic Bluegrass,
Poa arctica

Seed producing varieties of **Arctic Bluegrass** are also available. This species can be used on a wide variety of soils throughout Alaska. Arctic Bluegrass is found as raised clumps on gravel, wet meadows, and soils near wetlands. It is able to grow on both acidic outcrops and calcareous substrate. *Poa arctica* can be found on rocks, gravel, soil, moss, sand, silt, and clay (Aiken, et. al., 1995). Arctic Bluegrass's tolerance of acidity is an important characteristic for mine reclamation. A wetness loving species, Arctic Bluegrass, can effectively grow where other grasses might die from excess water.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

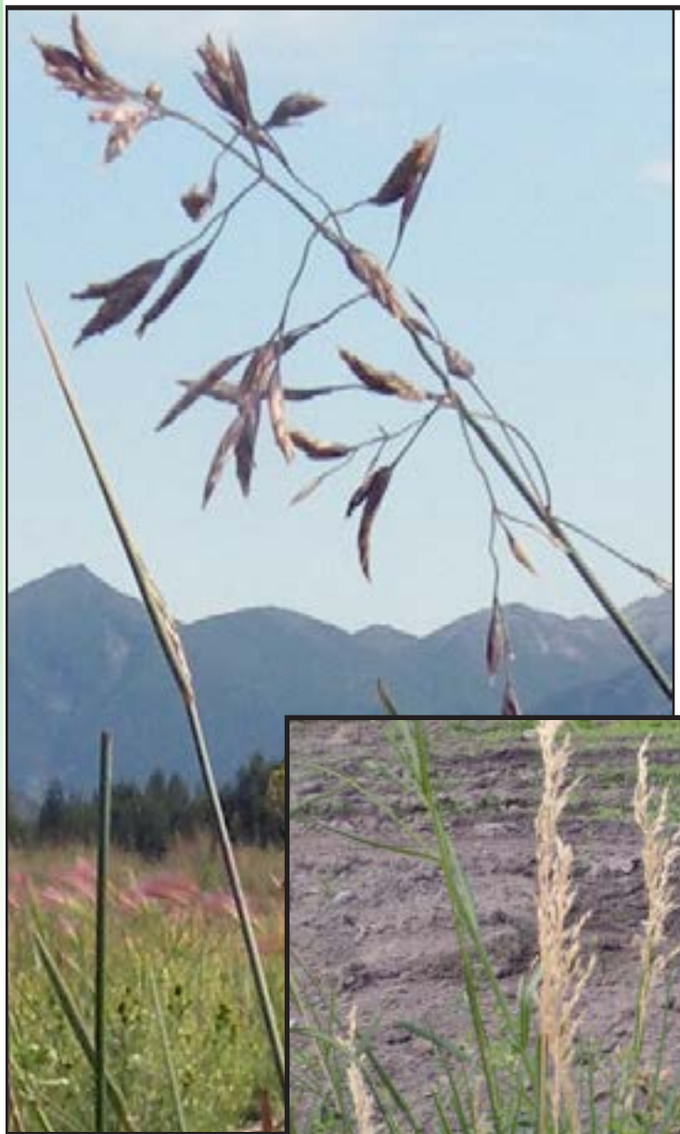
Council selected class germplasm produces true seed.



Council **Arctic Bluegrass**, *Poa arctica*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	12 in.	5.0-7.8	Poor	Good	Good	Strong

- **Aiken, S.G, Consaul, L.L. and Dallwitz, M.J.** 1995 onwards. Poaceae of the Canadian Arctic Archipelago. www.mun.ca/biology/delta/arcticf.



Glaucous Bluegrass,
Poa glauca

Glaucous Bluegrass can be found on many types of soil - from slightly acidic to slightly basic; in very dry to slightly moist areas; and on gravel, sand, or organic matter. It is a pioneer species, forming tussocks in disturbed areas. This provides a cover where willows and forbs can become established (Aiken, et. al., 1995). In the extreme arctic, Glaucous Bluegrass's growth form is short and erect. In other areas of Alaska, it is more spreading.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Tundra' is a variety best suited for revegetation in extreme northern areas with severe environmental conditions (Mitchell, 1980).

Nome selected class germplasm is a relatively common grass on dry mineral soils in the state. This variety has a wider use range than 'Tundra'; however, it is not recommended for use in arctic regions.

PRIMARY

'Tundra' **Glaucous Bluegrass**, *Poa glauca*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor - Fair	Bunch	10 - 12 in.	5.0-8.0	Good	Excellent	Poor	Strong

- **Aiken, S.G, Consaul, L.L. and Dallwitz, M.J.** 1995 onwards. Poaceae of the Canadian Arctic Archipelago. www.mun.ca/biology/delta/arcticf.
- **Mitchell, W.W.** 1980. Registration of Tundra Bluegrass. Crop Science 20(5): 669.

Beautiful Jacob's Ladder,
Polemonium pulcherrimum

Beautiful Jacob's Ladder is highly adapted to gravelly soils. It has a colorful appearance, and can add to the visual impact of a revegetation project. Using this species enhances diversity, in addition to aesthetic considerations. It grows in alpine, subalpine, mid and low elevation sites. When used in seed mixes at 5% by weight, Beautiful Jacob's Ladder performs vigorously.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Butte selected class germplasm

Butte **Beautiful Jacob's Ladder**, *Polemonium pulcherrimum*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	16 in.	6.5-8.5	Good	Excellent	Poor	Weak

Spike Trisetum,
Trisetum spicatum

Spike Trisetum is used for revegetation of dry sites with mineral soils. The species has nearly a world-wide distribution and is one of the more cosmopolitan grasses. *Trisetum spicatum* is a common grass found on disturbed sandy or silty soils, on both acid and alkaline substrates, and on rocks, gravel, clay, or tilled earth (Aiken et al., 1999). Spike Trisetum has a high root / shoot ratio. This enables it to be useful for soil building and erosion control (Hardy, 1989).

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Nelchina selected class germplasm

Nelchina **Spike Trisetum**, *Trisetum spicatum*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	18 in.	4.9-7.5	Poor	Good	Good	Strong

- **Aiken, S.G, Consaul, L.L. and Dallwitz, M.J.** 1995 onwards. Poaceae of the Canadian Arctic Archipelago. www.mun.ca/biology/delta/arcticf.
- **Hardy BBT Limited**. 1989. Manual of plant species suitability for reclamation in Alberta, *2nd edition*. RRTAC Report No. 89-4. Alberta Land Conservation and Reclamation Council, Edmonton, Alberta.

Case Studies

Photo: Will Menheere (Fairbanks Gold Mining Inc.)

A recontoured and revegetated mine site at the Fort Knox mine, north of Fairbanks

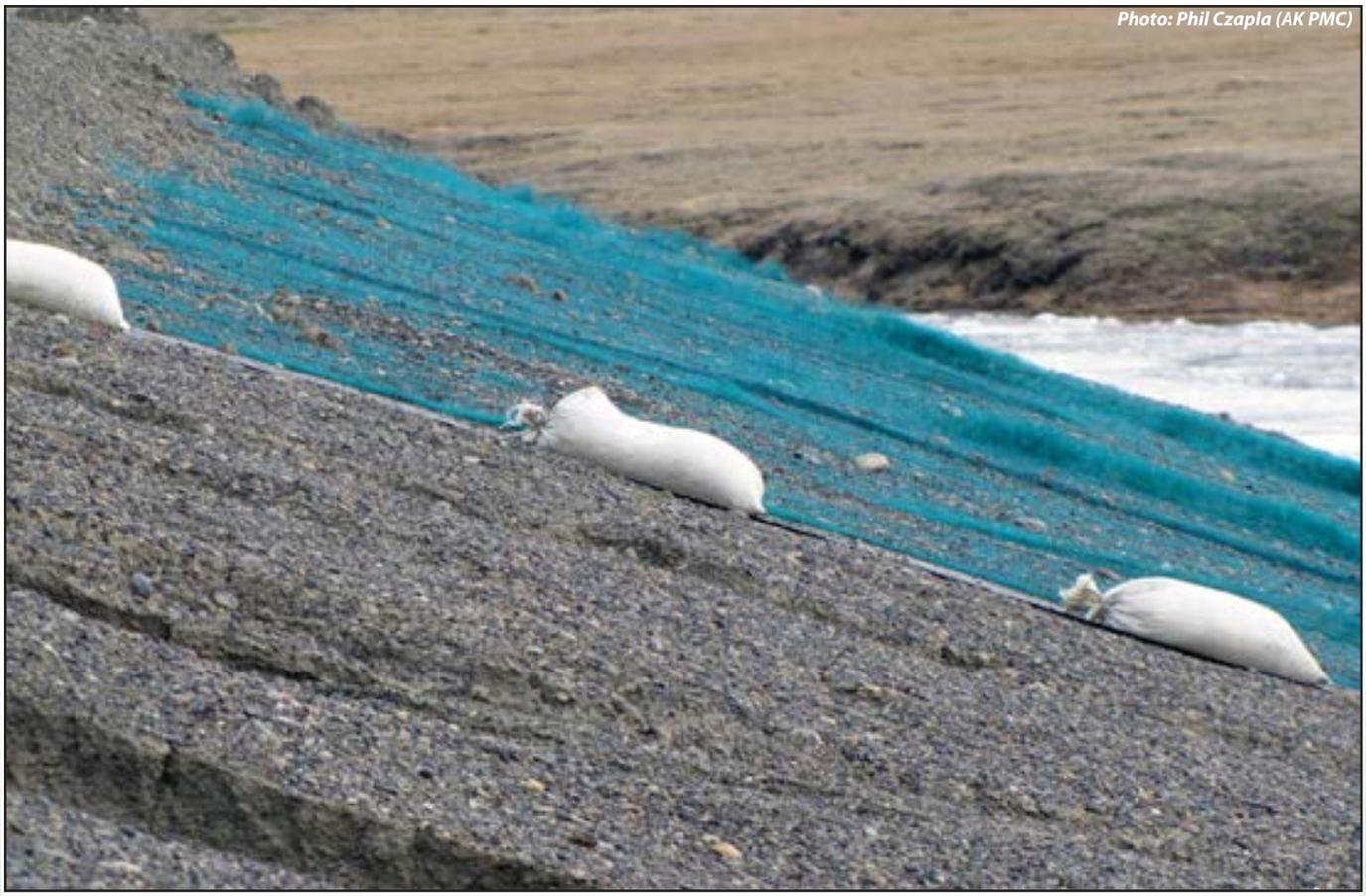
Section 4:

Interior Alaska Revegetation Projects

- *True North Mine Reclamation, Fairbanks;*
- *Chistochina River Wetland Restoration;*
- *Kanuti Pit Rehabilitiation, Dalton Highway;*
- *Partial Landfill Closure, Fairbanks;*
- *Riparian Reclamation of Nome Creek -*
  White Mountains National Recreation Area; &
- *Illinois Creek Mine Site Revegetation, Kaiyuh Mountains.*

Case Studies

Acknowledgements:



Geo-textile fabric armoring protects a constructed slope from wind and water erosion.

The case studies section of this publication would not have been possible without the participation and involvement of professionals across the state. The authors would like to extend a special thanks to:

- **Will Menheere** - Fairbanks Gold Mining Inc.,
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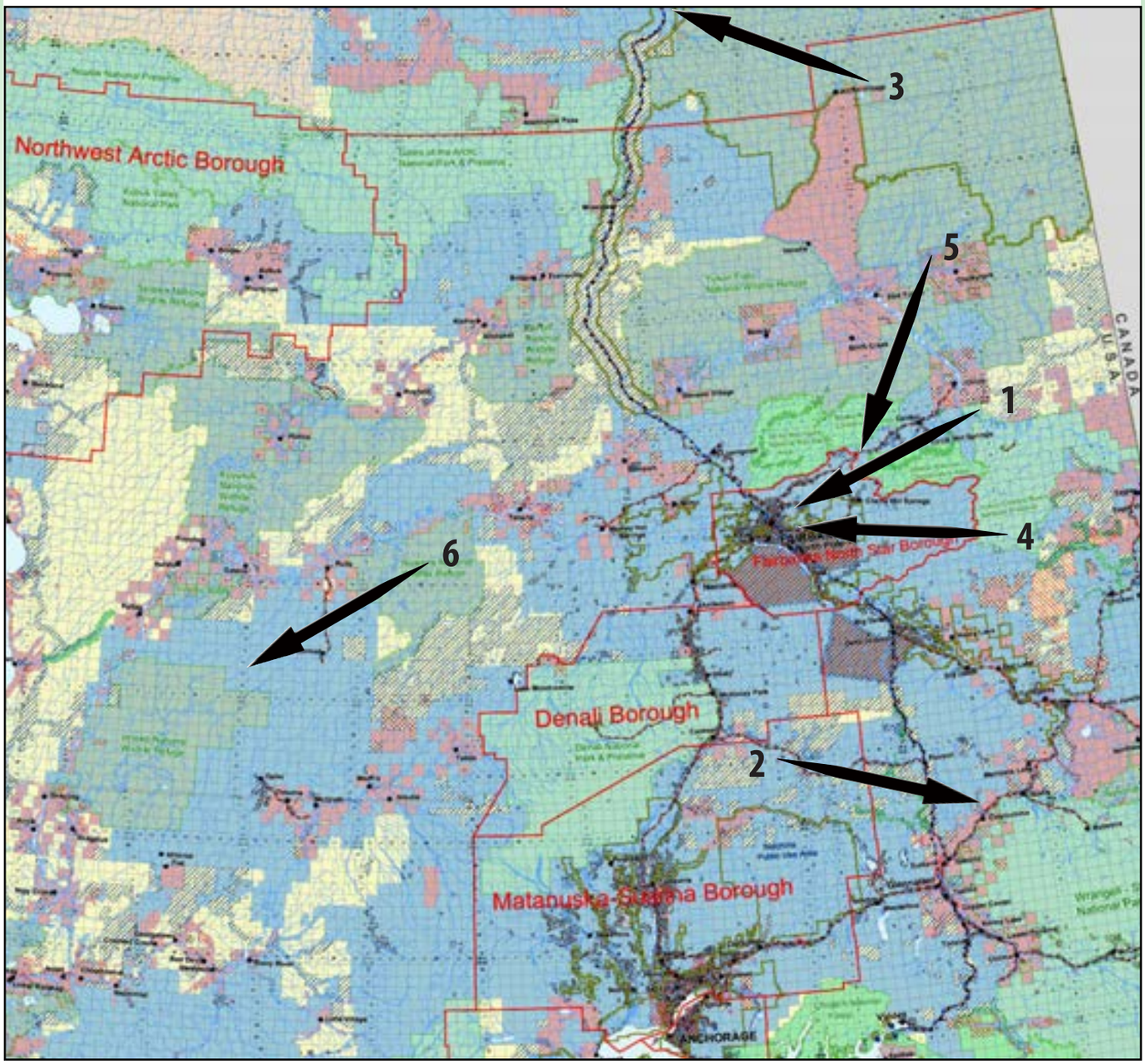
- **Steve McGroarty** - Alaska Department of Transportation & Public Facilities, and
- **Andy Nolen** - Alaska Department of Natural Resources, Division of Agriculture, Alaska Plant Materials Center.

Revegetation Projects

Interior Alaska Revegetation & Erosion Control Guide

1. True North Mine Reclamation
2. Chistochina River Wetland Restoration
3. Kanuti Pit Rehabilitation
4. Fairbanks Partial Landfill Closure
5. Riparian Reclamation of Nome Creek
6. Illinois Creek Mine Site Revegetation



True North Mine Reclamation

Submitted by Will Menheere, Fairbanks Gold Mining Inc.

Introduction / Objective:

In 1999, Kinross Gold Corp. acquired 100% ownership of the True North mine from the True North Joint Venture Project, a partnership between Newmont Alaska Limited and La Teko Resources. In 1999, Fairbanks Gold Mining Incorporated (FGMI) continued geologic exploration and baseline hydrologic data collection activities at the True North mine site.

Prior to construction of the mine facilities; placer, exploration, and other mining activities had disturbed approximately 68 acres within the True North Mine area. This disturbance does not include trails, historic ditches, cabin sites, and small-localized disturbances that existed before exploration. Some of these previously disturbed areas are located where the Hindenburg pit, East pit, and waste rock dumps are situated.

Mining occurred at the True North mine from early 2001 until late 2004, when it was decided that the mine would be put into “care and maintenance” status. Operations at True North mine were subsequently discontinued, and reclamation activities began in 2007. Reclamation activities occurred in 2007, 2009 and 2010, with the bulk of work completed in 2009 and 2010.

Methods of Revegetation:

Retaining and putting aside growth media is an important step in the reclamation process. Growth media is defined as all native soil material with the physical and chemical properties capable of germinating and sustaining vegetation growth with or without amendments.

The term growth media is synonymous with the terms topsoil and subsoil. Subsoil material is the unconsolidated material that lies between the topsoil horizon and bedrock and exhibits no chemical characteristics that will inhibit vegetation development. Approximately 12 inches of growth media was applied to areas of unsuccessful growth to promote natural re-invasion by native plant species.

Mine related disturbances can result in compacted surfaces unsuitable for revegetation. Thus, preparation of a seedbed suitable for plant germination and growth is a critical task in any successful land reclamation project.

At True North mine, the general method of seedbed preparation was ripping or scarifying along the contour using a D8N CAT equipped with a 2 or 3-shank ripper. Ripping occurred along contours of sloped areas to create a suitable seedbed and provide a measure of erosion control.

Following the application of growth media (if necessary) specific sites were prepared for seeding by scarifying on the contour to roughen the surface. A broken, roughened surface serves to trap moisture, reduce wind shear, minimize surface erosion by increasing infiltration, and create micro-habitats conducive to seed germination and development.

Specific fertilization requirements depend on the quality of growth media being used. At True North, the rate of fertilizer application generally ranged from 100 to 300 pounds per acre of 20N-20P-10K for a spring seeding or 10N-20P-10K for an early fall seeding. The fertilizer was applied using aerial broadcasting prior to, after, or during the seeding operation.

Species Used:

The grass seed mix used at True North mine consisted of:

- 50% ‘Arctared’ **Red Fescue**
- 20% ‘Gruening’ **Alpine Bluegrass**
- 20% ‘Tundra’ **Glaucous Bluegrass**
- 10% ‘Nortran’ **Tufted Hairgrass**

The primary purpose of the seed mix was to achieve quick vegetative cover to minimize soil erosion. Seeding was accomplished using aerial broadcast application, at a rate of 11 to 18 pounds of pure live seed per acre. The need for mulch application will be evaluated if seed germination becomes a limiting factor in the re-establishment of vegetation.

Results:

Since the initiation of reclamation, revegetation efforts have been successful at True North. To date, approximately 70% of the disturbed areas have been seeded and are achieving adequate growth. To ensure the continued growth of these areas, vegetative maintenance (seeding and fertilization) will be performed as needed.

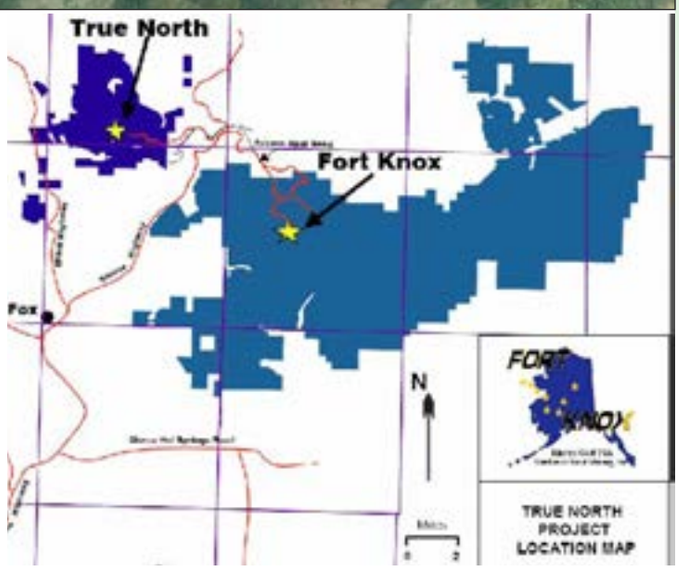
In addition to the applied seeding, natural re-invasion of native species has occurred throughout the mine. Areas such as the pit walls where no revegetation effort was made now contain eight-foot high birch saplings (volunteer species) on several benches. Areas reclaimed in 2007 now contain large patches of willow/alder/birch in addition to seeded grasses.

References:

Menheere, Will 2010. Interior Alaska Revegetation Report. Fairbanks Gold Mining Inc., 17 pp.

Project Location:

The True North mine is within the Chatanika River watershed, located on the northwest flank of Pedro Dome, approximately 25 miles northeast of Fairbanks.



Aerial seeding - mid September, 2010


Photo: Will Menheere (FGMI)

North Shepard dump - mid September, 2010 (seeded mid-August, 2010). Note furrows along horizontal contour of slope.


Photo: DNR

North Shepard dump - 2005


Photo: Will Menheere (FGMI)

North Shepard dump - mid August 2010.
Area reworked in July, 2010; surrounding area seeded in 2007.


Photo: DNR

Tall grass at north Shepard dump - mid-September, 2010


Photo: DNR

View of north Shepard dump - mid September, 2010

Zepplin / Hindenburg dump - Summer 2007

Hindenburg dump - September 2010 (seeded late 2005)

Zepplin / Hindenburg dump - July 2010

Shepard pit vegetation - August 2010. Note: Pit walls were never seeded; growth is due to natural reinvasion.

Louis dumps; area seeded late August 2009

South Shepard dump revegetation progress - early September, 2010 (area seeded late July, 2010)

Louis dumps - mid September, 2010

Chistochina River Wetland Restoration

Contributions by Andy Nolen, Alaska Plant Materials Center

Introduction / Objective:

In conjunction with a roadway realignment and bridge replacement project by the Alaska Department of Transportation and Public Facilities (DOT&PF), three wetlands were created along the Chistochina River in 2006. The planning and revegetation for the three newly constructed wetlands was done by the Alaska Plant Materials Center (PMC).

Methods of Revegetation:

Site revegetation began in June 2006. Revegetaton methods included seeding, fertilizer application and live staking of dormant willow cuttings. Bundles (facines), and transplants of wild collected grasses and sedges were also installed. The three wetland areas are referred to as **northwest**, **southwest**, and **northeast**.

The **northwest wetland** was the largest area and first to be revegetated. Willow bundles, live stakes, and transplants of sedge and Bluejoint Reedgrass were installed. Afterwards, the entire area was treated with 450 lbs/acre of fertilizer and 40 lbs/acre of grass seed mix. Following seeding, a harrow was pulled behind an ATV to incorporate the seed and fertilizer into the soil.

The **northwest wetland** also contained two special treatment areas. One treatment area received only fertilizer, while the other area received fertilizer and wild-collected sedge seed of the species *Carex aquatilis* and *Carex utriculata*.

The **southwest wetland** was revegetated in much the same way as the northwest site. Live willow stakes and bundles were installed, as well as sedge and bluejoint transplants. Fertilizer was applied at a rate of 450 lbs/acre followed by 40 lbs/acre of the revegetation mixture.

Live willow stakes were planted in the **northeast wetland** also. After cuttings were installed, fertilizer and seed mix were applied, at rates of 450 lbs/acre and 40 lbs/acre, respectively.

Species Used:

Prior planning was necessary before revegetation species were selected. Initial site visits were conducted in 2004 at the Chistochina River and nearby wetlands. This was done to examine species present and identify revegetation techniques that would achieve the restoration goals of the project. Sedge species, Bluejoint Reedgrass, and some woody species like alder, cottonwood, and aspen were identified.

Collection procedures for willow, as well as implementation guidelines for live stakes and bundles were taken from Streambank Revegetation and Protection: A Guide for Alaska (2005). Felt-leaf Willow (*Salix alaxensis*) cuttings were collected in April 2006. Approximately 6000 cuttings were harvested with hand pruners and stored in a walk-in cooler (at 35 degrees Fahrenheit) to maintain dormancy. Stored willow cuttings were prepared for transport later in 2006. 1500 cuttings were used to create 20 bundles while the remaining 4500 cuttings were planted as live stakes.

Seed for the project was acquired from commercial sources, or collected from the project area. Field collection of seed occurred in the fall of 2004 and 2005 with the use of a mechanical seed stripper towed behind an ATV. The area selected for harvest was easily accessible and had the desired wetland plant material present, consisting of Water Sedge (*Carex aquatilis*), Northwest Territory Sedge (*Carex utriculata*), and Bluejoint Reedgrass (*Calamagrostis canadensis*). A total of three pounds of seed was collected in 2004.

An additional collection of the same species took place in 2005, resulting in 1.5 pounds of usable seed. Collected seed was used to produce plugs in the greenhouse, and later transplanted to the project sites. Greenhouse plug production consisted of 3000 plugs of Bluejoint Reedgrass (*Calamagrostis canadensis*), 500 plugs of Water Sedge (*Carex aquatilis*), and 500 plugs of Northwest Territory Sedge (*Carex utriculata*).

Commercial seed and fertilizer used at the project site was purchased from Alaskan suppliers. 2000 pounds of 20N - 20P - 10K fertilizer was used. The seed purchase consisted of:

Lbs	Common Name	Scientific Name
10	**Chamisso Sedge**	*Carex pachystachya*
15	'Arctared' **Red Fescue**	*Festuca rubra*
15	Wainwright **Slender Wheatgrass**	*Elymus trachcaulus*
15	'Gruening' **Alpine Bluegrass**	*Poa alpina*

Lbs	Common Name	Scientific Name
15	'Alyeska' **Polargrass**	*Arctagrostis latifolia*
20	'Egan' **American Sloughgrass**	*Beckmannia syziachne*
30	'Nortran' **Tufted Hairgrass**	*Deschampsia caespitosa*

Two seed mixtures were prepared from the purchased seed - one adapted to wetter, low lying areas of the project, and one for the drier upland areas. These mixes were spread on the three wetland sites. Seed mixtures, by weight, were comprised of the following species:

Wet Mix:

15%	'Arctared' **Red Fescue**
25%	'Nortran' **Tufted Hairgrass**
10%	Wainwright **Slender Wheatgrass**
10%	'Gruening' **Alpine Bluegrass**
15%	'Egan' **American Sloughgrass**
15%	'Alyeska' **Polargrass**
10%	**Chamisso Sedge**

Dry Mix:

15%	'Arctared' **Red Fescue**
25%	'Nortran' **Tufted Hairgrass**
15%	Wainwright **Slender Wheatgrass**
15%	'Gruening' **Alpine Bluegrass**
15%	'Egan' **American Sloughgrass**
15%	'Alyeska' **Polargrass**

Results:

Revegetation material planted on the project site has become established. Vegetation growth and vigor was greatest near the water's edge in all three wetland locations. This is probably due to increased moisture availability in these lower areas. A large portion of the project site had soil consisting of sandy gravel, with little moisture holding capacity. About 80% of the dormant willow cuttings that were planted survived.

Conclusions:

The planning, plant material acquisition (cuttings, transplants & seed), and revegetation phases all met expectations. Plant material installation in June, 2006 provided plenty of time for the plantings to become established.

An uncontrollable factor that did not favor the project was the water level. During planting, the Chistochina River was at or near the high ordinary water line. This did not impede installation of plant materials, but better results might have occurred with lower water levels. The sedge species planted are obligate, meaning wet conditions are required for survival. Sedges were planted at the water's edge during installation, but receding water levels increased the relative distance from the plants to the water line. The potential for sedge transplant failure existed. For future projects, installation of sedges should be timed to coincide with lower water levels.

References:

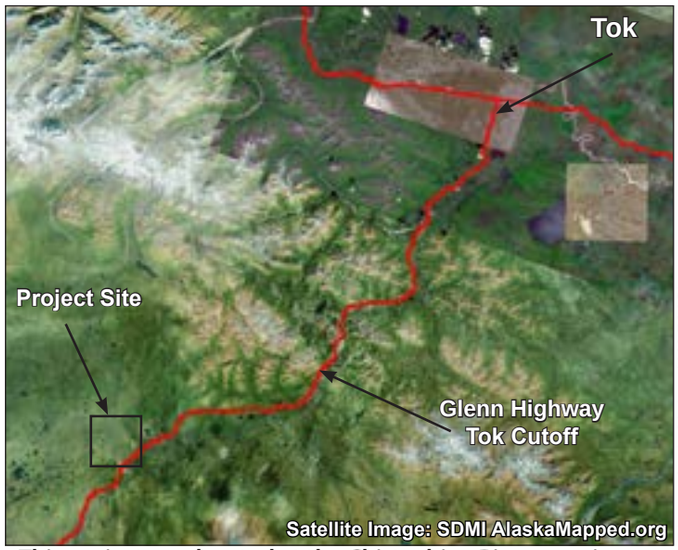
Nolen, Andy. [2007] Chistochina River Wetland Restoration Tok Cutoff 30E Project. State of Alaska, Department of Natural Resources, Division of Agriculture, Alaska Plant Materials Center. 15 pp.

Nolen, Andy. [2008] Chistochina River Wetland Restoration Tok Cutoff 30E Project - One Year Evaluation. State of Alaska, Department of Natural Resources, Division of Agriculture, Alaska Plant Materials Center. 10 pp.

Project Location:

This wetland complex is located near mile 35 of the Tok cutoff.

Site Photos:



This project was located at the Chistochina River crossing on the Glenn Highway (Tok Cutoff).

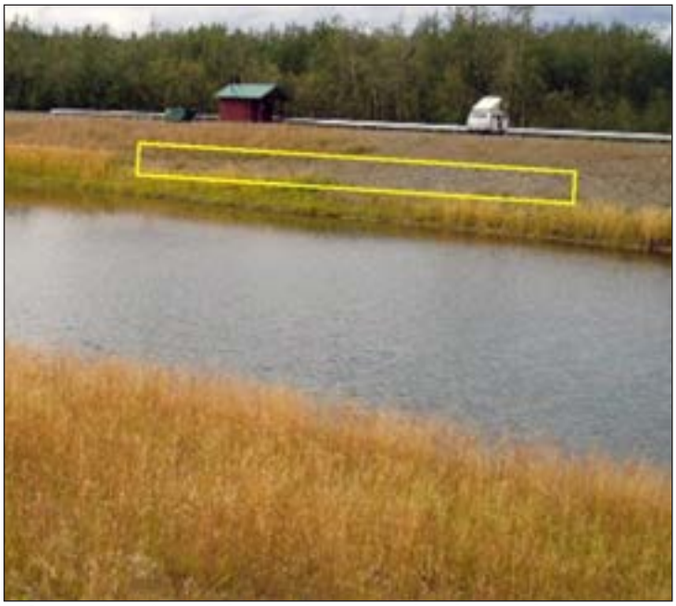
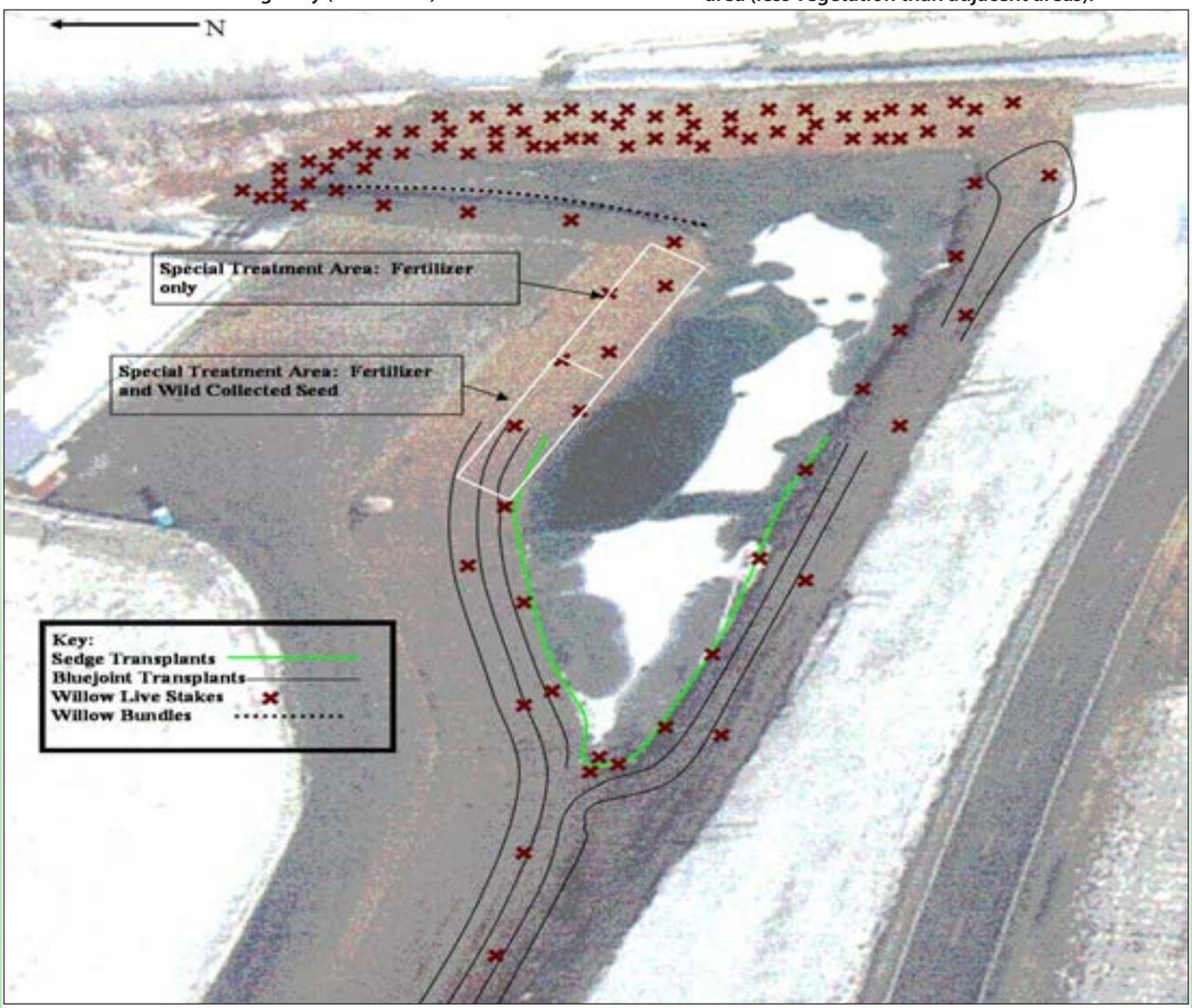


Photo: Andy Nolen (AK PMC)

Approximation of the northwest wetland special treatment area (less vegetation than adjacent areas).



Northwest wetland revegetation area

Photos: Andy Nolen (AK PMC)

Northwest wetland - mid June, 2006

Northwest wetland - late July, 2006

Northwest wetland - late August, 2007

Well established leaves on willow live stakes

Northwest wetland- mid June, 2006

Northwest wetland - late July, 2006

Northwest wetland - late August, 2007

Northwest wetland - late July, 2006

Northwest wetland - late August, 2007

Northwest wetland - late August, 2007

Northwest wetland - mid June, 2006

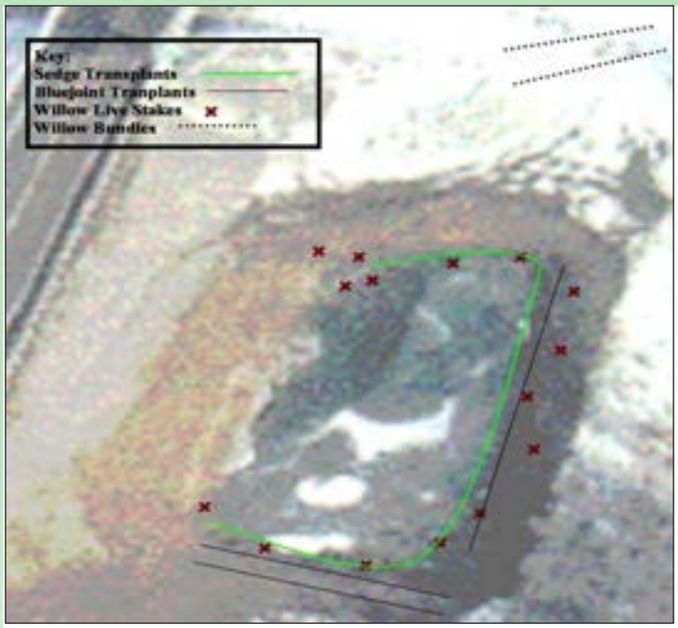
Northwest wetland - mid June, 2006

Northwest wetland - late July, 2006

Northwest wetland - late July, 2006

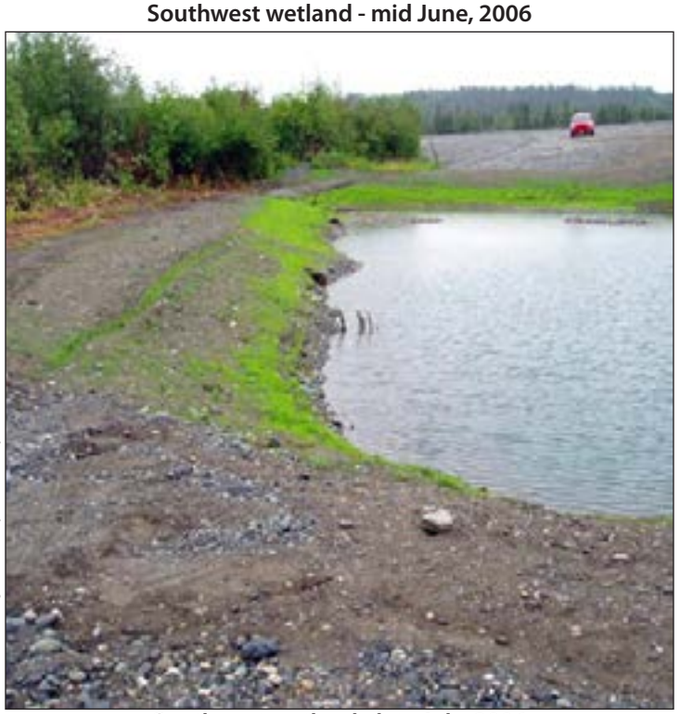
Northwest wetland - late August, 2007

Photos: Andy Nolen (AK PMC)



Southwest wetland revegetation area

Southwest wetland - mid June, 2006



Southwest wetland - late July, 2006

Southwest wetland - late August, 2007

Established seedlings and transplants

Thriving sedge transplant

Photos: Andy Nolen (AK PMC)

Northeast wetland revegetation area

Northeast wetland - mid June, 2006

Photo: Bill Cole

Northeast wetland - late July, 2006

Northeast wetland - late August, 2007

Right-of-Way collection area with desired wetland species

Mechanical seed stripper towed by an ATV

High survival rate for planted dormant willow cuttings

Photos: Andy Nolen (AK PMC)

Kanuti Pit Rehabilitation

Introduction / Objective:

The Alaska Plant Materials Center (PMC) assisted the Alaska Department of Transportation and Public Facilities (DOT&PF) with revegetation and monitoring of a 19.5 acre materials site (gravel pit) at milepost 105 of the Dalton Highway. The Kanuti Pit was used by Alyeska Pipeline Service Company to build the Dalton Highway in the 1970's.

In 2001, asbestos was found in the pit and a closeout program for the site was subsequently developed. Rehabilitation goals for the site included soil stability, plant growth, water retention, and wetland habitat creation. The goal was that the rehabilitated site match the surrounding landscape.

Methods of Revegetation:

Site preparation began in 2002. The area containing asbestos was capped with organic overburden material from the Bonanza Creek material site. The site was then contoured to establish littoral wetland areas.

Site preparation continued in 2003, with the spreading of organic soils by a dozer. To encourage invasion of alder and willow species, 'ripping' of the site was specified in the revegetation plan. The dozer did not include a ripper, however. Instead, the site was track-walked to created micro-catchments for seed and fertilizer and moisture.

Seed and fertilizer was applied on July 31, 2003, using hand held or ATV mounted broadcast spreaders.

Species used on the site:

The seed mixture used consisted of native grasses. Seeding occurred at a rate of 20 lbs / acre, with 20N-20P-10K fertilizer applied at a rate of 450 to 500 lbs / acre. The seed mix used was:

%	Common Name	Scientific Name
25	Wainwright **Slender Wheatgrass**	*Elymus trachycaulus*
25	'Nortran' **Tufted Hairgrass**	*Deschampsia caespitosa*
25	'Gruening' **Alpine Bluegrass**	*Poa alpina*
15	'Egan' **American Sloughgrass**	*Beckmannia syzigachne*
10	'Arctared' **Red Fescue**	*Festuca rubra*

All of the selected species were bunch grasses, with the exception of 'Arctared' Red Fescue, a sod forming grass. The bunch grasses component of the seed mix better allowed for natural re-invasion of native species.

Results:

Monitoring of the site occurred yearly from 2003 to 2007, and again in 2010. Two 300 feet transects were installed in 2007, for quantitative measures of species diversity and plant cover. Observations were taken at one foot intervals along the transect, resulting in a total of 300 hit-points per transect. Qualitative monitoring consisted of photo point pictures documenting the overall revegetation performance over time.

In 2010, satisfactory performance of seeded grasses was observed. High density plant cover was also noted in the 2010 monitoring. Planted species were evident and natural re-invasion of other native species was observed. Wetland areas were holding water, promoting the development of niche wetland habitats. Monitoring will continue through 2013.

Conclusions / Lessons Learned:

The shortcomings of the Kanuti Pit Rehabilitation resulted from poor planning and not having the right equipment. The dozer was not equipped with a ripper as called for in the work plan. The track-walking technique used was the next best option. A ripping implement would have reduced soil compaction and created larger catchments for seed, fertilizer, and moisture. It may have also better supported woody species establishment.

Application of the seed and fertilizer was to be overseen and directed by a PMC staff member. Due to scheduling and communication issues, this did not happen. The work plan specified that the seeding and fertilizer boundary would encompass the entire pit area. It appeared during 2003 monitoring that seed and fertilizer were only applied to those areas that were completely void of vegetation. Had the bordering area also been fertilized, it would have encouraged seed production of colonizing species present in the area, thus promoting the natural re-invasion of native plants.

One area of the project exhibited less plant cover than other areas during the 2006 monitoring. Soil in this area consisted of sandy gravel. This area was also inaccessible during the site preparation phase, due to snow drifts. The low plant coverage may be due to no organic soil being spread in this area. Organic soil in this area would increase the moisture holding capacity of the sandy gravel soil and provide a better substrate for vegetation growth.

References:

Nolen, Andrew, 2008. Rehabilitation of the Kanuti Pit Materials Site 65-9-031-2 Located at Milepost 105 of the Dalton Highway. State of Alaska, Department of Natural Resouces. 15pp.

Project Location:

The approximately 19.5 acre Kanuti Pit (Material Site 65-9-031-2) is located at milepost 105 on the Dalton Hwy, just south of the Kanuti River, USGS Bettles (B-2) T18NR14W-Sec. 31&32, Fairbanks Meridian.

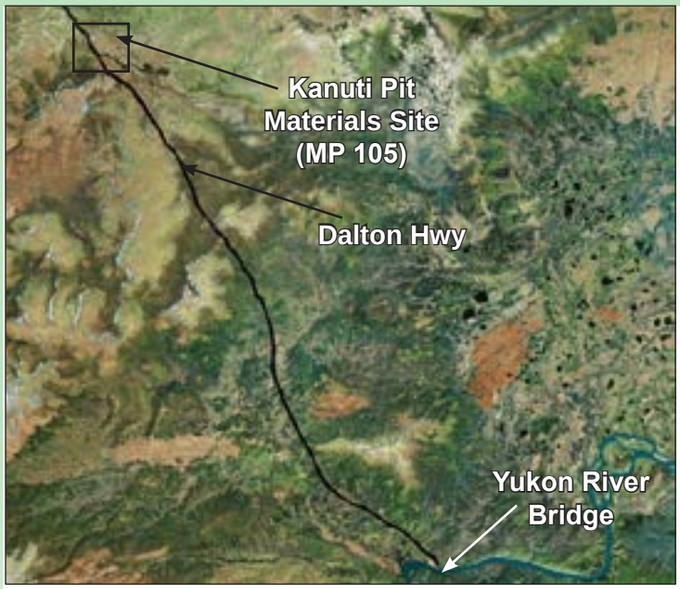
Site Photos:

Photos: AK PMC

Aerial overview of Kanuti pit materials site, after grading and site preparation - Summer, 2002

This photo depicts the planned seeding and fertilizer application boundary (in yellow) with the actual application boundary (in red), based on monitoring observations.

Dozer spreading organic soil during site preparation phase - June, 2003



Satellite Image: SDMI | AlaskaMapped.org

Kanuti Pit is located 49 miles north of the Yukon River crossing.

Photo point 1 - early June, 2003

Photo point 1 - mid September, 2010

Photo point 2 - early June, 2003

Photos: AK PMC

Photo point 2 - mid September, 2010

Photo point 3 - early June, 2003

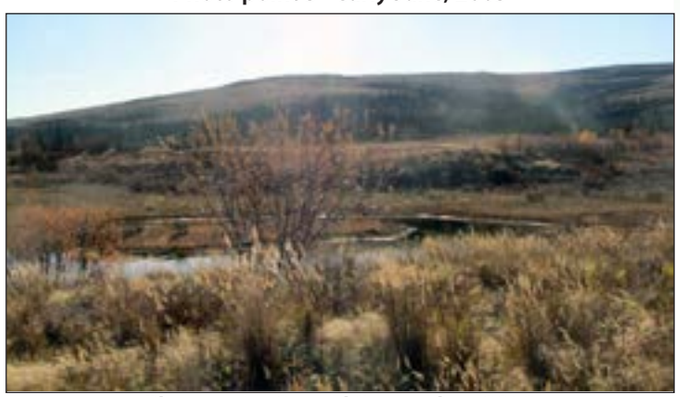


Photo point 3 - mid September, 2010

Photo point 4 - early June, 2003

Photo point 4 - mid September, 2010

Photo point 5 - early June, 2003

Photo point 5 - mid September, 2010

Photo point 6 - early June, 2003

Photo point 6 - mid September, 2010

Photos: AK PMC

Photo: Lyubomir Mahlev (AK PMC)

Rehabilitated Kanuti pit materials site - Summer, 2009

Fairbanks Partial Landfill Closure

Introduction / Objective:

Great Northwest Inc. was contacted to assist the Fairbanks North Star Borough with the closure of a landfill. The objectives were threefold:

1. Provide gas collection wells and piping systems,
2. Provide a leachate recirculation system, and
3. Provide closure cover and surface drainage for up to 28 acres.

Methods of Revegetation:

After reconstruction of proper site topography and slopes to specifications, a 6 inch layer of topsoil was applied. Topsoil is very fertile and contains the nutrients and microorganisms that enhance revegetation success. Prior to seeding the surface was scarified using a Bobcat T-200 with a land planer attachment. Scarifying along the contour roughened the soil surface and provided favorable micro-sites for seed germination and growth.

Ninety percent of the project area was drilled in one direction using a Bobcat T-200 with a drill seeder attachment. After drill seeding, the areas were sprayed with a light application of Eco-Fibre/Plus, containing tackifier in the mulch. The purpose of the mulch application was to moderate soil surface temperatures, conserve soil moisture, and increase seed germination.

The ditch and the berm were the only areas hydroseeded. Two load applications were applied within eight hours of each other. This was necessary to provide a thriving stand of vegetation. Cell C/D received 2 feet of N-Viro (treated sludge from the Borough) with 6" of topsoil on top.

Species used on the site:

The seed mixture was applied at a rate of approximately 2 pounds per 1,000 square feet. This was followed by 20N-20P-10K fertilizer, dispersed by hand at a rate of 5 pounds per 1,000 square feet. The grass seed mix used consisted of:

%	Common Name	Scientific Name
50	'Arctared' **Red Fescue**	*Festuca rubra*
25	'Nortran' **Tufted Hairgrass**	*Deschampsia caespitosa*
25	'Gruening' **Alpine Bluegrass**	*Poa alpina*

Results:

The drill seeded areas displayed good germination results within 8 days, and a very uniform and thick stand of vegetative cover was present within 30 days. The hydroseeded areas did not produce the cover expected and re-seeding was necessary over 40% of the area. By the end of summer, 2010, 80% coverage was established in the ditches and berms.

Erosion, for the most part was a non-issue. Some minor erosion occurred along a berm, which prevented water from flowing down slope. This intensified the run-off volume along the length of the berm, carrying soil and seed away. The area was subsequently re-contoured and seeded.

Conclusions / Lessons Learned:

Drill seeding is the preferred method of seeding when site conditions allow. Hydroseeding required more human maintenance (watering), so this method may not be appropriate for remote sites or areas without an available water supply.

References:

Schlosser, Gordon, 2010. Solid Waste Partial Landfill Closure of Cell C/D and Cell #1. Great Northwest Inc, Fairbanks, Alaska. 2 pp.

Project Location:

Fairbanks, Alaska.

Site Photos:

View of site prior to construction activities - mid April, 2010

Site recontoured before topsoil placement - mid June, 2010

Two feet of N-Viro treated sludge was deposited on cell C/D - early June, 2010

Salvaged topsoil was applied in a 6" layer all over the site.

A rubber liner was placed along the length of the ditch in late June, 2010.

The ditch was filled in a three step process: 6" of gravel was placed over the rubber liner, followed by 18" of silt, and then capped with 6" of topsoil in early July, 2010.

Photos: Gordon Scholsser (Great Northwest, Inc)

Photos: Gordon Scholsser (Great Northwest, Inc)

A Bobcat T-200 dozer with a drill seeder attachment applies a seeding mixture to the site.

A hydro-mulch application of Eco-Fibre / Plus with tackifier was lightly sprayed over the area after drill seeding in mid July, 2010.

Seeded species establishment - mid July, 2010

Riparian Reclamation of Nome Creek

Introduction / Objective:

Nome creek is a tributary of the Beaver Creek National Wild River, located within White Mountains National Recreation Area, a BLM land holding. Land disturbance activities by way of placer gold mining had a large effect on portions of the drainage. Over seven miles of stream was disturbed by miners, and by the 1980s the floodplain was obliterated in many areas.

Nome Creek's accessible location relative to the Beaver Creek Wild and Scenic River Corridor and plans to develop Mount Prindle Campground and Nome Creek Road made riparian reclamation and stream channel reconstruction of this area a priority. This project was directed by BLM's Steese/White Mountains District (SWMD), now called the Eastern Interior Field Office. Project objectives were three-fold:

1. Keep the stream within a single channel;
2. Eliminate debris piles and settling ponds contributing to sediment runoff; and
3. Stabilize and revegetate the floodplain.

Reclamation work began in July of 1991. A D8 bulldozer was the primary piece of equipment used. Channel reconstruction began with the filling in of settling ponds using material from tailings piles and then grading the area flat. A pilot stream channel was constructed to avoid these ponds and meander down the valley at a relatively uniform grade.

Periodic flooding, from storm runoff, summer rains, and overflow icing resulted in erosion of the floodplain and destruction of willow plantings adjacent to the stream. This occurred during the summers of 1991, 1994, 1998, 2000, and 2003. The flooding problem was partially corrected by widening the pilot channel, flattening meanders on the inside of bends, and floodplain regrading.

Methods of Revegetation:

The Steese/White Mountains District fisheries began organizing willow cutting and planting for reclaimed areas along the creek in 1992. District personnel harvested dormant felt-leaf willow cuttings in mid April, 1992. Selected cuttings were approximately 12 inches long with at least 2 years growth. Cuttings were stored in a freezer until late June when they were taken to the site and placed in gravel using a dibble. The cuttings were planted with at least ¾ buried below the surface, with the above-ground portion containing 1 to 2 viable buds. Also, about 24 willow bundles, each consisting of 8-12 willow cuttings were lashed together and armored into the stream bank.

In June of 1993, additional felt-leaf willow cuttings were harvested, this time during the summer, and planted at the site using a dibble. Again, cuttings approximately 12 inches long with 2 years of growth were taken, and planted with ¾ below ground and 1 to 2 visible buds. To reduce water loss, green leaves were stripped off the cuttings after planting.

A site approximately 3 acres in size was seeded in late June, 1993. The seed mixture applied included 70% 'Arctared' Red Fescue, 20% Bering Hairgrass, and 10% Annual Ryegrass. A fertilizer mix consisting of 50% 10N-20P-20K and 50% 10N-10P-20K was broadcast concurrent with seeding. Hand-held broadcaster seeders were used to distribute the seed and fertilizer.

Species used on the site:

Planting techniques included the planting of both dormant and live willow cuttings and grass seedings. Approximately 2000 dormant cuttings of felt-leaf willow were planted in 1992, and 1250 live felt-leaf willow cuttings were planted in 1993.

The grass seed mixture was applied at a rate of 55 lbs/acre. The original seeding rate called for 42 lbs/acre, but the initial acreage estimate was too high resulting in the higher rate. The seed mix consisted of:

70% 'Arctared' **Red Fescue** (*Festuca rubra*)
20% **Bering Hairgrass** (*Deschampsia beringensis*)
10% **Annual Ryegrass** (*Lolium multiflorum*)

Results:

Willow Monitoring:

Six 5 meter square plots were established in the 1992 and 1993 willow planting areas in late August of 1993, for a total of 12 plots. Within each of these plots the number of willow cuttings planted, number alive, and volunteer plants present were counted. Willow bundle survival was quantified by establishing a 30 meter transect along the stream bank.

The results of the willow monitoring are as follows:

1992 willow plantings:

Average survival for the willow cuttings was 90%, and nine willow bundles were encountered along the transect, with all nine alive and well.

1993 willow plantings:

Average survival of willow cuttings was 87%.

Grass Seeding Area 1993:

Twenty-two 1 m² plots were established along a transect in August 1993. This was done to determine composition of the seeding area. The percent cover of rock, grass, bare ground, mosses/liverworts, exposed rock, and other plant species was recorded. The average grass cover was 68%. This high establishment rate could be attributed to the slow steady rain lasting for several hours shortly after seeding. Also, many precipitation events throughout the summer aided seedling growth.

1996 Evaluation of Willows & Grass Seeding:

A large portion of willows were lost due to flood scouring and earthwork with heavy equipment. Those willows that were planted as cuttings continued to show high survival, more so than naturally occuring willows. The total % cover of willows planted from cuttings was observed to be much lower than that of colonizing willows.

The performance of the seeded grasses was disappointing. The grasses created a dense, tough sod and much of the grass was dead or dying in 1996. Live cover of the three seeded species was estimated at only 15%, with dead grass litter averaging 69%. Native species colonization was also low with only a small amount of forb and willow cover documented.

An adjacent area with limited fines and topsoil did not receive the seed or fertilizer treatment. This area was beginning to show desirable grass and willow cover by the 1996 monitoring. Live grass cover of native *Calamagrostis* and *Carex* species was 34%. 9% willow cover was also observed in this area.

Conclusions / Lessons Learned:

The grass seeding and fertilizer applied resulted in a very dense vegetative cover that was effective for erosion control. It appears that the high seeding rate of red fescue, a sod forming grass, hampered the recolonization of native species and left a thatch of dead grass.

A portion of the seeded area did not receive fertilizer. The seeded grasses established there but not to the size or density as the areas which were seeded and fertilized. This oversight left more space for natural colonization and resulted in a higher proportion of live to dead grass.

Seeding and fertilizing at lower application rates may promote natural revegetation. With lower seeding and fertilizer rates, colonizing seed from the surrounding area are more able to move in and find available space and micro-climates needed for growth. Had the acreage not been overestimated and original seeding rate of 42 lbs/acre been applied instead of 55 lbs/acre, survival and cover may have also been improved.

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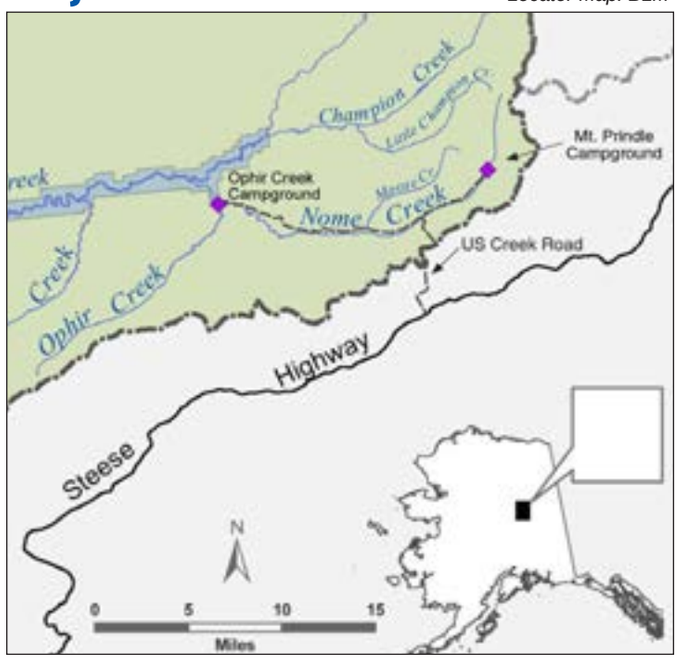
Project Location:

Locator Map: BLM



Nome creek is located within the White Mountains National Recreation Area, approximately 75 mi. Northeast of Fairbanks

The grass seeding and fertilizer application resulted in a very dense vegetative cover that was

Site Photos:

Archive Photo: BLM

Drag-line used by a placer mining operation on Nome Creek in the early part of the 20th century.

Photo: Jon Kostohrys (BLM)

The initial step in reclamation was to fill the settling ponds using the material from the surrounding tailings piles.

Photo: Jon Kostohrys (BLM)

After filling the ponds, the bulldozer then graded the floodplain as flat as possible.

Photo: Jon Kostohrys (BLM)

The bulldozer constructed the channel using short, almost level grading to deepen the pilot channel.

Photo: Jon Kostohrys (BLM)

Aerial photo of Nome Creek before reclamation

Photo: Jon Kostohrys (BLM)

Upper Nome Creek, road, and campground after reclamation

Photo: Jon Kostohrys (BLM)

The lower portion of the Nome Creek drainage is surrounded by low hills near the confluence with Beaver Creek.

Upstream portion of the reclaimed area, showing grass establishment in 1993. Most of this grass was dead or dying by 1996.

Photo: Jon Kostohrys (BLM)

Illinois Creek Mine Site Revegetation

Introduction / Objective:

Illinois Creek Mine Project was a gold/silver deposit operated by USMX, a subsidiary of USMX/ Dakota Mining. Gold production began in early 1997, although the mine operation shut down within a few months, due to financial difficulties. Operations began again later that year, but ceased again when USMX declared bankruptcy in 1998. Using the reclamation bond put up by USMX, the State of Alaska took control of the leases and the mine site in 1999.

The $1.6 million from the reclamation bond was not sufficient, and the State estimated an additional $ 1.0 million was needed. A “mine to reclaim” plan to operate the mine in order to generate funds for complete closure of the facility was implemented by the American Reclamation Group (ARG). A $3.76 million reclamation plan and estimate was submitted by ARG in 2000, detailing mining activities and reclamation tasks for each site facility.

This case study documents the reclamation actions taken at a few of the facility areas. Specific sites are listed under Methods of Revegetation, detailing the reclamation activities conducted by ARG.

Methods of Revegetation:

Central Pit:

Sections of the Central Pit were back filled with waste rock generated during mining. This allowed for shorter haul distances and minimal expansion of the waste rock dump during backfilling. Recontouring of the slopes was done by dozer and topsoil and vegetative debris was spread over the site.

Central Pit Waste Rock Dump:

Dozers were used to smooth the slopes to a 40% grade and blend various benches. Work started at the highest bench and proceeded downward to the original ground surface. Stockpiles of topsoil were dumped at the top of slopes and pushed downhill with dozers to a thickness of approximately 8 inches. Initial track-walking of slopes was done to form catchments for seed and water. This left the slopes too smooth, however, and erosion features were evident. Slope recontouring helped prevent erosion by roughening the soil surface.

The flat areas of the dumps were ripped with a Cat 12G grader. Haul trucks dumped windrows of topsoil over the site. The topsoil was then spread with dozers. Areas compacted during topsoil haulage were ripped a second time. Hand-held broadcast seeders were used to apply the seed to the slopes.

Road between Central and West Pits:

The access road between the central and west pits was ripped with a dozer. Topsoil and vegetative debris set aside during commissioning of the road was then spread back over the road, and followed with an application of seed and fertilizer.

West Pit:

Reclamation of the West Pit began by backfilling the pit with waste rock acquired from the Central Pit. Backfill material placement continued until the waste rock was significantly above the groundwater level in the West Pit. This additional backfilling also reduced the height of the remaining highwalls (unexcavated faces of exposed overburden). Highwall steepness was further reduced by utilizing a dozer to recontour the slopes.

Topsoil and vegetative debris was spread on the slopes and portions of the pit. Only those areas that received topsoil were seeded and fertilized. The portion of the pit that did not receive topsoil was expected to be colonized by native plant species, through the deposition of sediments and fines (conducive for vegetation growth) in storm events.

West Pit Waste Rock Dump:

Vegetation and topsoil was set aside and stockpiled in windrows prior to development. Waste rock was backfilled into the pit and recontoured using a dozer. The vegetative debris was spread back over the site and left in a roughened condition. Application of a seed and fertilizer mixture followed.

Species used on the site:

Central Pit:

Vegetative debris already present on the site was used for revegetation.

Central Pit Waste Rock Dump:

Vegetative debris and seed were used for revegetation. Fertilizer was applied at a rate of 500 pounds per acre using 20N-20P-20K.

Access Road between Central and West Pits:

Vegetative debris, seed and fertilizer were used to revegetate the roadbed.

West Pit:

Vegetative debris was spread across the site after the slopes were recontoured. A portion of the site received topsoil. Later, seed and fertilizer was also applied to these areas.

West Pit Waste Rock Dump:

Vegetative debris, seed and fertilizer were used to revegetate this area.

Results:

Each reclamation component associated with each of the project areas was approved by the Department of Natural Resources. Natural revegetation, enhanced natural reinvasion, and a common approach of surface preparation, seeding, and fertilizer were used to revegetate the project areas. Future monitoring will continue in order to observe revegetation performance and evaluate any erosion concerns.

Conclusions / Lessons Learned:

The most costly lesson from this project was that the reclamation bond paid to the State of Alaska was insufficient to meet the actual costs of restoring this mine site. Speaking to the Anchorage Daily News in 2005, the former director of the Division of Mining Land and Water, who had originally approved the mine and the reclamation bond, said of the $1.6 million bond: “The amount should have been twice that”.

This was the Alaska DNR’s first experience with the bankruptcy of a large mining operation. For some time, it was uncertain whether the State would be stuck with the reclamation bill. Initial attempts to lease the mine to new operators were unsuccessful; Viceroy Resources abandoned the project one year after taking it over in 1998, under an emergency lease agreement.

The reclamation effort relied upon proven methodologies, and no surprises or technical challenges were encountered. A trust fund for the continued monitoring of the Illinois creek mine was set up, receiving a $200,000 contribution from ARG.

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Project Location:

Illinois creek is located on state lands within the Kaiyuh Mountains. The site is only accessible by air, and is 23 miles east of the Yukon River and 57 miles from Galena.

The Illinois Creek site is located 23 miles east of the Yukon River.

Site Photos:

Aerial photo of Illinois Creek site - October, 2008

IC trail between old mills site and heap - October, 2008

IC trail between old mills site and heap - August, 2009

West pit waste rock dump - July, 2003

West pit waste rock dump - July, 2005

Central pit waste rock dump, before regrade - August, 2001

Recontoured slope at central pit waste rock dump - August,

Initial vegetation cover at central pit waste rock dump - July,

Revegetated central pit waste rock dump - October, 2004

Photos: American Reclamation Group

SW corner of central pit waste rock dump - August, 2002

SW corner of central pit waste rock dump - July, 2003

SW corner of central pit waste rock dump, - October, 2004

Office / shop area - September, 2005

Reclaimed office / shop area - June, 2009

Photos: American Reclamation Group

Further Information

Photo: Casey Dinkel (AK PMC)

Rolling hills covered with spruce and hardwood forest north of Fairbanks. The Trans-Alaska Pipeline is visible in the distance.

Section 5:

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Appendix A:

State of Alaska Seed Regulations

Alaska Administrative Code:

Title 11, Chapter 34

Title 11, Alaska Administrative Code,
Chapter 34: ***Plant Health and Quarantine***

Article 1:

Article 2:

Article 4:

SEED REGULATIONS: 11 AAC 34.010

ARTICLE 1

11 AAC 34.010.
Labeling

(a) Each lot or package of agricultural seed sold or offered for sale within the state must bear on it or have attached to it in a conspicuous place, a legibly written or printed label or tag, in English, providing the following information:

(1) the commonly accepted name of the kind and variety of the seed;

(2) the country or state where the seed was grown;

(3) the total percentage by weight of pure seed;

(4) the total percentage by weight of all weed seed;

(5) the total percentage by weight of inert matter;

(6) the total percentage by weight of other crop seed;

(7) the name and approximate number per pound of each kind of restricted noxious weed seed, as listed in 11 AAC 34.020;

(8) the percentage of germination of the agricultural seed, together with the month and year the seed was tested;

(9) the percentage of hard seed, if any is present;

(10) the name and address of the person labeling the seed or selling, offering, or exposing the seed for sale within the state; and

(11) the lot number or other lot identification.

(b) Each lot of mixed agricultural seed sold or offered for sale within the state must bear on it or have attached to it in a conspicuous place, a legibly written or printed label or tag, in English, providing the following information:

(1) that the seed is a mixture;

(2) the name and variety and total percentage by weight of each kind of agricultural seed present in order of predominance;

(3) the total percentage by weight of other crop seed less than five percent of the mixture; and

(4) the information listed in (a)(4), (a)(5), (a)(7), (a)(8), (a)(10), and (a)(11) of this section.

(c) Vegetable seed in a container of one-half pound or more sold or offered for sale within the state must bear on the container or have attached to the container in a conspicuous place, a legibly written or printed label or tag, in English, providing the following information:

(1) the name of the kind and the variety and total percentage by weight; and

(2) the information listed in (a)(4) - (a)(8), (a)(10), and (a)(11) of this section.

(d) Vegetable seed in a container of less than one-half pound sold or offered for sale within the state and which meets the germination standards and tolerances in 7 U.S.C. 1551 - 1611 (Federal Seed Act) must bear on the container or have attached to the container in a conspicuous place, a legibly written or printed label or tag, in English, providing the following information:

(1) the name of the kind and variety of the seed;

(2) the name and address of the person or firm labeling the seed, or selling, offering, or exposing the seed for sale within the state;

(3) the year the seed was packed; and

(4) the lot number or other identification.

(e) Vegetable seed in a container of less than one-half pound sold or offered for sale within the state and which does not meet the germination standards and tolerances in 7 U.S.C. 1551 - 1611 (Federal Seed Act) must be labeled, in English, to provide the information required by (d) of this section and the following:

(1) percentage of germination;

(2) percentage of hard seed, if applicable; and

(3) the phrase “substandard germination” in not less than eight-point type.

(f) Any agricultural or vegetable seed treated with toxic substances must be labeled to provide the information required by (a) - (e) of this section and the following:

(1) a word or statement, in type no less than eight points, that the seed has been treated;

(2) the commonly accepted coined or chemical name of the applied substances; and

(3) a caution statement and appropriate poison symbol if the applied substance presents a hazard to human or animal health.

(g) Seed packed in hermetically sealed containers must be labeled to provide the information required by (a) - (f) of this section and the following:

(1) that the container is hermetically sealed;

(2) that the seed has been preconditioned as to moisture content;

(3) that the germination test is valid for a period of not more than 24 months from the date of germination test for seed offered for sale on a wholesale basis, and for a period of not more than 36 months for seed offered for sale at retail; and

(4) that the germination of seeds at the time of packaging was equal to or above standards and tolerances prescribed in the 7 U.S.C. 1551 - 1611 (Federal Seed Act).

(h) Agricultural seeds, mixed agricultural seeds, or bulk vegetable seeds, are exempt from the provisions of this section when

(1) the seeds are grown in or sold within the state to be recleaned before being sold, exposed, or offered for sale for seeding purposes;

(2) the seeds are held for purposes of recleaning; or

(3) the seeds are held or sold for milling for food or for feeding purposes only.

(i) Tetrazolium viability test results are not considered valid germination tests for the purposes of labeling as required by this section.

(j) Hybrid seed, as defined in 7 C.F.R. 201.2(y), must be labeled in accordance with provisions of 7 C.F.R. 201.11(a).

History: In effect before 7/28/59;
am 3/2/78, Register 65;
am 10/28/83, Register 88

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.020.
Prohibited and restricted noxious weeds

(a) The following are prohibited noxious weeds:

(1) **Bindweed, field** (*Convolvulus arvensis*);
(2) **Fieldcress, Austrian** (*Rorippa austriaca*);
(3) **Galensoga** (*Galensoga parviflora*);
(4) **Hempnettle** (*Galeopsis tetrahit*);

(5) **Horsenettle** (*Solanum carolinense*);
(6) **Knapweed, Russian** (*Centaurea repens*);
(7) **Lettuce, blue-flowering** (*Lactuca puichella*);
(8) **Orange Hawkweed** (*Hieracium aurantiacum*);
(9) **Purple Loosestrife** (*Lythrum salicaria*);
(10) **Quackgrass** (Ag*ropyron repens*);
(11) **Sowthistle**, perennial (*Sonchus arvensis*);
(12) **Spurge, leafy** (*Euphorbia esula*);
(13) **Thistle, Canada** (*Cirsium arvense*);
(14) **Whitetops** and its varieties (*Cardaria drabe*, *Cardaria pubescens*, *Lepidium latifolium*).

(b) The following are restricted noxious weeds, with their maximum allowable tolerances:

(1) **Annual bluegrass** (*Poa annua*), 90 seeds per pound;
(2) **Blue burr** (*Lappula echinatat*), 18 seeds per pound;
(3) **Mustard** (*Brassica kaber, juncea*), 36 seeds per pound;
(4) **Oats wild** (*Avena fatua*), seven seeds per pound;
(5) **Plantain, buckhorn** (*Plantago sp.*), 90 seeds per pound;
(6) **Radish** (*Raphanus raphanistrum*), 27 seeds per pound;
(7) **Toadflax, yellow** (*Linaria vulgaris*), one seed per pound;
(8) **Vetch, tufted** (*Vicia cracca*), two seeds per pound;
(9) **Wild Buckwheat** (*Polygonum convovulus*), two seeds per pound.

History: In effect before 7/28/59;
am 3/2/78, Register 65;
am 10/28/83, Register 88;
am 7/28/2007, Register 183

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.030.
Weed seed as agricultural seed

The following seeds, when occurring incidentally in agricultural and vegetable seeds, are classed as weed seeds, except when sold alone or as a specific constituent of a definite seed mixture:

- Black Medic (Medicago lupulina);
- Cardoon (Cynara cardunculus);
- Dandelion (Taraxacum species);
- Lupine (Lupinus species);
- Pigweed (Amaranthus species);
- Radish (Raphanus sativus);

- Rape (Brassica campestris and napus);
- Sunflower (Helianthus annuus);
- Yarrow (Achillea millefolium); and
- Tufted Vetch (Vicia cracca).

History: In effect before 7/28/59;
am 3/2/78, Register 65;
am 10/28/83, Register 88

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.040.
Sampling procedure for purity and germination tests

(a) A sample of seed chosen by an authorized agent of the division of agriculture for the purpose of determining whether or not the seed meets the requirements of this chapter is known as an “official sample,” and must be drawn in a manner to represent as nearly as possible the entire lot from which it is taken.

(b) Official samples of seed shall be taken according to procedures which conform as nearly as practicable to those used by the United States Department of Agriculture pursuant to 7 C.F.R. 201.39 - 201.44.

History: In effect before 7/28/59;
am 3/2/78, Register 65

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.045.
Duties and authority of the director

(a) The duty of enforcing this chapter and of carrying out its provisions and requirements is vested in the director. The duties and authority of the director include the following:

(1) to sample, inspect, make analyses of, and test any agricultural or vegetable seed held, transported, sold, offered, or exposed for sale within the state for planting purposes, at the time, place, and to the extent the director finds necessary to determine whether the seed is in compliance with this chapter;

(2) to sample, inspect, make analyses of any tree, shrub, or flower seed held, transported, sold, offered, or exposed for sale within the state for planting purposes, at the time, place, and the extent as the director may find necessary to determine whether the seed is in compliance with this chapter;

(3) to issue and enforce a written stop sale order or to issue a violation notice, whichever the director determines applicable, to the possessor or owner of any lot of agricultural, vegetable, tree, shrub, or flower seed which is found to be in violation of this chapter; and

(4) to prohibit the further sale, processing, or movement of seed, except on approval of the director, until evidence is obtained that shows that the requirements of this chapter have been complied with and a release from the stop sale order has been issued for the seed.

(b) When seed is denied further sale, processing, or movement under (a)(3) and (a)(4) of this section, the owner or processor of the seed has the right to appeal to a court of competent jurisdiction in the locality in which the seeds were found in violation, asking for a judgment as to the justification of the order and for the discharge of the seed from the order prohibiting the sale, processing, or movement, in accordance with the findings of the court.

(c) The provisions of (a)(3) and (a)(4) of this section do not limit the right of the director to proceed as authorized by other sections of this chapter.

(d) For the purpose of carrying out the provisions of this chapter, the director or his authorized agents, may

(1) enter upon any public or private premises during regular business hours in order to access seeds and associated records maintained under this chapter, and any truck or other conveyer by land, water, or air at any time when the conveyer is accessible, for the same purposes; and

(2) either alone or in the presence of a representative or employee of the person whose premises are entered, examine and inspect any agricultural, vegetable, tree, shrub, or flower seed in possession, offered, or exposed for sale for planting purposes in this state, for compliance with this chapter.

(e) A sample taken under this section, and the report showing the results of the official test made on a sample, is prima facie evidence of the true condition of the entire lot from which the sample was taken.

(f) A copy of the results of any seed test from a sample taken under this section may be mailed to any person or his authorized representative, known to own, possess, or hold the seed from which the sample was taken.

History: Eff. 10/28/83, Register 88

Authority:
AS 03.05.010 , AS 03.05.030 , AS 03.05.040 , AS 03.05.050 , AS 44.37.030

11 AAC 34.050.
Germination and purity tests

Germination and purity tests of seeds must be conducted according to procedures which conform as nearly as practicable to those used by the United States Department of Agriculture pursuant to 7 C.F.R. 201.59 - 201.66.

Authority: AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.060.
Laboratory fees and schedule

(a) Germination and purity tests are performed at the Alaska Seed Testing Laboratory.

(b) State residents may submit seed samples for routine testing free of charge if the samples are limited to three per year per person and are submitted before April 15 of the year.

(c) Samples submitted by residents in excess of three per year or after April 15, or submitted by nonresidents will be charged a service fee as determined by the director.

(d) Samples submitted by residents and nonresidents for germination tests requiring tetrazolium procedures will be charged a service fee to be determined by the director according to a fee schedule based upon the difficulty of the species being tested.

History: Eff. 3/2/78, Register 65

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.070.
Code of Federal Regulations

Except where in conflict with specific provisions of this chapter, the rules, regulations and recommendations pertaining to sampling procedures and germination and purity testing procedures and standards contained in 7 C.F.R. 201.39 - 201.44 and 201.59 - 201.66 are adopted by reference and made part of this chapter. Copies of these provisions may be obtained from the U.S. Government Printing Office, Washington, D.C. 20250. Any reference in these provisions to U.S. Government officials and agencies shall be construed to refer to the corresponding officials and agencies of the State of Alaska.

History: Eff. 3/2/78, Register 65

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

Editor's note: *These regulations are adopted by reference. The official Rules and Regulations under the Federal Seed Act are published by the U.S. Department of Agriculture and are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20250*

11 AAC 34.075.
Prohibited acts

(a) No person may sell, offer for sale, expose for sale, or transport for use in planting in the state any agricultural or vegetable seed that

(1) unless exempt under 11 AAC 34.010(h) , has not been labeled as required by 11 AAC 34.010;

(2) bears a false or misleading label;

(3) contains any prohibited noxious weed seed, except as allowed in (g) of this section;

(4) contains any restricted noxious weed seed in excess of the permissible tolerance per pound established under 11 AAC 34.020(b) , except as allowed in (g) of this section; or

(5) has not been tested within the 18 months preceding the sale, offering, or exposure for sale, or transportation, not including the calendar month in which the test was completed, except for hermetically sealed containers under 11 AAC 34.010(g) (3), and except that

(A) the director will, in his discretion, allow a shorter period for kinds of seed which he finds, under ordinary conditions of handling, will not maintain a germination within the established limits of tolerance during the prescribed time period, or a longer period for kinds of seed which are packaged in a container and under conditions the director determines will, during the longer period, maintain the viability of the seed under ordinary conditions of handling;

(B) a person in possession of seed shall keep on file, available for department inspection, the original or duplicate copy of the latest test made of the seed which must show, in addition to the information required by this chapter, the date and name of the person making the test.

(b) No person may substitute uncertified seed for certified seed.

(c) No person may use tags or seals indicating certification other than as prescribed by the authorized certification agency unless the tuber, horticultural, vegetable, tree, shrub, flower, or cereal grain seed has been produced, tested, examined, and labeled in accordance with this chapter or the official certification agency of another state, territory, or country. No person may

(1) sell, offer for sale, expose for sale, advertise, or transport any tuber, plant, or seed, falsely representing it to be certified; or

(2) use in connection with a tuber, plant, or seed any tags or seals similar to those used in official certification as established by this chapter.

(d) No person may hinder or obstruct in any way, any authorized person in the performance of his duties under this chapter.

(e) No person may sell, offer, or expose for sale, plant, transport or process any seed that is under a stop sale order issued under 11 AAC 34.045(a) (3) or that is in violation of this chapter, without express approval of the director.

(f) No person may plant in this state any agricultural, vegetable, tree, shrub, or flower seed containing any prohibited noxious weeds listed in 11 AAC 34.020(a) or any restricted noxious weeds in excess of the maximum allowable tolerances listed in 11 AAC 34.020(b) , except as provided in 11 AAC 34.030, without express written approval of the director, or as provided in (g) of this section.

(g) No person may use, sell, offer, expose for sale, give away, or transport for feeding, seeding, or mulching purposes any seed or grain screenings containing any prohibited noxious weed seed listed in 11 AAC 34.020(a) or any restricted noxious weeds in excess of the maximum allowable tolerances listed in 11 AAC 34.020(b), except as provided in 11 AAC 34.030, and except that the director may

allow sale or transport of screenings for

(1) complete destruction;

(2) removal outside of the boundaries of the state;

(3) recleaning to the point of being in compliance with 11 AAC 34.020(a) and (b); or

(4) processing to make the weed seed nonviable.

(h) No person may sell, offer, or expose for sale for seeding purposes, seed containing more than one and one-half percent by weight of all weed seed.

(i) No person may sell, offer, expose for sale or transportation, or transport a container or package of seed within this state unless the container or package of seed is labeled with a net contents statement, expressed by either weight, volume, or numerical count, except for seed being transported from an owner's field to a warehouse for storage, cleaning, or processing.

(j) No person may sell, offer for sale, or represent potatoes as seed potatoes unless the potatoes have been certified by the official seed certifying agency of the state or country of origin.

History: Eff. 10/28/83, Register 88;
am 10/28/87, Register 104

Authority:
AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.077.
Weed seeds in shipment

Whenever anything brought into a part of the state from another part of the state or from any other state or foreign country is found to be infested with the seed of any prohibited noxious weed, the director will notify the owner or bailee of the shipment to return it to the point of shipment within 48 hours, and the owner or bailee of the shipment shall return it. If the director determines that the seeds can be destroyed by treatment, the shipment may, at the option and expense of the owner or bailee, be treated under the supervision of the director, and may be released after treatment.

History: Eff. 10/28/83, Register 88

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.080.
Penalties

Penalties for violation of this chapter are as provided in AS 03.05.090.

Authority: AS 03.05.010 , AS 03.05.030 , AS 03.05.090

11 AAC 34.085.
When penalties not applicable

No person may be subjected to the penalties of AS 03.05.090 for selling, offering, exposing for sale, or transporting in this state any agricultural or vegetable seed that;

(1) is incorrectly labeled or represented as to kind and variety or origin, and which cannot be identified except by a field test, when that person

(A) obtains an invoice or grower's declaration stating the kind, or kind and variety, and origin, if required;

(B) takes the invoice or grower's declaration in good faith; and

(C) takes other precautions as are reasonable to insure the identity of the seeds to be as stated;

(2) does not conform to the label on the container, but is within the tolerances authorized by the director under this chapter; or

(3) is in violation of this chapter, but is allowed sale or movement under specific written permission of the director.

History: Eff. 10/28/83, Register 88

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.090.
Records

Each person whose name appears on the label as handling agricultural or vegetable seed subject to this chapter shall keep for two years a complete record of each lot of agricultural or vegetable seed handled, and shall keep for two years a file sample of each lot of seed after final disposition of the lot. All records and samples pertaining to the shipment or shipments involved must be accessible for inspections by the director or his designated agent during customary business hours.

History: Eff. 10/28/83, Register 88

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.100.
Expense of treatments

Any treatment which may be required under the provisions of this chapter shall be at the risk and at the expense of the owner or persons in charge or in possession thereof at the time of treatment unless otherwise provided.

History: In effect before 7/28/59

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

ARTICLE 2

11 AAC 34.105.
Quarantine officers

(a) The director is an enforcing officer of all laws, rules and regulations relative to the prevention of the introduction into, or the spread within the state of pests.

(b) The director and such inspectors as he may appoint, holding valid certificates of eligibility for the office to which they have been appointed, are hereby designated State Plant Quarantine officers for the purpose of certifying to the pest condition or pest treatment of shipments, when certification as a condition of movement is officially required, and for the purpose of enforcing of laws, rules and regulations, relative to plant quarantine.

History: In effect before 7/28/59

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.110.
Pest certificate fees

The director may establish a schedule of fees for any or all classes of certificates to be paid by shippers requesting such certificates. Upon receipt of such scheduled fee, or in the event no schedule has been established, then upon request of the shipper it is the duty of the director to make such inspection as may be necessary to determine the facts required by the state or country of intended destination and to issue a certificate stating the facts determined; provided, that no fee shall be charged for certification required by any law, regulation, or requirement of the United States or of this state. The schedule of fees established for such certificates shall be based upon the approximate cost of the inspection made therefor.

History: In effect before 7/28/59

Authority:
AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.115.
Appeals from director's decision

(a) In cases relative to the prevention of the introduction into, or the dissemination within the state of pests, any interested person aggrieved by any action or order of the director may appeal in writing to the office of the director within five days after notice of action or order where there is no time limit upon such action or order, and in cases where a time limit is fixed, within such time limit. In cases where the director is empowered to, and does take summary action, no appeal may be taken.

(b) Appeals will be heard by the director within 10 days after receipt thereof upon notice to all interested parties and his decision shall be final.

History: In effect before 7/28/59

Authority:
AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.120.
Federal-state cooperation

Whenever quarantine regulations are established under this chapter, if there are any authorities or officers of the United States having authority to act in such matter, or any part thereof, the director shall notify such authorities or officers and seek their cooperation as far as possible. When any article is found to have been transported into this state from any other state, or district of the United States, in violation of the provisions of a quarantine established by the Secretary of Agriculture of the United States, such article shall be subject to seizure, destruction or other disposition to the same extent and in the same manner as if such article had originated in this state and was in violation of a provision of this chapter.

History: In effect before 7/28/59

Authority:
AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.125.
Inspection stations

To prevent the introduction into, or the spread within this state, of pests, the director may maintain at such places within this state as he deems necessary quarantine inspection stations for the purpose of inspecting all conveyances which might carry plants or other things which are or are liable to be infested or infected with pests.

History: In effect before 7/28/59

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.130.
Quarantine regulations; inspections

(a) The director may establish, maintain and enforce such quarantine regulations as he deems necessary to protect the agricultural industry of this state from pests, by establishing quarantine at the boundaries of this state or elsewhere within the state. He may make and enforce such rules and regulations as are necessary to prevent any plant or thing which is or is liable to be infested or infected by or which might act as a carrier of any pest, from passing over any quarantine line established and proclaimed pursuant to this chapter. The person conducting the inspection shall not permit any such plant or thing to pass over the quarantine line during quarantine, except upon a certificate of inspection and release signed by him.

(b) No person shall conceal from plant quarantine officers any plant or fail to present the same or any quarantined article for inspection at the request of such officer.

History: In effect before 7/28/59

Authority:
AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.135.
Form of certain regulations

All quarantine regulations involving another state, district, or foreign country will be adopted by the commissioner and will be approved and proclaimed by the governor. A proclamation will be signed in duplicate. The original proclamation will be filed in the office of the lieutenant governor and a copy in the office of the director before it takes effect.

History: In effect before 7/28/59; am 10/28/83, Register 88

Authority:
AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.140.
New pests

Upon information received by the director of the existence of any pest not generally distributed within this state he shall thoroughly investigate the existence and probability of the spread thereof. He may also establish, maintain and enforce quarantine and such other regulations as are in his opinion necessary to circumscribe and exterminate or prevent the spread of such pest. The director may disinfect, or take such other action with reference to, any plants or things infested or infected with, or which in his opinion may have been exposed to infection or infestation by, any such pest, as in his discretion shall seem necessary.

History: In effect before 7/28/59

Authority:
AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.145.
Permits for pest shipment

No pest, live insect or disease may be imported into or shipped or transported within the state except for the purpose of identification, unless such shipment or transportation is authorized under written permit and the regulations of the director or the United States Department of Agriculture. Any unauthorized shipment shall be returned to the point or origin, shipped out of the state, or destroyed within 48 hours at the expense of the owner or bailee.

History: In effect before 7/28/59

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.150.
Notification of quarantined articles

Any person who transports, receives or imports into the state any things, or any plants against which quarantine has been established and who fails immediately after the arrival thereof to notify the director of their arrival, and to hold them for immediate inspection by the director, without unnecessarily moving them, or placing them where they may be harmful, is in violation of this section.

History: In effect before 7/28/59

Authority: AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.155.
Release from inspection

The director may designate certain plants arriving from certain areas not for planting, propagation or ornamental purposes within this State which may be released without inspection, if he finds upon investigation that such plants from such areas are not liable to cause the introduction of pests into the state.

History: In effect before 7/28/59

Authority: AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.160.
Right to inspect

The officer making the inspection may enter at any time into any conveyance or place within the state where the said plants or things are located, to ascertain whether they are or are liable to be infested or infected with any pest.

History: In effect before 7/28/59

Authority: AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.165.
Labeling and certificates

Each shipment of plants, brought into this state, shall have legibly marked thereon in a conspicuous manner and place the name and address of the shipper or owner, the name of the person to whom the same is forwarded or shipped, or his agents, the name of the country or state where the contents were grown, and a statement of the contents therein. Also each shipment of plants, grown in a country or state which maintains inspection of plants, shall be accompanied by a copy of a current inspection certificate from such country or state.

History: In effect before 7/28/59

Authority: AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.170.
Destruction or treatment of pests

When any shipment of plants brought into this state is found infested or infected or there is reasonable cause to presume that it may be so infested or infected with any pest, the shipment shall be immediately destroyed by, or under the such pest may be exterminated by treatment or processing prescribed by the director, and it is determined by the inspecting officer that the nature of the pest is such that no damage can be caused to agriculture in this state through such treatment or processing, or procedure incidental thereto. In such case, the shipment may be so treated or processed at the expense of the owner or bailee in the manner, and within the time specified by the inspecting officer, under his supervision, and if so treated or processed, upon determination by the enforcing officer that the pest has been exterminated, the shipment may be released.

History: In effect before 7/28/59

Authority: AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.180.
Treatment of appliances

(a) To prevent the dissemination of pests through the agency of appliances, the director will, in his discretion, publish a list of pests that can be carried that way and designating the appropriate treatment for appliances.

(b) No person may ship or move any used appliances unless he furnishes to the director proof satisfactory to the director that the appliances have not been exposed to infestation or infection by any pests, or that the appliances have been treated immediately before shipment or movement in the manner designated by the director.

History: In effect before 7/28/59;
am 10/28/83, Register 88

Authority: AS 03.05.010, AS 03.05.030, AS 44.37.030

ARTICLE 4 (Definitions)

11 AAC 34.400.
Definitions

The terms used in this chapter are construed to conform insofar as possible with the terms used in the Federal Seed Act (7 U.S.C. 1551 et seq.) and the regulations issued under that Act. Unless the context indicates otherwise, in this chapter

(1) "*advertisement*" means representation other than on labels, disseminated in any manner or by any means relating to seed within the scope of these regulations;

(2) "*agricultural seeds*" means the seeds of all domesticated grasses and cereals, and of all legumes and other plants grown as turf, cover crops, forage crops, fiber crops or field crops and mixtures of the seeds;

(3) "*appliance*" means box, tray, container, ladder, tent, vehicle, implement, or any other article which is or may be used in connection with the planting, growing, harvesting, handling, or transportation of an agricultural commodity;

(4) "*bailee*" means a person who, by warehouse receipt, bill of lading, or other document of title, acknowledges possession of goods and contracts to deliver them;

(5) "*certified*," as applied to bulblets, tuber, or horticultural plants or to agricultural, vegetable, tree, shrub, flower, or cereal grain seed, means inspected and labeled by and in accordance with the standards and rules and regulations of the official certification agency or in accordance with similar standards established by a similar authority in another state, country, or territory;

(6) "*certified seed potatoes*" means potatoes used for planting a crop, that have been officially certified as "foundation seed" or "certified seed" by an authorized inspector, in a manner approved by the director, or, in the case of seed imported into the state, meets the certification standards of the Association of Official Seed Certifying Agencies;

(7) "*commercial production*" means products not grown exclusively for use or consumption by the producer;

(8) "*director*" means the director of the division of agriculture, Department of Natural Resources, or the director's authorized agent;

(9) "*flower seed*" includes seed of herbaceous plants grown for their blooms, ornamental foliage, or other ornamental parts which is commonly sold under the name of flower seed in the state;

(10) "*labeling*" means all labels and other written, printed, or graphic representations in any form whatsoever, whether attached to, or accompanying and pertaining to any seed, whether in bulk or in containers and includes invoices;

(11) "*lot*" means a definite quantity of seed identified by a lot number or other mark, every portion of which is uniform within the recognized tolerances for the factors which appear in the labeling;

(12) "*mixed agricultural seeds*" means any lot of seeds that contains five percent or more by weight of each of two or more kinds of agricultural seeds;

(13) "*noxious weed*" means any species of plants, either annual, biennial, or perennial, reproduced by seed, root, underground stem, or bulblet, which when established is or may become destructive and difficult to control by ordinary means of cultivation or other farm practices; or seed of such weeds that is considered commercially inseparable from agricultural or vegetable seed;

(14) "*nursery stock*" means any plant for planting, propagation or ornamental use;

(15) "*other crop seed*" means that part of a lot or sample of seed that consists of the seed of cereal grain and agricultural and vegetable seeds other than those

named on the label;

(16) "*packer*" means the person or firm putting the seed into its final container in preparation for sale as seed;

(17) "*person*" means a individual, partnership, corporation, company, society, association, or cooperative;

(18) "*pest*" means a form of animal life, plant life, or infectious, transmissible, or contagious disease of plants, that is or is liable to be dangerous or detrimental to the agricultural industry of the state;

(19) "*plant*" means a whole or part of a plant, tree, shrub, vine, fruit, vegetable, seed, bulb, stolon, tuber, corm, pip, cutting, scion, bud, graft, or fruit pip, and includes an article made from a plant;

(20) "*pure seed*," "*germination*," and other seed labeling and testing terms in common use are defined as the terms are defined in the Rules for Seed Testing (Volume 6, #2, 1981) published by the Association of Official Seed Analysts, Stone Printing Company, Lansing, Michigan, and in the Federal Seed Act (7 U.S.C. 1551 et seq.) and the regulations promulgated under it (7 C.F.R. 201 et seq.);

(21) "*restricted noxious weed seed*" means the seed of weeds which are very objectionable in fields, lawns, and gardens of this state, but which can be controlled by good cultural practices;

(22) "*shipment*" means an article or thing, which may be, is being, or has been transported from one place to another place;

(23) "*tree and shrub seed*" means seed of woody plants commonly known and sold as tree and shrub seeds in this state;

(24) "*vegetable seeds*" means the seeds of all crops which are being grown or which may be grown in gardens, privately or commercially, and which are generally known and sold under the name of vegetable seeds; and

(25) "*weed seed*" means a restricted noxious weed seed and any seed not included in the definition of agricultural seed when it occurs incidentally in agricultural or vegetable seeds.

History:
In effect before 7/28/59;
am 3/2/78, Register 65;
am 10/28/83, Register 88

Authority: AS 03.05.010, AS 03.05.030, AS 44.37.030

Appendix B:

Partner Agencies

Seldom does a revegetation or restoration project occur in a vacuum. The following list includes state and federal agencies that may need to be consulted. Academic and private organizations are also listed.

Alaska Department of Fish & Game

http://adfg.alaska.gov/

The Mission of the Alaska Department of Fish & Game (ADF&G) is to protect, maintain, and improve the fish, game, and aquatic plant resources of the state, and manage their use and development in the best interest of the economy and the well-being of Alaskans.

Department of Natural Resources

http://dnr.alaska.gov/

The Department of Natural Resources (DNR) has a mission to develop, conserve, and enhance Alaska's natural resources for the benefit of all Alaskans. DNR manages all state-owned land, water and natural resources, except for fish and game, on behalf of the people of Alaska.

Division of Agriculture

http://dnr.alaska.gov/ag/

The Division of Agriculture works with local producers to promote and support Alaska's agricultural industry through financing for farmers and processors, plant material development, conservation education, marketing assistance, inspection and farm product certification. The Division of Agriculture houses the Alaska Plant Materials Center.

Division of Mining, Land, and Water

http://dnr.alaska.gov/mlw/

The Division of Mining, Land, and Water (DMLW) is the primary manager of the State of Alaska's land holdings. DMLW's responsibilities include preparing land-use plans and easement atlases; classifying, leasing and permitting state land for recreation, commercial and industrial uses, as well as coordinating and overseeing water rights.

State Pipeline Coordinator's Office

http://dnr.alaska.gov/commis/pco/

The State Pipeline Coordinator's Office (SPCO) is an agency of the Alaska Department of Natural Resources which provides general information and summarizes specific state oversight activities for pipeline construction, operation, and maintenance. SPCO oversees environmental studies, revegetation monitoring and erosion control activities occurring along pipelines.

Department of Environmental Conservation

http://dec.alaska.gov/

The Department of Environmental Conservation (DEC) has the mission of conserving, improving and protecting Alaska's natural resources and environment to enhance the health, safety, economic and social well being of Alaskans. The DEC houses the divisions of Air Quality, Environmental Health, Water, and Spill Prevention and Response.

Alaska Industrial Development and Export Authority

http://aidea.org

The Mission of the Alaska Industrial Development Authority (AIDEA) is to "promote, develop and advance economic growth and diversification in Alaska by providing various means of financing and investment". This agency is frequently involved in large projects such as mines and supporting infrastructure.

US Army Corps of Engineers, Alaska District

http://www.poa.usace.army.mil/

The US Army Corps of Engineers, Alaska District provides a full spectrum of quality engineering, technical, and construction support services in support of peacetime and contingency operations in Alaska and throughout the Pacific Region. Major programs focus on military construction, civil works and environmental cleanup.

National Climatic Data Center

http://www.ncdc.noaa.gov/oa/ncdc.html

The National Climate Data Center (NCDC) develops both national and global data sets used by both government and the private sector to maximize the resource provided by our climate and minimize the risks of climate variability and weather extremes. The Center has a statutory mission to describe the climate of the United States and the NCDC keeps track of trends and anomalies of weather and climate. The NCDC maintains the world's largest archive of climate data.

National Oceanic and Atmospheric Administration

http://www.noaa.gov/

The National Oceanic and Atmospheric Administration (NOAA) has responsibilities that include daily weather forecasts, severe storm warnings and climate monitoring.

NMFS Habitat Restoration Center

http://alaskafisheries.noaa.gov/habitat/restoration.htm

The NOAA Fisheries (NMFS) Restoration Center restores coastal habitats and provides technical restoration expertise on restoration planning, implementation and monitoring, as well as financial assistance through various grant programs. Since 1996, the NMFS Restoration Center has supported nearly 70 community restoration projects in Alaska, benefiting more than 560 acres of estuarine and riparian habitat.

Natural Resource Conservation Service

http://www.nrcs.usda.gov/

The Natural Resource Conservation Service (NRCS) is a program of the U.S. Department of Agriculture(USDA). NRCS works with landowners through conservation planning and assistance designed to benefit the soil, water, air, plants, and animals that result in productive lands and healthy ecosystems. NRCS works at the local level, maintaining field offices at 12 locations across Alaska. To find the closest service center for your region, refer to the map at: http://www.ak.nrcs.usda.gov/technical/fo.html. The Natural Resource Conservation Service provided the funding to produce this publication.

NRCS Soils Website

http://soils.usda.gov/

This NRCS soils website is part of the National Cooperative Soil Survey, an effort of Federal and State agencies, universities, and professional societies to deliver science-based soil information.

US Forest Service

http://www.fs.fed.us/

The U.S. Forest Service (USFS) is an agency of the U.S. Department of Agriculture. The Forest Service manages public lands in national forests and grasslands. Alaska has two National Forests managed by the USFS; the Chugach, in Southcentral Alaska, and the Tongass, in Southeast Alaska. These forests total nearly 22 million acres, including over 7 million acres of wetlands.

US Fish & Wildlife Service

http://fws.gov/

The U.S. Fish and Wildlife Service works to conserve, protect, and enhance fish, wildlife, plants, and their habitats. The USFWS is the only agency in the federal government whose primary responsibility is management of these important natural resources for the American public. USFWS is responsible for implementing and enforcing some important environmental laws, such as the Endangered Species Act, Migratory Bird Treaty Act, & Marine Mammal Protection.

US Bureau of Land Management

http://blm.gov/

In Alaska, the Bureau of Land Management administers approximately 75 million surface acres of federal public land - an area larger than the State of New Mexico. The Bureau has an active program of soil and watershed management on 86 million acres in Alaska. BLM encourages practices such as revegetation, protective fencing, and water development that are designed to conserve and enhance public land, including soil and watershed resources.

Western Regional Climate Center

http://www.wrcc.dri.edu/

The Western Regional Climate Center (WRCC) consolidates delivery of climate services at national, regional and state levels, working with the National Climatic Data Center, National Weather Service, the American Association of State Climatologists, and NOAA Research Institutes.

Alaska State Climate Center

http://climate.uaa.alaska.edu/

The Alaska State Climate Center, an effort of the University of Alaska, provides climatological information and official weather data to the public. The climate center library contains a wide variety of publications of climatologically interest.

Alaska Climate Research Center

http://climate.gi.alaska.edu/

The Alaska Climate Research Center is a research and service organization at the Geophysical Institute, University of Alaska Fairbanks. The group conducts research focusing on Alaska and polar regions climatology and maintains an archive of climatological data for Alaska.

Alaska Association of Conservation Districts

http://www.alaskaconservationdistricts.org/

Alaska Association of Conservation Districts' (AACD) mission is to actively support 12 statewide Soil and Water Conservation Districts, while providing other services such as education programs, information, meetings and conferences.

The Interior Alaska Revegetation & Erosion Control Guide was released by the Alaska Plant Materials Center, a part of the Department of Natural Resources, Division of Agriculture. This publication is intended for use by the general public and environmental professionals in the protection of Interior Alaska. It was produced at a cost of $25.98 per copy, and printed in Anchorage, Alaska. This publication is also available online, at http://plants.alaska.gov/reveg/.

Black Spruce trees in Interior Alaska often lean to one side due to permafrost conditions.

Back Cover: Nootka Reedgrass, *Calamagrostis nutkaensis* with winter frost