16. Erosion and Sediment Control

16.1. Erosion and Sediment Control Policies

Erosion and sedimentation are natural processes whereby soil materials are detached and transported from one location and deposited in another, primarily due to rainfall and runoff. Accelerated erosion and sedimentation can occur in conjunction with highway and transportation facility construction. This accelerated process can result in significant detrimental impacts such as safety hazards, expensive maintenance problems, unsightly conditions, instability of slopes, water quality problems, and disruption of ecosystems. For this reason, the designer must consider minimization of erosion and sedimentation throughout the design process.

16.1.1 Federal Policy

As a result of the 1972 amendments to the Federal Water Pollution Control Act (known as the Clean Water Act or CWA), much attention has been directed to the control of erosion and sedimentation. As a result, numerous state and federal regulations and controls governing earth-disturbing activities have been developed and published. Federal policy for erosion and sediment control for all construction projects that are funded at least in part under Title 23, U.S. Code is set forth in 23CFR650 Subpart B, which states that all such construction projects shall:

> "… be located, designed, constructed and operated according to standards that will minimize erosion and sediment damage to the highway and adjacent properties, and abate pollution of surface and ground water resources."

Within this Subpart, the Federal Highway Administration (FHWA) adopts the American Association of State Highway and Transportation Officials (AASHTO) Highway Drainage Guidelines, Volume III, Erosion and Sediment Control in Highway Construction, 1992. Other federal control requirements include:

- River and Harbor Act, Sections 9 and 10
- Coastal Zone Act Reauthorization Amendments of 1990, Section 6217(g)
- Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, 84-B-92-002, U.S. EPA, January, 1993
- Issuance of the Storm Water General Permit for Large and Small Construction Activities, EPA, 2003

16.1.2 AASHTO Policy

The policy for erosion and sediment control is stated in the AASHTO publication, "A Policy on Geometric Design of Rural Highways," as follows:

> "Erosion prevention is one of the major factors in the design, construction and maintenance of highways. Erosion can be controlled to a considerable degree by geometric design particularly relating to the cross section. In some respects the Erosion and Sediment Control Policies control is directly associated with proper provision for drainage and fitting landscape development. Effect on erosion should be considered in the location and design stages."
>
> "Erosion and maintenance are minimized largely by the use of flat side slopes, rounded and blended with natural terrain; drainage channels designed with due regard to width, depth, slopes, alignment and protective treatment; located and spaced facilities for ground water interception; dikes, berms and other protective devices; and protective ground covers and planting."

Although some standardization of methods for minimizing soil erosion in highway construction is possible, national guidelines for the control of erosion are of a general nature because of the wide variation in climate, topography, geology, soils, vegetation, water resources, and land use encountered in different parts of the country.

16.1.3 State Policy

In order to comply with federal policies, the Alaska Department of Transportation and Public Facilities (DOT&PF) has adopted the AASHTO Guidelines discussed above.

For all projects with disturbed earth, the Contractor must develop a Storm Water Pollution Prevention Plan (SWPPP) and the Project Engineer must approve it. However, the designer must provide sufficient information and guidance through the contract documents to ensure a well-conceived, economically justified SWPPP. This guidance, termed the Erosion and Sediment Control Plan (ESCP), is preferably provided as a stand-alone document inserted into the advertised contract documents. The ESCP may be incorporated into the plan sheets for small-scale projects. The level of effort required to develop an ESCP and implement a SWPPP will be commensurate with the complexity of the project's earth-disturbing activities and the potential detrimental impacts to receiving waters. Sections 16.5 and 16.6 discuss specific requirements for ESCPs and SWPPPs.

ESCPs may be prepared by a qualified person(s) (i.e. design engineer, regional hydraulic engineer, environmental analyst or consultant), but the ESCP plan sheets must be stamped by an Alaska-registered Professional Engineer. Regional Hydraulic Engineers should review all ESCPs for adequacy.

16.1.4 Program

All permanent erosion and sediment control measures will be included in the project's items of work and presented as individual bid items, where reasonable. The ESCP will specifically address temporary measures that will also serve as permanent measures.

Since highway construction may involve the disturbance of large land areas, control of erosion and sedimentation is a major concern. A commitment to erosion and sediment prevention and control is essential during all phases of highway design, construction, and maintenance. While much of the effort for control of erosion and sedimentation is expended during the construction phase of a highway development, a successful ESC program must address erosion and sedimentation during the planning, location, design, and future maintenance phases as well. The erosion and sediment control program should be a plan of actions and should include contract documents to achieve an acceptable level of control within established criteria and control limits.

This plan of action is analogous to an agency's highway development process, which results in contract plans and documents to provide and maintain transportation facilities based on certain criteria and controls. Before the Department develops a project's ESCP, the Department's project development process will include and account for the following:

- During the environmental scoping process, the project environmental analyst will identify sediment sensitive receiving areas. These areas are Waters of the United States, including wetlands, as defined by the 1987 Edition, Federal Manual for Identifying Jurisdictional Wetlands. The plans and/or specifications will identify the sediment sensitive receiving areas. Generally, these areas will be represented on the plan sheets.
- The design engineer will use highway geometrics to minimize soil erosion and sedimentation problems where practicable and feasible when setting final alignment.
- The hydrology and hydraulics report will characterize the drainage issues for the project.
- The geotechnical report will characterize the erodibility of soils anticipated to be exposed or imported for construction materials.

16.1.5 Guidelines

The design of erosion and sediment control systems involves the application of common sense planning, scheduling, and control actions that will minimize the adverse impacts of soil erosion, transport, and deposition. The following basic guidelines govern the development and implementation of a sound erosion and sediment control plan.

- Plan the project to take advantage of the topography, soils, waterways, and natural vegetation.
- Expose the smallest practical area for the shortest possible time.
- Apply on-site erosion control measures to reduce the erosion from the site.
- Use sediment control measures to prevent off-site detrimental impacts whenever primary on-site erosion control measures are insufficient.
- Implement a thorough maintenance and follow-up program.

16.1.6 Control Measures

In practice, these guidelines should be tied together in the design process, which identifies potential erosion and sediment control problems before construction begins. Control measures such as stabilizing emulsions and vegetation are required for all disturbed areas. Vegetation measures generally include retention or provision of strips of vegetation to provide a filtration buffer, temporary seeding, permanent seeding, sodding, and mulching. Structural control measures are required when potentially damaging sediment laden runoff leaves a disturbed site, and they generally include sediment traps, diversions, sediment basins, and permanent drainage facilities. Erosion and sediment control measures are commonly termed "Best Management Practices" (BMPs) in a variety of texts and publications.

16.2. Factors Influencing Erosion

The inherent erosion potential of any area is determined by four principal factors: soil characteristics; vegetative cover; topography, and climate. Although each of these factors is discussed separately herein, they are interrelated in determining erosion potential.

16.2.1 Soil Characteristics

The properties of soil that influence erosion by rainfall and runoff are those affecting the infiltration capacity of a soil and those affecting the resistance of a soil to detachment and being carried away by falling or flowing water. Soils containing high percentages of fine sands and silt are normally the most erodible. As the clay and organic matter content of these soils increases, the erodibility decreases. Clays act as a binder to soil particles, thus reducing erodibility. However, while clays have a tendency to resist erosion, once eroded they are easily transported by water. Soils high in organic matter have a more stable structure, which improves their permeability. Such soils resist raindrop detachment and infiltrate more rainwater. Clear, well-drained and well-graded gravels and gravel-sand mixtures are usually the least erodible soils. Soils with high infiltration rates and permeabilities reduce the amount of runoff.

16.2.2 Vegetative Cover

Vegetative cover plays an important role in controlling erosion in the following ways:

- shields the soil surface from raindrop impact
- holds soil particles in place
- maintains the soil's capacity to absorb water
- slows the velocity of runoff
- removes subsurface water between rainfalls through the process of evapotranspiration

By limiting and staging the removal of existing vegetation, and by decreasing the area and duration of exposure, soil erosion and sedimentation can be significantly reduced. Special consideration should be given to the maintenance of existing vegetative cover on areas of high erosion potential, such as erodible soils, steep slopes, drainage ways, permafrost areas, and stream banks.

16.2.3 Topography

The size, shape, and slope characteristics of a watershed influence the amount and rate of runoff. As both slope length and gradient increase, the rate of runoff increases and the potential for erosion is magnified. Slope orientation can also be a factor in determining erosion potential.

16.2.4 Climate

The frequency, intensity, and duration of rainfall are fundamental factors used for estimating the amounts of runoff produced in a given area. As both the volume and velocity of runoff increase, the capacity of runoff to detach and transport soil particles also increases. Where storms are frequent, intense, or of long duration, erosion risks are high. Seasonal changes in temperature, as well as variations in rainfall, help to define the high erosion risk period of the year. When precipitation falls as snow, no erosion will take place. However, in the spring the melting snow adds to the runoff, and erosion hazards are high. Because the ground is still partially frozen, its absorptive capacity is reduced. Frozen soils are relatively erosion-resistant. However, soils with high moisture content are subject to uplift by freezing action and are usually very easily eroded upon thawing. Extreme erosion potential can occur when the vegetative mat is removed in permafrost areas.

16.3. Technical Principles

For an erosion and sediment control program to be effective, the designer must consider it and provide for appropriate measures during the project environmental and design stages. These planned measures, when conscientiously and expeditiously applied during construction as part of the Contractor's Storm Water Pollution Prevention Plan (SWPPP), will result in orderly development with minimal environmental degradation. From the previous discussion about erosion and sedimentation processes and the factors affecting erosion, basic technical principles can be formulated to assist the designer in providing for effective control of erosion and sediment. The hierarchy of principles employed in order of preference are: avoidance, minimization, and lastly, active measures. Use the following principles to the maximum extent possible on all projects.

16.3.1 Avoidance

Plan the highway project to fit the particular topography, soils, drainage patterns, and natural vegetation as much as practicable. Map all surface waters, natural drainage ways, and direction of drainage patterns. Identify and avoid areas with steep slopes, erodible soils, and soils with severe limitations when possible.

16.3.2 Minimization

Minimize the extent and the duration of exposure. Plan the phases or stages of construction to minimize exposure. Complete grading as soon as possible after it is begun. Establish permanent vegetative cover immediately after grading is complete.

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16.3.3 Active Measures

Erosion Control

Apply erosion control practices (BMPs) to prevent excessive on-site damage. This third principle relates to using practices that control erosion on a site to prevent excessive sediment from being produced. Keep soil covered as much as possible with temporary or permanent vegetation or with various mulch or mat materials. You may use special grading methods such as roughening a slope on the contour or tracking with a cleated dozer. Other practices include diversion structures to divert surface runoff from exposed soils and grade stabilization structures to control surface water. "Gross" erosion such as gullies must be prevented by these water control devices.

Sedimentation Control

Apply perimeter control practices (BMPs) to protect the disturbed area from off-site runoff and to prevent sedimentation damage to areas below the construction site. This principle relates to using practices that effectively isolate the construction site from surrounding properties, and especially to controlling sediment once it is produced and preventing its transport from the site. Diversions, dikes, sediment traps, and vegetative and structural sediment control measures are classified as either temporary or permanent, depending on whether or not they will remain in use after construction is complete.

Generally, you can retain sediment by two methods: (a) filtering runoff as it flows through an area and (b) impounding the sediment-laden runoff for a period of time so that the soil particles settle out. The best way to control sediment, however, is to prevent erosion.

Velocity Control

Keep runoff velocities low and detain runoff on the site. The removal of existing vegetative cover and the resulting decrease in retention time during construction will increase both the volume and velocity of runoff. Take these increases into account when providing for erosion control. Keeping slope lengths short and gradients low and preserving natural vegetative cover can keep storm water velocities low and limit erosion hazards. You should safely convey runoff from developed areas to a stable outlet using storm drains, diversion structures/techniques, stable waterways, or similar measures. Design conveyance systems to withstand the velocities of projected peak discharges, and make these facilities operational as soon as possible.

Stabilization

Stabilize disturbed areas immediately after final grade has been attained. Employ permanent structures, temporary or permanent vegetation, mulch, stabilizing emulsions, or a combination of these measures, as quickly as possible after the land is disturbed. Temporary vegetation and mulches and other control materials can be most effective when it is not practical to establish permanent vegetation or until the vegetation is established. Use such temporary measures immediately after rough grading is completed, if you anticipate a delay in obtaining finished grade. In the design, consider the stability and ease of maintenance for the finished slope of a cut or fill. Stabilize roadways, parking areas, and paved areas with a gravel sub-base whenever possible.

Maintenance

Implement a thorough maintenance and follow-up program. Maintenance is vital to the success of active measures. A construction site cannot be effectively controlled without thorough, periodic checks of the erosion and sediment control practices. Just as with construction equipment, you must maintain control practices and check and inventory material. Provide detailed requirements for the maintenance and follow-up program in the contract specifications.

Usually, avoidance, minimization, and active measures are integrated into a system of vegetative and structural measures coupled with management techniques to develop a plan to prevent erosion and control sediment. In most cases, a combination of limited time of exposure and a judicious selection of erosion control practices and sediment trapping facilities will prove to be the most practical method of controlling erosion and the associated production and transport of sediment.

16.4. Guidance for Controlling Erosion

Using the principles of avoidance, minimization and finally, active measures, consider the following guidance as minimum requirements for controlling erosion and sedimentation from earth-disturbing activities. These general criteria work in concert with individually developed erosion and sediment control plans.

Stabilization

The following refers to stabilization of denuded areas and soil stockpiles.

Apply permanent or temporary soil stabilization to denuded areas as soon as possible, but always within 15 days after final grade is reached on any portion of the site. Apply soil stabilization within 15 days to denuded areas that may not be at final grade but will remain dormant (undisturbed) for longer than 45 days.

- Soil stabilization refers to measures that protect soil from the erosive forces of raindrop impact and flowing water. Wind may also become a factor in soil stabilization. Applicable practices include the use of temporary erosion control material, vegetative establishment, mulching, and the early application of a gravel base on areas to be paved. Select soil stabilization measures that are appropriate for the time of year, site conditions, and estimated duration of use.
- Stabilize or protect erodible soil stockpiles with sediment trapping measures to prevent soil loss. If stockpiles are small, you may cover them with tarps, etc.

Perimeter Controls

You should protect properties and receiving waters adjacent to the site of a land disturbance from sediment deposition. Protective measures include (1) preserving a well-vegetated buffer strip around the lower perimeter of the land disturbance (2) installing perimeter controls such as sediment barriers, filters, dikes, or sediment basins, or (3) a combination of such measures.

Timing and Stabilization

Construct sediment basins and traps, perimeter dikes, sediment barriers, and other measures intended to trap sediment on-site as a first step in grading, and make them functional before upslope land disturbance takes place. Seed and mulch earthen structures such as dams, dikes, and diversions within 15 days of installation.

Sediment Basins

Storm water runoff from drainage areas with more than 5 acres disturbed area should pass through a sediment basin or other suitable sediment trapping facility. Sediment basins are more cost effective when most of the area draining to the basin is disturbed area, since their size must be based on total contributing area. Appropriately sized and stabilized conveyance channels will normally be required to funnel runoff to the basins.

Cut and Fill Slopes

Design and construct cut and fill slopes to minimize erosion. Consider the length and steepness of the slope, the soil type, upslope drainage area, groundwater conditions, and other applicable factors. The following guidelines will aid site designers and plan reviewers in developing an adequate design.

- Roughened soil surfaces are generally preferred to smooth surfaces on slopes.
- Construct diversions at the top of long steep slopes that have significant drainage areas above the slope. You may also use diversions or terraces to reduce slope length.
- Do not allow concentrated storm water to flow down cut or fill slopes unless contained

within an adequate temporary or permanent channel, flume, or slope drain structure.

- Wherever a slope face crosses a water seepage plane that endangers the stability of the slope, provide adequate subsurface drainage or other protection. A geotechnical investigation should provide recommendations to the designers for this situation.

Waterways and Outlets

Design and construct all on-site temporary storm water conveyance channels to withstand the expected velocity of flow from a 2-year frequency storm with minimum erosion. Design permanent measures for a 10-year frequency storm. Provide erosion control measures such as energy dissipaters at the outlets of all pipes and paved channels.

Inlet Protection

Protect all storm drain inlets made operable during construction, so that sediment-laden water will not enter the conveyance system without first being filtered or otherwise treated to remove sediment.

Crossing Watercourses

Keep construction vehicles out of watercourses as much as possible. Where in-channel work is necessary, stabilize the work area during construction to minimize erosion. Always restabilize the channel (including bed and banks) immediately after in-channel work is completed. Where an active (wet) watercourse must be crossed by construction vehicles regularly during construction, provide a temporary stream crossing. You may need environmental permits for in-water work.

Disposition of Measures

Dispose of all temporary erosion and sediment control measures within a specified time after final site stabilization or after the temporary measures are no longer needed. To prevent further erosion and sedimentation, permanently stabilize trapped sediment and other disturbed soil areas resulting from the disposition of temporary measures.

Maintenance

Maintain and repair all temporary and permanent erosion and sediment control practices as needed to assure continued performance of their intended function.

16.5. Erosion and Sediment Control Plan

16.5.1 Definition and Overview

Simply stated, an Erosion and Sediment Control Plan (ESCP) is a document that illustrates measures to control erosion and sediment problems on a project. The plan consists of maps and/or site plans. Written descriptions or narratives may be provided when needed to clarify the ESCP. DOT&PF prepares the plan, including standards and specifications, and includes it as part of the contract documents. The ESCP provides bidders a basis for cost estimating, and it ultimately provides the awarded Contractor information and guidance for developing an acceptable Storm Water Pollution Prevention Plan (SWPPP).

The ESCP provides a practicable plan, while giving the Contractor enough latitude to develop a sequence of operations based on season, site conditions, personnel, and equipment. For example: a simple overlay project may require only a short description in the specifications; the ESCP for a project with a small amount of disturbance could completely specify all measures; while an ESCP for a project with a complex sequence of earth-disturbing activities may have to be limited to locating preliminary control measures and measures at final grade, leaving the interim measures to be developed in the Contractor's SWPPP. It is important, however, for the ESCP to provide the Contractor with sufficient information such as appropriate control measures, problem areas, areas identified in permits, timing limitations, and specifications.

An ESCP narrative describes the erosion and sediment control plan and identifies the assumptions and the reasoning for particular recommendations or requirements. The narrative is important to the Project Engineer, inspectors, and Contractors responsible for implementing an approved SWPPP.

The length and complexity of the plan should be commensurate with the size of the project, the severity of site conditions, the erosion and sedimentation risks, and the potential for off-site damage.

16.5.2 Plan Development Procedures

Step 1 - Data Collection and Preliminary Analysis

The highway construction plans can serve as the base map for the ESCP. If available, obtain a soils map from the local office of the USDA Natural Resource Conservation Service. The designer responsible for

the plan should inspect the site to verify natural drainage patterns, drainage areas, general soil characteristics, and off-site factors. It is important that this review occur at the beginning of the design phase to avoid loss of time and resources on developing impractical alternatives.

The base data should consider such characteristics as:

- receiving waters (Waters of the U.S.)
- land slopes
- natural drainage patterns
- unstable stream reaches
- flood marks
- watershed areas
- existing vegetation (noting special vegetative associations)
- critical areas such as steep slopes, eroding areas, rock outcroppings, and seepage zones
- property and unique or noteworthy landscape values to protect or avoid
- adjacent land uses - especially areas sensitive to sedimentation or flooding
- critical or highly erodible soils that should be left undisturbed

In the analysis of these data, identify:

- right-of-way requirements
- buffer zones
- areas of steep natural and man-made slopes
- stream crossing areas
- access routes for construction and maintenance of sedimentation control devices
- state-provided borrow and waste disposal areas
- the most practical sites for control practices
- potential for sediment pollution of adjacent water courses and properties

When all of the data are considered together, a picture of the site potentials and limitations should begin to emerge. The designer should be able to determine those areas that have potentially critical erosion hazards. Appendix C describes soil erodibility by type and slope.

Step 2 - Design of Erosion And Sediment Control Plan

We recommend the following general procedure for erosion and sediment control design.

1. Determine limits of clearing and grading. Pay special attention to critical areas that must be disturbed and areas where vegetation can be left intact.

2. Divide the site into drainage areas. Determine how runoff will travel over the site during construction. Consider how erosion and sedimentation can be controlled in each small drainage area before looking at the entire site. Remember, it is easier to control erosion than to contend with sediment after it has been carried downstream.

3. Select erosion and sediment control practices (BMPs). These practices are divided into 3 broad categories: erosion prevention, sedimentation control, and management measures. Management measures are construction management techniques that, if properly utilized, can minimize the need for physical controls and possibly reduce costs.

a. Erosion Prevention Measures - The first line of defense is to prevent erosion by protecting the soil surface from raindrop impact and overland flow of runoff. The best way to protect the soil surface is to preserve the existing ground cover. Where land disturbance is necessary, use temporary seeding, mulching, or other erosion control measures on areas that will be exposed for long periods of time. Temporary seeding may be impractical in certain Alaskan climatic regions.

   Erosion and sediment control plans should contain provisions for permanent stabilization of disturbed areas. Consider the following when selecting permanent vegetation:

   - availability and practicality of native species
   - establishment requirements
   - adaptability to site conditions
   - aesthetics
   - maintenance requirements

b. Sedimentation Controls - Structural practices are used mainly to control eroded material. They are generally more costly and less efficient than erosion control measures.

However, they are usually necessary, since not all disturbed areas can be completely protected. They are often used as a second or third line of defense to capture sediment before it leaves the site. It is very important that structural practices be selected, designed, and installed according to the contract standards and specifications. Improper use or inadequate installation can create problems that are greater than the structure was designed to solve.

Structural controls also include the permanent drainage facilities. The Contractor must construct these as early as possible.

c. Management Measures - Good construction management is as important as physical practices for erosion and sediment control, and there is generally little or no cost involved. Discuss pertinent issues within the ESCP. The Contractor should specifically address these issues in the Storm Water Pollution Prevention Plan. Management considerations include:

- Sequence construction so that no area remains exposed for unnecessarily long periods of time (e.g. 15 days).
- Notify the seeding Contractor in advance to avoid delays in seeding once slopes are prepared.
- Where practicable, perform temporary seeding immediately after grading.
- On large projects, stage the construction, if possible, so that one area can be stabilized before another is disturbed.
- Develop and carry out a regular maintenance schedule for erosion and sediment control practices.
- Make sure that key workers understand the major provisions of the erosion and sediment control plan.
- Designate responsibility for implementing the erosion and sediment control plan to one individual.

Step 3 - Prepare the Plan

The final step consists of consolidating the pertinent information and developing it into a specific erosion and sediment control plan for the project, using maps and plan sheets. As discussed in Section 16.5.1, you may supplement the plan with a narrative if necessary to verbally explain specific problems and their solutions.

For complex projects, you may need to key individual plan sheets to a master plan sheet to show the general erosion and sediment control requirements for the entire project.

Include in the ESCP, as far as practicable, the items listed in Sections 16.6.3 and 16.6.4. Those items we consider to be a minimum for the ESCP are denoted by an (*).

Step 4 – Have the Plan Reviewed by the Regional Hydraulics engineer.

16.6. Storm Water Pollution Prevention Plan

16.6.1 Description

The Storm Water Pollution Prevention Plan (SWPPP) is the detailed site-specific plan prepared by the Contractor for the temporary and permanent control of erosion and sedimentation during project construction. The SWPPP is based upon the ESCP, and when approved, replaces the ESCP. If the project disturbs more than 1 acre of ground, the SWPPP is prepared according to the requirements of the National Pollutant Discharge Elimination System Storm Water General Permit for Large and Small Construction Activities. Specific direction for the development of the SWPPP is given in DOT&PF's "Storm Water Pollution Prevention Plan Guide" (SWPPP Guide)

16.6.2 SWPPP

The Contractor must prepare the SWPPP, which must address all earth-disturbing activities designated by the contract, including off-site support activities. The Department will review the Contractor's draft SWPPP and either approve it or recommend changes. The Contractor will make the necessary revisions to obtain the Department's approval. The approved SWPPP must be signed by the Contractor and the Department in accordance with the NPDES General Permit. The approved SWPPP is not intended to be a rigid document. It must be amended as necessary to address unanticipated or emergency conditions to maintain water quality.

DOT&PF's "Storm Water Pollution Prevention Plan Guide" (SWPPP Guide) and the NPDES Storm Water General Permit for Large and Small Construction Activities give detailed descriptions of the required contents of the SWPPP. The SWPPP must follow the format presented below and address all storm water discharge control and management issues identified in the ESCP. The SWPPP shall include the following:

16.6.3 Site Description

The site description should contain the following information:

- Description of the nature and extent of the construction activity (*).
- Description of the intended sequence of major earth-disturbing activities, such as grubbing, excavation, grading, or utility installation.
- Estimates (to the nearest quarter acre) of the total area of the project site (including related off-site areas such as borrow pits, waste areas, etc.) and the total area that is expected to be disturbed (*).
- Name and description of the storm water discharge receiving waters (*). These areas are Waters of the United States including wetlands as defined by the 1987 Edition, Federal Manual for Identifying Jurisdictional Wetlands. This also includes the extent and description of wetlands or special aquatic sites at or near the project site that will be disturbed or receive storm water discharge from disturbed areas of the site.
- A general location map and a site map showing the following:
  a. drainage patterns (* projects > 1 acres)
  b. approximate slopes after grading (*projects > 1 acres)
  c. areas of soil disturbance and undisturbed areas (*)
  d. location of major structural and nonstructural controls identified in the SWPPP (*) (Note: Contractor may modify the Department's proposed controls).
  e. location of areas where stabilization is expected to occur (*). (Note: ESCP may identify such areas, but locations are often dependent on the Contractor's methodology.)
  e. location of surface waters (including wetlands and all waters that will pass through the project site), and locations where storm water is discharged to a surface water (*)
  f. location of any impaired waters or waters with approved and final Total Maximum Daily Loads (TMDLs) for Alaska (*).
  g. location of all off-site material, waste, borrow or equipment storage areas. (Note: ESCP will identify state-designated material sites and disposal sites.)
- Location and description of any discharge associated with industrial activity other than construction, and location of storm water discharges from dedicated asphalt or concrete plants covered by this permit.
- If disturbed area is greater than 1 acre, include a copy of the NPDES General Permit requirements as an appendix to the SWPPP.
- If disturbed area is greater than 1 acre, information on whether listed threatened or endangered species, or their critical habitat, are found in proximity to the project (*) and off-site support areas, and whether such species or habitat may be affected by pollutants in storm water discharges or related activities. (Note: Contractor is responsible for their off-site material and disposal areas).
- If disturbed area is greater than 1 acre, information on historic sites, including (1) whether any sites listed on the National Register of Historic Places may be affected by storm water discharges, and (2) whether any agreement is in place with the state historic preservation officer (*). (Note: Contractor is responsible for their off-site material and disposal areas).

(*): minimum information to be contained in ESCP

In addition, include a copy of the signed and certified Notice of Intent (NOI) form that was submitted to

EPA. Upon receipt, include a copy of the electronic mail message or letter from EPA Storm Water Notice Processing Center notifying the applicant of receipt of the administratively completed NOI.

16.6.4 Control Measures

The SWPPP must include a description of appropriate control measures to be implemented as part of the construction activities to control pollutants in storm water discharges.

The SWPPP must clearly describe, for each major earth-disturbing activity described above, the appropriate control measures and the general timing (or sequence) during the construction process that the measures will be implemented, and who (Contractor or Subcontractor) will be responsible for implementation. The description and implementation of the controls shall address the following minimum components:

1. Erosion Control Practices
   A plan view or description of interim and permanent measures such as the preservation of vegetative cover, temporary and permanent vegetation establishment, mulching, geotextiles, etc. shall be included.

   The following records shall be maintained and attached to the SWPPP or be accessible in the Project Engineer's office:

   a. dates when major grading activities occur
   b. dates when construction activities cease on a portion of the site, either temporarily or permanently
   c. dates when stabilization measures are initiated

2. Structural Practices
   A plan view or description of structural practices to divert flows from exposed soils, store flows, or otherwise limit runoff and discharges shall be included. Examples of structural practices include silt fences, earth dikes, drainage swales, sediment traps, check dams, subsurface drains, and temporary or permanent sediment basins.

3. Storm Water Management
   A section shall include a description of measures that will be installed during construction to control sediment and pollutants in storm water discharges that will occur after construction operations. Examples include storm water detention structures (wet ponds), storm water retention structures, flow attenuation, on-site filtration, and sequential systems. Permanent measures such as these will also be included in the Department's ESCP.

4. Other Controls
   This section shall address measures to be used to minimize dust and off-site vehicle tracking of sediments; a description of any on-site material storage and measures to be used to minimize exposure of the materials to storm water; measures to be used for spill prevention and response; and a description of pollutant sources from areas other than construction and a description of controls. The SWPPP shall also include a description of measures necessary to protect listed endangered or threatened species or critical habitat.

16.6.5 Maintenance

All erosion and sediment control measures and other protective measures identified in the SWPPP must be maintained in effective operating condition. If the required inspections described in the following item identify a measure that is not operating effectively, maintenance shall be performed before the next anticipated runoff event, or as necessary to maintain continued effectiveness of the storm water controls. If maintenance prior to the next runoff event is impractical, maintenance must be scheduled as soon as practicable.

16.6.6 Inspections

Qualified personnel must inspect the following:

1. disturbed areas of the construction site that have not been finally stabilized
2. areas used for storage of erodible material exposed to precipitation and/or runoff
3. erosion prevention measures
4. structural control measures
5. locations where vehicles enter or exit the site

Inspections should occur at least once every 7 calendar days and within 24 hours of the end of a storm that produces 0.5 in or more rainfall over a 24-hour period. Based on the results of the inspection, the Contractor must modify the SWPPP as necessary to include additional or modified measures to correct identified problems. The Contractor must complete

the revisions within 7 calendar days following the inspections. If modifications are made to existing measures, the Contractor must implement the modification within 7 days of the inspection.

During winter shutdown, the Contractor must conduct inspections at least once every month and within 24 hours of the end of a storm that produces 0.5 in or more rainfall over a 24-hour period. The Contractor is eligible for a waiver of the monthly inspection requirements until one month before thawing conditions are expected to result in a discharge, if all of the following requirements are met:

- earth-disturbing activities have been suspended
- the project is located in an area where frozen conditions are anticipated to continue for extended periods of time (i.e. more than one month)
- the Contractor documents the beginning and end dates of the waiver period in the SWPPP

Contract specifications or special provisions may have different inspection requirements, depending on site-specific conditions.

16.7. Control Measures and Practices

16.7.1 Introduction

Appendix A is a discussion of the more commonly used erosion and sediment control practices (BMPs), where we have:

- outlined objectives and applications for each practice
- described use considerations, common failures, alternate measures, and relationship with other erosion and sediment control practices
- described design, materials, installation, inspection, maintenance, and removal

The measures are by no means all-inclusive. Variations are based on site-specific conditions, and there are other practices we didn't specifically discuss. The references cited at the end of this chapter give more detailed discussions of erosion control measures. Table 16.1 lists a matrix of uses for selected practices, and suggested symbology for plans.

The success of erosion and sediment control at construction sites depends on the Contractor's design, construction, and maintenance of individual measures with regard to the site, to other measures, and to construction methods. Section 16.8 discusses revegetation, either temporary or permanent, which is integral to the process.

16.8. Revegetation

Why revegetate an area? The reasons vary, and in this section we address some of the commonly accepted ones.

16.8.1 Vegetative Erosion Control

Vegetative erosion control is based on the assumption that soil can be kept in place with a vegetative cover. The reasons to keep soil in place include:

- protection of engineered grades
- reduction of maintenance on buildings, structures, and other man-made objects
- maintenance of surface water quality
- visual enhancement

Temporary vs. Permanent Seedings

Temporary seedings are intended, as the name implies, to provide immediate erosion protection until a permanent vegetation cover can be established. When seeding is used, annual ryegrass is the ideal material. However, the resulting vegetative mat formed may interfere with the establishment of permanent seedings if the site is not suitably prepared for the permanent seedings. An alternative to seeding could be loose mulch such as straw.

Use permanent seedings on final grades. The species used tend to be long-lived and suitable for erosion control. At times, a portion of the mix may be composed of annual ryegrass or some other annual species. In this case, the annual species provides quick temporary cover on the site and in some regard assists the permanent species in becoming established. When practical, permanent seedings should be chosen over temporary seedings.

Special Revegetation Techniques

Special or alternative techniques for revegetation use materials other than seed to provide a vegetative cover. Usually, these techniques rely on vegetative (cuttings and sprigs) or transplanting procedures. These alternatives should be carefully assessed prior to implementation. Costs can be considerably higher than seeding. However, in certain circumstances, these

alternatives will provide the best results. This section will only cover seeding with grasses.

Streambank Revegetation

This process is a specialized form of erosion control and revegetation. Often the technique is prescribed as a condition for protection of sensitive stream areas. When this technique is called for, refer to the publication Streambank Revegetation and Protection: A Guide For Alaska (1998) by G. A. Muhlberg and N. J. Moore. This guide is very well prepared and gives instruction on the proper method of installing the various treatments and orders of protection. See Chapter 17 of this manual for additional details.

Coastal Areas

Coastal areas also present special problems in erosion control. These areas are often subject to high winds. The potential erosion problems associated with wind are often aggravated by sandy soils that are easily transported. The ideal species to use in these areas is Beach Wildrye. Again, a specific guide has been developed to address the use of this species: Beach Wildrye Planting Guide for Alaska (1994) by S. J. Wright.

Interior Alaska South Facing Slopes

The south facing road cuts and fill slopes pose special problems in the Interior of Alaska. These sites tend to be very warm and dry. Much of the recent revegetation research has centered on selection of plant material suitable for these sites. Native wheatgrass species colonize these sites naturally. It is logical that if wheatgrass seed is applied during the revegetation process, it will establish on similar sites. Wainwright Slender Wheatgrass is a selection commercially available for use on this type of area. The species has been incorporated into seed mixes for the Interior.

An additional point to consider on south facing slopes is that seed/soil contact is critical in these situations. Drill seeding or incorporated broadcast seeding may give better seed/soil contact and moisture conservation than hydroseeding. It might be advisable to consider seed application methods used when dealing with dry south facing slopes.

Natural Revegetation

With time, most disturbed sites will revegetate. However, very few landowners and managers find this revegetation approach acceptable. Surface preparation techniques and fertilization can hasten the invasion of native plants, but the process can take many years.

Native Species

Revegetation with native species is strongly encouraged. Federal agencies are directed or strongly encouraged to use native species by various Executive and Administrative Orders. These orders do not, as yet, specify germplasm source; however, species collected near a disturbance tend to be more biologically suited for revegetating the site.

The need to select more native species for revegetation in Alaska provided the incentive for the state to fund the seed collection program. This section will be updated when new native species become available. Also, in 2000, the Alaska Plant Materials Center published a revised Native Plant Directory.

Revegetation with native species provides the following advantages:

- They are better adapted and appear more natural than introduced species.
- Introduced species have the potential to escape into the natural environment. This problem has not yet become a grower's problem in Alaska. Some introduced species have, however, become well established; clovers are a good example, as is Reed Canarygrass in southeast, Interior, and southwest Alaska.

The use of introduced species for lawns and playing fields is acceptable.

Availability will, for the near term, be the primary obstacle in using native species. In-state production is increasing and market consistency is required to assure future availability. The Department of Transportation and Public Facilities (DOT&PF) is a critical component in the development of the native seed industry. While mandates to use native species may originate in other agencies, DOT&PF is often the primary agency faced with the issue of using native species. Much has been done in the past decade to make these materials available. Their performance is superior to introduced material, but prices may be higher. Most of the price issue is related to the simple laws of supply and demand. Eventually, prices will stabilize and then decline. Section 16.8.3 gives a list of potential commercially available native species. As these materials become available commercially or for demonstration projects, the Alaska Plant Materials Center, (907) 745-4469, will advise the end users,

including DOT&PF.

Species to Avoid

In most areas of Alaska, avoid clovers because they have been known to invade native plant communities and attract large mammals (deer, moose, bear). This is especially true in remote areas.

Landscape and Wildflower Plantings

Landscape plantings are included in this section simply as an advisory note. This form of revegetation includes all plantings around buildings and special emphasis areas where aesthetics are the primary concern. These plantings usually require a maintenance program and intensive management. They are not exactly erosion control projects but at times do contribute to a degree of erosion protection. The species used tend to be less hardy and often require supplemental waterings, fertilization and mowing for survival and the desired appearance. These mixes are important but not in the context of this section. Landscape plantings require very specific local knowledge based on specific site conditions and the designer's concept of the final product. They are not addressed in this section. Nugget Kentucky Bluegrass and Arctared Red Fescue are often used in grass mixes intended for this purpose. In some areas, the large expanses of highly palatable, manicured lawns attract geese and other unwanted pests. It is best to rely on local knowledge with regard to landscape plantings, including lawns, shrubs, and trees. It is not worth the trouble to recommend designs for these situations unless the designer is fully aware of all of the local problems and conditions. Wildflower research is progressing. In a few years, mixes or selections will be incorporated into the seed selection charts. For the time being, if you want wildflowers, limit selections to lupine, yarrow, and whatever is commercially available.

16.8.2 Basic Steps of Revegetation

Operations

As the first step in any revegetation project, determine the timing and sequence of operations. This planning is critical, since the designer is working with biological processes that have specific timing and environmental requirements.

In addition to identifying the type and purpose of revegetation, carefully consider logistics. After the project contract is awarded, the Contractor should purchase seed and plant materials to ensure that the revegetation portion of the project can be completed while equipment and personnel are available.

Make contractors aware that cultivars could be difficult to obtain. If questions arise, the Contractor should contact local suppliers regarding availability or contact the State of Alaska, Department of Natural Resources, Plant Materials Center at (907) 745-4469.

Site Preparation

Site preparation methods are fairly standard for all forms of revegetation. An adequately prepared site will have these characteristics:

- Free of construction debris.
- Relatively few large rocks or other natural objects.
- Free of ruts or gullies.
- Top two inches should be in a friable condition (non-compacted), ideally allowing a heel to make a ¼-inch impression.
- Heavily compacted sites should be scarified to a depth of 6 to 8 inches.

Methods of Preparation

Availability of soil preparation equipment is often limited, but the Contractor can often use standard construction machinery. For example, ripper teeth on a grader tool bar will adequately prepare a site. Ideally, scarification will be done in two passes perpendicular to each other. However, on sloping land and in areas of high wind, use mono-directional scarification perpendicular to the direction of slope or prevailing wind. Appendix A to this chapter illustrates a number of methods. 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 used to apply seed, surface preparation as described in this section may not be necessary.

Seed Specifications

Quality seed is a critical component to success. The ideal method to assure quality is to specify "certified" seed. Certified seed must meet certain standards for germination and purity, and certification provides some assurance of genetic quality.

Some native seed species are not available as certified seed; however, you may ascertain seed quality by examining percent germination and percent purity, which is required information for any seed sold in

Alaska.

Determine the true cost of seed by multiplying percent germination by the percent purity, which equals Pure Live Seed (PLS). Then multiply PLS by the price per pound. These calculations can increase the accuracy of bid comparisons. All seed sold or used in the state of Alaska must also be free of noxious weeds, which is noted on seed tags along with germination and purity. The seed mixes presented in this section have been carefully developed and are based on results from trials throughout the state. Give careful consideration before deviating from the recommendations. If problems occur or questions arise regarding seed, call the Alaska Plant Materials Center. Seed stored on site should be kept cool, dry, and in rodent-free areas.

Certified Seed

The term Certified Seed causes confusion, as it is used to describe two different issues.

The first and proper use of the term "C"ertified Seed (with a capital "C") is seed that has been grown under the rules of the Seed Certification Program. This is a program that denotes pedigree of the named cultivar; i.e., 'Arctared Red Fescue.'

The term cultivar is analagous to a model. For example, with pickup trucks, one might view Ford, Dodge or Chevy as "species." Within these species, you can select cultivars, or "models," such as F-250 or W-350. Each model (cultivar) has special or unique abilities over the other model.

Certified seed is much like the pedigree of a registered dog: it simply states that the seed is from a defined source. Also, Certified seed must have been produced under the rules of the Certification agency. Certified Seed is the usual commercial category of seed. Its ancestry can be traced back to Registered Class or Foundation Class and Breeder Seed. In addition, the Certified Seed must meet variable standards of purity and germination. These standards are marketing tools and means of verifying authenticity of a seed source. 'Arctared' Red Fescue, along with all Alaska varieties or cultivars, can be sold as Certified or common.

Seed can also be "c"ertified (lower case "c") free of weeds and as having minimum germination. This has nothing to do with pedigree protection or variety identification. It simply gives the quality of the seed. In other words, the buyer knows quality but has no assurance of type (other than species).

If possible, you should use Certified (with a capital C) seed, but it is sometimes unavailable. Seed produced in Alaska is easy to trace to origin. Therefore, if Alaska-produced seed is used, the chances are that seed is from its stated origin. It may be common (uncertified) Arctared, but it is still Arctared. Minimum purities and germination should be stated with orders. Common seed is a usable product and will be necessary to meet demands. Common seed should meet "C"ertified germination and purity standards. But these, too, may need to be relaxed if the job is to get done. Lower germination rates can be overcome by increasing seeding rates. You should carefully consider using lower purity seed, however, as weeds can be very problematic.

Other Certification Classes

Many new native seed sources are being developed in Alaska. They, for the most part, will not be sold as "C"ertified Seed. They may carry the designations: Source Identified, Tested, or Selected. These classes will usually be in keeping with the "C"ertification system, but the term "C"ertified Seed will not apply. On the other hand, certification of germination and purity will still apply.

16.8.3 Cultivars & Species for Use in Alaska

The following listing of adapted, commercially available species and cultivars represents what is available in Alaska. None pose a sight distance problem. All will be less than 24 inches high. Appendix B presents tables for the selection of species and cultivars by region within Alaska.

a. 'Arctared' Red Fescue, *Festuca rubra*, was released in 1965 as a revegetation species showing extreme hardiness throughout Alaska (Hodgson, 1978). The overly aggressive, sod-forming nature of this species often makes this cultivar unacceptable in reclamation. However, in erosion control the cultivar is outstanding. Also, the aggressive nature of this sod forming species may be a way of preventing the invasion of native shrub species such as alder and willow. The University of Alaska Agricultural Experiment Station and the USDA cooperatively developed the cultivar.

b. 'Boreal' Red Fescue, *Festuca rubra*, was developed by the Canadian Department of Agriculture Research Station, Beaverlodge, Alberta (USDA 1972). This very hardy cultivar is similar to Arctared in adaptation and potential use in Alaska. It is often substituted

for Arctared and is less expensive.

c. 'Pennlawn' Red Fescue, *Festuca rubra*, was released in 1954 by the Pennsylvania Agricultural Experiment Station (USDA 1972). The cultivar is not as hardy as Arctared or Boreal, but still has potential in milder areas of Alaska. This cultivar was selected for turf uses, and therefore, tends to be used for landscaping more than for revegetation.

d. 'Egan' American Sloughgrass, *Beckmannia syzigachne*, was released by the Alaska Plant Materials Center in 1990 as a wetland rehabilitation cultivar (Wright, 1991a). This is the state's first cultivar developed solely for wetland restoration. Additionally, the species has wildlife benefits by providing forage and seed for waterfowl (Wright 1992).

e. 'Alyeska' Polargrass, *Arctagrostis latifolia*, is a cultivar developed by the University of Alaska Agricultural Experiment Station. The prime purpose for this cultivar is revegetation in interior and western Alaska (Mitchell, 1979). The species is adapted to moderately wet areas (Wright 1992).

f. 'Kenai' Polargrass, *Arctagrostis latifolia*, is a variety recommended for forage and revegetation in the central interior and southern portions of Alaska (Mitchell, 1987). This species has potential for revegetating wet areas. This cultivar was developed by the Alaska Agriculture and Forestry Experiment Station at Palmer, Alaska.

g. 'Sourdough' Bluejoint, *Calamagrostis canadensis*, is a cultivar with a wide range of adaptability. The species occurs throughout Alaska on both dry and wet sites. The cultivar was developed by the University of Alaska Agricultural Experiment Station for revegetation in northern latitudes (Mitchell, 1979). Commercial availability is erratic, and when it is available, the seed is expensive (Wright 1992).

h. 'Norcoast' Bering Hairgrass, *Deschampsia beringensis*, was released in 1981 by the University of Alaska Agricultural Experiment Station as a forage and revegetation grass in northern areas. Norcoast is recommended for revegetation use in coastal regions of western Alaska to southwestern Alaska and possibly in the northern maritime regions (Mitchell, 1985).

i. 'Nortran' Tufted Hairgrass was also released by the University of Alaska Agricultural Experiment Station. Intended use is similar to Norcoast; however, this cultivar is better adapted to northern regions of Alaska (Mitchell, 1985).

j. 'Tundra' Glaucous Bluegrass, *Poa glauca*, was originally collected in Arctic Alaska. The cultivar was released by the University of Alaska Agricultural Experiment Station for revegetation in extreme northern areas with severe environmental conditions (Mitchell, 1979).

k. 'Caiggluk' Tilesy Sagebrush, *Artemisia tilesii*, was developed and released by the Alaska Plant Materials Center in 1989 as a reclamation species. This forb has a wide range of adaptations throughout Alaska (Wright, 1992).

l. 'Gruening' Alpine Bluegrass, *Poa alpina*, was released by the Alaska Plant Materials Center in 1986. The species is widely adapted throughout Alaska. As the name implies, the species is adapted to high elevation areas. It also performs well on sites drier than those tolerated by Kentucky bluegrass. Seed availability is limited. Before this cultivar is included in a planting plan, you should research the availability of the seed.

m. 'Nugget' Kentucky Bluegrass, *Poa pratensis*, was released and developed by the University of Alaska Experiment Station in 1966. The source of this cultivar was a single plant collection made in 1957 at Hope, Alaska. Nugget has outstanding winter survival (USDA 1972), and is used extensively in Alaska for turf and lawns.

n. 'Park' Kentucky Bluegrass, *Poa pratensis*, was developed by the Minnesota Agricultural Experiment Station in 1957 (USDA 1972). Hardiness of this cultivar is not as good as Nugget in extreme northern areas of Alaska. However, it is still used in volume in Alaska. Like Nugget, its use tends to be limited to landscape and lawns.

o. 'Merion' Kentucky Bluegrass, *Poa pratensis*, was released in 1947 by the USDA Plant Service Research Division, ARS and the U.S. Golf Association Green Section. The cultivar is more adapted to close mowing than any other Kentucky bluegrass (USDA 1972). Merion is often used in lawn mixes in Alaska.

p. 'Reeve' Beach Wildrye, *Elymus arenarius* (*Leymus arenarius*), is a 1991 release of the Alaska Plant Materials Center. The cultivar has high potential in coastal restoration, especially in the fore dune and other sandy sites throughout coastal Alaska (Wright 1991a).

q. 'Benson' Beach Wildrye, *Elymus mollis* (*Leymus mollis*), is a cultivar of native species released by the Alaska Plant Materials Center in 1991 (Wright 1991b). Unlike Reeve, Benson is available only from vegetative cuttings (sprigs). Seed will not be available. Benson was selected for use in sandy areas of high erosion potential. Revegetation with sprigs is a preferred method of revegetating at highly erosive areas.

r. Annual & Perennial Ryegrass. There are no cultivars called for in these species since long-term survival is not critical and may not be desirable. These species provide a quick, temporary cover and should be limited to 10% or less of a seed mix. These species use nutrients that are intended for the perennial species included in the mixes and can produce a heavy plant cover, which can slow the growth of the perennial species. Annual and perennial rye grass are also very attractive to herbivores, which may cause vehicle/animal conflicts.

16.8.4 Fertilizer & Other Soil Amendments

Fertilizer

In all forms of revegetation, applications of fertilizer at the time of seeding are necessary. Most commercial fertilizers meet minimum standards, and quality problems are seldom encountered. If problems arise with fertilizers, they can usually be traced to the product becoming wet during storage or shipment.

If possible, you should apply fertilizer at the same time or prior to seeding, because once the seed has been applied, you should allow no additional traffic on the site.

Generally, we recommend a 20-20-10 fertilizer unless specific site conditions require different proportions. The numbers are percentages of three elements: nitrogen, phosphorus, and potassium, respectively. Therefore, 20-20-10 fertilizer contains 20% nitrogen, 20% phosphorus, and 10% potassium by weight.

Lime & Other Amendments to Adjust pH

Using adapted or native species will not require the use of lime or agents to acidify the soils. In testing throughout the state, amendments have never been needed to establish effective stands of vegetation, provided adapted or native species are used. The species and varieties called for in this manual will survive and produce effective stands without amendments.

Lawns, playing fields, and other high maintenance areas may require lime if extremely lush growth is required. These areas will only benefit from such application if pH is lower than 5.0.

Topsoil

Gravelly sites tend not to be highly erodible, and if some fines are present, can grow adapted species without topsoil. The addition of a layer of topsoil on the gravel surface could increase the erosion potential. The top layer of soil in undisturbed areas often is very thin and expensive 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. This, however, on its own does not warrant the use of topsoil. Often, imported topsoil is a very peaty material, and although it may look dark and rich, it does not provide a suitable growing medium. Restrict topsoil use to high maintenance lawn areas and other non-erosion control landscape and visual enhancement projects.

16.8.5 Equipment Needs (Specialized)

Normally, the Contractor supplies the equipment for a revegetation project. This section on equipment will give the designer the advantages and drawbacks of each.

Broadcast Seeders

Broadcast seeders are usually the least expensive and require less training and support equipment. Broadcast type equipment can usually be used for both seed and fertilizer.

Drop Spreaders

Drop application methods rely on gravity feed, are simple in design, and are easy to use. Two problems can occur with this method: stripes can appear if the drop

pattern is not overlapped; and the equipment will corrode if it is not thoroughly cleaned after applying fertilizer. Avoid stripes in lawn areas by setting the spreader at 1/2 the recommended application rate and running two tracks perpendicular to each other over the site. Drop spreaders tend to be more precise than broadcast seeders.

Drill Seeders

Drill seeders most often are used in agricultural settings. Only one drill seeder, the Brillion, has been used for revegetation of mine and construction sites. This seeder has been used on most soil types except very gravelly soils. Fertilizer cannot be applied with this seeder; however, the unit incorporates the seed into the soil, packs the seed in place, and provides accurate application rates. This allows the seeding rate to be reduced by 50 percent.

Hydroseeding

In recent years, hydroseeding has been portrayed as the most effective means for revegetating an area. However, many professionals are finding that this claim is overstated. Hydroseeders are well suited for seeding steep slopes and rocky areas; and they apply mulch, seed, and fertilizer in one step. The primary disadvantage is the requirement for large quantities of water, which at times can result in numerous trips across the land that is being revegetated. The equipment is complex, and mechanical problems can result in delays. Hydroseeder manufacturers have claimed that hydroseeding promotes more vigorous plant growth; however, that claim has not proven to be true. Grass growth can be inhibited if too much mulch is applied.

Hydroseeders come in truck-mounted and trailer form. Major Contractors either have a hydroseeder or can easily subcontract for one. Hydroseeders are often used as supplemental watering trucks once seed has been applied. Additional watering is not always necessary to produce a good stand of vegetation; and it does cost more. Without additional watering, the seed will wait until there is sufficient moisture to germinate.

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

16.8.6 Mulch & Erosion Matting

Mulches and erosion matting are only appropriate or necessary if erosion potential is significant. Erosive forces can be either wind or water. However, when hydroseeders are used, mulch is standard. The mulch fiber forms a slurry that acts as a carrier for the seed and fertilizer. Without the mulch, seed and fertilizer would not suspend in solution, and uniform distribution would be impossible. The mulch also marks the area that has been sprayed.

When deciding on the use of a mulch such as straw or an erosion matting, consider several factors, erosion potential being the first. If the soil does not have a high erosion potential, then mulch and/or matting should be skipped. Secondly, consider the cost. Application of mulch and matting adds significant costs to a project, not only in materials, but also in labor. Next, consider safety. The concern with some netting is the potential of sections coming loose and causing a hazard. Finally, remember that straw may introduce unwanted noxious weeds.

The above concerns do not apply to wood and paper fiber or similar products used in hydroseeders.

Table 16-1
Erosion and Sediment Control Measures and Suggested Drawing Symbols

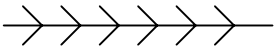
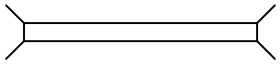
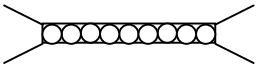
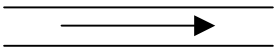
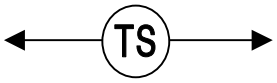
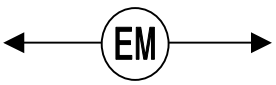
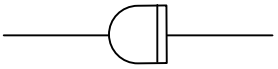
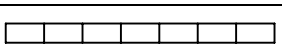
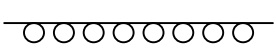
Erosion & Sediment Control Measures	Structural Measures		Stabilization (Erosion Control)	Temporary/ Permanent	Symbol
	Velocity Control	Sediment Control			
Interception/ Diversion Ditch	X			T, P	
Slope Drain	X			T	
Rock Flume	X			T, P	
Outlet Protection	X			T, P	
Storm water Conveyance Channel	X			T, P	
Rock Check Dam	X			T, P	
Mulching			X	T	
Temporary Seeding			X	T	
Surface Roughening and Terracing			X	T	
Rolled Erosion Control Products			X	T, P	
Temporary Sediment Trap		X		T	
Vegetative Buffer Strip		X		T, P	
Silt Fence		X		T	
Inlet Protection		X		T	
Straw Bale Barrier		X		T	
Brush Barrier		X		T	
Vehicle Tracking Entrance/Exit		X		T	

Table 16-2
Species/Cultivar Characteristic Chart

Species	Cultivar	Percent Germination	Purity	Avaiability[1]	Site Conditions Adaptation	Growth Form[2]	Height Ave[2]
Red Fescue	Arctared	80	98	Very Good	Dry to Wet	Sod	18 in.
	Boreal	80	98	Excellent	Dry to Wet	Sod	18 in.
	Pennlawn	80	98	Excellent	Dry to Wet	Sod	12 in.
American Sloughgrass	Egan	75	90	Good	Wet	Bunch	18 in.
Bering Hairgrass	Norcoast	75	95	Excellent	Dry to Wet	Bunch	20 in.
Tufted Hairgrass	Nortran	75	95	1993 Poor	Dry to Wet	Bunch	20 in.
Polargrass	Alyeska	75	95	Fair	Wetter Areas	Sod	24 in.
	Kenai	75	95	Fair	Wetter Areas	Sod	24 in.
Bluejoint	Sourdough	75	95	Poor	All	Sod	36 in.
Tilesy Sagebrush	Caiggluk	75	95	Poor	All	Bunch	20 in.
Glaucous Bluegrass	Tundra	80	95	Fair	North of Alaska Range, Dry	Bunch	9 in.
Alpine Bluegrass	Gruening	80	90	Fair	Dry	Bunch	6 in.
Kentucky Bluegrass	Nugget	80	95	Excellent	Lawns	Sod	9 in.
	Park	80	95	Excellent	Lawns	Sod	9 in.
	Merion	80	95	Excellent	Lawns	Sod	9 in.
Beach Wildrye	Benson	-	-	Poor	Sandy, Dry	Sod	24 in.
	Reeve	30	95	Poor	Sandy, Dry	Sod	24 in.
Annual Ryegrass	-	80	95	Excellent	Dry, Limit Use	Temp	
Perennial Ryegrass	-	80	95	Excellent	Dry, Limit Use	Temp	

1. Availability varies from year to year and within a given year.
2. Growth form and height will vary with conditions. Typical DOT&PF sites will tend to produce shorter and bunchier stands of these species.

Table 16-3
Characteristics of Various Spreading Equipment*

Type	Advantages	Disadvantages
Hand-held Spinner Type Spreader	• Inexpensive • Simple to use & repair • Can apply both fertilizer & seed • No special training needed	• Slow • High labor use • Skip & overlap possible • Seed may need to be incorporated into the soil following application
Mechanical Spinner Type Spreaders	• Fast • Can apply both seed & fertilizer • Relatively low-cost equipment	• Skip & overlap possible • Seed may need to be incorporated into the soil following application
Drop Type Spreaders	• Fast • Simple • Can be used to apply both fertilizer & seed	• Skip & overlap a serious problem if care is not taken • Hard to calibrate • Equipment needs high degree of care
Drill Type Seeders**	• Seed incorporation not needed as a separate step • Precise application • Skip not a problem • Uses only half the seed	• Does not apply fertilizer • Equipment more costly • Needs higher degree of seedbed preparations
Hydroseeders	• Degree of slope not a problem • Skip not a problem • Can apply both seed & fertilizer	• Equipment costly and complex • Needs water source

* The Contractor should choose the type of machinery for applying seed and fertilizer. The choice is often based on local availability. The Contractor should note the method in the bid response so the contracting officer can make an accurate comparison.

** If drill seeders are employed, only use 1/2 the recommended seeding rates.

Table 16-4
Mulch & Netting Comparison Chart

Mulch/ Netting	Difficulty In Use	Erosion Resistance	Cost to Purchase	Cost to Apply	Environment Restrictions in Use	Most Effective on Soil Type
Wood/Paper Fiber	No	Low	Low	Low	Few	All
Straw	No	Medium	High	Moderate	High Winds Hamper Use	Fine Grain
Jute Mesh	Yes	Medium	Moderate	High	None	Course Grain
Tack Netting	Yes	Low	Moderate	High	None	Course Grain
Excelcior	Yes	High	High	High	Plastic Netting Could be a Problem	All
Chemical Stabilizer	No	Varies	Varies	Low	Temperature Requirement	Course Grain

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