

STANDARD UPLAND REVEGETATION SPECIFICATIONS FOR THE BUTTE PRIORITY SOILS OPERABLE UNIT SILVER BOW CREEK/BUTTE AREA SUPERFUND SITE BUTTE, MONTANA¹

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Abstract. This paper will describe the development and implementation of standards for the revegetation of lands disturbed by mining activities in Butte, Montana. The Butte area has served as a globally important mining, milling, and smelting district since the time gold was discovered in the area in 1864. Metal-sulfide deposits rich in copper and zinc were discovered a short time later and became the primary ores in Butte. Over a century of mining resulted in the development of more than 500 underground mines with roughly 3,000 miles of underground workings and numerous waste rock dumps. The operation of mines, mills, concentrators, and smelters generated a variety of waste materials containing elevated concentrations of arsenic, lead, and other metals.

In the early 1980s, the Butte area was designated as a Superfund site by the U.S. Environmental Protection Agency (EPA). Land reclamation involving vegetated soil caps has been a vital component of cleanup actions taken to address mine-impacted lands within the largely urban area known as the Butte Priority Soils Operable Unit (BPSOU). Several parties, including EPA, the state abandoned mine lands bureau, the local county government, and members of the responsible party group, have implemented reclamation activities that include the use of vegetated soil caps placed over mining-related wastes. The results of early reclamation efforts were mixed, with both successes and failures.

Successful reclamation using soil caps is a critical component of the long-term cleanup plan for the BPSOU. In the late 1990s, EPA, in conjunction with the responsible party group and other stakeholders, agreed upon a standard set of site-specific revegetation construction specifications for upland areas in the BPSOU to ensure consistency in the reclamation work. Criteria were established for pH testing of the subgrade, limestone application, cover soil quality and texture, organic amendment application, seed mixtures, fertilizer, mulch, and seed application. The specifications were derived from a variety of sources including existing abandoned mine reclamation specifications, previous reclamation practices established by EPA and by the local county government, and technical standards developed by the Reclamation Research Unit at Montana State University, as well as negotiation with the responsible party group and input from other stakeholders at the site. The specifications have strengths and weaknesses, but have served the site well in establishing the standards, expectations, and quality of revegetation work conducted at the BPSOU.

Additional Key Words: chemical suitability criteria, slope, organic matter content, noxious weed seed, and seedbed preparation

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Introduction

The Butte Priority Soils Operable Unit (BPSOU) of the Silver Bow Creek/Butte Area National Priorities List Site is located in southwestern Montana. It is one of four contiguous Environmental Protection Agency (EPA) Superfund Sites in the upper Clark Fork River Basin, extending 140 miles from the headwaters of Silver Bow Creek to the Milltown Reservoir near Missoula, Montana. The Silver Bow Creek/Butte Area Site lies immediately west of the continental divide, at the easternmost extent and headwaters of the upper Clark Fork River drainage. It encompasses approximately 85 square miles, including the entire length of Silver Bow Creek and associated land contamination, from Butte westward (26 miles) to the Warm Springs Ponds near Anaconda (Fig.1).



Figure 1. Site Location Map

The BPSOU is one of seven operable units within the Silver Bow Creek/Butte Area Site and consists of a five square mile area encompassing the town of Walkerville and a large portion of the city of Butte. The BPSOU is centered on “Butte Hill”, which is the location of the historic Butte Mining District. Silver Bow Creek is a small stream that flows along the base of the Butte Hill. The BPSOU is situated in a predominantly urban setting and includes residential neighborhoods, schools and parks, as well as commercial and industrial areas.

Historically, Butte has served as a globally important mining, milling, and smelting district. Gold was first discovered near Butte in 1864. Metal-sulfide deposits rich in copper and zinc

were discovered later and became the primary ores in Butte. By 1884, there were some 300 operating copper mines, at least 10 silver mines, 8 smelters, and over 4,000 posted claims. Mining in Butte was entirely underground until 1955, with the development of open pit mining operations in the Berkeley Pit. The pit has a total depth of 1,780 feet and encompasses an area approximately 1 square mile. The Berkeley Pit was mined until 1982. Mining in the adjacent Continental Pit, just east of the Berkeley Pit, began in 1985 and continues today.

Mining in Butte has resulted in the development of over 500 underground mines with roughly 3,000 miles of underground workings and numerous waste rock dumps. The operation of mills, concentrators, and smelters generated tailings and a variety of other waste materials containing elevated concentrations of arsenic, lead, and other metals. Butte and Walkerville were established with the advent of mining in the area and grew as the mining and milling industries flourished. Neighborhoods were established close to or surrounding the mining and milling centers as a matter of convenience.

EPA formed the BPSOU in 1987. Since that time, EPA has implemented (or required the responsible party to implement) many response actions to address high-priority human health risks and reduce the severity of contaminant loading to Silver Bow Creek. Response actions completed to date have addressed over 8 million cubic yards of mining-related wastes using removal, capping, and/or land reclamation. Over 400 acres of mine-impacted land on the Butte Hill has been reclaimed (Fig. 2). Also, 1.2 million cubic yards of tailings that were previously in contact with ground and surface water have been removed from the Silver Bow Creek floodplain. Storm water controls, including conveyance channels, diversions, and detention basins, have been constructed to reduce contaminant loading carried from the Butte Hill via storm water runoff.

Since the middle 1980s, land reclamation using vegetated soil caps has been a vital component in most of the response actions implemented at the BPSOU, and will continue to play an important role in future EPA-sanctioned response actions. In early reclamation efforts, cap integrity and vegetation response at reclaimed sites in the BPSOU were inconsistent, due in part to the variations in the procedures and practices used by the responsible party, EPA, and the State of Montana to reclaim these sites. The results of early reclamation efforts were mixed, with both successes and failures.

In 1999, EPA, in conjunction with the responsible party group and other stakeholders, agreed upon a standard set of site-specific revegetation construction specifications for upland areas in the BPSOU to ensure greater consistency in the reclamation work performed. The purpose of this paper is neither to defend the criterion and methods that were established, nor to necessarily promote their general use in circumstances similar to those found in Butte. Rather, it is intended to disseminate an example of the technical agreements that are reached by disparate entities involved in the Superfund process. The specifications have strengths and weaknesses, but have served the site well in establishing the standards, expectations, and quality of revegetation work conducted at the BPSOU.

Butte Priority Soils Operable Unit

Butte, Montana

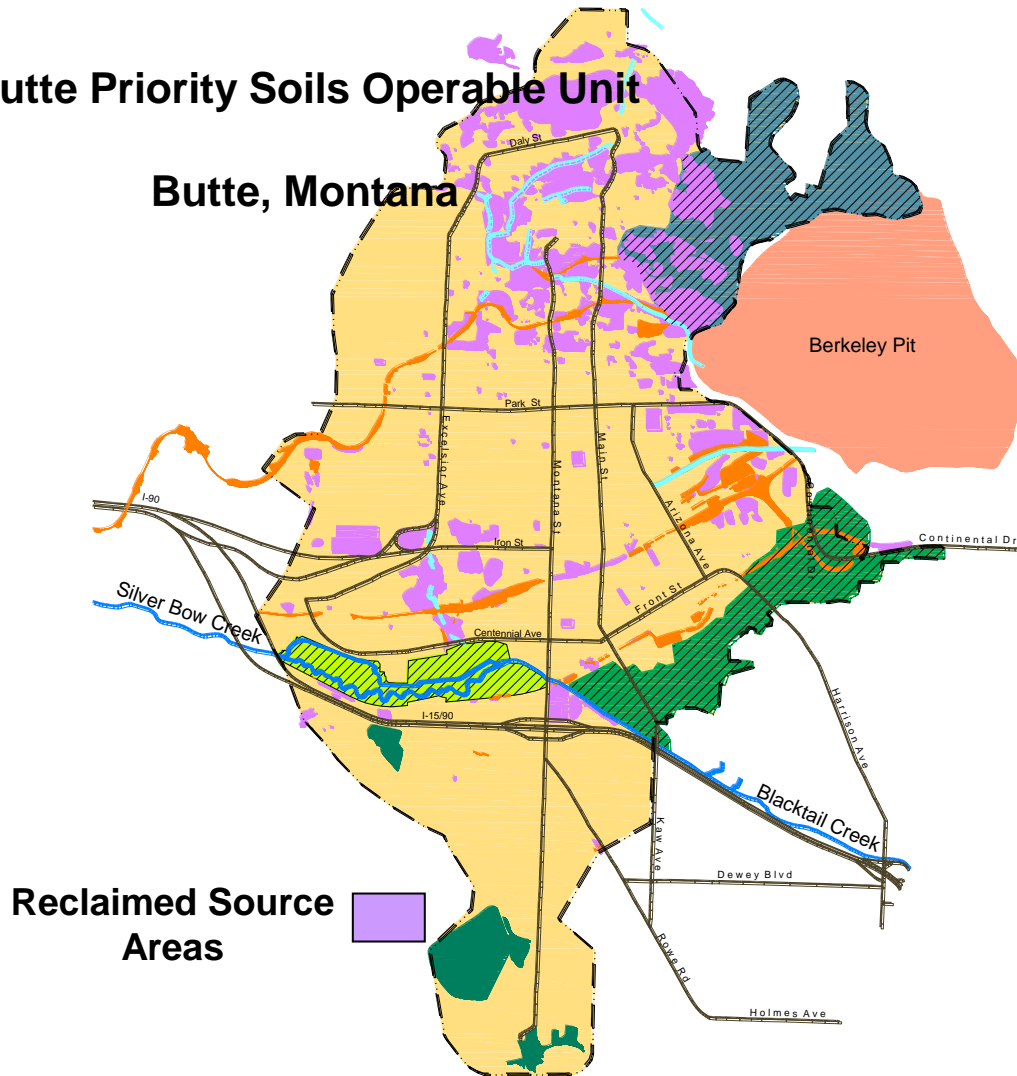


Figure 2. Reclaimed Source Areas in the Butte Priority Soils Operable Unit

Development of the Butte Hill Revegetation Specifications

A copy of the Butte Hill Revegetation Specifications is provided as an attachment. Criteria were established for pH testing of the subgrade, limestone application, cover soil quality and texture, organic amendment application, seed mixtures, fertilizer, mulch, and seed application. The specifications were derived from a variety of sources including existing State of Montana abandoned mine reclamation specifications, previous reclamation practices established by EPA and by the local county government, and technical standards developed by the Reclamation Research Unit at Montana State University (RRU/MSU), as well as negotiation with the responsible party group and input from other stakeholders at the site. The following sections discuss the origin of each criterion in the specifications.

Limestone Stabilization

Limestone stabilization involves the placement of a layer of limestone between the mine waste materials and the cover soil. The limestone layer is intended to help prevent the upward translocation of acidity and metals into the coversoil and ensure the sustainability of plant growth. Although application of this amendment is a logical step given the large number of acidic waste piles in the BPSOU, its efficacy in preventing translocation remains untested at reclaimed sites in Butte.

Materials. The specifications cited here were essentially matched to suit a limestone source owned by the responsible party located west of the town of Anaconda, Montana. Test results for this material demonstrated a calcium carbonate equivalence (CCE) of about 71%; thus, the specification of a CCE of 65% was suggested by the responsible party as a minimum. There is also some evidence in Schaefer and Associates (1986) that the responsible party had access to a lime reject source (a by-product of lime manufacturing) with a CCE of about 65% and the 65% CCE criterion may also have been suggested to broaden the range of available lime-like materials. The criterion that 50% of the limestone must pass a 60 mesh (<0.25 mm) sieve was recommended by RRU/MSU to ensure that immediately reactive small particles of limestone were available in the limestone layer. The <1-inch fraction also served as a marker layer between the waste materials and cover soil, and may also act as a crude capillary break.

Specification Highlights – Limestone Stabilization

...Limestone may be from any approved source and shall have a calcium carbonate equivalent content of not less than 65%. All limestone must be <1 inch in diameter and 50% (weight basis) must pass a 60 mesh (<0.25 mm) sieve...

...A minimum 350 tons/acre (approximately 2 inches) of limestone shall be placed on the low pH soil. Placement of the limestone layer on a site will be based on site-specific data and approved by EPA prior to placement of limestone....

...Limestone addition shall include areas to be revegetated where the subgrade soil has a pH of less than 5.5...

...A minimum 350 tons/acre (approximately 2 inches) of limestone shall be placed on the low pH soil...

pH Testing of Subgrade. The need for a limestone layer is determined by pH testing of the waste materials that make up the subgrade. The tests are conducted after final grading of the subgrade. Areas with a pH below 5.5 require the installation of a limestone layer. A simple, site-specific standard operating procedure for the pH tests was developed which uses distilled water to create a saturated paste and pH measurement using a standard probe. Acid-base accounting can be

specified by EPA, but was rarely performed due to the ease, speed, and low cost of pH testing. Colorimetric testing using Hellige-Truog® test kits are used to a limited extent and, in certain circumstances, eliminated the standard pH tests. However, these kits are accurate only to within about 0.5 standard units. EPA determined that the precision of colorimetric tests was inadequate and required that colorimetric pH testing only be used to eliminate standard soil pH testing when extremely acidic conditions were encountered (i.e., when the colorimetric solution turned yellow, indicating a pH of less than 4.0). When the responsible party determined that a limestone layer was not necessary, proof in the form of field or laboratory saturated paste data documenting that the soil pH was greater than 5.5 had to be provided to EPA.

Installation of Limestone. The origin of the limestone placement criterion of 350 tons/acre is not known, but it is not believed to have a scientifically-based origin. Rather, the origin can likely be attributed to the practical ease with which a 2-inch layer of crushed limestone can be installed and verified in the field.

Butte Hill Cover Soil

Vegetation failures in early reclamation efforts at the BPSOU can generally be traced to the use of cover soils with unsuitable textures with insufficient water-holding capacity. Adequate

Specification Highlights – Cover Soil

...Each of the...3 soil samples shall be analyzed by an approved laboratory for the following parameters: texture class and particle size; pH; saturation percent; electrical conductivity (EC) in mmhos/cm; organic matter percent; NO₃ - nitrogen; available phosphorus (P); and available potassium (K)...

...Cover soil sources will be approved by EPA. Cover soil thickness shall be a minimum of 18 inches, unless otherwise approved by EPA in writing. Eighteen inches is considered the minimum thickness required for long-term vegetation success...

...Cover soil shall be a friable material and the <2.0 mm fraction characterized as loam, sandy loam, sandy clay loam, sandy clay, clay loam, silty clay, silty clay loam, silt loam, or silt in accordance with the USDA Soil Conservation Service textural classification...

...The following chemical suitability criteria are general guidelines to be followed as screening standards:

As <97 mg/kg
Cd <4 mg/kg
Cu <250 mg/kg
Pb <100 mg/kg
Zn <250 mg/kg...

...For revegetation purposes, slopes must not exceed a maximum of 3:1 (3 horizontal to 1 vertical) unless previously agreed to...because of site specific requirements...

sources of suitably-textured cover soil remained unidentified until the mid-1990s, when a source area near the Butte-Silver Bow County landfill west of Butte was identified. This source, a non-welded, ash flow tuff of the Lowland Creek Volcanics formation, is a virgin material excavated as much as 15 to 20 meters below ground surface. The source requires the use of organic amendments and fertilizer to ensure adequate plant growth.

Submittals. The requirement for the collection of at least three samples from each cover soil source area generally worked well to ensure that suitable materials were used, but is potentially an inadequate number of samples if variability within the source area is high or the potential source area is large. In practice, EPA and responsible party oversight personnel had to exercise professional judgment as to whether a source area was sufficiently characterized.

Materials. The 18-inch cover soil thickness criterion was established as the minimum acceptable thickness during early reclamation efforts and was likely implemented, in part, due to the lack of identified suitable cover soil sources at that time. To help ensure continued vegetative success, a detailed operations and maintenance program has been implemented to ensure long-term vegetation success at all reclaimed sites.

The rock content criterion was intensively debated during development of the specifications, but has not been an issue since the specifications were implemented. EPA's initial criterion for rock content was less than 35%, but eventually concluded that a maximum of 45% is acceptable if the remainder of the cover soil material is suitably textured.

Potential soil sources with a clay texture classification are rare in the Butte area and no cover soils with this classification have been proposed for use. Due to poor water-holding capacity, sand and loamy sand textures were generally excluded from use. Since the time the specifications were adopted, there has been only one instance where loamy sand was allowed, during a "volunteer" reclamation effort conducted by the responsible party. In this case, loamy sand was allowed in the lower 9- to 18-inch portion of the profile and overlain by a 9-inch layer of sandy loam material. Criteria for pH, sodium adsorption ratio, soil saturation percentage, and electrical conductivity were adopted from generally accepted agricultural practices.

The origin of the chemical suitability criteria is not well documented in site records, but they are derived from a scientific basis. It is believed that the arsenic guideline was derived from human health criterion established during early risk assessments at the site. The remaining guidelines for cadmium, copper, lead, and zinc are based on plant phytotoxicity.

Construction Requirements. Visual inspection of excavated cover soil generally worked well, but continual care and conscientiousness was necessary on the part of the construction inspectors. Occasionally, however, small quantities of overly coarse material were emplaced. In retrospect, a greater number of laboratory textural tests ahead of the excavation may have identified coarse zones more quickly than hand-texturing. Fortunately, the landfill borrow source was fairly consistent in quality with infrequent coarse zones. The 3:1 maximum slope criterion was implemented to help prevent rill and gully formation.

Butte Hill Organic Amendment Application

Specification Highlights – Organic Amendment

...Analyses for organic amendments (such as manure, compost, etc.) shall include the gravimetric water content (% dry weight), the percentage of rock and/or other fragments >2.0 mm fraction (% dry weight), and organic matter content of the <2.0 mm fraction (% dry weight). The organic matter content of the <2.0 mm fraction shall be determined in the laboratory using Walkley-Black procedure...

...The field application rate shall be calculated using 3% organic amendment on a dry weight basis in the upper 6 inches of cover soil...

...Organic Amendment shall be applied with agricultural manure spreaders or other approved application equipment that enables spreading a uniformly regulated amount of material...

Most of the cover soil sources used contained little or no organic matter; thus, the addition of organic amendments was a necessity. Organic amendment sources required EPA approval. There was a fair amount of debate whether compost or manure should be the preferred amendment. Ultimately, manure proved to be the least costly alternative and was used the majority of the time. Weed seed in the manure was an occasional problem and EPA

preferred that only aged, stockpiled manure be used.

Materials. Testing of the organic amendment was necessary to determine the application rate in the field. The intention was to achieve an organic matter content of about 1 to 1.5% in the upper six inches of cover soil. The typical organic matter content of the manure sources was about 40 to 50% which equated to a manure application rate of about 30 dry tons/acre.

Construction Requirements. The construction requirements for organic amendment application were adopted from state specifications (DSL, 1991).

Butte Hill Seeding and Fertilizing

Materials. The material specifications for seed, fertilizer, and mulch were adapted from state specifications (DSL, 1991). Copies of the seed bag tags and state certification must be retained and included in the construction completion documentation for each project area.

Construction Requirements. Most of the construction requirements for seeding and fertilizing were adapted from state specifications (DSL, 1991). Broadcast and hydraulic seeding methods were rarely used and only in circumstances where mechanical seeding equipment could not be used. The seed mixtures were developed from site experience and input from county consultants. Three mixtures have been developed and include a primary mixture, a mix for gentle slopes, and a mixture for grass-lined ditches. In practice, the gentle

Specification Highlights – Seeding and Fertilizing

...indigenous seeds include the seeds of those plants that are naturally adapted to an area where the intended use is for revegetation of disturbed sites. These species include grasses, forbs, shrubs, and legumes...

...Vegetative mulch shall be either grass hay or straw... Application rates shall be 3,000 lbs/acre on flat non-critical erosion areas and 4,000 lbs/acre on all critical runoff areas...

...Excessively tight or compacted soils shall be loosened to the minimum depth of 6 inches. Disking, chiseling, or tilling of the soils shall be done at right angles to the natural flow of water on the slopes...

...If surface soil nutrient availability data are not available, fertilizer will be applied at a rate to achieve soil concentrations of 60 lbs. of nitrogen (N) per acre, 80 lbs. of P₂O₅ per acre, and 150 lbs. of K₂O per acre...

slope seed mixture was rarely used. Mulch was applied to suit the field conditions and was generally applied at a rate of 3,000 lbs. per acre.

Conclusions

The specifications, as written, attempt to strike a balance between overly-prescriptive requirements that could lead to disputes and construction delays, and weak requirements that could lead to poor vegetation condition and excessive erosion. A recurring theme in the specifications is the need to obtain EPA and/or responsible party approval at various steps in the revegetation process. This was done mainly to allow some flexibility during construction to take into account site-specific conditions and variations in the materials that were available. This structure also allowed EPA to intervene if inappropriate practices were being employed.

The specifications have both strengths and weaknesses. Strengths include the ability to better estimate reclamation costs, to define the expectations for reclamation activities implemented on Butte Hill, and to generally ensure the successful revegetation and stability of

the cover soil caps. Having general agreement on reclamation activities among the disparate parties involved in the BPSOU was a significant step that helped accelerate the pace of cleanup. The primary weakness probably lies with the limited amount of testing that is required. The quality of the work relied heavily on field observations made by EPA and responsible party oversight engineers and scientists, making the selection of appropriately trained and experienced personnel a must.

Literature Cited

DSL. 1991. Standard Specifications for Abandoned Mine Reclamation Construction, 1991 Edition, Update No. 5: February 1998. Adopted by the Montana Department of State Lands, Abandoned Mine Reclamation Bureau, Helena, Montana.

Schafer and Associates. 1986. Anaconda Minerals Disturbed Lands Stabilization Techniques 1950 to Present. EPA Records Center, Helena, Montana. File: 2030100, Doc. No.: 426373. January 1.

Attachment

**BUTTE HILL REVEGETATION SPECIFICATIONS
as of March 1999**

Notes :

AERL = ARCO Environmental Remediation, LLC

BSB = Butte-Silver Bow County

BUTTE HILL LIMESTONE STABILIZATION

GENERAL

Work described in this section shall consist of preparing the ground surface for limestone stabilization, hauling, placing, and spreading the limestone and fill on prepared areas in accordance with this Specification at the locations shown on the Drawings.

MATERIALS

Limestone sources will be approved by EPA. Limestone may be from any approved source and shall have a calcium carbonate equivalent content of not less than 65%. All limestone must be <1 inch in diameter and 50% (weight basis) must pass a 60 mesh (<0.25 mm) sieve.

CONSTRUCTION REQUIREMENTS

pH Testing of Subgrade

AERL shall test the subgrade soil pH of all areas to be revegetated. The frequency of testing shall not be less than one test per 40,000 square feet (approximately 200 x 200 foot grid). Limestone addition shall include areas to be revegetated where the subgrade soil has a pH of less than 5.5. Acid-base accounting (ABA) may be required by EPA under certain circumstances, such as the presence of acid-generating minerals, and the method used to determine ABA shall be as described in EPA-600/2-78-054. Documentation of this sampling effort, including a map showing sampling locations and sample results, shall be included in the final construction completion document(s) for the project.

Installation of Limestone

The surface of the subgrade in the area to be covered shall be brought to grade and finished smooth and uniform immediately prior to dumping and spreading the limestone. The limestone shall be placed prior to the placing of the cover soil. A minimum 350 tons/acre (approximately 2 inches) of limestone shall be placed on the low pH soil. Placement of the limestone layer on a site will be based on site-specific data and approved by EPA prior to placement of limestone.

Grades on the area to be covered shall be maintained in a true and even condition. Where grades have not been established, the areas shall be graded and sloped to drain. The surface shall be left smooth in an even and properly compacted condition to prevent, insofar as practical, the formation of low places or pockets where water will stand.

BUTTE HILL COVER SOIL

GENERAL

The work of this section covers all operations required for furnishing, excavating, hauling, stockpiling, spreading, and seedbed preparation of approved cover soil.

SUBMITTALS

Cover soil submittals will be provided in the Design Report or under separate cover and approved by EPA prior to use. The following submittals shall be provided to EPA for each cover soil source:

- The intended cover soil source site location, including details on the area and depth to be excavated at the source site location.
- For each cover soil source, AERL shall be required to secure at least 3 soil samples from the source area. EPA will be notified in advance of the sampling effort and the approximate location and depth where samples will be collected.
- Each of the above 3 soil samples shall be analyzed by an approved laboratory for the following parameters: texture class and particle size; pH; saturation percent; electrical conductivity (EC) in mmhos/cm; organic matter percent; NO₃ - nitrogen; available phosphorus (P); and available potassium (K). The above parameters shall be analyzed using USDA classification and test methods as described in ASA/SSSA Monograph No. 9, Methods of Soil Analysis, Parts 1-2, most recent edition or as described in EPA approved Clark Fork River Superfund Site Investigations documents. Also, each of the above 3 soil samples shall be analyzed by an approved laboratory for the following soil metals parameters: arsenic, cadmium, copper, lead, and zinc. Cover soil placement shall not begin until test results of the soil samples are known.

MATERIALS

Cover soil sources will be approved by EPA. Cover soil thickness shall be a minimum of 18 inches, unless otherwise approved by EPA in writing. Eighteen inches is considered the minimum thickness required for long-term vegetation success. Sufficient cover soil should be applied to account for settling, sloughing, and erosion. Cover soil material shall be reasonably free of any trash, rocks, lumps of soil, stumps, and brush. Rock content (i.e., particles >2.0 mm) must constitute <45% (by volume) of the cover soil and the maximum allowable rock size is 6 inches in diameter. To the extent possible, the cover soil source should be free of any noxious weeds.

Cover soil shall be a friable material and the <2.0 mm fraction characterized as loam, sandy loam, sandy clay loam, sandy clay, clay loam, silty clay, silty clay loam, silt loam, or silt in accordance with the USDA Soil Conservation Service textural classification provided below. Per approval of EPA, loamy sand may be acceptable from 6 to 18 inches in certain circumstances.

The soil pH shall be between 5.5 and 8.5. The soil SAR shall be <12. Soil saturation percent will be less than 85% and greater than 25%. The soil shall have an EC less than 4 mmhos/cm. NO₃, P, and K will be used by EPA and AERL to verify fertilizer rates.

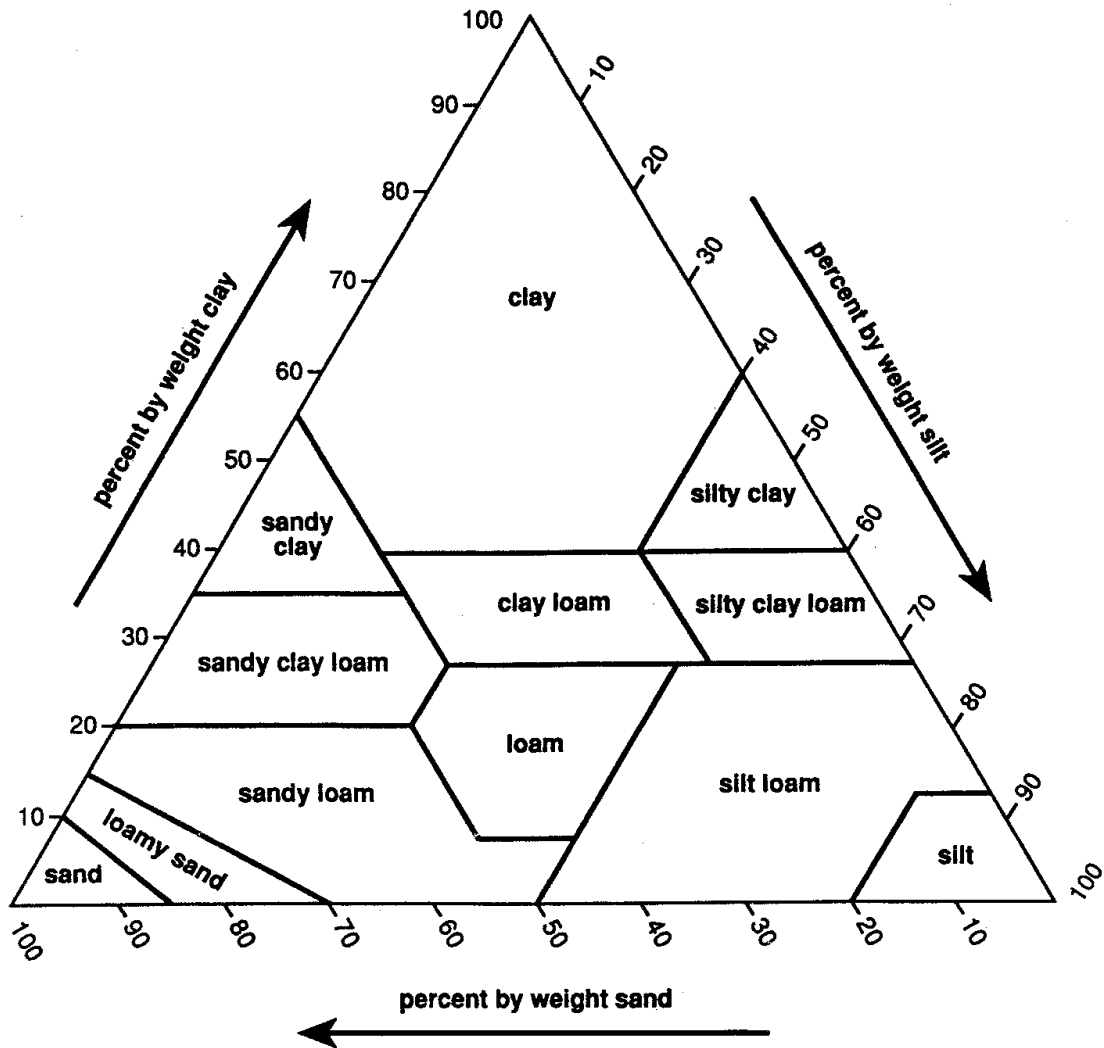


Figure 1. Graphic guide for textural classification of the less than 2 mm portion. (Source: USDA Soil Conservation Service)

The following chemical suitability criteria are general guidelines to be followed as screening standards:

As	<97 mg/kg
Cd	<4 mg/kg
Cu	<250 mg/kg
Pb	<100 mg/kg
Zn	<250 mg/kg

With the exception of zinc, these suitability criteria were established for parks, play areas, and residential yards in the Final Work Plan for Residential Areas, Butte Priority Soils Expedited Response Action prepared by ARCO dated May 1, 1995. These values were provided in a February 14, 1995, letter from Sara Weinstock (EPA) to Dave Sinkbeil (ARCO) providing final comments on the above work plan. The criterion for zinc was reduced to <250 mg/kg from <500 mg/kg to take into account potential phytotoxic effects noted at the higher level in the Final Baseline Ecological Risk Assessment, Anaconda Regional Water, Waste, and Soils Operable Unit, Anaconda Smelter NPL Site, Anaconda, Montana, prepared in October 1997 by CDM Federal Programs Corporation for EPA. The chemical suitability criteria listed above were established for the Butte Hill and may not be appropriate for use at other Clark Fork River Basin Superfund Sites.

It should be noted that some exceedances of the above criteria may still allow successful long-term vegetation. Therefore, if cover soil sampling shows a variance from the chemical suitability criteria, AERL will notify EPA and a plan to address the usability of that cover soil source will be discussed. EPA must approve in writing any cover soil sources which exceed the above suitability criteria.

CONSTRUCTION REQUIREMENTS

Visual inspection of excavated cover soil shall be a continuous process to carefully observe and recognize changes in source material characteristics. Visual inspection, in conjunction with hand-texturing of the <2.0 mm fraction, will be used to determine the adequacy of the borrow material ahead of excavation, to assure that current material meets textural criteria, and to identify areas to move to if material begins to fall out of specification. Each inspection shall record the location, test number for that day, date, time, estimated rock content percentage, and soil texture (<2.0 mm fraction). The frequency of inspection is dependent on the variability of the cover soil source material, but must be performed and recorded at least once daily during periods of source material excavation and transport. It is desirable to have the same person perform the inspections for the duration of excavation at a particular source area. In addition to the above visual inspections, textural analysis by laboratory hydrometer testing may be requested by EPA at a rate not to exceed one test for every 5,000 cubic yards of cover soil material excavated. These tests will be used for comparison and guidance for field testing and field observations. Copies of all inspection records and laboratory analyses shall be provided to EPA for review. Summaries of inspection records and analyses shall be included in the final construction completion documents for the project.

For revegetation purposes, slopes must not exceed a maximum of 3:1 (3 horizontal to 1 vertical) unless previously agreed to by EPA and AERL because of site specific requirements. Cover soil shall not be placed until the areas to be covered have been properly prepared, the limestone layer appropriately applied (if required), all construction work in the area has been completed and approved by AERL, and EPA notified that all subgrade preparations have been completed.

After the cover soil has been spread, large clods, hard lumps, rocks, and large roots over 6 inches in diameter; litter; or other foreign material (exposed iron, timbers, etc.) shall be raked up, removed from the cover soil and disposed of properly. Further preparation of the cover soil for seeding is provided in the specifications for Seeding and Fertilizing.

AERL shall grade the source area borrow site(s) to existing contours at slopes not to exceed 3:1 (unless previously agreed to by EPA and AERL because of site specific requirements) and to provide positive drainage. AERL shall replace stockpiled topsoil to the borrow area. The borrow area shall be prepared for seeding, mulching, and fertilizing as are other areas receiving cover soil.

BUTTE HILL ORGANIC AMENDMENT APPLICATION

GENERAL

Organic amendment application shall consist of furnishing, applying, and incorporating soil amendments, such as manure and compost, at locations and rates designated on the Drawings.

SUBMITTALS

Organic amendment submittals will be provided in the Design Report or under separate cover and approved by EPA prior to use. The following submittals shall be provided to EPA for each organic amendment source:

- Location of Supplier;
- For each supplier, at least three organic amendment analyses, including gravimetric water content, rock and other fragment content, and organic matter content, as described further under Materials; and
- Proposed organic amendment application and incorporation methods and equipment.

MATERIALS

Analyses for organic amendments (such as manure, compost, etc.) shall include the gravimetric water content (% , dry weight), the percentage of rock and/or other fragments >2.0 mm fraction (% , dry weight), and organic matter content of the <2.0 mm fraction (% , dry weight). The organic matter content of the <2.0 mm fraction shall be determined in the laboratory using Walkley-Black procedure, ASA, Meth. Soil Anal., 1986, Method 29-3.5.2.

If manure is used as the organic amendment source, cattle manure shall be the preferred manure type. Straw bedding material mixed into the manure is acceptable, but it shall not constitute more than 20% of the dry weight.

Application Rate

The field application rate shall be calculated using 3% organic amendment on a dry weight basis in the upper 6 inches of cover soil. Upon approval or direction from EPA, the 3% application rate may be modified to account for site-specific conditions. Analyses for organic amendments shall be submitted for each Supplier on a regular basis to determine if adjustments to the field application rates are necessary. The water and rock and/or other fragment content shall be deducted in calculating the field organic amendment application rate. Documentation of the organic amendment application, including application rate calculations, shall be included in the final construction completion documents(s) for the project.

CONSTRUCTION REQUIREMENTS

Stockpiling Organic Amendment

Prior to stockpiling organic amendment on site, the Contractor shall develop an acceptable stockpiling plan for AERL review and approval. The plan shall include the location of the stockpile and adequate measures to prevent contamination of underlying and adjacent soils and prevent air or water pollution.

Site Grading

Prior to placement of the organic amendment, all areas shall be graded as necessary to approximately restore the design contours of the ground or to produce a contour that will blend with contours of adjacent areas. This shall include grading erosion channels in revegetated areas that are to receive organic amendment.

Organic Amendment Application

Organic Amendment shall be applied with agricultural manure spreaders or other approved application equipment that enables spreading a uniformly regulated amount of material.

For a specified application rate, the Contractor shall apply the organic amendment in a uniform manner across the landscape. Localized organic amendment application thicker than 6 inches is unacceptable.

Contractor shall calibrate the organic amendment spreader prior to each use of the equipment unless site conditions have not changed and equipment settings have not been altered since previous calibration. Calibration records shall be furnished to AERL. Upon request, copies of equipment calibration shall be provided to EPA for review. All calibration records shall be included in the final construction completion document(s) for the project.

Under no circumstances shall the Contractor apply the organic amendment during wind conditions strong enough to displace material onto adjacent sites.

Organic Amendment Incorporation

Following organic amendment application, the soil shall be ripped to a 6-inch depth at 12-inch centers. The soil shall then be tilled to a depth of 6 inches with a disc, rototiller, moldboard plow, or chisel plow. An agricultural disc with a disc diameter of approximately 20 inches having cone-shaped discs at a spacing width of 6-8 inches is recommended. Multiple tilling equipment passes may be required to achieve adequate incorporation. Adequate incorporation will be a complete and uniform mixing of the manure and soil to a depth of 6 inches. All tillage procedures shall be completed as soon as practicable after amendment application.

BUTTE HILL SEEDING AND FERTILIZING

GENERAL

Revegetation work described in this section includes fertilization, seeding, and mulching on all project designated and disturbed areas upon completion of construction work. These areas include finished embankment slopes, borrow areas, areas to be revegetated, and disturbed areas.

MATERIALS

Seed

Hand collected native species and some of the special wetland species collected cannot meet the following requirements. All seed shall comply with, and be labeled in accordance with, the Montana Seed Law. Montana Code Annotated (MCA) 80-5-104 (2) states. Indigenous seeds, as defined in 80-5-101, in amounts of one pound or more, whether in packages or bulk, must be labeled with the following information:

1. The statement "Labeled only for reclamation purposes";
2. Lot number or other distinguishing mark;
3. The common name, genus, species, and subspecies, when applicable, including the name of each kind of seed present in excess of 5 percent. When two or more kinds of seed are named on the label, the label shall specify the percentage of each. When only one kind of seed is present in excess of 5 percent and no variety name or type designation is shown, the percentage must apply to seed of the kind named. If the name of the variety is given, the name may be associated with the name of the kind. The percentage in this case may be shown as shown as pure "Alive seed" and must apply only to the seed of the variety named;
4. State or county of origin;
5. The approximate percentage of viable seed, together with the date of test. When labeling mixtures, the percentage viability of each kind shall be stated;
6. The approximate percentage, by weight, of pure seed, meaning the freedom of seed from inert matter and from other seeds;
7. The approximate percentage, by weight, of sand, dirt, broken seeds, sticks, chaff, and other inert matter;
8. The approximate total percentage, by weight, of other seeds;
9. The name and approximate number of each kind of species of prohibited and restricted noxious weed seeds occurring per pound of seed; and
10. The full name and address of person, firm, or corporation selling the seed.

As listed in the Montana Seed Law, seed shall contain no "PROHIBITED" noxious weed seed. The seed shall contain no "RESTRICTED" noxious weed seed in excess of the maximum numbers per pound, as specified by MCA 80-5-105, or as specified by the appropriate BSB County Weed Board, whichever is more stringent.

As defined by MCA 80-5-101(4), indigenous seeds include the seeds of those plants that are naturally adapted to an area where the intended use is for revegetation of disturbed sites. These species include grasses, forbs, shrubs, and legumes.

The Contractor must supply AERL with all seed bag tags and certification from the supplier stating that the seed complies with the Federal Seed Act and the Montana Seed Laws (MCA 80-5-101- through 305). Upon request, copies of said tags shall be submitted to EPA for review. Copies of seed bag tags and certification shall be included in the final construction completion documentation the project.

When legumes are seeded as the predominant mixture, the seed supplier shall include inoculants (rhizobia) and provide documentation as specified in the Seed Certification. Seed Certifications shall be submitted to AERL prior to any seeding. The Contractor shall also submit a copy of the bill or other documentation from the seed supplier showing actual bulk weights of the individual seed types combined in the mix an verification of legume inoculation. The required certifications and documentation shall be provided to AERL at least three days prior to the seeding.

Fertilizer

Fertilizer shall be delivered in standard-size bags of the manufacturer showing weight analysis and manufacturer=s name, or in bulk quantities accompanied with written certifications from the manufacturer stating that the fertilizer supplied complies with applicable Specifications.

Fertilizer shall be soluble commercial carrier of available plant food element or combination thereof. The fertilizer to be used on the project shall supply the quantities of available chemical elements stipulated below. The fertilizer shall be of uniform composition and in good condition for application by suitable equipment. It shall be labeled with the manufacturer=s guaranteed analysis, as governed by applicable fertilizer laws. Any fertilizer that becomes contaminated or damaged, making it unsuitable for use, shall not be accepted. All required fertilizer certificates shall be provided to AERL a minimum of three days prior to fertilizing. The certification shall include the guaranteed analysis of the fertilizers stated in the terms of the percentages of nitrogen, and available phosphorous, potash, and boron, in that order.

Mulch

Vegetative mulch shall be either grass hay or straw. Grass hay material shall be composed primarily of perennial grasses. The grass hay mulch shall contain greater than 70 percent grass by weight and shall not contain more than 10 percent alfalfa, crested wheatgrass or yellow sweet clover. Grass hay shall be relatively free of noxious weeds and other undesirable species.

Straw mulch material shall be clean grain straw, shall be relatively free of noxious weeds and other undesirable species, and shall not contain greater than 5 percent cereal seed by weight, i.e., seed heads. Wheat straw will be used whenever possible. Harvesting will be performed with modern combines, which leave less grain in the straw. Written approval of straw and hay sources from the supervisor of the BSB County weed board shall be obtained.

Chopped or ground material is not acceptable. The mulch material is not acceptable if it is damaged by rotting, molding, etc. to seriously limit its use for mulch. It shall be relatively free of stones, dirt, roots, stumps, or other foreign material.

Application rates shall be 3,000 lbs/acre on flat non-critical erosion and potential dust generating areas and 4,000 lbs/acre on all critical runoff and potential dust generating areas. Exact application rates will be adjusted in the field to accommodate differences in mulch material and seedbed conditions.

CONSTRUCTION REQUIREMENTS

Seedbed Preparation

Prior to executing the seeding, fertilizing and mulching work items, the seed bed at all sites shall be prepared so these items can most efficiently be completed, with the areas resulting in reasonable conformity to specified line and grade. The fertilizing, seeding, and mulching work items shall be executed only after the seedbed condition has been approved by AERL. The cover soil shall be prepared as described in the Cover Soil specifications.

The seedbed surface must be in a condition that does not preclude growth at the time of application of seed. Conditions that may preclude growth include, but are not limited to: large clumps, clods, and impervious crusts of dirt; areas too tightly compacted to allow seed growth; and areas of loose soils which could possibly become too compacted during the seed applications to allow growth. The decisions on the conditions of the seedbed shall be made by AERL. If AERL determines the seedbed is inadequate for seeding, the Contractor shall treat the inadequate areas, as directed by AERL, to attain as nearly as practicable the adequate condition at no additional cost to AERL.

Excessively tight or compacted soils shall be loosened to the minimum depth of 6 inches. Disking, chiseling, or tilling of the soils shall be done at right angles to the natural flow of water on the slopes, unless otherwise directed or approved by AERL. Compaction of the soil, when required, shall be performed by equipment that shall produce a uniform rough-textured surface ready for seeding and mulching.

Existing structures and facilities shall be adequately protected and any damage done by the Contractor shall be repaired or adjusted to the satisfaction of AERL.

Seed Application

General

Slopes and areas finished during the period of October 15 through June 15 may be permanently seeded within this time period. The Contractor must obtain AERL permission to commence seeding operations. Slopes and areas finished during the period June 16 through October 14 shall receive an annual cover crop from the strawmulch seed to protect the in-place cover soils during this period. The control of noxious weeds and other undesirable species will also be addressed during this period. The perennial seed mix shall then be applied to the areas after October 15. EPA shall be notified prior to commencement of seeding activities.

Specifications of each type of seed mix are outlined below. The seeding of steep slopes, narrow medians, or small areas that are impractical to seed by drill may be performed by using the hydraulic seeding methods, when approved by AERL. The hydraulic seeding methods shall be used when the seedbed surface is too wet or swampy to permit seeding by drill. Hydraulic seeding methods shall not be used during adverse weather, as determined by AERL.

The applied seed, regardless of the method of application, shall not be covered by a soil thickness greater than 1 inch in depth.

Seed Application Equipment

Drill Seeding

Seeding equipment used for applying grass/forb seed must be designed, modified or equipped to regulate the application rate and planting depth of the seed mixture. Seed must be uniformly distributed in the drill hopper during the drilling operation. Acceptable drills are: custom seeders, furrow drills, disc drills or other drills approved by AERL. All seeding equipment shall be operated perpendicular to the slope. Contractor shall calibrate the drill seeder prior to each use of the equipment unless site conditions have not changed and equipment settings have not been altered since previous calibration. Calibration records shall be furnished to AERL. Upon request, copies of equipment calibration shall be provided to EPA for review.

A summary of all calibration records shall be included in the final construction completion document(s) for the project.

Planting depth shall be regulated by depth bands or coulters. The drill box shall be partitioned by dividers no more than 24 inches apart, in order to provide for more even distribution on sloping areas. The rows or planted seed shall be a maximum of 8 inches apart. Drilling depth shall be from 1/4 to 1 inch.

Broadcast Seeding

Seeding by hand or mechanical broadcasting shall be permitted on areas inaccessible to drills or impractical to seed by other prescribed methods. The broadcast seeding rate shall not be less than twice the drill seeding rate. Following the seeding, the soil shall be hand-raked to cover the seed. Broadcast seeding requires the prior approval of AERL.

Hydraulic Seeding

The Contractor must provide one pound of wood fiber mulch per each 3 gallons water in the hydraulic seeder as a cushion against seed damage. The mulch used as a cushion may be part of the total required mulch with the remainder applied after the seed is in place. The Contractor may be required to use extension hoses to reach the extremities of slopes.

When using vegetative mulch, the Contractor may mix the seed with the fertilizer if his hydraulic seed equipment is capable of uniformly mixing water, fertilizer, and seed, in that order, and power blowing or spraying the mixture uniformly over the seedbed. After blending, the slurry shall be applied to the seedbed within 45 minutes after the seed has been added to the water-fertilizer mixture. If the slurry cannot be applied within the specified time, it shall be fortified, at no cost to AERL, with the correct ratio of seed to the remaining slurry and a new 45-minute time frame established for applying the fortified mixture. At no time shall seed and fertilizer remain in a slurry for more than 45 minutes.

Seed Application Areas/Rates - The revegetation mixes include:

Butte Hill 1997 Primary Seed Mixture Revegetation Mix

Seed Mixture	Rate, #PLS/Acre
Slender Wheatgrass	3.0
Thickspike Wheatgrass	2.0
Sheep Fescue	2.0
Crested Wheatgrass	1.0
Ladak Alfalfa	1.0
Red Clover	2.0
Canada Bluegrass	1.0
Birdsfoot Trefoil	1.0
Total	13.0

Butte Hill Alternate Seed Mixture No. 1

Gentle Sloped Areas (Less than 10:1) Revegetation Mix

Seed Mixture	Rate, #PLS/Acre	Planting
Bozoisky Russian Wildrye	5.0	Initial seeding, drill seeded on 15-18 inch centers.
Ladak Alfalfa	2.0	Interseeded during following years as determined by vegetation monitoring.
Total	7.0	

Butte Hill Alternate Seed Mixture No. 2

Grass-lined Ditches

Seed Mixture	Rate, #PLS/Acre
Smooth Broughm	5.0
Birdsfoot Trefoil	1.0
Red Clover	0.5
Total	6.5

Pure live seed application rates shall be as specified in the tables.

The 1997 primary seed mixture was proposed by BSB County and is based upon their monitoring results for successful revegetation within the Butte area and has been reviewed and approved by BSB County, EPA and the State for use in upland areas of the Butte Priority Soils Operable Unit. The Alternate Seed Mixture No. 1 will only be used in areas with slopes of <10:1 that are particularly susceptible to weed infestation. Additional optimal conditions for use of the alternative seed mix include locations with high moisture holding capacity and shelter from strong wind conditions. The Alternate Seed Mixture No. 2 has been proposed by BSB County and is an option for hand seeding grass-lined ditches and detention basins.

Calculations of pure Alive seed@ may be made on the basis of either a germination test or a tetrazolium test in addition to the purity analysis. Seed shall be applied on a pure Alive seed@ basis. The quantity of pure Alive seed@ in a 100-lb. container shall be determined by the formula: 100 multiplied by germination percentage, and this product multiplied by the purity percentage. For example, if the seed is 85 percent pure and test 90 percent germination, then a 100-lb. container would contain 76.5 pounds of pure Alive seed@.

Fertilizer Application

If surface soil nutrient availability data are not available, fertilizer will be applied at a rate to achieve soil concentrations of 60 lbs. of nitrogen (N) per acre, 80 lbs. of P₂O₅ per acre, and 150 lbs. of K₂O per acre. Mechanical or hydraulic methods of application are allowed, providing a uniform application at the specified rate is accomplished. The application method is subject to approval by AERL. When scheduling and soil conditions permit, the fertilizer shall be incorporated into the soil by disking, raking, or shallow plowing to the full depth of the topsoil or to a maximum depth of six inches, whichever is less.

Fertilizer shall be applied to the prepared seedbed prior to seeding or mulching and shall be blended with the top layer of soil or concurrently with the seed (as Ano-till@ drills allow). Upon EPA approval, fertilizer may be applied subsequent to seeding and mulching. Refertilization following seedling establishment will not require incorporation. In no instance shall subsoil be incorporated into the seedbed as a result of the fertilization operation.

Mulch Application

Mulch is usually applied during the summer and early fall and drill seeded after October 15th. The mulch shall be applied in a uniform manner by a mulch spreader at rates varying from 2,000 to 4,000 lbs. per acre. The actual rate utilized shall depend upon site conditions (i.e., slope, erosion potential, etc.) and shall be approved by AERL and EPA prior to application. The mulch spreader shall be designed specifically for this type of work. The vegetative material shall be fed in the mechanical spreader at an even, uniform rate.

The mulch shall be anchored into the seedbed by using a mulch tiller (crimper). Straw or hay shall be clean grain straw and shall be pliable.

Mulch tillers shall have round, flat, notched blades of these approximate dimensions: 0.25-inch thick by 18 inches in diameter and spaced 8 inches apart. The tiller shall have sufficient weight to force the vegetative mulch a minimum of 3 inches into the soil and shall be equipped with disc scrapers. Mulch tilling shall be done on all slopes capable of being safely traversed by a tracked vehicle. All mulch tilling shall be done perpendicular of the flow-line of the slope.

Mulch, where required, will be applied to seeded areas as close as possible to the completion of seeding operations for the area. Mulch shall not be applied in the presence of free surface water, but may be applied upon damp ground.

Mulch shall not be applied to areas having a substantial vegetative growth, such as grasses, weeds, and grains. Areas not to be mulched shall be determined by AERL. Mulching shall not be done during adverse weather conditions or when wind prevents uniform distribution. Application shall be in a manner to not seriously disturb the seedbed surface.