Guidelines for Compliance

with

Land Use And Vegetation Requirements

of the

Colorado Mined Land Reclamation Board

for

Coal Mining

October, 1988

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I. Introduction

This document provides guidelines to assist coal mine applicants in developing plans which will meet Colorado Regulatory Requirements for land use and vegetation. The document represents the Division's interpretation of portions of the regulations. However, the guidelines do not carry the authority of regulations. Techniques and approaches which differ from those outlined in this document but meet the regulatory requirements are acceptable. Such proposals should be discussed with Division staff in pre-application meetings, prior to substantial investments of time or money. Given the variability of environmental conditions and the diversity of vegetation types within and among the coal regions in Colorado, the Division strongly recommends that all applicants schedule pre-application meetings prior to initiation of baseline vegetation sampling.

This guideline document is not intended to be a training manual. Vegetation inventory and revegetation programs should be planned and overseen by qualified individuals with training in vegetation ecology, range science, or closely related fields.

II. Land Use

A. Assessment of Pre-Mine Land Use

Rule 2.04.3 of the regulations is fairly specific with regard to the type of information and level of detail which the applicant is required to submit regarding pre-mine land use and site conditions within the proposed permit area. Information regarding land capability, productivity and condition can generally be derived from site specific soil and vegetation data, supplemented by Soil Conservation Service (SCS) soil survey information and range site descriptions.

Definitions in Rule 1.04(71) for the major land uses of rangeland, pastureland, and fish and wildlife habitat are rather broad, and they are open to a certain amount of interpretation. "Pastureland" as defined by Rule 1.04(71)(b) means " . . . land which is used for the production of adapted, domesticated forage plants for livestock grazing or occasional hay production. Pastureland maintenance entails cultural inputs such as seeding, irrigation, fertilization, brush control and pest control. Land used for facilities in support of pastureland is also included."*

"Rangeland" is defined by Rule 1.04(71)(c) as meaning "land on which plant cover is principally valuable for forage. Except for brush control, management is primarily achieved by regulating the intensity of grazing and season of use." The major difference between "pastureland" and "rangeland" is that rangeland is managed for types of vegetation which are not dependent on cultural controls (other than brush control) for long-term maintenance. In most cases, rangeland vegetation communities are dominated by and managed for native species. Management is based primarily on ecological rather than agronomic principles, often through manipulating the intensity, frequency and season of grazing. Fencing, herding, stock water development, and other

*Definition given is currently (1/88) proposed, anticipated final approval by June, 1988.

controls on animal use are activities typically associated with rangeland management. Control of undesirable brush and noxious or poisonous weeds is sometimes undertaken on rangeland, but with less regularity than on pastureland.

"Fish and Wildlife Habitat" is defined by Rule 1.04(71)(h) as "land used wholly or partially in the production, protection or management of species of fish or wildlife." Much of the land in and adjacent to existing and anticipated coal permit areas in Colorado is rangeland which typically supports both livestock grazing and important wildlife habitat. When this is the case, it is necessary that both uses be acknowledged and that the reclamation plan and post-mine land use plan reflect a balanced consideration of livestock use and the needs of wildlife species of concern.

B. Post-Mine Land Use

The ultimate objective of the reclamation plan is to ensure that the reclaimed area is fully capable of supporting the intended final land use(s). All aspects of the reclamation plan must reflect this consideration. In most cases, proposed final land use(s) will be the same as the pre-mine land use(s). In the case of a single mining operation disturbing both cropland and rangeland, or some other combination of land uses, the percentage of the area reclaimed to support each land use should be approximately equivalent to that which existed prior to disturbance. If this were not the case, specific criteria regarding alternative post-mine land use would have to be addressed in the application. The regulations allow for alternative post-mine land uses (final land uses different than pre-mine land uses) when specific criteria are met, as described in Rule 4.16.

Whether pre-mine land use restoration or alternative uses are proposed, portions of the proposed reclaimed surface which will be reclaimed to support particular land uses must be delineated on a post-mine land use map, and reclamation techniques and revegetation success standards applicable to the various proposed post-mine land uses must be set forth in the permit application.

III. Pre-Mine Inventory and Sampling

A. Vegetation Mapping and Description

Vegetation types within the permit or proposed disturbance area should be delineated on a topographic base map at a scale of 1:6000 (1 inch = 500 feet) or larger. For surface mines, the entire permit area and adjacent area should be mapped. For underground mines, only areas of proposed surface disturbance and adjacent areas need be mapped. In general, the adjacent area should extend at least 1/2 mile beyond the boundary of the permit or disturbed area. Vegetation type delineation should be based on existing, visually dominant species rather potential plant communities (e.g. SCS range sites).

An exception is that if major plant communities within the study area are dominated by noxious weeds or other undesirable invader species, resulting in a poor condition range designation based on SCS criteria, a range site map reflecting potential plant community expression may be appropriate, in addition to the standard vegetation type map.

In addition to vegetation type delineation, the location of all reference areas should be depicted on the vegetation map, as well as roads, support facilities, and permit boundaries as required by Rule 2.10.1.

Plant communities identified on the vegetation map should be described as required by Rule 2.04.10(4). The description should discuss the major plant species with supporting data from the quantitative sampling. A general discussion of the ecological characteristics of the community and controlling factors is helpful as well as the existing condition of each vegetation type.

B. Major and Minor Communities

In general, restoration (exact duplication) of rangeland plant communities on reclaimed areas as they existed prior to disturbance is acknowledged as being beyond the current state of the art. This is due to the magnitude of the disruption of physical and biological ecosystem components which occurs as a result of mining and reclamation, and the relatively short time spans in which the success of reclamation is evaluated. Vegetation establishment and other reclamation measures should always be directed towards achieving the planned post-mine land use(s) and establishing a stable self-perpetuating vegetative community.

In light of the above, the Division generally requires quantitative sampling only within major vegetation communities. Quantitative sampling and reference areas (or other success standards) are usually not required for minor communities (those communities whose total aggregate area occupies less than 5% of the permit area or less than 10 acres, whichever is smaller). Such communities should be qualitatively described in the permit application. Mapping and quantitative sampling might be required, as well as special reclamation techniques and success standards, when a minor community is of exceptionally high value to the land use (riparian habitat, for example) or if the community is associated with threatened or endangered species.

C. Threatened and Endangered Species Inventory

As part of the pre-mining vegetation inventory, the applicant needs to address the existence of and impacts to threatened and endangered species as required pursuant to Rule 2.04.10(5). Prior to initiating baseline studies the applicant should contact appropriate agencies including the U.S. Fish and Wildlife Service and the Colorado Natural Areas Program to determine if any critical species or their habitat are known to occur in the general vicinity of the project area. The existence of threatened and endangered species or their habitat should be further evaluated during the baseline sampling program. Any threatened or endangered species encountered during production sampling should be noted on the data forms, reported to the above agencies, and the plant should be left undisturbed.

Attached as Appendix A is the most current listing of "Plant Species of Special Concern" for the State of Colorado. This listing reflects both those plant species recognized as threatened or endangered by the U.S. Fish and Wildlife Service and those plant species not recognized by the federal government but recognized as threatened or endangered by the State of Colorado. Also, this listing reflects those species that may be threatened or

endangered in the near future as presented on the last page of the appendix entitled "A 'Watch List' of Colorado Plants."

When it is determined that a threatened or endangered plant species occurs within a proposed permit area, the applicant should contact the Division to discuss the extent of the species occurrence, and the need for avoidance or mitigation.

Rule 2.05.6(2)(iii) identifies the information that would need to be included in the permit application if threatened or endangered plant species were encountered. Those actions to be implemented to protect or enhance the threatened or endangered species would have to be addressed. Examples of actions that could be taken by the applicant are as follows:

1. Expand the vegetation inventory to adjacent lands to determine extent of species occurrence.

2. Collect seed for distribution to interested parties (e.g. Upper Colorado Environmental Plant Center) for propogation purposes.

3. Establish a test plot to determine the potential for re-establishment of the species.

4. Create non-disturbance areas or buffer zones where the species occurs for protection from mining and mining-related activities.

The applicant should consult with the Division during the permit review process to determine the best action or actions to implement.

D. Vegetation Sampling (General)

Vegetation parameters evaluated to determine pre-mine baseline conditions and to demonstrate revegetation success on reclaimed areas are vegetation cover, production, woody plant density and species diversity. When the post-mining land use is cropland, only production is applicable and other parameters need not be measured. It is critical that sampling be as objective and repeatable as possible. Procedures used in collecting baseline data must be adaptable for use in post-mining data collection even though, in many cases, the post-mine vegetation community structure will be different than pre-mining. Methods recommended in this document are those which the Division has found to be the most efficient, accurate and objective. Sampling procedures must be fully described in the permit application, and consistency of techniques must be maintained in all baseline and subsequent sampling.

Quadrats (circular or rectangular plots) are typically used to sample production and density, while cover is usually estimated by point intercept or line intercept methods. Diversity determinations are based on either relative cover or relative production species composition (usually relative cover due to the relative ease of data collection). Sampling should always be stratified by vegetation type, and the selection of sampling techniques should be based on the characteristics of the vegetation type being sampled. For example, quadrats must be large enough to encompass individual plants of the

larger species being sampled and must also be large enough to ensure that very few plots will enclose no vegetation. Quadrat size will increase both as distance between plants and number of species increase. Within each vegetation type, it is important that unbiased samples be obtained. In general, the Division recommends that transect samples be randomly located. Quadrat samples should be either randomly located or spaced at random or systematic intervals along randomly located transects.

Ideally, cover and production data collection should coincide as closely as possible with peak production of the dominant species. As a practical matter, sampling in most areas can be conducted from July through September. Reference areas and corresponding affected areas should be sampled as concurrently as practicable.

It is advisable to include the entire area which could potentially be affected during the life of the mine within the baseline study area. At a minimum, the study area must encompass the area of proposed disturbance.

Division recommendations and general considerations with regard to cover, production and woody plant density sampling techniques are outlined below. For more detailed discussion of sampling techniques and sample design, the reference listed under Vegetation Sampling and Statistics in Appendix C are suggested. Vegetation sampling programs should be designed and overseen by qualified individuals with appropriate training.

E. Cover Sampling

A number of terms are utilized to describe vegetation cover. Pertinent terms are defined below.

Total Vegetation Cover	-Percentage of the ground shielded by the aerial parts of living vegetation.
Relative Cover	-That portion of the total vegetation cover made up by a particular species.
Herbaceous Cover	-That portion of the ground surface covered by aerial parts of herbaceous vegetation.
Basal Cover	-A subset of herbaceous or total cover that encompasses the area occupied by the base of each plant, but not the entire area covered by foliage.

In general, the Division recommends that total vegetation cover be estimated in pre-mine vegetation inventories. Though there may be some advantages to measuring basal cover, total vegetation cover is recommended by the Division in most instances because it is applicable to a wider range of vegetation types and, when combined with surface litter, is more closely correlated with erosion protection.

From a reclamation perspective, cover data is important for two reasons:

1. Cover is a measure of the effectiveness of the vegetation in providing erosion protection through raindrop interception.

2. Collection of cover data by species provides composition and diversity information--the basis for the species diversity standard. Cover data should always be collected by species and summary tables for each vegetation type and corresponding reference area should list both total cover and relative cover estimates for each species.

Two methods of cover sampling are briefly discussed below. Quadrat cover sampling is not included. The method is considered to be more subject to variation among different observers than other methods of estimating cover, and as a result is generally not acceptable to the Division.

Although only vegetation cover is specifically considered in regard to determinations of successful revegetation, percent litter, rock, and bare ground should also be recorded during cover sampling and included in cover summaries. Such data are easy to obtain and provide valuable information regarding potential runoff and soil loss.

Line Intercept

1. The sampling unit is a tape at least 30m long. Vegetation cover is measured by totaling the segments of the transect intercepted by vegetation. The procedure is time consuming and tedious; best suited to very sparse vegetation communities.

2. The tape must be viewed from above, with cover determined by vertical optical projection of a particular line segment downward to the ground surface. As as result, cover measurements are limited to below approximately four feet above the ground. In tall mountain shrub (oakbrush-chokecherry-serviceberry) and aspen communities, a certain component of cover provided by the upper canopy will not be accounted for. This is not felt to be critical, since in aspen communities the majority of the soil stabilization is typically provided by herbaceous or low growing shrub cover. In mountain shrub communities, the "bushy" growth form of the shrubs is such that the foliar cover at four (4) feet is generally as extensive as the cover above that height.

Point Intercept

1. The sample is a series of points at regular intervals along a transect. In general, one sample would consist of a transect of at least 30 meters in length, with at least fifty data points at regular intervals along the transect. The point can be a sharpened pin or an ocular sighting device. In either case, some type of frame is necessary to ensure unbiased point placement. A 10-point frame is most commonly employed. Although not without

disadvantages, it is more objective than quadrat sampling and suited to a wider range of vegetation types than the line intercept method.

2. "First hit" and subsequent "hits" on vegetation at a particular point should be recorded separately by the observer. Only first hit data is utilized in estimating total cover and establishing the cover success standard. Species composition is based on all hits on vegetation.

   For example, if out of 50 sample points there were 30 "1st hits" and 52 total hits, of which 10 were Agropyron cristatum (Agcr), the following would be true:

   Total Cover = 30/50 = 60%
   Agcr Relative Cover = 10/52 = 19%

3. As with the line intercept method, a height cutoff of four feet is generally employed.

F. Production Sampling

Vegetation production, as required by the regulations, is more specifically defined as current annual herbage yield (with the exception of certain agricultural crops such as grains, truck crops and fruits).

Production of rangeland and pastureland vegetation is estimated by clipping vegetation in quadrats at ground level, or in the case of woody plants, by clipping the current annual growth. In most cases, however, no sampling of woody plant production is required. Clippings are bagged, marked, oven dried, or air dried, and weighed. Crop production from an area can often be measured directly when the crop is harvested by, for example, recording truckloads of wheat to determine bushels per acre or bales of hay to determine pounds per acre.

The objective of production sampling is to estimate the quantity of livestock and wildlife forage or cash crop produced on an area, in order to establish success standards which will ensure effective revegetation to meet the post-mining land use needs.

Quadrat Sampling

1. The sampling unit is a rectangular or circular plot frame. The frame must be sized appropriately for the vegetation type being sampled. Generally, a minimum plot size of $1/4m^2$ is recommended for grassland, lm^2 for shrub land, pinyon-juniper, or salt desert vegetation. Plots may need to be as large as $10m^2$ on some sparse communities.

2. Unless the species diversity standard is to be based on production data, the data does not need to be collected or reported separately by species.

3. During the growing season in which sampling is conducted, production plots must be protected from livestock grazing, either through fencing or the use of production cages.

4. Standard clipping procedure is to clip either plants rooted in the quadrat or to clip plants and plant parts within the volumetric vertical projection of the plot. The method used must be described in the application and applied consistently in all baseline and subsequent sampling.

5. Vegetation clippings should be dried in a forced air oven or air dried until a constant weight is attained ($\pm$0.1 gram). Data should be reported as g/m^2, lb/acre, or other appropriate units and the units should be used consistently throughout the vegetation section of the application.

6. Quadrats can be located randomly, independent of transects or a number of quadrats can be placed along a transect. In the latter case, unless the sample design incorporates more than a one random start, the entire transect is the sampling unit and the individual quadrats are treated as subsamples.

G. Woody Plant Density Sampling

Rule 4.15.8 defines woody plant density as "number of countable tree and shrub stems per unit area." In the Coal Regulations, the definition of woody plant does not include half shrubs (low shrubby perennials with woody bases but herbaceous upper stems). Half shrubs (also known as suffruticose) species should be included in cover and production, but not density sampling. Common half shrub species include fringed sage (Artemisia frigida), Louisiana sagewort (Artemisia ludoviciana), winterfat (Ceratoides lanata), snakeweed, (Xanthocephalum sarothrae) and soapweed (Yucca glauca). In some cases, half shrubs may have been treated as woody plants during baseline sampling. If the established woody plant density standard for a mine was based on a pre-mining density estimate that included certain half shrubs those half shrub species should be included in post-mining woody plant density sampling, for demonstration of revegetation success.

On cropland, woody plant density sampling is not required and woody plant density is not a criterion for revegetation success. In most instances the criteria are applicable only to rangeland or wildlife habitat.

Methods and Considerations

1. The most common method of estimating woody plant density is by use of a belt transect which is usually a quadrat 1-5 meters wide running the length of a transect. All woody species rooted in the quadrat are counted. A sample can also consist of a series (minimum of 5) of square or circular plots located randomly or systematically along a randomly located transect. The latter method is more suited to very dense woody communities. As with cover and production quadrat sampling, the quadrat must be large enough to encompass individual plants of the larger species being sampled.

2. Due to the sprouting characteristic of certain species such as snowberry and chokecherry, multiple stems originate from the same root crown. This tendency creates some confusion in determining what constitutes an individual plant. To insure that comparisons between sites and between years are valid, the specific method used in counting heavily root sprouting shrubs should be described in the application.

3. In sampling of reclaimed areas which contain mature transplant clumps, the density of woody plants within the clumps should be estimated separately from surrounding seeded areas. Total woody density would be obtained from an acreage-weighted summation of mature transplant clump woody plant density and seeded area woody plant density.

4. The regulations specify that density be the success criteria for woody plants, out of a realization that a very long period of time would be required, in many cases, to develop woody cover and production comparable to pre-mine conditions. Pre-mine density estimates may or may not be the basis for revegetation success standards, depending on site specific considerations and post-mine land use objectives. In some cases, depending on the amount of available information and the Division's familiarity with the site pre-mine density sampling may not be required. This issue should be discussed with the Division prior to initiation of baseline sampling.

IV. Methods for Determining Revegetation Success

A. General Considerations

Vegetation cover, production, woody plant density and species diversity success standards must be determined prior to permit issuance, and achievement of those standards must be demonstrated prior to final bond release.

Various means of establishing success standards and methods of comparison are available to an applicant, depending on the type of operation and site specific considerations. The success standards should be based on the environmental characteristics of the affected area and the post-mining land use objectives.

B. Production and Cover

The following methods are acceptable means of establishing standards against which vegetation on the reclaimed area will be compared for bond release.

1. Reference Area - An area of at least 3 acres which will not be disturbed by mining and which is used in a direct comparison with reclaimed areas. As described in the regulations, reference areas shall be selected to be representative of each plant community within the area to be disturbed, unless otherwise approved by the Division. Two or more smaller reference areas with a combined acreage of at least three acres may be used in lieu of a single reference area. Alternatively, extended reference areas which may cover 50 to 100 acres or more are appropriate when large areas will

be disturbed, and are encouraged by the Division. Extended reference areas must be located outside of areas which would potentially be disturbed during the life of the mine.

As discussed in Rule 4.15.7(4) of the regulations, reference areas can be used in either of two methods of determining revegetation success, weighted average or individual reference area comparison. Since particular portions of a reclaimed landscape are not usually designated for the reestablishment of specific pre-mine plant communities, the weighted average comparison is most commonly employed. In this method, the acreage formerly occupied by each pre-mine vegetation type within the reclaimed parcel being evaluated for bond release is determined and the reclaimed area data are compared with weighted average reference area data. For example, consider a particular parcel of reclaimed land which supports, prior to mining, a sagebrush community on 60% of its area, mountain shrub on 30% and aspen on 10%. If mean reference area production is estimated to be 600, 1000 and 1500 pounds per acre respectively, then the weighted average reference area production mean would be 600 (.6) + 1000 (.3) + 1500 (.1) or 810 pounds per acre.

Generally, weighted-average comparisons are appropriate when the entire parcel being evaluated is either rangeland or wildlife habitat. Direct comparisons between individual reference areas and discrete reclaimed parcels are appropriate when a portion or all of the reclaimed area under consideration is designated as pastureland or cropland.

For example, consider a large surface mine which affects and will be restored to three land use types; rangeland, pastureland and cropland. The following vegetation/crop types occur within each land use category and each has an associated reference area:

Rangeland	Pastureland	Cropland
Mountain Shrub	Dryland	Wheat
Sagebrush	Irrigated	Alfalfa
Aspen		

That portion of the reclaimed parcel designated as rangeland might easily lend itself to the weighted average method, whereas land reclaimed to dryland pasture should be compared directly to the dryland pasture reference area. Direct reference area comparisons would also be appropriate for irrigated pastureland, and wheat and alfalfa cropland.

Revegetation success for production and cover is demonstrated when the reclaimed area mean is not less than 90% of the reference area (or weighted average reference area) mean, at the 90% statistical confidence level for two consecutive years. For mines to which the 10-year bonding liability period applies, sampling for the purpose of final bond release cannot begin until the 9th growing season (a stand originally seeded in the fall of 1978 would be eligible for final bond release following successful reference area comparisons in 1987 and 1988).

Application of the reference area concept to dense woody communities is often complicated by the fact that reclamation plans may not be directed toward reestablishing original woody plant densities. In such cases, some adjustment of the reference area cover or production standards may be necessary to compensate for partial elimination of the woody component. In some situations it may be appropriate to use total cover, production, or both as a success standard rather than herbaceous production and cover.

Alternatively, in woody communities characterized by dense woody cover and a weak herbaceous understory or poor condition rangeland dominated by weedy annuals or other undesirable species, a "modified" reference area based on the planned post-mining vegetation community might be appropriate. This might be a reference area which is in better condition than the affected community or in some cases it might be a reference area which represents another vegetation type present within the area to be affected. For example, a treated sagebrush reference area might also be used as a standard of comparison for non-treated sagebrush type that would not be replaced at the original woody density.

To ensure that the selected reference area standards are appropriate and attainable, the reference area should, to the extent possible, be representative of dominant pre-mining and post-mining soil conditions, slope and dominant aspect, and elevation. Additionally, in the "standard" or pre-mine community reference area approach, the dominant species in the reference and affected areas must be the same and cover and production must be demonstrated to be statistically comparable in the reference and affected areas.

2. The Historic Record

As it is conceived in the Colorado regulations (Rule 4.15.7(2)(d)(v)), the historic record approach to the establishment of revegetation success standards consists of the development over a period of time of a data base for a particular vegetation type which can be used to set standards for that vegetation type. This approach can best be applied to the establishment of standards for cover and production.

A suitable data base for the historic record would consists of at least seven years of data, collected to achieve sample adequacy and using the same sampling technique for each year. The mean value for each parameter from each yearly sampling period would averaged to obtain an overall mean which would then be used directly as the success standard.

Of considerable importance is the design of the sampling program and the selection of suitable sampling methods. Decisions must be made at the outset as to the nature of the success standards to be set. If the appropriate success standards would be total cover and production, the data should be collected accordingly. Alternatively, there are situations where herbaceous cover and production, in conjunction with woody plant density, would be the parameters of interest. This choice is based on the same considerations that apply to the establishment of reference areas. If an operator elects to pursue a historic record approach, pre-sampling discussions should be undertaken with the Division staff.

3. Technical Documents

Standards established by reference to technical documents of the USDA, USDI, or other authorities are allowed by the regulations (Rule 4.15.7(2)(d)(ii)) when specifically approved by the Division and the Director of the Office of Surface Mining. The Division should be consulted if this approach is being considered. For areas that have been previously disturbed and no adjacent sites are suitable for reference areas, technical standards may be the only option.

4. Standards Set by the Division for Disturbances Less Than 40 Acres

Rule 4.15.7(2)(d)(vi) allows for the Division to set standards of revegetation success for surface disturbances of 40 acrs or less, based on pre-mining data for the area to be disturbed which are obtained from statistically valid sampling procedures and collection methods. The applicant must provide information to the Division indicating that the data are representative of local conditions for land under proper management and that the year during which baseline sampling was accomplished was a normal or above-normal precipitation year.

A normal precipitation year is a year in which effective precipitation is at least 90% of the 10-year average and at least 90% of the 10-year monthly average for the last month of the effective precipitation period. Effective precipitation is that which falls from October 1 of the previous year to the end of the month prior to sampling.

C. Woody Plant Density

The Colorado regulations require that the density of woody plants be restored to approximate pre-mine levels following mining, with a specific provision

allowing lesser or greater densities in situations where the lesser or greater density would better achieve the goals of the post-mining land use. The inclusion of woody plant density as a success standard is based primarily on the importance of woody plants in providing browse and cover for wildlife. High density stands of sagebrush, oakbrush, and other shrubs are common throughout the coal mining regions of Colorado. In many cases, the pre-mining shrub densities may not reflect optimum conditions for wildlife use, livestock grazing or erosion control.

Woody density standards should be based on site-specific environmental conditions, importance of the mined area to particular wildlife populations, and post-mine land use objectives. Though site specific conditions may warrant higher or lower standards, some general guidelines have been developed by the Division and the Colorado Division of Wildlife (DOW) for woody plant communities in western Colorado, as set forth below:

1. When aspen communities or shrub habitats identified as big game winter range are disturbed, the woody density standard should be a minimum of 1000 stems per acre, and the plantings ideally should be concentrated on between 25 and 50 percent of the affected area. Within the concentrated planting areas, the densities would need to be high enough that, when averaged in with the woody density over the remainder of the area, the overall density of 1000 stems per acre would be achieved.

2. On sage grouse winter range, the standard should be a minimum of 3000 sagebrush stems per acre.

D. Species Diversity

The regulations require coal operators to establish a diverse vegetative cover on reclaimed lands and allow for the use of pre-mining data as the basis for evaluating species diversity on revegetated areas. The Division recommends that a simple comparison of species composition, life form, and seasonality between pre-mine communities and the revegetated area be employed to demonstrate success in establishing a diverse vegetative cover.

In general, for herbaceous vegetation, the number of perennial herbaceous species contributing greater than 3 percent relative production or cover in the pre-mine data for each affected community designates the number of species, the seasonality and the life forms of the species to be established on the reclaimed area. As with reference areas, success can be evaluated based on a direct comparison between a particular pre-mine community and corresponding parcel of reclaimed land, or the evaluation can entail a weighted average comparison based on the relative acreage occupied by various vegetation communities prior to disturbance of the reclaimed parcel in question. An illustration of the weighted average comparison approach is provided below.

Vegetation Type A = 25 Acres

3 cool season grasses, each contributing greater than 3 percent relative cover, and 1 perennial forb contributing greater than 3 percent relative cover

Vegetation Type B = 50 Acres

4 cool season grasses, 2 warm season short grasses, and 1 perennial forb contributing greater than 3 percent relative cover

Vegetation Type C = 25 Acres

2 cool season grasses, 2 forbs greater than 3 percent relative cover

The species diversity standard for the reclaimed parcel (assuming that cool season grass, warm season short grass, and perennial forb were selected as the life forms of concern) would be at least 3 cool season grasses, 1 warm season short grass and 1 perennial forb exhibiting greater than 3% relative cover. To ensure that no one species dominates the stand to the extent that desired species are inhibited, a maximum allowable relative cover value for any one species would also be set, based on the relative cover of the most dominant species in the pre-mine communities (e.g., if the relative cover value of vegetation type A dominant was 25%, vegetation type B dominant was 30% and vegetation type C dominant was 40%, the maximum cover value would be 40%). The standard would not be based on pre-mine composition of poor condition rangelands.

E. Cropland

The regulations state that for areas to be used as cropland, success of revegetation shall be determined on the basis of crop production from the mined area as compared to approved reference areas or other approved standard(s) (Rule 4.15.9). The most logical non-reference area standard would be local yield averages for a particular crop. For example, if the pre-mine and post-mine land use in an affected area is dryland wheat production, the yield from the area prior to mining would be compared to the average yield of adjacent fields, and a ratio established which would be used to modify the local average for bond release comparisons.

In the case of irrigated cropland, yields from the affected area prior to mining would generally be an acceptable alternative to the reference area. Ideally, the standard should be based on average yield over a number of years.

In instances involving a change in post-mining land use from rangeland or wildlife habitat to cropland, or where the crop grown post-mining is different than the crop grown prior to mining, standards will have to be established on a case-by-case basis, but would generally be based on local yield averages.

F. Previously Mined Areas

Areas disturbed by mining activity prior to August 3, 1977 and not reclaimed to the requirements of the Surface Mining Control and Reclamation Act (SMCRA) must be reclaimed to the standards of Rule 4.15.10 if they are redisturbed by mining activity.

Vegetation cover is the only standard of success on these areas. The standard will be established on a case-by-case basis, but must be at least equal to the cover existing prior to re-disturbance, and be adequate to control erosion.

Areas disturbed prior to August 3, 1977 which have been in continual use by the mining operation (such as long-term facilities and underground mine benches) are not considered to be "previously mined areas." Such areas are subject to the revegetation success standards of Rule 4.15.8.

V. Statistical Evaluations

A. Sample Adequacy Determination

The regulations require a demonstration that pre- and post-mine vegetation communities and reference areas have been sampled so as to obtain a statistically valid estimate of the mean for particular parameters such as cover, production and woody plant density. The Snedecor-Cochran sample size adequacy formula is recommended by the Division, as detailed below.

$$N_{min} = \frac{t^2 s^2}{(d\bar{x})^2}$$

Where:

N_{min}	=	the minimum number of observations needed,
t	=	1.64 (which is the t table value for a double-tailed t test with infinite degrees of freedom at the 90% confidence level),
s^2	=	the sample variance,
d	=	.1 (level of precision for estimate of the mean to be within 10% of the actual mean),
$\bar{x}$	=	sample mean (= the sum of the sample values divided by the total number of samples)

The applicant should obtain a minimum of 15 samples for baseline vegetation communities and post-mine sample areas and 10 samples from reference areas whenever sampling is conducted. In some cases, vegetation community structure is such that obtaining an adequate sample for certain parameters is exceedingly difficult. An upper limit of 50 samples is usually set, if appropriate sampling procedures (i.e., vegetation mapping, random design, quadrat size, transect length, etc.) as set forth in Section III of this document are followed.

B. Reference Area Comparison

When reference areas are utilized as standards of success for vegetation cover and production, demonstrations are required prior to permit issuance to show that the reference areas are statistically comparable to the vegetation types which will be affected. Later, when at least 9 years have passed since a reclaimed parcel was reseeded, (assuming the 10-year liability period applies) a demonstration must be made that the reclaimed are cover and production means are at least 90% of the reference area cover and production means with 90% statistical confidence in each of 2 consecutive years.

Pre-mining Comparisons

The pre-mining demonstration of reference area comparability can be made using the Students t-test as set forth below. Reference area production and cover should be comparable at the 95% confidence limit with affected area production and cover. The following is modified from Larson (1980).

Evaluation of pre-mine vegetation type and reference area cover
Null hypothesis H_o: Reference area cover is equal to vegetation type cover
Alternate hypothesis H_a: Reference area cover is not equal to vegetation type cover

Determine the calculated t value (t_c) using the following t-test equation. Obtain the comparison standard from a t-distribution table for two-tailed t value. The appropriate table t value (t_t) is determined from the t table value for the pooled sample degrees of freedom [$(n^j + n^i) - 2$ d.f.].

$$t_c = \frac{\left| \bar{x}_j - \bar{x}_i \right|}{\sqrt{\frac{sp^2}{n_j} + \frac{sp^2}{n_i}}}$$

Where:

$\underline{x}_j$	=	Reference area cover sample mean
x_i	=	Affected vegetation type cover sample mean
n_j	=	Number of reference area samples
n_i	=	Number of affected vegetation type samples
t_c	=	Calculated t value
sp^2	=	Pooled sample variance

$$= \frac{(n_j - 1)(s^2_j) + (n_i - 1)(s^2_i)}{(n_j + n_i) - 2}$$

If t_t is greater than t_c, the null hypothesis (H_o) would be accepted. If t_t is less than t_c, the null hypothesis would be rejected and the conclusion would be that reference area cover is not equal to the affected area vegetation type cover.

Post-mining Comparisons

The post-mining demonstration of revegetation success for cover and production can also be made through a t-test comparison of the reclaimed area cover and production means and the reference area cover and production standards (90% of the means). The statistical test is necessary only when the reclaimed area sample mean is less than the reference area standard and it is necessary to determine if the difference is statistically significant at the 90% confidence level.

Once the data have been collected on the reclaimed and reference areas and the means and variances (weighted mean and weighted variance if weighted average comparison is to be used) have been calculated, the following test can be employed, as described in Larson (1980).

Null hypothesis H_o: Revegetated area cover is greater than or equal to reference area standard

Alternate hypothesis H_a: Revegetated area cover is less than reference area standard

$$t_c = \frac{.9\bar{x}_j - \bar{x}_i}{\sqrt{\frac{sp^2}{n_j} + \frac{sp^2}{n_i}}}$$

Where:

$\underline{t}_c$ = Calculated t value
$\underline{x}_j$ = Reference Area Sample Mean
x_i = Revegetated Area Sample Mean
n_j = Number of Reference Area Samples
n_i = Number of Revegetated Area Samples
sp^2 = Pooled Sample Variance

If t_c is less than or equal to the one tailed t value at the 90% confidence level for $(n_j + n_i) - 2$ degrees of freedom, the null hypothesis (H_o) is accepted and revegetation efforts are considered successful for the parameter (cover or production) being evaluated.

The preceding discussion of statistical evaluations is a brief summary of statistical methods applicable to determinations of sample adequacy and reference area comparison. More detailed treatment of various statistical methods applicable to evaluation of vegetation data can be found in the references listed under Vegetation Sampling and Statistics in Appendix C.

VI. Development of a Revegetation Plan

Rule 4.15.1(1) requires every surface coal mining operator to " . . establish on all affected land a diverse, effective, and permanent vegetation cover of the same seasonal variety native to the area of disturbed land, or species that support the approved post-mining land use." The initial step taken to achieve this goal is the development of a revegetation plan (reference Rule 2.05.4). Specific considerations in the development of a revegetation plan include the following:

A. Post-mining land use,
B. Seeding and planting,
C. Introduced species,
D. Soil stabilization,
E. Soil amendments and fertilization,
F. Irrigation,
G. Weed and pest control,
H. Field Trials,
I. Monitoring, and
J. Management under liability period.

A. Post-mining land use

Typically, the post-mining land use will be the same as the pre-mining land use. If this is the case, the applicant can utilize the information obtained during the pre-mining inventory and sampling to assist in developing the revegetation plan. If a post-mining land use different than the pre-mining land use is proposed, the revegetation plan will need to reflect these variances. Narrative discussions pertaining to the proposed post-mining land use need to be provided in the permit application to comply with Rules 2.05.5 and 4.16. Along with this narrative description, the applicant must provide " . . . a copy of the comments concerning the proposed (land) use by the legal or equitable owner of record of the surface of the proposed permit area . . ." as required pursuant to Rule 2.05.5(1)(b) or (2)(b).

B. Seeding and planting

Once the post-mining land use for various portions of the permit area has been established, a seeding and planting plan must be formulated which will minimize erosion and soil loss and which will satisfy the post-mining land use needs. Small mines typically affect only one or two vegetation types and identify a single post-mining land use, whereas large surface mines may affect several thousand acres encompassing two or more land uses as well as wide variation in elevation, precipitation, topography, aspect, soils and vegetation.

For a typical small mine, post-mining environmental conditions may be sufficiently uniform that a single seeding and planting plan would be applicable to the entire site. In the case of large mines, separate seed mixes and planting plans tailored to anticipated post-mining environmental conditions may be warranted. For example, a different suite of species would be adapted to deep sandy loam soils on a north slope at an elevation of 8000

feet than would be adapted to shallow clayey soils on a south facing slope at and elevation of 6000 feet and specific aspects of the revegetation plan should reflect this consideration.

When wildlife habitat or rangeland/wildlife habitat is the post-mining land use, seed mixes should contain a variety of adapted herbaceous and woody species. The number of species should be sufficient to ensure compliance with the revegetation success standards (Rule 4.15.8), and to occupy the various ecological niches on the reclaimed surface. In general, if a single seed mix is to be used over a large, ecologically variable area the number of species and the overall seeding rate would need to be increased in comparison to a plan that included specific seed mixes for specific ecological response units.

Besides formulating the permanent seed mixtures, the applicant should develop seed mixtures for temporary reclamation such as topsoil stockpiles, road cuts, and other disturbed areas needing protection from wind and water erosion on an interim basis. Development of the temporary seed mixture should take into consideration the factors addressed above as well as suitability for the intended use (e.g., good ground cover, quick growing, etc.). Also, the species included in the temporary seed mixture should be compatible with the species composing the permanent seed mixture. The concern the Division has is that species expressed in the temporary seed mixture could eventually be expressed in the permanent reclaimed areas.

The Soil Conservation Service (SCS) has accumulated data from numerous studies throughout Colorado which have allowed the development seeding rate recommendations for a variety of seeding practices. Of particular note are the rates recommended for "Critical Area Planting." A "Critical Area," as defined by the SCS, is " . . . highly erodible or critically erodible or critically eroding areas" that encompass surface-mined areas. The seeding rate defined by the SCS for "Critical Area Planting," taking into consideration environmental factors applicable to Colorado, is 40 pure live seeds per square feet (PLS/SQ.FT.) for non-irrigated areas and 50 PLS/SQ.FT. for irrigated areas. As further specified by the SCS, "Actual seeding rates should be within 90 to 125 percent of the rates given above." the 40 PLS/SQ.FT. rate is the drill seeding rate. For broadcast seeding the rate should be doubled. For most grasses and forbs drill seeding is preferred over broadcast seeding. Most species should be seeded at a depth of between 1/4 and 1/2 inches.

Whenever broadcast seeding is utilized it is necessary to cover the seed. Without seed coverage,the probability for successful revegetation is greatly diminished. One method is to drag the site to cover the seed with soil to ensure proper seed-to-soil contact. Another method is to hydromulch the site following seeding to cover the seed. It should be stressed, however, that combining seeding and hydromulching into one step is not an accepted practice. Combining these two steps causes the seed to be thoroughly mixed with the hydromulch and, when spread onto the reclaimed slope, the seed is unable to make the necessary seed-to-soil contact. Therefore, the site should be seeded in the first step followed by hydromulching as a separate step.

Seeding should be accomplished immediately prior to the season(s) of most reliable precipitation. In most parts of Colorado this means seeding should be done in late Fall. Seeding should be late enough in the year to prevent germination but prior to snow accumulation. Generally, this correlates to seeding between September 15 and October 15. These dates are subject to modification to reflect actual conditions at each particular site. Seed tags should be retained as documentation that the approved seed mix was used.

Monitoring reports and observations of reclamation in Colorado have shown that in general, reestablishment of herbaceous vegetation sufficient to meet cover and productivity success standards is being met with traditional rangeland seeding methods. However, reestablishment of slow growing woody plants and less competitive forbs has proven more difficult. In order to meet woody plant density and species diversity success standards within an acceptable period of time, methods other than traditional drill seeding will usually need to be applied on portions of reclaimed areas when wildlife habitat or rangeland/wildlife habitat is a post-mine land use.

A technique which has shown considerable promise is live topsoil handling (direct application of freshly stripped topsoil to regraded areas). The live handling preserves the biological component of the topsoil (seeds, vegetative propagules and microorganisms) which is impacted by stockpiling for long periods of time. In field trials at one Routt County mine, the practice has resulted in successful initial vegetation establishment with no supplemental seeding. In the field trials, aspen and mountain shrub woody vegetation was shredded and picked up with the topsoil.

Other promising methods of establishing shrubs and less competitive forbs from seed usually entail minimizing herbaceous competition during establishment. One technique is to seed shrubs and native forbs in the first appropriate season after topsoiling, with grasses and more aggressive forbs interseeded the following year. Competition can also be minimized by seeding a shrub/forb only mix in alternate drill rows or in small patches or irregular strips within a larger area seeded with a standard rangeland mix. When quick growing grasses are excluded from a seed mix or seeded in subsequent years, attention must be given to stabilizing the site through alternative means. Shrub establishment efforts should be concentrated in mesic sites conducive to their growth where erosion is not an overriding concern. Quick, effective and permanent vegetative erosion control should be the primary reclamation objective on harsh sites and steep slopes and adapted perennial grasses should always be utilized in such situations.

In addition to direct seeding, woody plants are frequently transplanted as seedlings or mature transplants in order to augment the direct seeding and live handling methods. Seedling transplants are subject to many of the same establishment problems as seeded woody plants, and due to the time and labor involved in planting, it is critical that consideration be given to selection of optimal planting sites, minimization of herbaceous competition and damage by herivores, and proper planting technique.

Mature transplanting usually involves the movement of tree or shrub pads with a front-end loader or more specialized equipment from areas in advance of topsoil stripping to regraded soils. The technique is encouraged by the Division in that it augments the other establishment methods, and can enhance the wildlife habitat value of reclaimed areas during the early years of reclamation. Mature transplant clumps also serve as centers for seed dispersal and vegetative propagation.

Techniques of vegetation establishment with applicability to reclamation of coal mined lands in Colorado are addressed in numerous publications, several of which are listed under Revegetation Techniques in Appendix C.

C. Introduced Species

When rangeland or wildlife habitat is the intended post-mining land use, the seed mixture should be composed predominately of species native to the area. In some instances, however, it may be necessary to include introduced species in the seed mixture. The use of introduced species is an acceptable practice if the requirements of Rule 4.15.2 are met by the applicant, demonstrating that the proposed species are appropriate, and necessary. Appendix B is the latest listing of noxious plants for the State of Colorado. The surface coal mining operator should consult this listing when addressing the requirements of 4.15.2(2).

Certain introduced species which have been widely used in the past for stabilization of disturbed land are characterized by their low cost, ease of establishment and aggressive nature. Examples would be intermediate wheatgrass (Agropyron intermedium), pubescent wheatgrass (Agropyron trichophorum), smooth brome (Bromus inermis) and alfalfa (Medicago sativa).

Under certain conditions, such as steep slope areas where soil stabilization is an overriding concern, or when the land is reclaimed to intensively managed pastureland, some combination of the above species may be warranted and appropriate. However, due to their aggressive tendencies and the resultant suppression of woody plants and less aggressive herbaceous species, they should be used cautiously, if at all, in other situations. Alfalfa, in addition to its aggressive tendencies, can cause bloat in cattle and therefore should generally not be included in rangeland seed mixes.

D. Soil Stabilization

Rule 4.15.4(1) specifies that "Soil stabilization practices approved by the Division shall be used on all regraded and topsoiled areas." A primary objective of reclamation is to achieve soil stabilization through establishment of an effective, permanent vegetation cover. Unfortunately, a number of years is required in most cases before a newly seeded perennial stand provides cover sufficient to stabilize the soil. Therefore, it is necessary to combine the practice of seeding the site with one or more temporary soil stabilizing practices to ensure adequate protection from wind and water erosion during the first few growing seasons. Soil stabilizing practices include mulching with straw or hay, netting, hydromulching, and

stubble mulching, as well as various soil surface manipulation techniques designed to retain or divert surface runoff. On long slopes typically encountered at surface mines, temporary diversion ditches spaced at appropriate intervals are often necessary to prevent excessive rilling and gullying in the early years of reclamation.

The predominant form of soil stabilization used in conjunction with seeding is usually mulching with straw or hay. Typically, straw or hay is spread over the site immediately following seeding at 1 1/2 - 2 tons per acre. Immediately following spreading, it is necessary to anchor the straw or hay to the soil by crimping to avoid loss of this protective material. When utilizing this form of mulch, it is imperative that the operator obtain as clean a straw or hay as possible to reduce the potential for introduction of unwanted plant species.

On exceedingly steep slopes that are mulched with straw or hay, it may be impossible for safety reasons to crimp this material into the soil. The common practice is to utilize netting or asphalt emulsion tackifier to hold the straw or hay mulch in place. Netting may not be effective if it is not properly anchored to the soil. Proper installation generally requires between three and five staples per square yard. Also, if plastic the netting should be ultra-violet (UV) sensitive to ensure breakdown in a timely fashion.

Hydromulching is another method that can be used along with seeding for soil stabilization purposes. As mentioned above in the "Seeding and Planting" section, seeding and hydromulching must be done in separate steps. The common practice is to hydromulch at 1500 pounds per acre. On steep slopes where the potential for soil erosion is greater, the surface coal mining operator should utilize hydromulch with a soil tackifier.

On level or gently sloping sites, the operator could use a stubble mulch for soil stabilization purposes. Commonly, the mulch crop, generally an annual grain species, is planted during the spring to stabilize the site until the permanent seed mixture is sown in the fall. It is important that the cover crop be mowed prior to seed head production to lower the potential for continued re-colonization by the cover crop. Failure to properly manage annual grain cover crops has resulted in complete failure of perennial stands due to competition from volunteer wheat and barley.

E. Soil amendments and fertilization

Rule 4.06.5 requires the surface coal mining operator to test the redistributed topsoil for nutrients or other soil amendments to be applied based on the soil test results. This testing should be accomplished for all redistributed topsoil except when high nutrient topsoil is direct hauled from removal area to redistribution area with no intermediate stockpiling. In these instances, the topsoil would have sufficient nutrients with minimal deterioration from hauling. These high nutrient topsoil areas would be identified during the baseline inventorying of soil. For all other topsoil redistribution scenarios, it is necessary to analyze the soil. The most common parameters analyzed are pH, nitrogen, phosphorous, potassium, and organic matter. Depending upon the results from the baseline soils inventory,

it may be also necessary to analyze for electrical conductivity (EC), sodium adsorption ratio (SAR), bulk density, and micronutrients. The applicant should specify the parameters to be analyzed and include a sampling plan and soil amendment plan for redistributed topsoil in the permit application when addressing Rule 4.06.5.

F. Irrigation

One of the more critical times in the reclamation of disturbed lands is during seed germination and early establishment. In arid regions of the eastern plains or extreme western Colorado, irrigation may be necessary, in some cases, to ensure satisfactory germination and establishment. When the proposed post-mining land use is irrigated cropland or pastureland, irrigation will always be an integral part of the reclamation plan every year. In all other instances, however, irrigation would only be used for initial stand establishment. Following successful stand establishment, it is necessary to wean the vegetation from the supplemental water and force the seedlings to survive with only the natural precipitation.

One approach is to supplement rather than replace natural precipitation through irrigation. This can be accomplished by irrigating only in conjunction with precipitation up to the average amount of precipitation for that particular month. The precipitation information will be contained in the permit application to comply with Rule 2.04.8. Therefore, the operator needs only to collect monthly precipitation at the mine site by using rain gauges. The difference between current month precipitation and average precipitation would be augmented by irrigation. When irrigation is stopped, a plant stand should have been developed to withstand typical environmental conditions at the site.

The information pertaining to irrigation should be presented by the applicant in the permit application when addressing Rule 2.05.4(2)(e)(v).

G. Weed and Pest Control

Successful vegetation establishment may be inhibited by weed or pest problems. On recently revegetated areas, the predominant plant species may be annual weeds. After two to three years, however, these weed species usually are replaced by the planted perennial vegetation. If this transformation does not occur, it will be necessary for the operator to take corrective steps such as interseeding, spraying, or mowing to control the situation.

A potentially more serious problem than annual weeds is represented by noxious perennial weeds such as Canada thistle and leafy spurge, and biennial weeds such as musk thistle, Scotch thistle, spotted knapweed, and houndstongue. In order to minimize the potential for serious weed infestation, all seed materials should be certified as weed-free by the Colorado Seed Lab or equivialent authority if seed is obtained from a neighboring state. Measures should be taken to control such plants when they are observed on reclaimed areas. Appendix B is the current listing of noxious plant species in Colorado.

One last area of concern on revegetated areas is the invasion of insect pests such as grasshoppers which can cause considerable damage during high infestation years if not controlled.

Rule 2.05.4(2)(e)(v) requires that the applicant address plans for " . . pest and disease control, if any." Unfortunately, the applicant is not able to address all of the various pests, diseases or weed species that may be encountered years down the line during revegetation. Therefore, it may be necessary for the operator to submit a revision to the permit addressing this issue when the problem is encountered. Prior to submittal, the operator should consult with the local extension agent or other appropriate authority regarding the problem and proposed control measures to ensure compliance with local, state, and federal laws. A commitment within the permit application to the consultation and revision submittal is adequate to satisfy the requirement of 2.05.4(2)(e)(v).

H. Field Trials

Applicants may elect to conduct field trial tests to evaluate individual species, mixes, planting techniques or other treatments on designated research plots within the permit area. Under certain situations, such as when untested techniques or species are being proposed, the Division may require the use of field trials prior to approving large-scale application. Field trial locations should be depicted on a permit area map, and the experimental objectives, design and proposed methods of evaluation should be included in the text of the application.

I. Monitoring

Periodic revegetation monitoring and reporting is generally required by the Division primarily for the purpose of identifying problem areas that may require maintenance or retreatment and for the purpose of providing information regarding the relative merits of various species, mixes and cultural treatments. Limited interseeding, planting, erosion repair, etc. can be conducted during the first 5 years following initial reseeding without reinitiating the 10-year liability period. For this reason, the Division generally recommends that monitoring be conducted during the second or third growing season, and periodically thereafter (every 2-4 years) until bond is released.

A detailed description of the monitoring plan, including a schedule for report submittal should be included in the permit application. The report should include appropriate maps and tables identifying the sampled area, and seeding period as well as the summarized data and an evaluation of the status of the stand. In most cases, vegetation cover and woody plant density data is sufficient for monitoring purposes, though in special cases, production or frequency data may be appropriate. Data should be summarized in tabular form by species. A minimum of 10 samples should be taken within individual seeded stands. Extensively eroded areas not representative of the site should not be sampled, but the extent of such areas should be reported. Likewise, sample transects should not bisect mature shrub transplants, since the purpose of the monitoring is to obtain a representative estimate. Density of woody plants within mature transplant clumps should be estimated separately from the seeded area, and the relative acreage occupied by the clumps should be reported.

J. Management During the Liability Period

During the first five years of the liability period, maintenance activities such as rill an gully repair and limited interseeding and planting for the purpose of increasing diversity or woody density or treating small problem areas can be undertaken without reinitiating the 10-year liability period. As discussed previously under weed and pest control, it is difficult to predict what measures may be necessary until the problem is identified. With respect to rill and gully erosion, methods for locating and repairing excessive erosion would be set forth in a rill and gully stabilization plan pursuant to Rule 4.14.6 (see the Division's May 2, 1985 policy memorandum, Management of Rills and Gullies).

Livestock grazing cannot be conducted on reclaimed areas until at least one year after seeding or planting, and generally it is advisable to delay grazing at least one additional year. Livestock must be closely managed on reclaimed lands during the liability period to ensure that grazing is not contributing to excessive erosion or otherwise having a detrimental effect on the establishment of the planned post-mining land use. A plan for preventing livestock grazing during establishment must be included in the permit application, and it is recommended that a plan for managing grazing during the liability period be included as well.

APPENDIX C

SUGGESTED REFERENCES

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