A METHOD FOR ASSESSING VEGETATION ADEQUACY FOR PHASE II BOND RELEASE IN MONTANA[1]

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Abstract. Phase II bond release is defined in Montana as "soil replacement and soil tillage being completed and perennial vegetation establishing that is consistent with revegetation criteria" (ARM 17.24.1116). Office of Surface Mining Reclamation and Enforcement (OSMRE) rules (30 CFR 800.40) define Phase II bond release as "after revegetation has been established on the regraded mined lands in accordance with the approved reclamation plan." These definitions are similar, but not identical, and neither definition mandates quantitative measures that provide objective standards for judging success or failure. In the past, judgments have sometimes differed between various mine inspectors. This problem is exacerbated in years where high production of introduced opportunistic species, such as annual bromes (*Bromus tectorum, B. japonicus*) or yellow sweetclover (*Mellilotus officinalis*), may obscure the perennial vegetation.

A method for determining the adequacy of vegetation establishment for Phase II bond release for surface coal mines in Montana is described. The method is designed to be quick, easy, and objective. It is used only for areas where questions or disagreements between regulatory personnel exist. The method assesses the percentage of 0.1 m^2 sample hoops that contain adequate perennial vegetation. We provide details for the method used in Montana, and we discuss potential adaptations for other geographic areas as well.

Additional Key Words: vegetation standards, mine reclamation

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[1] Paper was presented at the 2009 National Meeting of the American Society of Mining and Reclamation, Billings, MT, ***Revitalizing the Environment: Proven Solutions and Innovative Approaches*** May 30 – June 5, 2009. R.I. Barnhisel (Ed.) Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502.

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Proceedings America Society of Mining and Reclamation, 2009 pp 348-358
DOI: 10.21000/JASMR09010348
http://dx.doi.org/10.21000/JASMR09010348

Introduction

The predictability of bond release has become increasingly important to surface mine operators as the cost of bonding has increased, and the availability of credit has decreased. Physical parameters for Phase I and II bond release, such as post-mine topography, generally have less inherent variation and are more easily and precisely measured than biological parameters, such as vegetation. Quantitative vegetation success standards for Phase III bond release are specified in detail in the Code of Federal Regulations (30 CFR 816.116) and in state regulations with federally approved programs.

However, no quantitative vegetation success standards or other objective assessments are specified for Phase II bond release. Thus, mine inspectors have relied on subjective assessments that may differ with inspector, site, vegetative phenology, and even occurrence. This problem is exacerbated in those years where high production of introduced opportunistic species, such as annual bromes (*Bromus tectorum*, *B. japonicus*) or yellow sweetclover (*Melilotus officinalis*), may obscure the perennial vegetation.

In such circumstances mine operators cannot dependably know whether an area can reasonably be expected to meet Phase II bond release criteria. In the past, operators often waited to apply for Phase II bond release until an area was measurably ready for Phase III. In the current fiscal environment, this strategy becomes very costly. Differences of opinion between inspectors also erode the credibility of regulatory agencies.

In Montana Phase II bond release is defined as "soil replacement and soil tillage being completed and perennial vegetation establishing that is consistent with revegetation criteria" (ARM 17.24.1116). Federal rules (30 CFR 800.40) define Phase II bond release as "after revegetation has been established on the regraded mined lands in accordance with the approved reclamation plan." These definitions are similar, but not identical. This ambiguity, combined with frustration engendered by the subjective nature of Phase II bond release inspections, prompted us to develop a field method for determining the adequacy of perennial vegetation for Phase II bond release. Requirements for this field method were that it:

- be quickly and easily accomplished in the course of a normal bond release inspection;
- utilize simple and transparent calculations;
- provide an objective measure that made sense from an ecological standpoint;

- provide an unambiguous basis for the decision to deny or grant bond release;
- be accepted by all involved parties from the OSMRE Casper Field Office and the Montana DEQ Coal Program.

The requirement for strict statistical rigor and validity was deliberately excluded from the list of requirements for the methodology, based on the rationale that such a requirement for Phase II bond release would exceed the requirements in federal and state law and rules. This paper details the methodology we developed.

Assessment Considerations

Mine operators may apply for Phase II bond release after: 1) regrading has been completed and approved; 2) soils have been replaced; 3) perennial vegetation has been seeded; and, 4) at least two growing seasons have passed after seeding is completed. In contrast, application for Phase III bond release (final bond release in all states except Montana, which has a fourth phase) cannot be made until a minimum of ten years after seeding for reclaimed mined areas receiving 26.0 inches or less average annual precipitation (30 CFR 816.116(c)(3)). The ten-year period is expected to result in development of the re-established vegetation to the extent that production and cover compare favorably with unmined reference areas. However, the emphasis for Phase II is that perennial vegetation has become adequately established. "Establish" is defined as "to make firm or secure, fix in a stable condition" (Morris 1969). Thus, for plants, "establishment" would mean that they have progressed beyond the seedling stage. We have chosen to consider established perennial plants as those that have at least three true leaves.

The adequacy of perennial vegetation establishment is apparent in many areas during bond-release field inspections. In the coal-producing region of southeastern Montana, such conditions entail fairly dense perennial grasses with relatively low preponderance of bare ground and weedy annual species. Shrubs may be quite small if they are present at all. Perennial forbs are a minor component even in fully developed vegetation. Other areas may appear obviously inadequate, as when a seeding has clearly failed, and bare ground dominates, or the only vegetation is weedy or invasive annual species.

However, some reclamation units, or substantial portions of units, may be questionable to one or more observers. Some areas a few years after seeding have a high cover of ruderal species, either native or exotic, mixed with perennial vegetation. These ruderal species will typically drop out of the community or persist only in small proportions with the growth and eventual dominance of the perennial vegetation. Examples of such species are kochia (*Kochia scoparia*) and tumble mustard (*Sisymbrium altissimum*). At other times, weather conditions of the previous fall and spring create an unusual abundance of opportunistic species such as annual bromes or yellow sweetclover. In southeastern Montana, the abundance of annual bromes varies greatly from year to year in both undisturbed and reclaimed areas and is seldom indicative of a successional change (Buckner and Downey, *in press*). The abundance of such species creates visual and botanical "noise" which may distract inspectors from an accurate perception of the established perennial vegetation. This is especially the case when the perennial vegetation is over-topped by opportunistic species. One is inclined to cast a gaze across such a field and exclaim, "It's all just cheatgrass!" The question to be answered in these situations is whether an adequate density of perennial plants is present, not whether or not it is a good year for annual bromes.

After an initial visual assessment, inspectors and mine personnel should agree, on which areas clearly "pass," which "fail," and which are in question. Areas with either contradictory opinions or where everyone agrees that it is "too close to call" are those areas that should be objectively assessed.

Ideally, assessments will be made on discrete reclamation units or fields. A reclamation unit or field is defined as a contiguous area of land, all of which was planted at the same time using the same seed mix. For fields that appear inconsistent across their extent (i.e., one part clearly has adequate perennial vegetation, and another part is questionable), the inspectors must decide if the entire field is to be assessed or only the questionable portion. If the regulatory agency or the mine operator is unwilling to partition off the questionable portion for bond release and future tracking, or if the questionable area is less than three contiguous acres, the field should be assessed in its entirety. If neither of these conditions pertains, the assessment should be applied to the entire field for both sampling purposes and bond release.

One further consideration is that an electronic polygon for the assessment area is useful during sampling. Mine operators are likely to have such polygons already available for reclamation units, but a new polygon would need to be created before the quantitative assessment is performed for an assessment area of lesser spatial extent than the entire reclamation unit. With the appropriate GPS equipment, the polygon for the partial field unit could be delineated by walking the perimeter of the area in question while recording GPS positions.

Methodology

Sampling Approach

The method by which we assess the adequacy of established perennial vegetation is analogous to frequency, which ultimately equates to density (Elzinga et al., 1998). Using a 0.1 m^2 sampling frame or hoop[1], we assess the percentage of samples that contain hits of established perennial plants. If a frame is used, it should be square, rather than rectangular, so as to minimize the perimeter relative to the area; for this reason, as well as ease of use, we prefer a hoop. For southeastern Montana, we have defined a hit as the presence of two or more established perennial plants. Particular species are irrelevant, with the exception that noxious weeds may not contribute. As long as the plants are perennials, they may be native or introduced grasses, forbs, shrubs, or trees.

We use a stratified-random approach to collect the samples that is designed to eliminate bias and provide an adequate assessment of the entire sampling area. Depending on the size and shape of the area to be sampled, we plan a travel path crossing back and forth from side to side or end to end. We also decide how many paces we will travel between sampling locations, a minimum of five paces and a maximum of 30 paces. We target collection of 100 samples from 50 locations (i.e. two hoops samples from each location); very large areas would require more, and small areas may require fewer. Even for very small areas, a minimum of 50 samples should be read. Large areas may require as many as 250 samples.

Sampling Logistics

Sampling is best done with at least two people. The recorder keeps track of position to assure that sampling stays within the area of concern using a GPS unit, determines the sampling locations, and records the results. The sampler places and reads the frames or hoops. Using a spatially-referenced view of the polygon in question on the GPS screen, the recorder proceeds the predetermined number of paces along the travel path. The sampler then joins the recorder, turns with his or her back toward the direction of travel and tosses the sampling hoops over the

[1] A sampling hoop of 1 ft^2 may also be used, as they differ little in area; 1 ft^2 = 0.0929 m^2. Thus using the 1 ft^2 sampling hoop is approximately 7% more conservative than using 0.1 m^2.

shoulder. A blind toss is used to insure randomness and lack of bias. The sampler then locates the hoops, assesses whether or not two or more established perennial plants are present[2] and informs the recorder of the results. The recorder must note samples with adequate vegetation, as well as those without to keep track of the total number of samples collected. The recorder then paces off along the travel path to the next sampling location, and the process continues until the area has been covered.

Suggested Practices

Ideally, assessment should be conducted when annual plants have cured and perennial plants are still green, and the two can be easily distinguished from one another. In southeastern Montana, this set of circumstances usually occurs between mid-June and mid-August. If sampling is done too early in the spring, all plants are green shoots and must be examined closely to determine if they are annuals or perennials. More leeway exists at the late end of the season, as long as flowers and/or fruits remain intact. However, hailstorms and strong winds may remove such evidence rather abruptly.

We prefer to use sampling hoops, rather than frames, as they are light, strong, and easily coiled to fit into a daypack. A hoop can be constructed using 3-4 mm diameter wire cable joined together with cable coupling so that the resulting hoop has the requisite area. For a 0.1 m^2 hoop the finished length of cable (the circumference) must be 1.12 m, and the diameter will be 0.357 m. The cable may be threaded through plastic tubing prior to connecting the coupler to make the surface smoother if the cable is very rough. Bright flagging should be attached or the cable should be spray-painted with a bright color for ease of location in the field.

If vegetation is tall and dense, the hoops have a tendency to become lodged in the upper layers, rather than landing evenly on the ground. In such cases sampling points can be established by tossing a lawn dart, or even a small rock, and then centering the hoop or frame over the point of impact.

Recording is most easily done using the dot-count method, as illustrated in Fig. 1. This method allows quick tallies based on groups of ten, thus facilitating tracking of the number of samples completed.

[2] In southeastern Montana, the one exception to requiring two perennial plants to count as a hit occurs when one plant (usually a bunchgrass) is so large that it essentially fills the frame or hoop.

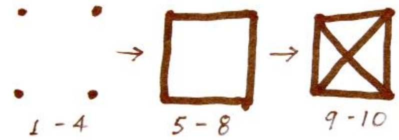

Figure 1. Dot-count tallying example.

Ecological factors such as species diversity, plant vigor, population age structure, and any other pertinent information should be noted in the course of the assessment.

Finally, control must be implemented to insure that all samples fall within the area in question. The unit boundaries must be definitively marked in the field if GPS technology is not available for checking position against a spatially-referenced polygon.

Determining Results

Once sampling is completed, we tally the number of samples that passed vs. failed and calculate the result as a percentage. For southeastern Montana, we want a minimum of 70% of the samples to contain two or more established perennial plants. See Fig. 2 for an example of a completed data sheet. A results of 70% or greater does not always mean that the unit in question will pass bond release. If the result is marginal (e.g. 72%) and most of the plants were extremely young and small, inspectors still have the flexibility to deny bond release. However, if the result is marginal, but the majority of plants were large and robust, inspectors may justifiably grant bond release.

Discussion

This method provides two specific advantages for determining vegetation adequacy for Phase II bond release when such adequacy is in question. First, it forces inspectors and mine operators to focus on a small sample in which, based on agreed upon criteria, one may unequivocally determine whether adequate perennial vegetation is present or not. Second, it provides a means to quickly and easily record and quantify the prevalence of such criteria across the area in question. Observational notes comprise an important component of this method, as with any other bond release inspection. The objective measure derived from the methodical sampling can then be combined with observations to provide a specific ecological rationale for granting or denying bond release – hot sun, long days in the field, and personality conflicts notwithstanding.

Phase II PERENNIAL PLANT FREQUENCY ASSESSMENT
for Southeastern Montana Coal Mines
Montana Department of Environmental Quality

Observers: S. Kew, MDEQ; D. John, OSM

Mine: Lotsa Coal   Date: 07/08/09

Toss a sampling hoop over your shoulder ~100 times while traveling throughout the area in question. Record the number of times the hoop includes established perennial plants or not, using a dot count (4 dots plus 6 lines = 10). Perennial plant establishment is considered adequate if at least 70% of the time two or more perennial plants fall within the sampling hoop.

Reclamation Unit: West Swale

Sample Result:	Total #	Percent
≤ 1 plant:	37	37
≥ 2 plants:	63	63
	100	**100**

Fail

Reclamation Unit: East Corner

Sample Result:	Total #	Percent
≤ 1 plant:	12	24
≥ 2 plants:	38	76
	50	**100**

Pass

Reclamation Unit: __________

Sample Result:	Total #	Percent
≤ 1 plant:		
≥ 2 plants:		
		100

Figure 2. Example of a completed data sheet.

If bond release is denied because the vegetation is inadequate, we endeavor to always provide a specific ecological reason for such denial. General statements such as, “The vegetation did not conform to the approved reclamation plan,” or “The vegetation was not consistent with revegetation criteria,” are too vague to document the inspectors’ rationale or the state of the vegetation at the time. A more appropriate justification for denying bond release would be, “Only 67% of samples contained adequate perennial vegetation, few plants were of adequate vigor to produce flowering stalks, and few perennial seedlings were observed.” Conversely, in supporting bond release, the rationale may be given such as, “In spite of high cover of annual bromes, 78% of all samples contained adequate perennial vegetation, species diversity was high, and most plants were producing seed.” Such rationale provides a strong foundation for supporting or denying bond release without an enormous investment of time, effort, and expense.

Adaptation to Other Geographic Areas

In adapting this method of assessment to other geographic areas, the primary considerations are:

- how large a sampling hoop is appropriate;
- how many perennial plants within a sample constitute a hit;
- what percentage of samples must pass for the field as a whole to pass?

Northern Great Plains rangeland vegetation is a mix of rhizomatous and caespitose, cool- and warm-season grasses. Bare ground is less than 20% on moderate to slight slopes with silty or clayey soils (USDA, 2003), and plants are closely spaced. This circumstance contrasts markedly with the Great Basin and the Intermountain areas, where bunch grasses and shrubs dominate, bare ground is abundant, and plants are widely spaced. In such situations, sampling hoop size may need to increase to as much as 1 m^2. In the more mesic vegetation types of the eastern coal fields, the hoop size may be reduced, but this increases the likelihood that it will hang up in tall vegetation.

The number of plants within the sampling hoop that are required to constitute a “hit” interacts with the size of the hoop. For reclamation in true desert dominated by shrubs and/or bunch grasses, one plant in a 1 m^2 hoop may be an adequate standard. In the Midwest or Appalachia, four perennial plants in a small hoop might be appropriate.

Likewise, the appropriate percentage of samples with a positive hit needs to be determined for different vegetation types, again with awareness of how frame or hoop size influences the likelihood of encountering common vs. rare plants (Elzinga et al., 1998). To illustrate with an extreme example, if Phase II bond release were dependent on the adequate establishment of trees, one might choose to use a sample plot of 10 m^2 and a minimum of 50% positive hits.

For any given vegetation type, the appropriate sample hoop size, determination of what constitutes a hit, and minimum percentage of hits for success is perhaps best determined by running the methodology in areas where everyone agrees the vegetation fully meets Phase II bond release, as well as areas where all agree that it fails. Using this verification approach in several different areas for both passing and failing vegetation should quickly provide a feel for the appropriate criteria. We spent a half-day ground-truthing the success criteria in this manner. The exercise prompted us to modify our original standards and provided consensus and confidence in applying the method to an area where Phase II bond release was in dispute.

Conclusions

Mine operators, regulatory personnel, and the public desire reasonableness, consistency, and predictability in bond release decisions. The recent increases in the cost of bonding and decreases in credit have put pressure on mining companies and regulatory agencies to complete bond release as soon as conditions warrant and the requisite time periods have been met, rather than waiting many years until the vegetation has developed far beyond the required thresholds. Our method is objective, though not statistically rigorous, and may be used to assist the concerned parties in arriving at a justifiable rationale to support or deny Phase II bond release with a minimal sampling effort.

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