The New Mexico Mining Act requires that mined land be reclaimed to achieve a "self-sustaining ecosystem." This is the foundation standard addressing reclamation under the Act and warrants further discussion in order to understand its application. For Existing Mining Operations language addressing this requirement is found under Section 507.A. For New Mining Operations identical language is found under Section 603. The language found under both Sections follows:

The permit area will be reclaimed to a condition that allows for re-establishment of a self-sustaining ecosystem appropriate for the life zone of the surrounding areas following closure unless conflicting with the approved post-mining land use. Each closeout plan must be developed to meet the site-specific characteristics of the mining operation and the site.

This standard contains the terms "reclamation", "self-sustaining ecosystem" and "post-mining land use." These two terms are defined further by the New Mexico Mining Act Rules under Section 107.HH, Section 107.LL, and Section 107.EE. The three definitions follow:

"Reclamation" means the employment during and after a mining operation of measures designed to mitigate the disturbance of affected areas and permit areas and to the extent practicable, provide for the stabilization of a permit area following closure that will minimize future impact to the environment from the mining operation and protect air and water resources.

"Self-sustaining ecosystem" means reclaimed land that is self-renewing without augmented seeding, amendments, or other assistance which is capable of supporting communities of living organisms and their environment. A self-sustaining ecosystem includes hydrologic and nutrient cycles functioning at levels of productivity sufficient to support biological diversity.

"Post-mining land use" means a beneficial use or multiple uses which will be established on a permit area after completion of a mining project. The post-mining land use may involve active management of the land. The use shall be selected by the owner of the land and approved by the Director. The uses which may be approved as post-mining land uses may include agricultural, commercial or ecological uses that would ensure compliance with Federal, State or local laws, regulations and standards and which are feasible. Approved post-mining land use categories include, but are not limited to:

1. cropland
In order to understand how to apply the standard discussed in Section 507.A and Section 603 in the development of a closeout plan for an existing mine, it is important to understand the definitions above and to further expand what is meant by a self-sustaining ecosystem (SSE) and how it fits into the overall post-mine landuse proposal for the mine.

The concept of biological diversity is identified as part of the definition of self-sustaining ecosystem and needs to be taken into account when developing site specific standards to measure the success of reclamation on a mine site. Biodiversity has been defined in the literature as being composed of four major categories including genetic diversity, species diversity, community or ecosystem diversity, and landscape or regional diversity (West 1993). Because it is addressed as such in the Mining Act Rules, MMD will be looking at predominantly the community component of biodiversity. The ecosystem component of biodiversity may also be taken into account when appropriate.

When evaluating diversity at the community level, composition, structure, and the life form component can be studied and documented. Composition can include parameters such as: species frequency, richness, evenness, diversity, proportion of life form, and similarity indices. Structure includes: substrate and soil variables, slope, aspect, biomass, density and key physical features (West 1993).

Based on the above discussion the following items identify how MMD intends to apply and interpret the SSE concept to an existing mining operations closeout plan:

1. SSE will pertain to post-mine land uses such as: grazing land, forestry, and wildlife habitat. Other post-mine land uses that SSE may pertain to include pasture land, residential, recreation and tourism, and scientific/educational. These types of post-mine uses will be addressed on a case by case basis to determine whether or not they should be considered within the SSE category. SSE will not be applied to industrial/commercial post-mine land uses or developed water resources. Any post-mine landuse that will involve continued maintenance and input by man will not be considered self-sustaining ecosystems.

2. If the designated post-mine landuse in the closeout plan falls under SSE, then the complete
12 year waiting period must be met before such areas can be released under the Mining Act. The 12 year waiting period will not apply to areas not considered to be SSE’s. The required 12 year waiting period is specific to identifying plant community success. Section 69-36-7 R(1) of the New Mexico Mining Act states:

...and provided further that for revegetated areas, the director shall retain the amount of financial assurance necessary for a third party to reestablish vegetation for a period of twelve years after the last year of augmented seeding, fertilizing, irrigation or other work, unless a post-mining land use is achieved that is inconsistent with the further need for revegetation.

3. In re-establishing a SSE, the life zone (plant communities) of the surrounding areas will be evaluated and used as a means of comparison to identify standards for success. These communities are typically at late or mature successional stages of development and are not typically at an early successional (seral) stage. Closeout plan success will be judged on re-establishing communities on the mine site having the characteristics of a mid to late successional (seral) stage ecosystem, unless the life zone of the surrounding community is clearly at an early successional stage. Some identifying characteristics of a maturing ecosystem are: highly diverse plant communities; increased soil organic matter; slow decomposition; mid to low annual production; high overall standing biomass; lack of a predominance of invasive or weedy species; narrow niche specialization, high stratification and spatial diversity (Odum 1969). Some of those characteristics can be used to identify maturing and stable ecosystems on mine sites. MMD will provide guidance for establishing the parameters to evaluate plant communities (see item #8).

4. In order to develop the standards for final reclamation success, reference areas should be established on undisturbed areas related to the disturbed site. Reference areas are not test plots. They are plots established to evaluate the condition and structure of existing plant communities. MMD should be involved in the identification and location of reference areas. Please see MMD’s April 30, 1996 Guidelines in regard to setting up reference areas (MMD, 1996).

5. If reference areas will not work alone to establish reclamation standards, then test plots may be developed by the operator and used to identify technical standards to be used for reclamation and release. Test plots are best applied to sites where site specific conditions have been radically changed by mining and reference areas alone will not provide reasonable standards for reclamation success. Test plots should be developed in conjunction with reference areas or range site descriptions. Reference areas can be used as a means of evaluating test plot success and establishing interim revegetation standards. Again MMD should be involved in the identification and design of test plots prior to their establishment.
6. Closeout plan success will be judged on the re-establishment of communities that are approaching a climax community. In other words successful revegetation will not be based on communities that have been poorly managed or negatively impacted by man or domestic animals. In order to make this evaluation we will be asking operators to identify what type of rangeland or woodland condition a potential reference area is in. The condition of a particular reference area will be measured using NRCS or BLM methodology. Reclamation success will be based on comparing reclaimed areas with rangeland or woodland sites in good or better condition.

7. Typically the methods for measuring and comparing ecosystems in mined land reclamation involve the evaluation of the plant communities. Sometimes soil conditions can be measured and compared as well as animal populations indigenous to an area. For the most part MMD will be looking only at the evaluation of plant communities re-established on disturbed areas. The comparison is made by locating and establishing reference areas on areas not impacted by mining, then comparing plant community characteristics to those of the reclaimed areas on the mine site. If conditions are similar in both communities the reclamation is considered to be a success.

In some cases the operator may elect to incorporate the evaluation of soil erosion into the establishment of standards for final release.

8. Parameters to be monitored on plant reference areas and reclaimed areas should include at a minimum: herbaceous cover, diversity, productivity and woody-stem density. The same methodology should be used in measuring these parameters on both reference areas and reclaimed areas. The evaluations should be performed on both areas in such a way that ensures replication and statistical accuracy. These evaluations will require randomized sample design and the use of sampling adequacy formulas. Methods that can be used for these types of evaluations are provided in MMD’s Revegetation Guidelines (MMD 1996).

9. A detailed plan for establishing and monitoring reference areas or test plots must be developed in the closeout plan. Also, specific parameters and standards that will be applied during the evaluation for financial assurance release need to be established during the development of the closeout plan.

10. Where test plots are used to establish post-reclamation standards, interim standards should be established in the closeout plan. The interim standards should remain in effect until technical standards can be developed from test plots. The interim standards should be used for establishing an initial financial assurance figure for closeout and standards to be used should the operator reclaim the site prior to the completion of a test plot program.

Interim standards should be based on plant community statistics developed in the original permit application, reference areas, and/or NRCS woodland and range site descriptions.
However, range and forest site descriptions are very general and may not be representative of site specific conditions. It will be important to complete test plot evaluations as soon as possible during the operation of the mine so that standards specific to the conditions found at the mine site can be established. Test plot evaluations should be completed within 3 to 4 years after establishment.

11. Monitoring of reference areas should be conducted at the beginning of mining or plan development, every 2 to 3 years during mining, reclamation, and the last 2 to 3 years prior to financial assurance release. The monitoring should take place towards the end of the peak growing season. Monitoring of test plots should be conducted after the second growing season of plot development, then every year until reclamation standards have been established, then annually the last 2 to 3 years prior to financial assurance release. Monitoring of revegetated areas on the mine site should be conducted after the first 2 growing seasons, then every 2 to 3 years during reclamation, and then the last 2 to 3 years prior to financial assurance release.

12. “The use of the prefix “re” in “reestablish” and “revegetate” indicates that the establishment of an ecosystem and vegetation that takes place in reclamation should mirror, as closely as is practicable, the pre-disturbance ecosystem and vegetation.”

Glossary of Terms to be Used for Self-Sustaining Ecosystem

1. **Community** - An assemblage of populations of plants, animals, bacteria, and fungi that live in an environment and interact with one another, forming together a distinctive living system with its own composition, structure, environmental relations, development, and function.

2. **Diversity** - A measure of the variety of species in a community that takes into account the relative abundance of each species.

3. **Early seral stage** - A stage within the successional sequence where the community structure is characterized by high overall production, low species diversity, low biochemical diversity, low or poorly organized stratification and spatial heterogeneity.

4. **Ecosystem** - Any unit that includes all of the organisms (i.e. “community”) in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity, and material cycles.
5. **Edaphic** - relating to the soil

6. **Mature seral stage** - A stage within the successional sequence where the community structure is characterized by low overall production, high species diversity, high biochemical diversity, high or complex stratification and spatial heterogeneity, and high amounts of inorganic nutrients tied up in biomass.

7. **Production** - Amount of biomass produced per unit time (year).

8. **Seral Stage** - One of the relatively transitory community stages within a Sere.

9. **Sere** - A series of stages of community change in a particular area, involving replacement of populations and leading towards a stable state. A sere starts with a pioneer or developmental stage and is completed by a climax community.

10. **Succession** - Replacement of populations in a habitat through a regular progression to a stable state (Ricklefs 1973)

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**Literature Cited**


