Appendix 11
Revegetation Plan

REVEGETATION GUIDELINES

AZUSA ROCK, INC.

Vulcan Materials Company
Western Division

August 2003

REVEGETATION GUIDELINES

AZUSA ROCK, INC.

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1.0 INTRODUCTION

This report provides a comprehensive description of the revegetation activities to be conducted by Azusa Rock, Inc. (a wholly-owned subsidiary of Vulcan Materials Company-Western Division) at their site in the City of Azusa, Los Angeles County, California. The site is situated in the foothills of the San Gabriel Mountains, adjacent to and northwest of the San Gabriel River and contiguous to the Angeles National Forest. These Revegetation Guidelines were developed to address revegetation activities to be conducted for the 299.7 acre mining site.

The mining and reclamation plan will be conducted according to the phases as described in the Azusa Rock, Inc. Reclamation Plan Amendment (RGP Planning & Development Services, 2005). It will be conducted such that reclamation and revegetation occurs simultaneously with mining. Reclamation of the quarry's final slopes will be accomplished as mining proceeds from top to bottom. These slopes will be recontoured to create natural-looking topography. As part of the final phase of the project, structures and equipment will be removed and the area will be revegetated pursuant to these guidelines.

Revegetation implementation will consist of numerous activities which are detailed in Section 2.0. Section 3.0 describes the maintenance that will be performed during establishment of the plantings. Section 4.0 details the monitoring methods to be used during implementation of the plantings and their establishment, and the methods to be used for determining when the revegetation efforts will be considered successful.

1.1 Plant Community Description

For the purpose of understanding these guidelines, a brief description of the plant community to be revegetated is presented. Plant species recommended for revegetation are based on those reported in *Preliminary Draft Results of the Biological Surveys for the Fish Creek Restoration, Azusa Operation Site* (Chambers Group, Inc., January 2001). As reported, only one plant community occurs in adjacent undisturbed upland areas: southern mixed chaparral. Components of this plant community will be used for the revegetation plantings. Botanical names used in this report are consistent with Hickman (1993), *The Jepson Manual: Higher Plants of California*. Information on other plant communities and wildlife species occurring on the site can be found in the Chambers Group report.

As reported by the Chambers Group, southern mixed chaparral is the most mesic of the chaparral communities in California. It consists of a mix of evergreen shrubs that are adapted to occasional wildfires. It is dense on ridge tops and on steep north and east facing slopes, and more open on south and west facing slopes. Shrub species found include chamise (*Adenostoma fasciculatum*), mountain mahogany (*Cercocarpus betuloides*), California sagebrush (*Artemisia californica*), black sage (*Salvia mellifera*), toyon (*Heteromeles arbutifolia*), laurel sumac (*Malosma laurina*), hoary leaf ceanothus (*Ceanothus crassifolius*) and occasional scrub oaks (*Quercus berberidifolia*). In the understory and open areas many herbaceous perennial species are found, such as California everlasting (*Gnaphalium californicum*), golden yarrow (*Eriophyllum confertiflorum*), small-flowered needlegrass *(Nassella lepida*), coast range melic (*Melica imperfecta*) and wild cucumber (*Marah macrocarpa*).

1.2 Revegetation Goals and Performance Criteria

The following goals and performance criteria are the standards that will indicate when the revegetation efforts are successful.

1.2.1 Revegetation Goals

Goals are based on revegetation requirements and evaluation of existing/proposed site conditions. Goals include:

- Recontouring to blend with adjacent undisturbed topography;
- Restoring vegetation using locally-occurring native plant species;
- Restoring vegetation that is ecologically appropriate to the sites;
- Providing conditions that allow natural processes such as soil development, nutrient cycling, plant succession, natural regeneration, and recovery from disturbance to occur;
- Preserving genetically adapted plant species through the use of propagules from local ecotypes;
- Establishing native vegetation that will control erosion; and
- Establishing native vegetation that will be self-sustaining over the long term.

1.2.2 Performance Criteria

Data on the development of vegetation within the revegetation planting areas will be collected and evaluated. In order to develop reference area information, data will also be collected from undisturbed native vegetation growing at nearby sites with characteristics (elevation, aspect and soil type) similar to the revegetation sites. This reference area data will be collected and analyzed using a method that will be repeatable on the steep slopes of the revegetation sites.

The reference data will be used to estimate the amount of vegetation cover, shrub density and species richness anticipated to develop in the revegetation areas within seven years from planting. It will also be used to determine the level of tolerance for weeds. This data will then be compared to data from the revegetation sites. Development of the revegetation areas will be considered successful when the performance criteria are achieved and no significant maintenance measures (eradicating major weed infestations or watering container-grown plants) will have been required during the previous two years. Quantitative monitoring (see Section 4.0) of the revegetation areas will be conducted to document the vegetation development and determine if the performance criteria have been met. It will occur when qualitative evaluations indicate that the vegetation appears to be approaching the performance criteria or seven years after planting, which ever occurs first.

If performance criteria for vegetation cover are not met, the conditions will be evaluated (see Section 4.6). For example, low cover values of native seedlings can often be attributed to periods of low rainfall. In this case, the germination and growth of seedlings will be evaluated to determine if the density of seedlings present will eventually provide adequate cover in future years when there is more rainfall. If the density is adequate, reseeding will not be recommended, as existing seedlings would be damaged or destroyed during the reseeding process. However, if shrub density or species richness does not meet the performance criteria, the need for remedial measures will also be considered.

2.0 REVEGETATION IMPLEMENTATION

Revegetation methods and materials used will be those which are considered most effective and efficient for the steep and rocky slope conditions. Because revegetation activities will continue for a number of years at this site, it is expected that the knowledge and experience gained in early phases will influence subsequent revegetation efforts. If certain methods or materials used during the early phases do not prove successful, different methods/materials will be adapted accordingly. In addition, new revegetation studies may suggest methods or materials that merit incorporation into these guidelines. Flexibility for adapting new methods and materials is an essential component of this plan.

It is planned that revegetation activities will consist of collecting locally-adapted seed materials, growing of locally-adapted container plants, weeding, installing an irrigation system for container-grown plants, hydroseeding with mycorrhizal inoculum, and maintenance and monitoring. After plantings are completed, the maintenance and monitoring programs will be instituted as described in Sections 3.0 and 4.0.

Seeds and container-grown plants for the project will be ordered approximately two years prior to the planting date. In order to ensure genetic adaptation of the plantings, seeds will be collected from local sites and container-grown plants will be propagated from locally collected materials.

Short-term irrigation (~2 years) of container-grown plants will be conducted to enhance survival during their establishment period. Irrigation is not proposed for the seeded revegetation areas since it is preferable that seeds germinate when natural weather conditions are suitable for their survival.

2.1 Sequence of Revegetation Implementation

For each phase, revegetation activities will be performed in the following sequence:

1) Two years prior to seeding, contract with native seed supplier for collection of local seed materials;

2) Two years prior to planting, contract with native plant nursery for propagation of container-grown plant materials using locally collected seeds and/or cuttings;

3) Provide weed control, if needed;

4) Install irrigation system for container-grown plants;

5) Install container-grown plants; and

6) Hydroseed with mycorrhizal inoculum.

All plantings will occur between November 15 and January 15 or later if climatic conditions remain favorable. It is essential to plant during this time, when temperatures and rainfall provide optimal conditions for germination and seedling establishment.

If any of the methods or materials described herein do not prove successful during the early phases of revegetation, different methods/materials may be used accordingly in subsequent phases.

2.2 Seed Materials

Seeds will be collected from the site itself or from nearby sites. To ensure genetically adapted source materials, collection sites will have characteristics similar to the revegetation site. These characteristics include elevation, aspect and soil type. To ensure availability of adequate seed quantities, a contract for seed collections will be established two years prior to the planting date. A commercial seed collector/supplier with experience in locally-adapted, native seed collections will collect the seeds shown in Table 1. Seeds will be cleaned to a grade acceptable in the trade; sticks

and large plant parts will be removed. After cleaning, seeds will be stored by the seed supplier in a cool dry place, safe from rodents, until needed for planting.

The species shown in Table 1 were selected because they occur adjacent to the site, are relatively reliable germinators, and produce collectable quantities of seed. The seed mix includes a combination of shrub, forb and annual species. The natural succession of a chaparral community begins with a predominance of annual and forb species, evolving eventually to a dominant shrub cover. The annual and forb species provide soil stabilization and protection for the slower-germinating, successional shrub species.

Seeds of certain woody species (i.e., *Ceanothus* spp., *Malosma laurina*, etc.) are sometimes not highly successful when direct seeded. However, because some seeds will likely germinate they will be included in the seed mix as well as planted from container-grown stock. Direct seeding is a desirable method for establishing plants because it allows maximum root development by eliminating the disturbance associated with transplanting of container-grown plants. In addition, because of their rapid root development, the need for long-term supplemental irrigation is generally less for direct seeded plants. Seed of some species of woody shrubs are more likely to germinate if scarified. These species are shown on Table 1 and will be scarified by the seed supplier prior to delivery.

Because seed collection during certain years (depending on climatic conditions) may result in either an abundance or shortage of some species, flexibility in seed application rates is necessary. The approximate application rates shown in Table 1 are based on average seed counts, expected quality, germination rates and amounts that are normally available for collection. The final seedmix species and application rates will be determined by the actual quantity and quality of the seed materials collected.

Table 1 Azusa Rock, Inc. Revegetation Seed Mix		
***Species*, Common Name**	**Minimum % Purity/Germ.**	**Approx. Lbs. / Acre**
Achnatherum coronatum, giant needlegrass	70/40	0.25
Adenostoma fasciculatum, chamise	5/20	2.00
Artemisia californica, California sagebrush	15/50	3.00
Brickellia californica, California brickellbush	10/15	0.25
Ceanothus crassifolius, hoary leaf ceanothus *	95/65	1.50
Ceanothus oliganthus, hairy ceanothus *	95/65	1.50
Cercocarpus betuloides, mountain mahogany	50/60	4.00
Chaenactis artemisiaefolia, white pincushion	60/30	0.10
Clarkia unguiculata, elegant clarkia	98/75	0.25
Croton californicus, California croton	90/40	0.25
Encelia farinosa, brittlebush	50/60	3.00
Eriastrum sapphirinum, sapphire eriastrum	5/60	0.25
Eriogonum elongatum var. elongatum, long-stemmed buckwheat	50/10	1.00
Eriogonum fasciculatum ssp. foliolosum, California buckwheat	50/10	10.00
Eriophyllum confertiflorum, golden yarrow	30/60	3.00
Eschscholzia californica, California poppy	98/80	2.00
Galium angustifolium, bedstraw	80/30	0.25
Gnaphalium californicum, California everlasting	2/50	0.25
Hazardia squarrosa, saw-toothed goldenbush	15/20	2.00
Heteromeles arbutifolia, toyon (dried berries)	95/40	1.00
Heterotheca grandiflora, telegraph weed	40/50	0.10
Isomeris arborea, bladderpod	90/60	4.00
Lotus scoparius, deerweed	90/60	8.00

Seed Mix Continued . . .

Table 1 (Continued) Azusa Rock, Inc. Revegetation Seed Mix		
***Species*, Common Name**	**Minimum % Purity/Germ.**	**Approx. Lbs. / Acre**
Lotus strigosus, strigose lotus	90/70	1.00
Lupinus truncatus, collar lupine	98/85	0.50
Malacothrix saxatilis, cliff malacothrix	30/50	0.10
Malosma laurina, laurel sumac *	95/70	4.00
Marah macrocarpus, wild cucumber	98/70	1.00
Mimulus aurantiacus, orange bush monkeyflower	2/60	2.50
Nassella lepida, small-flowered needlegrass	90/60	1.00
Penstemon spectablis, royal penstemon	95/75	1.00
Phacelia cicutaria, caterpillar phacelia	98/70	1.00
Phacelia minor, wild canterbury-bell	95/80	0.50
Phacelia ramosissima, branching phacelia	95/80	1.00
Rafinesquia californica, California chicory	N/A	0.10
Rhamnus californica, California coffeeberry	95/70	2.00
Rhus ovata, sugar bush (dried berries) *	90/60	1.50
Romneya coulteri, Coulter's matilija poppy	90/40	0.10
Salvia apiana, white sage	70/30	1.50
Salvia columbariae, chia	90/60	0.50
Salvia mellifera, black sage	70/50	3.50
Stephanomeria virgata, twiggy wreathplant	N/A	0.10
Yucca whipplei, our lord's candle	90/65	1.50
Total	----	**72.35**

* Seeds to be scarified by seed supplier just prior to delivery, using species appropriate scarification method for each species.

2.3 Container-Grown Plant Materials

If results from the early phases indicate that the use of container-grown plants is successful, then they will be installed within the revegetation areas. The species shown on Table 2 will be grown in containers and installed on the slope to provide the initial presence of woody shrubs and to provide immediate vegetation structure to the plantings. Container-grown plants will be propagated from seed collected from the site or from nearby sites with similar characteristics. Collection and propagation will take place approximately two years prior to planting, depending on the germination and growth requirements for the species to be grown. Container-grown plants will be propagated and grown by a native plant nursery specializing in locally-adapted species and will be inoculated with appropriate species of mycorrhizal fungi at the time of propagation. Section 2.7 provides details on planting methods and locations for the container-grown plant materials.

Table 2
Azusa Rock, Inc., Container-Grown Plants for Revegetation

***Species*, Common Name[(1)]**	**Percent Each Species[(2)]**
Ceanothus crassifolius, hoary leaf ceanothus	25%
Ceanothus oliganthus, hairy ceanothus	18%
Cercocarpus betuloides, birch-leaf mountain mahogany	18%
Heteromeles arbutifolia, toyon	8%
Malosma laurina, laurel sumac	18%
Rhamnus californica, California coffeeberry	8%
Rhus ovata, sugar bush	5%
Total	100%

1. All container-grown plants will be grown in “D-40” size pots (2 1/2" X 10" deep).
2. The areas to be planted with container plants will be determined for each phase after the grading plans are prepared. Within each container planting area, individual plants will be spaced approximately 10 feet on center. Species distribution will be in the percentages shown.

2.4 Recontouring and Application of Overburden Material

Recontoured slopes will consist of a series of benches and steps with various gradients, but generally to about 1:1 (horizontal:vertical). Small drainages will be created to form a natural appearance. The resulting slope surface is expected to be composed of broken rock material, with little, if any soil. If feasible and available, overburden materials will be pushed over the finish graded slopes and allowed to spill down the slope and fill in the cracks and crevices of the rocky material below.

2.5 Weed Control

The predominance of exotic, invasive weed species throughout California presents a formidable challenge to most revegetation projects. However, the quarry slopes are expected to be relatively weed free because of recontouring and lack of soil (containing weed seeds). If needed, comprehensive weed control efforts will be initiated prior to planting and during establishment of the plantings to ensure that weed competition does not impede development of the native vegetation. Prior to seeding/planting, weed eradication will be performed if necessary. The planting area will be reviewed to determine the types of weeds present and the control, if any, that will be required. The areas will be monitored regularly for the presence of weed species, and if found, will be removed using herbicide applications and/or manual methods, as described in Section 4.1.

2.6 Irrigation

If container-grown plants are installed they will be irrigated. Seeded areas will not be irrigated. The type of irrigation system to be used will be based on results of the systems tested (bubbler or porous pipe) in the early phases. Whichever system is

found to be most effective, it will be installed prior to planting container-grown materials and seeding operations. The irrigation system will be used through two growing seasons (approximately two years). It is anticipated that during the first year of irrigation, water will be applied at optimal intervals for the survival of the plants, and then irrigation frequencies will be reduced in the second year to wean the plants from irrigation. However, results from the early phases will influence this schedule (see Section 3.2 for more details on the proposed irrigation schedule). After the two-year irrigation period has ended, the systems will be dismantled and removed from the revegetation area.

2.7 Planting Methods for Container-Grown Materials

Certain portions of the planting areas are expected to be more suitable than others for container-grown plants. Areas within the drainages are considered the best planting locations. After the grading plans are completed for each phase, a planting plan for locating installation of container-grown plants will be created. The exact planting location of container-grown plants will be determined by the ability to excavate a planting hole. However, the distribution and quantity of each species will be as shown on the plans and based on Table 2. If feasible, it is intended that holes for container plants will be excavated during recontouring operations as heavy equipment will already be on site. Using the planting plans as a guide, equipment operators will determine the actual locations of planting holes by finding areas within the drainages where excavation is most feasible.

The hole size for plants will be dug slightly larger than the rootball. Planting holes will be filled with water twice prior to planting. Plants will then be placed in the pre-moistened holes with the root crown level with the surrounding grade. Backfill of the excavated material, excluding large stones, will be gently tamped in around each plant. Plants will be watered thoroughly immediately upon completion of planting. No soil amendments or fertilizers will be applied to container-grown plantings.

2.8 Hydroseeding Materials and Methods

After the irrigation system and container plants are installed, the slope will be seeded using hydroseeding equipment. It is expected that the hydroseeding will consist of the materials and methods described below. These are recommended based on the anticipated slope conditions after recontouring. However, upon completion of the recontouring, the slope will be reassessed to determine if these methods and materials are still considered optimal for the conditions. Results of the early phases will also be considered.

2.8.1 Hydroseeding Materials

Mycorrhizal Inoculum: Since topsoil will not be available for use on the slope, mycorrhizal inoculum will be applied during the hydroseeding operations to enhance development of soil microorganisms. Endo (arbuscular) mycorrhizal inoculum, consisting of spores, mycelium and mycorrhizal root fragments in a solid carrier suitable for handling by hydroseeding equipment, will be applied at the rate 3,600,000 live propagules per acre. Endomycorrhizal inoculum is a live material and will be kept at temperatures of less than 90 degrees Fahrenheit during delivery, storage and application.

Wood Fiber Mulch: Mulch will be applied to the slopes at the rate of 2,200 pounds per acre. It will be a green-dyed virgin wood cellulose fiber mulch containing no germination or growth inhibiting factors. After agitation in the slurry tank with seeds, water and other approved additives, the fibers in the material become uniformly suspended to form a homogeneous slurry that, when hydraulically sprayed on ground, forms a blotter-like ground cover uniformly impregnated with seeds which allows absorption of moisture and percolation of rainfall to underlying soil.

2.8.2 Hydroseeding Methods

Revegetation areas will be hydroseeded using the following materials:

> Seed mix – 72.35 pounds per acre (see Table 1)
> Mycorrhizal inoculum – 3, 600,000 live propagules per acre
> Wood fiber mulch – 2,200 pounds per acre

Hydroseeding equipment is portable and is capable of being moved close to areas to be sprayed in order to provide uniform distribution without waste. Hydroseeding equipment is hydraulic and has a built-in agitation system, and sufficient operating capacity to continuously agitate, suspend and homogeneously mix the slurry. Distribution lines are large enough to prevent stoppage and provide even distribution of slurry.

Immediately prior to the hydroseed application, the slurry will be mixed according to manufacturer's recommendations. Slurry will not remain in the tank for more than one (1) hour before application. The quantity of water will be as needed for application. Using the wood fiber as a visual guide, soil will be sprayed with a uniform coat of slurry in a sweeping motion, allowing wood fibers to build upon each other until complete, even coverage is achieved.

3.0 MAINTENANCE

Maintenance during the establishment of new plantings is necessary to ensure revegetation success and will begin immediately upon completion of each phase of planting. Maintenance of revegetation areas will consist of controlling weeds and watering container-grown plants. If necessary, it will also include controlling erosion and protecting revegetation sites from unauthorized entry. Maintenance measures will be conducted as needed. Weed control may be needed for two to four years after planting. Watering container-grown plants will be conducted for two growing seasons after planting. Other maintenance actions will be scheduled as needed and when feasible.

3.1 Weed Control

Weed control will be performed as needed to minimize the competition with emerging native species and to reduce the potential for weed species to produce seeds which may invade revegetation areas. The quarry slopes are expected to be relatively weed free and therefore, minimal if any weeding will be necessary. Access roads and slope perimeters are expected to be the most likely areas for weeds to occur; weeds will be controlled in these areas, as needed. If weeds are present they will be removed through herbicide applications and/or manual methods. If other weed control methods are needed for specific species or conditions, they will be recommended by a licensed pest control advisor. Weed control procedures will be monitored by the revegetation monitor. Personnel performing weed control will be knowledgeable in the identification of weed and native species.

3.1.1 Herbicide Application

Herbicide treatments will consist of conservative application methods such as spot spraying or the use of a wick applicator. A cut-and-spray technique will be used for species requiring root kill (those that resprout from underground roots or rhizomes). With this method, seed heads and most of the vegetation are cut from the base of the plant, which is then sprayed or wiped with a systemic herbicide such as glyphosate (trade name Roundup™ or Rodeo™), which contains a brightly colored dye to mark plants that have been sprayed. This technique kills weeds through the direct application of herbicide into a freshly cut wound in the plant stem, and avoids unnecessary broadcast spraying of herbicides over large areas. Weeds that have been cut will be properly disposed of.

Extreme care will be exercised to ensure that herbicides are used properly and only when necessary. The actual type and amount of herbicide to be used will be based on recommendations by a licensed pest control advisor and by following herbicide product labels. Herbicides will be applied by a licensed pest control applicator. Pre-

emergent herbicides shall not be used because they prevent germination of both weed and native species seed.

3.1.2 Manual Methods

The species targeted for this type of weed control are invasive annual weeds and young perennial species that compete with emerging native vegetation. Manual removal consists of cutting weed stems off below ground level or pulling weeds by hand. Cut/pulled weeds will be properly disposed of.

3.2 Watering Container-Grown Plants

As described in Section 2.6, irrigation will be provided to container-grown plants for about two years after planting. Seeded areas will not be watered. Although a sample irrigation schedule is described below and shown on Table 3, the actual schedule will be determined by the revegetation monitor or revegetation maintenance contractor and may vary considerably from the sample. The frequency of irrigation for container-grown plants will be based on weather patterns, soil moisture levels and vigor of plants as determined by the monitor or maintenance contractor.

The sample irrigation schedule was developed for the early phases using historical weather data, knowledge of native plant moisture requirements and evapotranspiration data from the California Irrigation Management Information System. The sample schedule is based on supplying about 9.0 inches of water, above and beyond the average annual rainfall of about 18 inches, during the first year. Frequency of irrigation will be reduced in the second year to wean the plants from irrigation. Irrigation will normally begin in March and continue through October, depending on weather conditions, with May through September being the months when the most water is supplied. However, if sufficient rain does not occur at regular intervals during the first two months after container plants are installed (when plant roots are most vulnerable to drying out) then irrigation must be provided. Table 3

provides a sample irrigation schedule by month (number of events per month) for the first year after planting. It is based on providing five gallons of water to each plant during each irrigation event.

Table 3
Azusa Rock, Inc., Revegetation
Sample Irrigation Schedule By Month For First Year [1]

Jan[2]	Feb[2]	March	April	May	June	July	Aug	Sept	Oct
4	4	2	2	3	4	4	4	3	2

1. Indicates number of irrigation events per month. Five gallons of water will be supplied to each plant during each watering event.

2. If rain does not occur at regular intervals during these two months of the first year, water must be supplied regularly to ensure survival of the container-grown plants.

3.3 Erosion Control

The slope surface is expected to be composed of rocky material with minimal erosive qualities. For this reason, the primary type of erosion control planned is for redirection of concentrated flows of water that run off roadways onto slopes. Should concentrated flows reach the slopes, roads and side berms will be graded to redirect water to stay within the roadway. Should other types of erosion occur, the revegetation monitor will determine if erosion is serious enough to prevent establishment of the plantings. If so, erosion control devices will be researched to determine the most effective materials/methods to correct erosion problems for the site conditions. The monitor will evaluate erosion problems on an individual basis and recommend appropriate methods/material to be tested.

Due to steep slopes and inaccessibility it may not be feasible to reseed eroded areas. However, if feasible, the plant species and installation methods employed in the

revegetation program will dictate which species will be used. The use of non-native species will not be allowed for erosion control.

3.4 Site Protection

Precautions will be taken to protect revegetation areas from damage by unauthorized activities. Identifying signs should be posted on the perimeter of the slopes to prevent or minimize mining or other activities which may create indirect impacts such as rock falls or future erosion problems through storm water diversion. Protective measures will be evaluated and implemented as needed. If necessary, fences, boulders or other barriers will be installed around the revegetation area boundaries with signs identifying the area as a “Revegetation Area.”

4.0 MONITORING

The objectives of monitoring the revegetation areas are to determine maintenance needs (if any) and develop an information base that documents implementation efforts, maintenance activities and development of newly-planted vegetation. To achieve these objectives, a revegetation monitor will oversee and guide implementation and maintenance activities. The monitor will also evaluate plant development and conduct data collection during establishment of the plantings, and prepare reports documenting the revegetation program. The revegetation monitor will have a minimum of three year’s experience in revegetation design, implementation and monitoring.

The revegetation sites will be monitored for a maximum period of seven years. Three types of monitoring will be provided: 1) implementation monitoring, 2) qualitative (horticultural) monitoring, and 3) quantitative (biological) monitoring. Quantitative monitoring will commence when the qualitative evaluations indicate that vegetation

cover appears to be approaching the levels of the reference area vegetation or at the end of seven years.

4.1 Implementation Monitoring

To ensure that these guidelines are followed, implementation activities will be supervised and recorded by the revegetation monitor. Records will include dates, locations, methods and materials used for irrigation installation, weed control and seeding/planting. Any significant problems encountered or changes made to the plan will be recorded to create an “as-planted” plan.

4.2 Qualitative Monitoring

Two necessary components of a successful revegetation program are the evaluation of plant health and the early detection and correction of problems when they arise. Qualitative (horticultural) monitoring, conducted periodically, will address these components. Monitoring will be triggered by seasonal events including spring and summer weed growth and periods of low soil moisture. During each site visit, the monitor will inspect the revegetation areas to assess soil moisture of container plantings, growth rates and vigor of seeded areas, as well as erosion and competition from weeds.

The monitor will record and report findings and, if problems arise, recommend maintenance actions to Vulcan after each monitoring event. The monitor will coordinate maintenance efforts with Vulcan and supervise the selected contractor in performance of maintenance activities as described in Section 3.0.

4.3 Quantitative Monitoring

Quantitative (biological) vegetation monitoring will measure and document development of the revegetation plantings to determine when these areas approach the levels of vegetation cover similar to the reference area vegetation. Reference data will provide quantitative criteria to describe the plant species composition of an undisturbed area. This data will be compared with monitoring data from the revegetation areas to detect and evaluate trends and changes in vegetation. Results from this comparison will determine if the newly-planted revegetation areas are approaching the characteristics of the reference area vegetation.

4.3.1 Quantitative Monitoring Methods

The vegetation characteristics to be monitored include vegetation cover, plant density, species richness and site characteristics (aspect, elevation and slope gradient). During each quantitative monitoring event, data on cover, density and species richness will be collected. Permanent monitoring stations will be used and therefore, data on site characteristics will be quantified only once. Additionally, a complete list of species within the revegetation area will be compiled each year to determine species richness. Evidence of natural recolonization of native plant species also will be noted since this can be a significant indicator of habitat establishment.

For the first three years after planting, the survival and growth rates of container-grown plants will be assessed.

Revegetation sites will be sampled using the method developed for collecting reference area data for this project. Because the slopes will likely be too steep to be safely traversed on foot, traditional monitoring methods (i.e., line-intercept transects) will not likely be feasible. Therefore, it is proposed that photos comparing the vegetation cover of the reference area to that of the revegetation area be conducted. A method using GIS and an on-the-ground measuring device to determine area of

vegetation cover on the slopes will be developed. The measuring device will be marked so that area of vegetation cover can be calculated from the photos. The photos will also provide the data on shrub density. To assess species richness, the reference and revegetation areas will be observed on foot, where feasible, and a list of observed species will be compiled. Should the photo comparison method provide insufficient data, then alternative monitoring methods will be researched and attempted in the field for their applicability to the slope conditions.

Traditionally, quantitative monitoring is conducted in the spring to coincide with germination and flowering and to control for seasonal variation in plant cover. Assessments of species richness will be conducted in spring. However, since the method for determining shrub cover and density will be with photo comparisons, it may be necessary to conduct the photography during the summer months when the shrubs can be more easily distinguished from grass and forb species. If quantitative monitoring data is collected for more than one year, the data collection events will occur during the same month(s) of each year.

4.3.2 Data Analysis

Vegetation data will be analyzed to detect changes or trends in cover and density of the dominant shrub species in irrigated and non-irrigated areas, and in areas with and without overburden. This will include calculating averages for shrub species cover and density, and total species richness. The ratio of native to exotic species and the ratio of shrub species to understory herbaceous species will also be analyzed. These analyses will be compared with those of the reference area in order to determine when the revegetation area vegetation approaches that of the reference area. Container-grown plant survival will be assessed to determine the number of surviving plants.

4.4 Photo Documentation

In addition to the quantitative photos that will be taken, permanent photographic stations will be established, recorded and marked for reuse every year on the revegetation areas. Photo stations will be located as to provide examples of typical vegetation conditions with the revegetation areas. Color prints documenting changes in the structure and composition of the revegetation area vegetation will be included in annual reports.

4.5 Annual Reports

Annual reports will be prepared and submitted to Vulcan to document the progress of the revegetation plantings. Annual reports will include information on: 1) monitoring methods, 2) general observations of vegetation development, 3) container plant survival and growth rates, 4) maintenance activities, 5) recommendations, 6) photos, and 7) comparisons of the current year's findings with those of previous years. The first annual report will also describe the as-planted implementation efforts.

During the year(s) when quantitative monitoring is conducted, reports will also include a description of methods used, data summary/analysis and comparison with the reference area vegetation.

4.6 Remedial Measures

Remedial measures are called for when performance criteria are not met. It is expected that the maintenance measures provided during establishment of the revegetation plantings will preclude the need for remedial measures. However, unforeseen natural events, such as prolonged drought, sometimes result in poor vegetation development. If necessary, the revegetation monitor will prescribe specific remedial measures.

Because the revegetation areas will consist of extremely steep, rocky slopes and safe access to slopes may not be possible as mining and reclamation progress, remedial measures may not be feasible. If it appears that there are areas that would benefit from remedial measures, they will only be conducted if safe access is available.

5.0 REFERENCES AND SOURCES OF INFORMATION

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