Incoming
M/037/0088
cc: Mike
Paul

Lisbon Valley Mining Company

LaSal, Utah

Reclamation Guidelines

October 2012

Submitted by:

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Div. of Oil, Gas & Mining

Lisbon Valley Mining Company

Reclamation Guidelines

Introduction

The Lisbon Valley Mining Company was requested by the Utah State Division of Oil, Gas and Mining to explore various reclamation methods and seed mixes in order to successfully reclaim mine dumps and other areas in need of permanent vegetation cover.

Existing Conditions

Vegetation

The Lisbon Valley is relatively typical of this region of the Colorado Plateau in that the valleys are covered in sagebrush and the hillsides are dominated by pinyon-juniper woodlands. Woodward Clyde completed a baseline flora and fauna report in June of 1994 as part of the Environmental Impact Statement (EIS) for the mine. In this report, there are general descriptions of the vegetation communities in the region. However, there does not appear to be an estimate of vegetation cover for the pinyon-juniper vegetation type, and furthermore, the cover estimate for the sagebrush communities varies from 40-80% cover.[1] Since these cover estimates are either non-existent or much too broad to use for target vegetation cover for bond release, it is requested by the Utah Division of Oil, Gas and Mining to gather more precise data regarding vegetation cover[2]. In order to have a target for vegetation cover for areas to be reclaimed and thus released from the monetary bond, it is necessary to have an accurate field determined estimate of pre-disturbance vegetation cover of each vegetation community. This is generally done with 10 quantitatively assessed vegetation transects within each vegetation community to obtain an average vegetation cover. Once this figure has been ascertained, the mine is required to reach 70% of that vegetation cover to be released from its bond. For example, if the sagebrush community was determined to have an average of 45% cover, the mine would be required to reach an average of 31.5% vegetation cover. Field determination of undisturbed vegetation cover can be completed any time prior to the request for bond release.

Soils

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[1] Flora and Fauna Baseline Data for Lisbon Valley, Utah. Prepared for St Mary Minerals Inc. Denver, CO June 1994 Woodward Clyde Consultants Denver, Colorado

[2] Paul Baker, Environmental Manager, Minerals Regulatory Program, pers. comm. September 12, 2012

The Natural Resource Conservation Service (NRCS) completed a soil survey for this area in 1991 and described all characteristics of the native soils. The parent materials for the native soils are alluvial in nature (deposited by flowing water), and the parent material is shale and sandstone. Native soils in the area range from deep to shallow depths, slow to rapid permeability and very slow to rapid runoff depending upon soil depth, soil texture and topographic position. Soils that are subject to revegetation are those that have been removed from their native topographic positions and profile depths and have been blended together, thus the native soil structure and profile have been modified. Therefore, LVMC sent several samples of the soils to be revegetated to a laboratory to have them analyzed for suitability as a growth medium (See Figure 1 and results in Appendix A).

In addition, there are specific bedrock strata deep within the earth in this area that contain coaly shale and coal, which have acid generation potential. When these beds are encountered in the mining process, operators strip these beds carefully and are sure to place them near the center of waste dumps to encapsulate them.

Soil samples were taken from several waste dump areas and analyzed in a laboratory (See Figure 1 and Appendix A). In summary, the non-acid generating soils pH varies from 7.8 to 8.4, textures are generally coarse (sandy to sandy loam), and some of the soils have a relatively high conductivity (up to 6.2 mmhos/cm). However, the Exchangeable Sodium (ESP) (high ESP can be a problem for plant growth) is low since there are adequate other exchangeable salts in the soil (magnesium and calcium) that reduce the negative effects of excess sodium. Thus, the soil samples don't show excessive physical or chemical issues as a growth medium. It should be noted, however, that it is possible that the differences in soil textures and chemistry throughout the modified profile could create issues for plant growth as the depth of coarse and/or fine soil types is dissimilar to what the plant species have evolved to tolerate.

The soil laboratory made recommendations to improve soil conditions for plant growth. An organic fertilizer (as outlined in #4 under the seedbed preparation below) will serve as a better amendment than the levels of inorganic fertilizer recommended. Large flushes of readily available fertilizer have a strong tendency to attract weedy species as they are more adapted for higher levels of nitrogen. As can be seen in the soil sample, the native soils are very low in nutrients and the native plants have adapted to those conditions. The organic fertilizer(s) added at the rates suggested below should be sufficient for a longer term boost in nutrient availability for the seeded species. Furthermore, the addition of elemental sulfur (presumably to reduce the pH of the soil) was recommended. The idea is that the sulfur combines with oxygen and water to form sulfuric acid (through a bacterial metabolic process). However, soils in the western U.S. have incredible buffering capacity to absorb acidic elements, and the addition of sulfur would have to take place each year to keep the pH low. The amount of free lime (calcium carbonates) in the soils in the project area would likely quickly neutralize the acid generated. Moreover, the NRCS soil survey (1991) shows the native soil pH ranging from 7.9 to 8.4, or within the soil test results received. Native plants are adapted to this high pH and lowering it is likely not necessary.

Although the term 'topsoil' is not defined, the Environmental Impact Statement (EIS) completed for the mine states a recommendation to put down 12" of topsoil prior to reclamation. In areas such as this with much less than 12" natural topsoil in its undisturbed state, Utah Division of Oil Gas and Mining

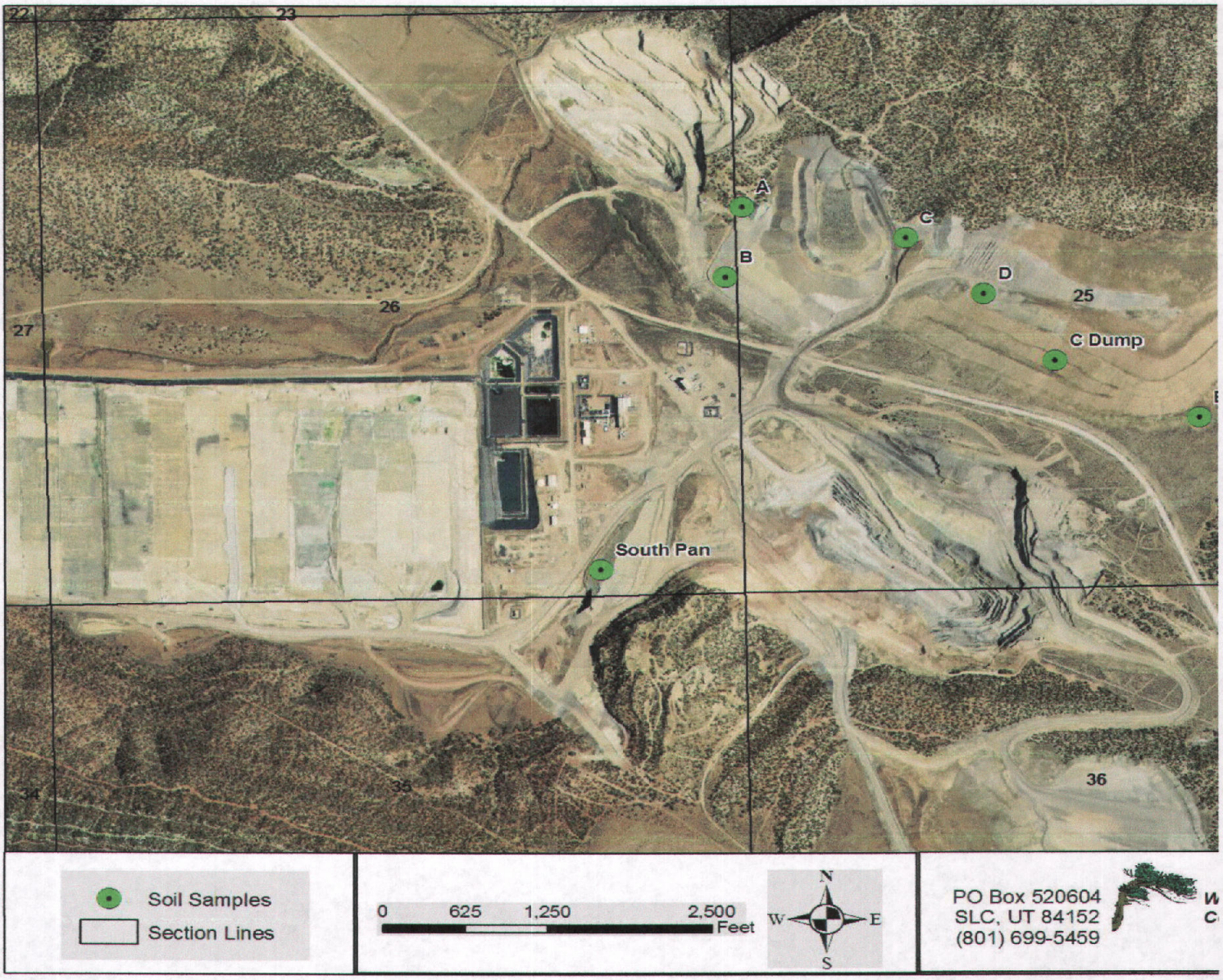
(DOGM), alternatively uses the term 'growth medium' for reclamation needs. Since the soils tested from the mine show no significant barriers to plant growth, it is assumed that all of it can be termed 'growth medium' and thus used as ' topsoil.'

Desired Conditions

As stated above, the revegetated areas must reach 70% of background vegetation cover in order to be released from the vegetation monetary bond for reclamation. Ideally, the reclaimed areas would resemble that of the native vegetation communities in terms of species diversity, abundance and functional groups (perennial grasses, perennial forbs, shrubs, etc). Areas that have been reclaimed can be eligible for bond release 3 years after seeding provided the vegetation cover has reached the target.

It should be noted that the results of revegetation efforts in this climate can take several years to determine. Depending upon conditions, it can take up to 3-5 years to accurately evaluate the level of success of a seeding as many seeds will wait to break dormancy for up to 2-3 years after seeding. For some species, just the right combination of environmental factors (sufficient moisture, sufficient temperatures, etc) at the right time of year need to occur in order for the seeds to germinate, establish and persist. This can be the case in any reseeding project, independent of soil type.

Figure 1. Soil Sample Locations



Reclamation Guidelines

Seedbed Preparation

Given the relative aridity and heat of the area, it can be difficult to reach reclamation vegetation targets. In order to achieve the best results as regularly as possible, a few suggested methods of revegetation are outlined below, followed by a proposed seed mix. Some general guidelines include such methods as:

1. **Break up the side slopes** with larger benches along the contour as possible to reduce erosion on the slope sides.
2. **Rip soils as deeply as possible**, especially if the slope has had sufficient time to compact (more than 6 months)
3. **Seed topsoil (growth medium) stock piles** to keep the soil biologically active. If the stock pile will be unattended for more than 6 months, it is a good idea to seed it with a temporary mix or even a more permanent mix depending upon how long the stockpile is to remain. This also serves to keep weed growth or other non-desirable plant growth on these stockpiles at bay.
4. To make soil more amenable to plant growth, the addition of **organic, slow release fertilizer** is recommended. Inorganic fertilizers will only serve to increase non-desirable weeds as these plants are more competitive with large, rapid flushes of available nitrogen. Organic fertilizers can include such material as composted manure (applied at about 10 tons/ acre). Another choice is a product called Bio-Sol® (or other organic fertilizer). Bio-Sol® is an excellent choice to add organic nitrogen, potassium and phosphorus at appropriate rates for healthier soil microbial activity, and can be applied at rates between 1,500-1,800 pounds/acre depending upon the health of the soils. Bio-Sol can be applied when hydroseeding or as a stand alone broadcast application, but should not be applied over snow.
5. When seeding, make the **seedbed as irregular as possible**. Construct many favorable microsites for seed to germinate and establish by strategically placing boulders within the area, creating small knolls or pits, or placing mounds of dead native vegetation as a wind break and/or a seed catchment in the seeded area. This vegetation could potentially come from newly disturbed areas around the mine or other activities in the vicinity.

The following are specific suggestions can be executed as possible to produce the most successful reclamation as possible.

A. Ripping along the contour (as deeply as possible – up to 18") with broadcast seeders and seedbed finishers in one pass

Mines with similar aridity issues have had good results with a D-9 dozer or other large piece of equipment pulling large tines (24"), hooked to a calibrated seed broadcaster, then immediately followed by a piece of chain link fence with a weight upon it. Each piece of equipment should be calibrated to treat a similar width of area with each pass. Doing all seeding steps in one pass will reduce compaction, reduce erosion, create a suitable seed bed, and bury the seed to a proper depth so as to prevent seed desiccation as well as potential loss to wildlife and lessen the need for mulch. This can be done on up to a 2H:1V slope provided the proper equipment is used.

B. Dozer Pitting

Somewhat evenly spaced earthen pits can be created with a dozer to create topographic breaks in the slope to reduce slope length to decrease erosion potential as well to serve as water catchment basins for more favorable plant growth. If the pits are small enough and slope is not too steep, it is possible to broadcast seed with equipment after these basins are created.

Seeding

A seed mix was created for Lisbon Valley Mining Company by Arkansas Valley Seed. The seed mix is appropriate for the mine site, however, the seeding rate is 25 pounds/ acre. When taking into account the seed sizes in the mix, the seeding rate translates to 158 seeds per square foot (see seed mix below). Even taking into account seed desiccation or other potential seeding issues, this seeding rate is excessive. Many professionals recommend anywhere between 40-80 seeds/ square foot depending upon seeding methods and environmental conditions. Furthermore, it is important to specify the most appropriate species and varieties of each species for the environmental conditions at the mine.

Original Seed mix:

Common name	Scientific name	Variety	PLS lbs	Seed/ lb	% of mix
Grasses					
Galleta grass	*Hilaria jamesii*		1	170000	2
Indian ricegrass	*Oryzopsis hymenoides*	Nezpar	4	183000	11
Russian Wildrye	*Psathrostachys juncea*		2	175000	5
Thickspike wheatgrass	*Elymus lanceolatus ssp lanceolatus*	Critana	3	154000	7
Bluebunch wheatgrass	*Pseudoroegneria spicata*	Secar	3	125680	5
Blue grama	*Bouteloua gracilis*		2	825000	24
Bottlebrush squirreltail	*Elymus elymoides*		1	191555	3
Sand dropseed	*Sporobolus cryptandrus*		0.25	5298000	19
Forbs/Wildflowers					
Annual sunflower	*Helianthus annuus*		3	58500	2.5
Desert globemallow	*Sphaeralcea ambigua*		0.5	500000	4
Gooseberry leaf globemallow	*Sphaeralcea grossulariaefolia*		0.5	500000	4
Blanket flower	*Gaillardia aristata*		1	132000	2
Shrubs					
Four wing saltbush	*Atriplex canescens*	VNS	2	52000	1.5
Winterfat	*Ceratoides lanata*		1.5	56700	1
Sagebrush	*Artemisia tridentata var wyomingesnsis*		0.25	2500000	9
		total lbs/acre	25		
		Seeds/sq ft.	**158**		

The seed mix below is a more reasonable rate and specifies the most appropriate species for the site. The seed mix contains a mix of perennial grasses, perennial and annual wildflowers, and shrubs such as sagebrush and winterfat. The representation of all life form types allows a more equitable use of resources (water, nutrients) present in the soil as each of these has a different rooting system and uses these resources from different soil

depths. It is also important to purchase the varieties that are mentioned in the mix, as they are the most adapted to Lisbon Valley's climate.

The varieties specified as UP Colorado or UP Dolores in this seed mix should be available from the Uncompahgre Partnership – a partnership of seed growers, researchers and practitioners for restoration specifically on the Colorado Plateau. The Uncompahgre Partnership can be reached at 970-708-7131.

Revised Seed Mix

Common name	Scientific name	Variety	PLS lbs	Seed/ lb	% of mix
Grasses					
Sandberg's bluegrass	*Poa secunda*	UP Colorado	0.5	925000	14
Galleta grass	*Hilaria jamesii*		1	170000	5
Indian ricegrass	*Oryzopsis hymenoides*	Rimrock	4	183000	21
Blue grama	*Chondrosum gracile*	Hachita	1	825000	24
Sand dropseed	*Sporobolus cryptandrus*	UP Dolores	0.1	5298000	16
Forbs/Wildflowers					
Annual sunflower	*Helianthus annuus*		3	58500	5
Gooseberry leaf globemallow	*Sphaeralcea grossulariaefolia*		0.2	500000	3
Shrubs					
Four wing saltbush	*Atriplex canescens*		3	52000	5
Winterfat	*Ceratoides lanata*		0.2	56700	0.3
Sagebrush	*Artemisia tridentata var vaseyana*		0.1	2500000	7
		total lbs/acre	13.1		
		Seeds/sq ft.	78		

This seed mix assumes it will be broadcast. If the seed mix is to be drilled (with an appropriate rangeland drill with different seed boxes for different types/sizes of seed), the seeding rate can be cut in half.

When ordering seed, request the most weed *and crop* seed free lots they have. *Do not accept* any seed lots that have more than 2% weed or crop seed in them. Furthermore, to ensure the most weed and crop free seed, it is best to obtain each species separately and mix the seed on your own, as that way the seed tags from each species will be attached to each bag to determine the purity of each part of the seed mix.

Buying mixed seed may be more convenient, but there can be risks, such as

- If Blue Tagged Certified Seed is specified in the mix, there is no way to assure that certified seed will be used. The buyer should ask for the blue tags removed from the bags of certified seed used in the mix.
- The expensive component in the mix may actually be reduced while the cheaper component may be increased.
- Lower quality, weedy lots can be blended into the mix.

It is therefore recommended that the following verbage be used for seed orders:

"Certified seed with blue tags attached to the seed bag shall be supplied where a named variety is specified. The vendor shall indicate on the bid whether Certified or common seed is being offered, as well as the origin

of the seed. The blue tags which are removed to mix the seed shall be given to the revegetation project manager. In addition, mix tags showing the weighted averages of the ingredients shall be attached to each bag."

Lastly, it is important to be cognizant of potential limitations of seeding equipment or seeding methods with the species in the mix. For example, many drill seeders place all seed in the mix at the same depth in the soil. However, since seed size differs between species, this likely means some seeds will either be buried too deeply or not deeply enough. Greater success can often be achieved with smaller grass seed and wildflower seed by placing them in a separate seed box and alternating the seeding depth between rows or dropping them directly on the ground to be covered by the action of heavy, trailing chains. Furthermore, fluffy seed (such as some grass or shrub seed) can cause issues with drill seeders or hydroseeders. This issue can often be overcome by having different seed boxes with agitators and picker wheels for drill seeders or reducing the proportion of fluffy seed in the mix for hydroseeders. Another option is to have the seed coated with a clay mixture prior to putting them in the hydroseeding mix.

Mulching

It is always advisable to mulch a newly seeded area to reduce seed loss to wildlife (birds) as well as to desiccation. Mulching also helps to keep moisture in the soil to provide a better environment for seed germination and establishment. Mulching options include those made from paper, wood or straw. If hydraulically applied, mulches should be mixed with a tackifier to assure the mulch remains on the ground for as long as possible. If a straight straw mulch is used, it is extremely important to use only **weed-free certified straw**. The Utah Department of Agriculture has a certified weed free hay and straw list. See: http://ag.utah.gov/news/publications/documents/Weed-FreeList.pdf If possible avoid hay mulch as it contains seed heads of potentially non-desirable species. It is best to crimp the straw in so as to anchor it to the ground while providing small wind breaks and microsites for the seed. Mulch should be applied at 1500 to 2000 lbs/ acre.

If seeds and mulch are being applied with a hydro seeder or hydro mulcher, it is very important to **not apply the seed and mulch together.** Seed first with only up to 20% of the mulch (as needed as a carrier), then the remainder of the mulch after the seed is down. This will prohibit the seed from becoming caught up in the mulch to prevent soil contact. Without good soil contact, the seeds will desiccate and die before they have a chance to germinate and establish.

It should also be noted that large and small pieces of scraped or dead native vegetation can also be used as a mulch. Since these microsites often serve as better seed germination and establishment areas, these microsites can serve as welcome variations in the reclamation landscape, as well as potential bio-islands to serve as a seed source for the surrounding area. However, if the scraped vegetation has non-desirable, weedy vegetation within it, this should either be removed first or not used at all.

APPENDIX A - SOIL TEST RESULTS

STUKENHOLTZ LABORATORY, INC.

2924 Addison Ave. E., P.O. Box 353 Twin Falls
208.734.3050, Fax: 734.3919 www.stukenholtz.com

2364

LISBON VALLEY MINING CO.
P.O. BOX 400

MOAB UT 84532

435/686-9950 435/686-2223
Report No.: 38509
Date Received: 7/27/12
Date Reported: 7/28/12

SOIL TEST DATA	Sample 1	Sample 2
pH	7.8	H
Salts, mmhos/cm	6.2	VH
Chlorides, ppm	17	L
Sodium, meq/100g	0.2	VL
CEC, meq/100g	15.1	M
Excess Lime, %	2.4	M
Organic Matter, %	0.84	L
Organic N, lb/Acre	25	L
Ammonium - N, ppm	5.5	L
Nitrate - N, ppm	11	M
Phosphorus, ppm	3	VL
Potassium, ppm	220	M
Calcium, meq/100g	10.9	H
Magnesium, meq/100g	3.3	VH
Sulfate - S, ppm	999	VH
Zinc, ppm	1.7	M
Iron, ppm	5.6	M
Manganese, ppm	3.2	M
Copper, ppm	8.7	VH
Boron, ppm	1.35	H
Molybdenum	0.06	

	Sample 1	Sample 2
Grower:	LISBON VALLEY MINE	
Sample Identity	E	
Crop	NATIVE PLANTS	
Yield Goal	GOOD	
Acres		
Prev. Crop T/Acre	NATIVE PLANTS	
Manure T/Acre		
Prev. Applied Nutrients		

RECOMMENDATIONS, lbs. Nutrients or Units Per Acre.

Nitrogen	120
P_2O_5 - Phosphate	105
K_2O - Potash	0
Calcium	0
Magnesium	0
Sulfate - Sulfur	0
Zinc	0
Iron	0
Manganese	0
Copper	0
Boron	0
Elemental Sulfur	0

RELATION OF CEC TO SOIL TEXTURE		SAMPLE	ACTUAL AND RECOMMENDED PERCENT OF CEC							
			Actual % Potassium	Recommended Potassium	Actual % Calcium	Recommended Calcium	Actual % Magnesium	Recommended Magnesium	Actual % Sodium	Recommended Sodium
0 - 5	Sand									
5 - 12	Loamy Sand									
12 - 18	Sandy Loam									
18 - 24	Silt Loam	1	4.9	3.0 - 6.0 %	72.2	65 - 80 %	21.9	15 - 25 %	1.3	< 3.0 %
24 -36	Clay Loam									
36 +	Clay	2								

Crop1:Split application of N is advised. Monitor crop with plant tissue tests and add N as needed.
Crop1: Soluble salts are too high. Germination may be significantly reduced.
Crop1: Establish good drainage and deep irrigate to remove excess soluble salts.

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MOAB UT 84532

435/686-9950 435/686-2223
Report No.: 38505
Date Received: 7/27/12
Date Reported: 7/28/12

SOIL TEST DATA	Sample 1	Sample 2
pH	8.0	H
Salts, mmhos/cm	1.8	L
Chlorides, ppm	11	L
Sodium, meq/100g	0.2	VL
CEC, meq/100g	12.6	M
Excess Lime, %	4.7	H
Organic Matter, %	0.50	VL
Organic N, lb/Acre	20	VL
Ammonium - N, ppm	3.1	VL
Nitrate - N, ppm	4	VL
Phosphorus, ppm	4	VL
Potassium, ppm	220	M
Calcium, meq/100g	9.5	VH
Magnesium, meq/100g	2.2	H
Sulfate - S, ppm	77	VH
Zinc, ppm	3.7	H
Iron, ppm	6.8	M
Manganese, ppm	6.2	H
Copper, ppm	71.3	VH
Boron, ppm	0.65	M
Molybdenum	0.03	

	Sample 1	Sample 2
Grower:	**LISBON VALLEY MINE**	
Sample Identity	**A**	
Crop	**NATIVE PLANTS**	
Yield Goal	**GOOD**	
Acres		
Prev. Crop T/Acre	**NATIVE PLANTS**	
Manure T/Acre		
Prev. Applied Nutrients		

RECOMMENDATIONS, lbs. Nutrients or Units Per Acre.

Nitrogen	140
P_2O_5 - Phosphate	110
K_2O - Potash	0
Calcium	0
Magnesium	0
Sulfate - Sulfur	0
Zinc	0
Iron	0
Manganese	0
Copper	0
Boron	0
Elemental Sulfur	1000 GYP

RELATION OF CEC TO SOIL TEXTURE		SAMPLE	ACTUAL AND RECOMMENDED PERCENT OF CEC							
			Actual % Potassium	Recommended Potassium	Actual % Calcium	Recommended Calcium	Actual % Magnesium	Recommended Magnesium	Actual % Sodium	Recommended Sodium
0 - 5	Sand									
5 - 12	Loamy Sand									
12 - 18	Sandy Loam									
18 - 24	Silt Loam	1	5.8	3.0 - 6.0 %	75.4	65 - 80 %	17.5	15 - 25 %	1.6	< 3.0 %
24 -36	Clay Loam									
36 +	Clay	2								

Crop1:Split application of N is advised. Monitor crop with plant tissue tests and add N as needed.
Crop1:Excessively Calcareous soils respond to 100-200 lbs/ac of Elemental Sulfur or Acid forming fertilizers.
Crop1: Copper is possibly toxic. Gypsum will help leach excess copper from the soi.

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MOAB UT 84532

435/686-9950 435/686-2223
Report No.: 38506
Date Received: 7/27/12
Date Reported: 7/28/12

SOIL TEST DATA	Sample 1	Sample 2
pH	7.8	H
Salts, mmhos/cm	3.8	H
Chlorides, ppm	10	VL
Sodium, meq/100g	0.1	VL
CEC, meq/100g	10.4	M
Excess Lime, %	5.0	H
Organic Matter, %	0.64	L
Organic N, lb/Acre	20	VL
Ammonium - N, ppm	2.8	VL
Nitrate - N, ppm	9	L
Phosphorus, ppm	3	VL
Potassium, ppm	180	M
Calcium, meq/100g	8.2	VH
Magnesium, meq/100g	1.5	H
Sulfate - S, ppm	95	VH
Zinc, ppm	4.1	VH
Iron, ppm	4.3	M
Manganese, ppm	4.3	M
Copper, ppm	99.9	VH
Boron, ppm	0.70	M
Molybdenum	0.03	

	Sample 1	Sample 2
Grower:	LISBON VALLEY MINE	
Sample Identity	B	
Crop	NATIVE PLANTS	
Yield Goal	GOOD	
Acres		
Prev. Crop T/Acre	NATIVE PLANTS	
Manure T/Acre		
Prev. Applied Nutrients		

RECOMMENDATIONS, lbs. Nutrients or Units Per Acre.

Nitrogen	125
P_2O_5 - Phosphate	110
K_2O - Potash	20
Calcium	0
Magnesium	0
Sulfate - Sulfur	0
Zinc	0
Iron	0
Manganese	0
Copper	0
Boron	0
Elemental Sulfur	2000 GYP

RELATION OF CEC TO SOIL TEXTURE		SAMPLE	ACTUAL AND RECOMMENDED PERCENT OF CEC							
			Actual % Potassium	Recommended Potassium	Actual % Calcium	Recommended Calcium	Actual % Magnesium	Recommended Magnesium	Actual % Sodium	Recommended Sodium
0 - 5	Sand									
5 - 12	Loamy Sand									
12 - 18	Sandy Loam									
18 - 24	Silt Loam	1	5.8	3.0 - 6.0 %	78.8	65 - 80 %	14.4	15 - 25 %	1.0	< 3.0 %
24 -36	Clay Loam									
36 +	Clay	2								

Crop1:Split application of N is advised. Monitor crop with plant tissue tests and add N as needed.
Crop1: Soluble Salts may reduce germination.
Crop1:Excessively Calcareous soils respond to 100-200 lbs/ac of Elemental Sulfur or Acid forming fertilizers.
Crop1: Copper is possible toxic. Gypsum will hlep leach excess copper.

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435/686-9950 435/686-2223
Report No.: 38507
Date Received: 7/27/12
Date Reported: 7/28/12

SOIL TEST DATA	Sample 1	Sample 2
pH	8.4	H
Salts, mmhos/cm	2.0	L
Chlorides, ppm	13	L
Sodium, meq/100g	0.1	VL
CEC, meq/100g	3.5	VL
Excess Lime, %	0.2	VL
Organic Matter, %	0.21	VL
Organic N, lb/Acre	15	VL
Ammonium - N, ppm	3.3	VL
Nitrate - N, ppm	5	VL
Phosphorus, ppm	1	VL
Potassium, ppm	25	VL
Calcium, meq/100g	2.5	H
Magnesium, meq/100g	0.8	VH
Sulfate - S, ppm	48	VH
Zinc, ppm	0.2	VL
Iron, ppm	2.6	L
Manganese, ppm	2.6	L
Copper, ppm	4.1	VH
Boron, ppm	0.30	VL
Molybdenum	0.01	

	Sample 1	Sample 2
Grower:	**LISBON VALLEY MINE**	
Sample Identity	**C**	
Crop	**NATIVE PLANTS**	
Yield Goal	**GOOD**	
Acres		
Prev. Crop T/Acre	**NATIVE PLANTS**	
Manure T/Acre		
Prev. Applied Nutrients		

RECOMMENDATIONS, lbs. Nutrients or Units Per Acre.

Nitrogen	135
P_2O_5 - Phosphate	140
K_2O - Potash	120
Calcium	0
Magnesium	0
Sulfate - Sulfur	0
Zinc	8
Iron	0
Manganese	0
Copper	0
Boron	1
Elemental Sulfur	0

RELATION OF CEC TO SOIL TEXTURE	
0 - 5	Sand
5 - 12	Loamy Sand
12 - 18	Sandy Loam
18 - 24	Silt Loam
24 -36	Clay Loam
36 +	Clay

ACTUAL AND RECOMMENDED PERCENT OF CEC

SAMPLE	Actual % Potassium	Recommended Potassium	Actual % Calcium	Recommended Calcium	Actual % Magnesium	Recommended Magnesium	Actual % Sodium	Recommended Sodium
1	2.4	3.0 - 6.0 %	71.4	65 - 80 %	22.9	15 - 25 %	2.9	< 3.0 %
2								

Crop1:Split application of N is advised. Monitor crop with plant tissue tests and add N as needed.
Crop1:Low soil Fe. Use stongly acid forming fertilizers or foliar nutrient sprays containing Fe.

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LISBON VALLEY MINNING CO.
920 COUNTY RD 313

LA SAL UT 84530

Report No. 76945

Date Received 7/13/07

Date Reported 7/14/07

GROWER: LISBON VALLEY

SOIL TEST DATA	Sample 1	Sample 2		Sample 1	Sample 2
			SAMPLE IDENTITY	DUMP C	
pH	8.0	H	CROP	NATIVE PLANTS	
SALTS, mmhos/cm	1.2	L	YIELD GOAL	GOOD	
SODIUM, meq/100g	0.1	VL	ACRES		
CEC, meq/100g	12.7	M	PAST CROP T/Acre	FALLOW	
EXCESS LIME, %	7.9	H	MANURE T/Acre	0	
ORGANIC MATTER, %	0.98	L	PREV. APPLIED NUTRIENTS	0	
ORGANIC N, lb/Acre	30	L	**RECOMMENDATIONS, lbs or Units Actual Nutrients per Acre**		
NITRATE-N, ppm	26	M	NITROGEN	100	
PHOSPHORUS, ppm	6	L	P_2O_5 - PHOSPHATE	80	
POTASSIUM, ppm	160	M	K_2O - POTASH	30	
CALCIUM, meq/100g	10.9	VH	CALCIUM	0	
MAGNESIUM, meq/100g	1.2	M	MAGNESIUM	10	
SULFATE-S, ppm	25	M	SULFATE-SULFUR	0	
ZINC, ppm	0.4	VL	ZINC	8	
IRON, ppm	4.3	M	IRON	0	
MANGANESE, ppm	6.1	H	MANGANESE	0	
COPPER, ppm	6.7	VH	COPPER	0	
BORON, ppm	0.75	M	BORON	0	
SOIL TEXTURE	SEE TABLE		ELEMENTAL SULFUR	50	

RATINGS : VL - Very Low L - Low M - Medium H - High VH - Very High

SAMPLE	ACTUAL AND RECOMMENDED PERCENT OF CEC							
	Actual % Potassium	Recommended Potassium	**Actual % Calcium**	Recommended Calcium	**Actual % Magnesium**	Recommended Magnesium	**Actual % Sodium**	Recommended Sodium
1	4.2	3.0-6.0%	85.8	65-80%	9.4	15-25%	0.8	<3.0%
2								

RELATION OF CEC TO SOIL TEXTURE	
0-5	Sand
5-12	Loamy Sand
12-18	Sandy Loam
18-24	Silt Loam
24-36	Clay Loam
36+	Clay

REMARKS: CROP1:NH4-N 4.3 ppm, CHLORIDE 34.0 ppm and MOLYBDENUM 0.090 ppm

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Supervised by: Paul Stukenholtz

Appendix I

Neutralization Potential Ratio

Neutralization Potential Ratio

The ratio of Acid Neutralization Potential (ANP) to Acid Generation Potential (AGP) can also be used to assess risk of developing acidic rock drainage (ARD). An NPR greater than 3 is thought to have a low ARD risk while samples with an NPR less than one (1) have a high ARD risk (Price, 1997).

Various guidance manuals describe the use of NPR in assessing acid generation.

- If the ratio is less than or equal to one (1) (ANP/AGP $\leq$ 1), the sample is likely to be acid generating;
- If the ratio is greater than one (1) but less than three (3), then the sample is potentially acid generating; and
- If the ratio is equal to or greater than three (3) to one (1) (ANP/AGP $\geq$ 3), then the sample is considered non-acid generating.

Ratios of ANP/AGP can also be used to assess the acid generation potential. An ANP/AGP ratio of 1:1 is equivalent to an NNP of zero (0). If the ratio of a sample's neutralization potential and acid production potential is greater than 3:1, then there is a low risk for acid drainage to develop. For samples with a NPR between 1:1 and 3:1, the uncertainty increases. As a result, additional testing is usually necessary using kinetic test methods. Samples with a ratio of 1:1 or less are more likely to generate acid (Smith and Barton-Bridges, 1991).

References

Price, W.A. (1997). Draft: *Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia*. British Columbia. Mine Reclamation Services (MRS). British Columbia Ministry of Employment and Investment, Energy and Minerals Division, Smithers, BC (April) 143 pgs.

Smith, A. and J.B. Barton Bridges, (1991). *Some Consideration in the Prediction and Control of Acid Mine Drainage Impact on Groundwater from Mining in North America*. Proceedings of the EPPIC Water Symposium. May 16-17, 1991, Johannesburg, South Africa.