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DIV. OF OIL, GAS & MINING

August 19, 1994

Ms. Pamela Grubaugh-Littig, Permit Supervisor
Utah Division of Oil, Gas and Mining
355 West North Temple
3 Triad Center, Suite 350
Salt Lake City, Utah 84180-1203

Copy Jim Carter, Lowell (letter only)
Susan, Tom, Henry, Joe - all
Pam, Daron
(All orig to file)

RE: J.B. KING ACT/015/002 - FINALIZATION OF RECLAMATION PLAN REVISIONS #2

Dear Ms. Grubaugh-Littig:

This submittal is in response to the Division's letter dated April 14, 1994 and a subsequent Modification of NOV extending the interim abatement deadlines for NOV's #91-25-06-01; #93-25-03-01; and #93-25-05-01 to August 20, 1994.

During this period, the following tasks were undertaken:

1. Hansen, Allen and Luce Inc., consulting engineers, collected samples from the site to:

a) determine geotechnical characteristics for channel sideslope design; b) check the material into which the proposed channel could potentially erode to determine if this could cause acidic or toxic runoff; c) determine if the refuse pile material buried on site is acid and toxic-forming; and d) determine the characteristics of two off-site soil samples in comparison to those above, taken at the J.B. King site. The results of this work is attached as a report entitled: Drilling and Sampling Program at the J.B. King Mine, August 1994. A copy is attached for your review.

2. Bamberg Associates, consulting scientists, performed an Ecological Monitoring and Environmental Characterization study for the area in and around the J.B. King minesite, dated August 1994. The objective of the study was to quantitatively determine the ecological relationships of biological and erosional factors at the J.B. King reclaimed minesite and compare that information to similar topographic landforms offsite, but in the same general

250 S. Rock Blvd., Suite 130 ▲ Reno, NV 89502 ▲ (702) 856-3339 ▲ FAX (702) 856-1818

vicinity of the reclaimed minesite. This documentation can now provide the guidance necessary to outline a realistic revegetation and erosional standard for the reclaimed J.B. King minesite. A copy is attached for your review.

3. Western States Minerals Corporation (WSMC) staff continued sample analysis and negotiations for acquisition of bio-solids from the City of Moab, Wastewater Treatment Plant, until such time that the Moab City Counsel decided to place the bio-solids in their local landfill versus allowing WSMC to use them for reclamation purposes. While no specific reason was given, it was inferred that they were concerned with the liability of their bio-solids being taken and used out of the county boundaries (and therefore out of their jurisdiction).

However, WSMC has opened negotiations with the Price River Water Improvement District to acquire bio-solids from their lagoon.

4. WSMC finalized terms with the Utah Department of Transportation for acquisition of a rock mulch product, located near the J.B. King reclaimed minesite. Analyses of this product have been performed and are included herein.

Recommendations and Conclusions:

Based upon the results of the aforementioned tasks, WSMC is willing to commit to the following action plans:

1. Permanent Diversion Channels: excavate new channels according to the following construction parameters and performance criteria.

a. Construction Parameters - The channels will be layed out and constructed according to details outlined in the February 18, 1994 Submittal and the August 1994 Drilling and Sampling Program results.

b. Performance Criteria - Channel performance will be defined as acceptable, if the channels constructed remain within the meander limits shown on Drawing JBK-7 and the stable profile limits shown on Drawing JBK-9 (i.e. JBK-7 and JBK-9 are map exhibits in the February 18, 1994 submittal).

c. Characterization of Material Found Within the Meander and Profile Limits - Using the Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining, April 1988 to classify those materials found within the meander and profile limits of the channel. It was found that pH, EC, SAR and A/B potential were all classified good to fair.

However, selenium and boron concentrations proved to be unacceptable. This overall classification is very similar (in all constituent categories) to the two off-site samples collected and analyzed.

Therefore, since the materials from the proposed permanent diversion channel are similar to representative material off-site, any potential erosion of the channel material on-site would not adversely impact the off-site environment.

2. Refuse Pile

a. Top of Refuse Pile - will be covered with excavated material from the permanent diversion channel excavation and revegetated as described, in Section 5.1 and Section 7.1.2 of the February 18, 1994 submittal. However, the use of sewage sludge (bio-solids) is predicated upon WSMC's successful negotiation for a source and the approval of a permit to use it at the site.

i. WSMC Role - WSMC will perform the work necessary to place the cover material and revegetate this area. The Division will pay WSMC for all related costs associated with this specific work. It is understood that WSMC is not responsible for any type of liability associated with this area.

ii. DOGM Role - The Division will assume all responsibility associated with the top of the refuse pile, including but not limited to, the vegetation and erosional standard that may be established, removal of the silt fence when that become necessary, and responsibility for any 10-day notices or NOV's that may be levied against the specific area in the future.

b. Sides of Refuse Pile - Based upon the results of: 1) sample testing of refuse material in the Hansen, Allen & Luce report, which shows that the refuse material would not adversely impact the off-site environment; 2) the Bamberg report gives quantitative measurements of erosional rilling off-site compared to on-site (including the refuse pile side slopes) which shows that on-site riling is comparable to or less than off-site; and 3) if the gravel mulch from the Utah DOT borrow pit is used to cover the side slopes, no vegetation is expected to grow on those slopes, WSMC requests the following:

WSMC proposal:

i. The required cover for the side slopes be reduced to 2 ft. (the same required for the top of the pile). We request the Division to allow a variance of the existing standard.

ii. The performance criteria for erosional stability be based upon the Bamberg report findings and be used for all future determinations of erosional stability of the reclaimed site.

iii. No gravel mulch would be placed on the side slopes and the erosional stability would continue to be observed and evaluated based upon the Bamberg report findings.

3. Revegetation and Vegetation Performance Criteria:

Based upon the Bamberg report findings, WSMC proposes the following:

a. Modify the existing permit to remove the present (totally inaccurate) vegetation reference area for performance standards, and begin using the new reference areas and methodology established on and off-site with the use of linear coupled transects (as noted in the Bamberg Report).

b. Do not try to revegetate (redisturb) perceived "bare" areas, when, in fact, these areas are of comparable extent to off-site situations and are within the vegetation performance criteria standard.

c. WSMC is only proposing to revegetate those areas directly disturbed by permanent diversion channel excavation and placement in alternate areas (i.e. top of refuse pile, at the Divisions's request, and the shaley slope area northwest of the diversions), and the access road/transport corridors required for earth movement.

d. The existing feeder ditch and main ditch will be left in place without further revegetation and reclassified as depressions rather than as diversionary structures consistent with R645-301-552.100.

With the Division's approval of these proposals, WSMC will formalize the Application for Permit Change and submit all revised text, maps, cost estimates, and associated other forms. This will take a maximum of ten working days from the Division's conceptual approval.

WSMC would like to begin work at the site on October 3, 1994 and should be completed by November 11, 1994 or earlier.

As stated before, because this proposal is in the form of an abatement action, and the Division presently holds the Phase II Bond of $126,078.00, we assume there will be no increase in the reclamation bond for the proposed activity. In addition, these activities should not restart the bond clock.

Finally, we understand that these activities will abate all outstanding notices of violation at the J.B. King Mine.

Hopefully, we can resolve any controversies that may exist at our August 22, 1994 meeting and begin work at the site shortly thereafter.

Sincerely,

E.M. (Buzz) Gerick
V.P. Operations

cc: S. Bamberg
B. Barnum
D. Dragoo

ECOLOGICAL MONITORING AND ENVIRONMENTAL CHARACTERIZATION

J.B. KING MINE EMERY COUNTY, UTAH

Submitted to:
WESTERN STATES MINERALS CORPORATION
290 S. Rock Blvd.
Reno, Nevada 89502

Prepared by:
SAMUEL A. BAMBERG, Ph.D.
Bamberg Associates
and
INGRID E. HANNE, M.S.
Pine Creek Associates

DRAFT

August 1994

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1.0 INTRODUCTION

The J.B. King Mine is a reclaimed underground coal mine located approximately 10 linear miles south of the town of Emery, Utah in Emery County, Utah in Range 6 East, Township 23 South, Section 32, SLBM. The J.B. King coal mine, reclaimed by Western States Minerals Corporation (WSMC), is in its eighth year of reclamation bonding. Reclamation and revegetation of the approximately thirty acre site was initiated in the fall of 1985, and the following spring, 1986, shrub were transplanted into the area. The site has been periodically monitored since 1986 for vegetation cover and density, and site conditions. This monitoring has allowed the conditions and trends in the vegetation to be assessed.

There have been recent Notices of Violation (NOVs) issued by the Utah Division of Oil, Gas, and Mining (Division) that cited failure to minimize erosion and properly construct ditches. These types of conditions have occurred repeatedly in the past, and WSMC has instituted corrective measure and rebuilt and installed control structures. These measures and reconstructions have, in general, not controlled the erosion processes on site resulting in a perpetuation of numerous NOVs by the Division. Recent NOVs have been issued concerning a perceived lack of revegetation success as it relates to erosion control and the size and extent of areas bare of vegetation.

There has been a need to reassess the erosion control and related revegetation conditions experienced at the J.B. King Mine during the last several years to analyze for trends and ecological conditions on the site and in the immediate areas surrounding the site. Vegetation has been monitored four times on the site during the past five years (1989, and 1990 through 1993) as required by Utah regulations, and additional document and reports prepared for modifications and proposed actions on the site for erosion control and enhancing revegetation (RA Consultants, 1992; Hansen Allen & Luce, 1994). This report presents the monitoring vegetation during the summer 1994, and in addition assess site and surrounding area ecological conditions.

The basic concern with the present reclamation standards and general requirements being used for determining success on the reclaimed mine site is that the criteria do not account for site specific and regional environmental conditions. The general requirements in R645-301-353.140 state such standards as "The vegetative cover will be: ....diverse, effective, and permanent; and ....capable of stabilizing the soil surface from erosion". Vegetation does not stabilize soil erosion in this region, and the other terminology is vague and subject to interpretation. There are no standards for erosion control except that sediment control measures will minimize erosion to the extent possible (R645-301-742.113). The engineered design and performance standards for reclamation may not be appropriate for conditions in this arid region with high rates of erosion and low vegetation cover. In order to determine if ecological and erosional factors on the site are in balance with natural environmental conditions it is necessary to know these relationships on the surrounding landscape, and how these relationships are applicable to conditions on the reclaimed mine site.

The landscape patterns and scale for vegetation in the arid western US are related to regional and local climate, topographic, and other environmental factors (Carlile, et.al., 1989). Methods have been developed for examining landscape and ecological scale (Cullinan and Thomas, 1992; Simmons, et al., 1992). The objective of the present monitoring study in this part of the Colorado Plateau was to determine the ecological relationships of biological and erosional factors on the site and in similar topographic situations in the area of Dog Valley where the site is situated. The approach was to measure biological parameters and environmental factors concurrently on the same areas using a linear plot design, and analyze the data for ecological relationships. This study provided information on the general regional and specific site factors of the climatic and geomorphologic processes that affect vegetation establishment and erosion rates. This information on existing ecological relationships in Dog Valley was then used to determine if site specific biological conditions have predictor value for vegetation on site, and to comply with reclamation standards, criteria, and stipulations for erosion and vegetation on the J.B. King site .

The specific concerns on the site expressed by the Division are: (1) areas with uncovered coal refuse or having limited cover of soil on the top of the refuse pile (this was left at the request of the Division as a revegetation test plot), (2) rate of erosion on the sides of the refuse pile, and (3) low vegetative cover on small, local areas of the site. These conditions were detailed in a series of Notices of Violation (NOVs) issued by the Division.

2.0 REGIONAL AND SITE CHARACTERISTICS

This section was abstracted from an earlier report on erosion and topographic characteristics at the J.B. King site prepared in 1992 (RA Consultants, 1992). The J.B. King reclaimed site is located in the western Canyonlands section of the Colorado Plateau in central Utah on the western edge of the San Rafael Swell and the eastern edge of High Plateaus section at the southern end of the Coal Cliffs.

2.1 Regional Setting

This part of the Colorado Plateau is characterized by many high plateaus that are drained by the Green and Colorado Rivers. On the Colorado Plateau, the distinguishing features are elevated plateaus underlain by near-horizontal bedrock weathered into a stepped landscape with many cliffs and escarpments separated by wide gentle slopes as a result of differential weathering (Morrison 1991). In the Canyonland section, the easily eroded Cretaceous shales and sandstones are cut into canyons in flat-lying older strata. This region is well known historically for the great significance of erosion in creating the unique topography and landforms of this area. Much of the sediment produced by mass wasting of landslides and mechanical weathering in source areas has been transported and result in aggradation of downstream valleys. Differential weathering of different strata has produced scarps that retreat by rockfall and slab-failure processes. Natural coal seams are common throughout the area.

This intermountain region has a continental type climate with warm summers and cold winters and wide contrasts and fluctuations in temperature and moisture. The climate is semiarid with averages of 6 to 16 inches of annual precipitation and a range of 45 to 55° F average annual temperature. The area is subject to "summer monsoon" type thunderstorms, winter frontal storms as snow or rain, and is noted for the intensity of the summer rainfall. Vegetation in the central and northern section is a shrub-grassland at lower elevation grading into pinyon-juniper woodlands on intermediate areas with coniferous forests at higher elevations.

Studies on the Colorado Plateau stress the importance of erosion process and the denudation of an area subject to widespread erosion and sediment transport. The main temporal actions in the erosion cycle are:

- loosening or detachment of particles by weathering to produce sediment
- water detachment of particle by rain splash, impact or shear
- infiltration followed by runoff
- lateral movement by sheet erosion
- rill (< 8") and gully (> 8") formation
- sediment transport and downslope movement

- deposition in an aggradation zone

The delivery rate is equal to the yield of sediment production divided by the erosion rate. Unconsolidated sediment is subject to detachment and will be transported at the first opportunity.

Numerous exposed coal seams outcrop in this "Coal Cliffs" portion of the Plateau, and are a part of the natural environment. These coal seams vary in thickness but are generally exposed at the base of shale slopes and are easily erodible. Coal material is naturally part of the sediment production, and is transported and deposited in drainage and alluvial materials. Some local plant species are adapted to grow in this material and are common. Coal exposed at the surface has been weathered and altered by microbial action, mainly fungus.

2.2. Specific Characteristics on the J.B. King Site.

The J.B. King Mine is located along the eastern edge of the Dog Valley Wash at 6240 to 6375 feet elevation. The area and vicinity of the site has the typical continental climate and receives about 10 inches annual precipitation with intense summer thunderstorms. The site forms a northwestern-facing amphitheater with resistant sandstone cliffs around an eroded alcove formed on Mancos Shale which underlies the sandstone and contains the coal. The reclaimed site has about 30 acres with a covered refuse pile, a main drainage, open flats and slopes, and a barrow area. The constructed ditches across the site have received large volumes of water as runoff from the drainage above and outside the site boundaries. Thunderstorms have produced splash erosion and sheet erosion on unprotected soil surfaces.

The soils and ranges sites in the vicinity of the site are in the Travessilla-Gerst badlands type according to the Soil Conservation Service (pers. comm., Leland Sasser, Soil Scientist, SCS, Price). This is considered a non-soil complex with shallow sandy material over bedrock on the sandstone flats and cliffs, and a clay loam on the Manchos Shale slopes. The erosion and weathering is too rapid for typical soil profiles to develop, and the soil is weathered bedrock materials with low vegetation cover. The alluvial slopes and bottoms below the cliffs and slopes has a variable non-defined colluvial or alluvial soils material with layers of coarse sand mixed with finer loams and clays.

There is a broad pattern of vegetation types related to soils and topography around the site. The sandstone flats above and east of Dog Valley are a pinyon-juniper woodland interspersed with shrub-grass on deeper sandy soils. Vegetation on the alluvial flats in the broad Dog Valley is dominated by greasewood (*Sarcobatus vermiculatus*) with a few scattered grass clumps. Grazing has reduced grass cover and an annual weedy flora covers sandy flats. Vegetation on the intermediate slopes between the sandstone outcrops and flats and the alluvial valley floors is a mixed shrub-scrub on the shaley and sandy slopes. Typical plant cover values are 8-10% on the shale slopes, and 18-20% on the alluvial slopes and flats, and about 12-15% on the sandstone outcrops and flats. There is a large variability in vegetation and ecological factors in the escarpment and sloping areas between sandstone bluffs (pinyon/juniper) and alluvial flats (greasewood shrub)

The area is grazed by cattle as winter rangeland except for the 30 acre reclaimed site which is fenced to exclude cattle. The grazing has been intense and has increased erosion and runoff by reducing the sparse plant cover and loosening and breaking the soil surface by trampling. The last several years until 1992 have had low rainfall and increased the effects of grazing by further reducing plant cover. Grazing of cattle has altered the dominant plants species on all areas around the site and introduced a large annual weedy component. The extent of this alteration in vegetative composition is unknown since there are no ungrazed reference areas.

Several soil and topographic conditions were altered on the mine site during active mining and later reclamation related activities. These mining and reclamation activities changed the conditions on the site from the premining state, and the site differs in these characteristics from slopes adjacent to the mine site. The main changes were; 1) a reduction in slopes so that the site is flatter than adjacent areas (except for the southwest side of the covered refuse pile), 2) the soil substrates are a mixed and transported material that is deeper than the in-place soils and rock outcrop on adjacent areas, 3) the soils are heterogenous mixed weathered and parent material that in places have a high nutrient content or may have a high salt content. Observations on surrounding landforms determined that the reclaimed site has mixed substrate and topographic conditions intermediate between the bluffs and upper slopes and the alluvial fans and flats downslope in Dog Valley. The conditions for plant growth and productivity, in general, are favorable but variable. There are a variety of substrate and slope for different types of vegetation. The resulting vegetation type and patterns are somewhat similar to the flatter alluvial valley sections of Dog Valley where large clumps of greasewood are interspersed with bare flat compacted soils. However, vegetation on the reclaimed site is varied with more species and higher productivity than observed on the flats in Dog Valley where grazing has reduced grass cover to less than a few percent, and a large part of the annual vegetation is weedy.

There are several contributing factors and conditions around Dog Valley that have affected and controlled erosion both on and off site. These factors have increased or altered the already high rates of erosion and sedimentation due to natural geomorphologic and climatic conditions and include: 1) cycles of drought followed by increased rainfalls has caused variations in vegetative growth and plant cover on and off the site; 2) cattle grazing with no management during this drought cycle on the reclaimed site until 1989 and off site during the early reclamation period resulted in decreased plant cover and loosened soil surfaces; and 3) the drought was interrupted in 1991 by a series of thunderstorms on and off the site. The drought did not increase the effectiveness of these storms to erode and move sediment, although large volumes of water entered the site in the drainage control ditches.

There are other site conditions that have contributed to changes in vegetation growth and erosion control. The site is located in a landform configuration with slopes, substrate conditions, and drainage that are naturally not in equilibrium for erosion processes, and mining and reclamation at first temporarily increased surface instability. The previous mining and reclamation activities left loose unconsolidated material on the site that initially was easily eroded and acted as a sediment source. This unconsolidated material (refuse pile, and other flats and slopes) required a period of time for armoring of loose surface and adjustment of micro-topography for drainage into rill and gullies on smooth slopes and flats. This process of soil armouring and stabilization has started on the site. The rate of these processes are unknown and depend on local episodic weather patterns. The sedimentation rate during the past eight years has been fairly slow as evidence by the lack of deposition of sediment into the sediment pond, and decreased by sediment control measures by WSM.

The consequences of the site conditions for erosion control are that natural conditions and reclamation activities have resulted in a short period of instability of the slopes, surfaces, and unconsolidated sediment on site, followed by increasing stability. The current study was designed to help determine if the erosional conditions and vegetational bare patterns on the J.B. King mine site exceed natural conditions in the surrounding environments. Permanently marked transects have been set up to monitor trends in vegetation and erosion (See Section 3.0 for methodology).

3.0 SAMPLING PROTOCOL

This sampling protocol has been developed for sampling vegetation cover and densities, and vegetative community patterns in relationship to topographic, soils, and erosional factors. The present reference area does not address the pattern of vegetation and size or percentage of bare, non-vegetated areas versus vegetated areas. The topography and soils on the reclaimed site are complex and disturbed, and the vegetation established is in a successional status and not uniform. This specific type of sampling determines the relationship of vegetation patterns to soils and topography on undisturbed natural areas in the vicinity of the mine site. The purpose of this sampling was to determine if the natural patterns and ecological factors affecting vegetation in this specific region of Utah can be determined, and if they will serve as a guide to predict present and future conditions (as it reflects on potential revegetation) on the reclaimed site.

The types of field analyses that were used are not a part of ordinary procedures covered in the Division's guidelines which uses fixed reference areas, range sites, or baseline data prior to mining. The guidelines suggest the use of belt transects or plots, but treat each randomly located plot as one sample. This type of sampling does not allow the determination of vegetation patterns and bare areas, nor relationships of vegetation types to environmental factors, such as erosion. Under R645-301-456.100 of the Coal Mining Rules "other approved success standards" may be used to judge the effectiveness of the vegetation. The requirement that the sampling techniques for measuring success using a 90% statistical confidence interval assumes a normally distributed population of samples, which may not be met in this highly variable and heterogenous landscape.

Linear coupled transects were established on and off the site. These were linear plots (2 x 10 meters in size) laid end to end along a straight compass line and oriented roughly parallel to the sandstone escarpments. The general areas surveyed were the western and northern facing escarpments and slopes of Dog Valley. Vegetative, topographic, erosional, and soil variables were recorded in each plot. The transects were then analyzed for the type of vegetation and patterns of vegetation types as they relate to topography, soils, and erosional features. Large bare area were noted but not sampled by the transect method.

A general field reconnaissance was conducted in the vicinity of the reclaimed mine to observe and record topographic, drainage conditions, and other environmental factors along the sandstone escarpments in a topographic position similar to the site. The downslope and drainage features in the alluvial wash below the site were characterized and photographed. These procedures used for the field program did not change significantly from an earlier proposed sampling protocol document. All minor changes to these procedures are documented in this report, and an explanation and rationale for the change included.

We evaluated the down-gradient drainage in the Dog Valley Wash below the site for present conditions from past uses, and the potential for effects from sedimentation from the J.B. King site. The drainage along Dog Valley, starting at the western edge of the site, was walked west and then north approximately 2 miles to the Interstate 70 freeway. The drainage was observed for major vegetation types, dominant plant species, and soil and topographic conditions.

3.1 Specific Procedures

The procedures are detailed in this section for the variables measured, the sampling locations and marking, number of samples, and analysis of the data.

<u>Sampling location and marking:</u> Two sets of sampling were conducted; a set of four lines off site, and a set of four lines on the reclaimed site. Two of the off site linear transects were run north and

one west from numbered perimeter fence posts chosen randomly; the fourth transect was down-valley from the site. The transects were run from the random points (fence posts) on the north edge of the site in a northerly direction (azimuths 15° and 17°) along gradients at the same elevation as the site, and roughly parallel to the escarpment face. This was repeated running west at an azimuth of 270° from the edge of the site along and below the sandstone bluffs. Transects were permanently marked with 3' lengths of #3 rebar driven 2' (or until refusal) into the ground at 30 meter intervals. A 30 meter steel tape was stretched between markers, and 3 plots (each 2x10 meters) recorded at 10 meter intervals. Similarly, three transects were run inside the perimeter fence on the reclaimed site from randomly chosen fence posts. A fourth transect was located on the steeper south and west facing portion of the refuse pile, this was not marked with rebar for the erosional study because of the uncertainty of future plans for the surface of the refuse pile.

The following table is a summary of the transects:

Location	Number	Azimuth	No. of Plots	Permanent Erosion Stakes
On site	A1	53°	35	Yes
On site	A2	160°	33	Yes
On site	A3	130°	45	Yes
Refuse pile	R1	--	36	No
North of site	N1	15°	45	Yes
North of site	N2	17°	36	Yes
West of site	W1	270°	34	Yes
Valley floor below site	V1	260°	30	No

Variables: The variables chosen were ecologically significant for measuring biological responses to environmental conditions as related to established reclamation procedures and situations on the reclaimed mine site. The dependent (response) variables in the transects measured for vegetation were: (1) total percent plant cover, (2) dominant species, and (3) total number of shrubs. The length of the center line that was vegetated was not recorded since no large bare areas were encountered along the transects. This aspect of the observations will be discussed in the vegetation patterns section. Instead of bare areas, the distance between areas with low cover was determined by inspection of the data for large scale pattern analysis.

The independent (predictor) variables measured were: (1) topographic features (degree and aspect of the slope), (2) soil surface features (type of substrate and percentage rock cover), (3) erosion features (depth and width of gullies and rills) and estimation of overall erosion factor, and (4) an estimated moisture factor. Moisture and the aggradation/degradation (erosional status) of surfaces was a qualitative factor estimated for each plot using scalars of 1 to 5. Three additional measurements on the stake were recorded: (1) the length of stake above ground, and the height above ground of a point parallel to and level with the stake in (2) front and (3) back of the stake at a one foot distance from the stake along the transect line (see diagram below). These last three measurements can be repeated at intervals over a period of years to determine erosion status around the stakes.

Specific field forms were used during the field measurements. Records from these forms were transferred to computer spreadsheets for general analysis and statistical tests. The following are the measurements for each variable that were measured in the field:

VARIABLES	FIELD MEASUREMENTS
DEPENDENT	
Vegetation	dominant species as a record
	total cover as a percent
	shrub density as a count
INDEPENDENT	
Topography	percent slope
	aspect for 8 cardinal points on a compass
Soil type	a descriptive term that gives the general texture in the field by inspection; from sand to clay
Substrate type	a descriptive term for the substrate from with the soil was derived; sandstone, shale, coal, alluvium, colluvium, aeolian, mixed
Rock	type as a rock type; sandstone, shale, coal
	rock cover of the soil as a percent
Moisture	a scaler of 1 (moist) to 5 (dry)
Erosion	a scaler of 1 (severe erosion) to 5 (obvious deposition)

<u>Number of samples:</u> The number of samples (minimum of 30 plots) was determined by the general length of the transects off site which covered the topographic position being sampled. The four lines off site were run until either an obstacle was encountered (such as a sandstone bluff) or the line was about 450 meters in length. Sample adequacy for the number of factors being measured was not of concern, but a large number of samples were needed for correlation and statistical analysis. The number of 10 meter plots sampled in the four lines off site was 145, and the number of plots in the four lines on site was 149.

<u>Analysis:</u> The purpose of the analysis was first, to characterize the vegetation and environmental parameters for each transect line, and then determine correlations. The results of the transects were first analyzed for: (1) the vegetative percentage cover and shrub densities, (2) the aspect and slopes of topographic features, (3) the types of soil and substrates, and (4) rock types and cover. The

parameters developed were statistical means and standard deviations, and other standard parameters.

The second major analysis was to develop a matrix of correlation coefficients between the dependent and independent variables. These correlations were determined using a computer statistic program, Statgraphics Plus. If significant correlations were found, then the third statistic performed was a multiple regression analysis. Only one multiple regression analysis was run; that was for plant cover as a function of moisture, rock cover, and gully width.

The vegetative cover for each set of transect plots was compared to all other sets using the *T-test* distribution. This test measures whether the means of the two sets of plots are similar, and if one set of samples can be used as a predictor of expected parameters of the other.

The results of the analysis are discussed for the ecological characteristics that can be used as predictors of vegetation parameters and erosion processes.

4.0 RESULTS

The results of the field sampling procedures and statistical analysis showed that, in general, the vegetation cover and density is highly variable both on and off site. There was generally no highly significant correlation to the soil, substrate, erosional, and topographic factors measured that would indicated a strong association. The single exception was a higher correlation between vegetation cover and the moisture factor. The results of the analysis are presented, and the general conditions in Dog Valley discussed followed by a discussion of their significance on the site.

4.1 Analysis of Transect Data

Standard statistical parameters: These parameters were calculated for the variables to determine the average, range, and standard deviation. The vegetation and environmental parameters are presented in Table 4.1 for the four on site transects and four off site transects. Average vegetative cover was 17.2% (20.1, 16.5, 23.2, and 9.1%) for on site vegetation; and for off site varied from 11.0% for N1, 15.9% for N2, 16.1% for V1, and 17.8% for W1 for an overall average of 15.2%. The standard deviation of the vegetation data was high for all plots in each transect, but was higher for the transects on site. Analysis of the plot data for variance and standard deviation indicate that the variability of all the measured variables is high. Sample adequacy was generally acceptable using a precision calculation of the width of the 95% confidence intervals of 30%.

Dominant plants species: The plant species recorded in the plots differed on the reclaimed mine from species off site. The reclaimed site was seeded with a species composition that differed from the off site natural vegetation. The dominant shrub species on site were four-wing saltbush (*Atriplex confertifolia* - a seeded and transplanted species) and greasewood (*Sarcobatus vermiculatus* - seeding naturally from nearly plants). Dominant grasses were the seeded species and hybrids of wheatgrass (*Agropyron* sp.), and Indian ricegrass (*Oryzopsis hymenoides*). The dominant shrub species off site were more varied with two species of saltbush, one sagebrush, and greasewood; grass species were also varied, although grass cover was low. Table 4.2 presents the dominant species in the transects by frequency. The type of vegetation based on dominant species is a shrub-scrub with a small grass component. The species dominance from area to area changes at these topographic locations with little predictable repeat patterns based on the results of our study. The broader scale vegetation patterns around the site are discussed in Section 2.2.

Table 4.1 Statistical Parameters for Vegetation and Ecological Parameters

Transect A-1

Parameter	Plant cover	Shrub density	Rill depth	Rill width	Slope	Rock cover	Erosion	Moisture
Sample size	35	35	35	35	35	35	35	35
Average	20.1	6.4	2.8	8.7	5.4	11.7	2.7	2.1
Median	15	5	0	0	5	10	3	2
Mode	18	5	0	0	3	3	3	2
Geometric mean	14.9	--	--	--	4.6	9.4	2.7	1.9
Variance	238.0	17.3	65.0	681.4	11.3	60.0	0.4	0.5
Standard deviation	15.4	4.2	8.0	26.1	3.4	7.7	0.6	0.7
Standard error	2.6	0.7	1.4	4.4	0.6	1.3	0.1	0.1
Minimum	2	0	0	0	2	3	2	1
Maximum	65	16	29	110	15	30	4	3
Range	63	16	29	110	13	27	2	2

Transect A-2

Parameter	Plant cover	Shrub density	Rill depth	Rill width	Slope	Rock cover	Erosion	Moisture
Sample size	33	33	33	33	33	33	33	33
Average	16.5	5.8	1	3.6	5.4	12.4	2.5	2.4
Median	15	5	0	0	3	10	3	2
Mode	15	6	0	0	1	2	3	1
Geometric mean	12.9	--	--	--	--	7.8	2.3	2.1
Variance	107.9	22.2	16.1	236.4	30.2	126.6	0.7	1.5
Standard deviation	10.4	4.7	4.0	15.4	5.5	11.3	0.8	1.2
Standard error	1.8	0.8	0.7	2.7	1.0	2.0	0.1	0.2
Minimum	2	0	0	0	0	1	1	1
Maximum	40	20	18	80	20	45	4	5
Range	38	20	18	80	20	44	3	4

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Transect A-3

Parameter	Plant cover	Shrub density	Rill depth	Rill width	Slope	Rock cover	Erosion	Moisture
Sample size	45	45	46	46	45	45	45	45
Average	23.2	6.2	4.1	10.4	6.2	6.3	2.5	2.6
Median	20	6	0	0	6	5	3	3
Mode	20	6	0	0	5	10	3	3
Geometric mean	18.3	--	--	--	--	5.0	2.4	2.5
Variance	182.6	13.6	365.9	1933	19.4	17.7	0.3	0.6
Standard deviation	13.5	3.7	19.1	44.0	4.4	4.2	0.6	0.7
Standard error	2.0	0.5	2.8	6.5	0.7	0.6	0.1	0.1
Minimum	1	0	0	0	0	1	1	1
Maximum	60	16	125	280	18	20	4	4
Range	59	16	125	280	18	19	3	3

Transect R-1

Parameter	Plant cover	Shrub density	Rill depth	Rill width	Slope	Rock cover	Erosion	Moisture
Sample size	36	36	42	42	36	36	36	36
Average	9.1	6.2	9.4	29.5	14.9	18.1	1.8	1.6
Median	9.5	6.0	12.0	40.0	14.5	15	2	2
Mode	10	5	0	0	15	15	2	2
Geometric mean	8.0	--	--	--	14.7	16.0	1.8	1.6
Variance	13.5	11.0	61.8	677.8	6.3	82.8	0.1	0.2
Standard deviation	3.7	3.3	7.9	26.0	2.5	9.1	0.4	0.5
Standard error	0.6	0.6	1.2	4.0	0.4	1.5	0.1	0.1
Minimum	1	0	0	0	12	5	1	1
Maximum	16	12	22	70	20	45	2	2
Range	15	12	22	70	8	40	1	1

Transect N-1

Parameter	Plant cover	Shrub density	Rill depth	Rill width	Slope	Rock cover	Erosion	Moisture
Sample size	45	45	46	46	45	45	45	45
Average	11.0	6.7	8.6	28.7	13.0	49.1	1.9	1.6
Median	10	6	0	0	12	50	2	2
Mode	12	3	0	0	12	60	2	1
Geometric mean	9.1	--	--	--	10.1	43.4	1.7	1.5
Variance	37.2	26.8	584.8	5264	77.4	430.1	0.6	0.4
Standard deviation	6.1	5.2	24.2	72.6	8.8	20.7	0.8	0.6
Standard error	0.9	0.8	3.6	10.7	1.3	3.1	0.1	0.1
Minimum	1	0	0	0	2	8	1	1
Maximum	26	25	120	300	30	90	4	3
Range	25	25	120	300	28	82	3	2

Transect N-2

Parameter	Plant cover	Shrub density	Rill depth	Rill width	Slope	Rock cover	Erosion	Moisture
Sample size	39	39	39	39	37	39	39	39
Average	15.9	7.5	10.4	18.3	8.2	42.8	2.2	1.9
Median	15	7	0	0	5	50	2	2
Mode	25	7	0	0	3	60	2	1
Geometric mean	14.1	--	--	--	5.1	30.8	2.1	1.7
Variance	53.3	16.1	955.8	1853	79.4	573.5	0.7	0.9
Standard deviation	7.3	4.0	30.9	43.0	8.9	23.9	0.8	0.9
Standard error	1.2	0.6	5.0	6.9	1.5	3.8	0.1	0.1
Minimum	5	0	0	0	1	1	1	1
Maximum	28	18	150	200	32	80	4	4
Range	23	18	150	200	31	79	3	3

Transect W-1

Parameter	Plant cover	Shrub density	Rill depth	Rill width	Slope	Rock cover	Erosion	Moisture
Sample size	39	39	41	41	39	39	39	39
Average	17.8	9.4	31.6	71.8	10.1	36.9	2.3	2.2
Median	17	7	12	40	6	40	2	2
Mode	12	5	0	0	3	65	2	2
Geometric mean	15.4	7.4	--	--	7.2	21.8	2.2	2.0
Variance	78.5	45.8	10207	20655	75.4	657.2	0.5	0.6
Standard deviation	8.9	6.8	101.0	143.7	8.7	25.6	0.7	0.7
Standard error	1.4	1.1	15.8	22.4	1.4	4.1	0.1	0.1
Minimum	3	2	0	0	2	1	1	1
Maximum	35	30	630	700	30	80	4	4
Range	32	28	630	700	28	79	3	3

Transect V-1

Parameter	Plant cover	Shrub density	Rill depth	Rill width	Slope	Rock cover	Erosion	Moisture
Sample size	30	30	30	30	30	30	30	30
Average	16.1	4.2	0.8	3.3	1.2	0.5	2.9	3.0
Median	11	3	0	0	1	0	3	3
Mode	5	1	0	0	1	0	3	3
Geometric mean	11.3	--	--	--	--	--	2.8	2.9
Variance	170.8	15.1	20.8	333.3	0.5	1.6	0.1	0.2
Standard deviation	13.1	3.9	4.6	18.3	0.7	1.3	0.3	0.5
Standard error	2.4	0.7	0.8	3.3	0.1	0.2	0.1	0.1
Minimum	2	0	0	0	0	0	2	2
Maximum	45	14	25	100	3	5	3	4
Range	43	14	25	100	3	5	1	2

Table 4.2 Dominant Plants On Site by Frequency

SHRUBS	
Atriplex confertifolia	85%
Sarcobatus vermiculatus	30%
GRASSES	
Agropyron spp	70%
Oryzopis	20%

Dominant Plants Off Site by Frequency

SHRUBS	
Atriplex canescens	44%
Atriplex gardneri	33%
Artemesia nova	13%
Sarcobatus vermiculatus	28%
FORBS/SUBSHRUBS	
Gutierrezia sarothrae	44%
GRASSES	
Sporobolus sp.	38%
Hilaria jamesii	15%

Simple Correlation Analysis: Simple correlation coefficients were calculated for dependent versus independent variables. A correlation coefficient value of greater than 0.5 or higher was considered highly significant (i.e. a strong association existed). Plant cover and shrub density (dependent variables) were each run independently against slope, percent of rock cover, erosion factor, moisture factor, depth and width of rills/gullies, soil type, substrate type, and aspect. The last three variables were recorded as alphanumeric, but were converted to numeric entries for analysis. The results of the correlations are given in Table 4.3:

Table 4.3 Correlation Coefficient Matrix for all Variable Measured

	A-1	A-2	A-3	R-1	N-1	N-2	W-1	V-1
plant cover vs. shrub density	0.52	0.62	0.78	0.79	0.26	-0.08	0.25	0.87
plant cover vs. rill width	0.39	0.10	0.02	0.35	0.10	-0.03	0.38	0.46
plant cover vs. rill depth	0.39	0.19	0.02	0.42	0.09	0.07	0.38	0.46
plant cover vs. slope	0.02	-0.03	-0.17	-0.08	0.06	-0.46	-0.17	0.09
plant cover vs. rock cover	-0.24	-0.31	-0.39	-0.21	-0.23	-0.70	-0.20	-0.03
plant cover vs. moisture	0.75	0.66	0.73	0.53	0.61	0.65	0.70	0.40
plant cover vs. erosion	0.07	0.35	0.18	-0.05	0.08	0.46	0.31	-0.45
shrub dens. vs. rill width	0.20	0.15	0.07	0.37	0.08	0.10	0.03	0.40
shrub dens. vs. rill depth	0.32	0.23	0.05	0.48	0.07	0.30	0.05	0.40
shrub density vs. slope	0.25	0.48	-0.04	-0.36	-0.36	0.07	0.39	0.15
shrub dens. vs. rock cover	-0.18	0.27	-0.35	-0.07	-0.48	-0.01	0.04	-0.08
shrub density vs. moisture	0.53	0.6	0.59	0.57	0.13	-0.16	0.48	0.28
shrub density vs. erosion	-0.07	-0.23	0.04	-0.11	0.11	-0.32	-0.06	-0.25
rill width vs. slope	0.07	0.41	-0.02	0.09	0.12	0.12	-0.23	-0.13
rill width vs. rock cover	-0.19	0.02	0.49	-0.14	-0.02	0.07	-0.26	-0.06
rill width vs. moisture	0.24	-0.01	-0.12	0.34	0.17	-0.08	0.27	0.45
rill width vs. erosion	-0.22	-0.33	-0.17	-0.16	-0.37	-0.14	-0.33	-0.55
rill depth vs. slope	0.15	0.48	-0.03	0.05	0.16	0.06	-0.19	-0.13
rill depth vs. rock cover	-0.17	0.01	0.48	-0.09	0.02	0.07	-0.26	-0.06
rill depth vs. moisture	0.24	0.01	-0.10	0.32	0.15	0.11	0.24	0.45
rill depth vs. erosion	-0.29	-0.32	-0.15	-0.21	-0.34	-0.06	-0.18	-0.55
slope vs. rock cover	0.46	0.49	0.10	-0.40	0.52	0.52	0.68	-0.07
slope vs. moisture	0.03	-0.47	-0.32	-0.08	-0.23	-0.43	0.11	-0.04
slope vs. erosion	-0.38	-0.70	-0.35	-0.05	-0.59	-0.67	-0.36	-0.19
rock cover vs. moisture	-0.05	-0.69	-0.50	-0.27	-0.20	-0.63	0.02	0.05
rock cover vs. erosion	-0.16	-0.65	-0.33	-0.18	-0.11	-0.32	-0.24	0.11
moisture vs. erosion	0.03	0.66	0.28	-0.03	0.35	0.51	0.19	-0.56

The strongest associations (high correlation coefficients) indicate that vegetative cover is positively correlated with moisture, and negatively correlated with rock cover. Except for one off site transect (N-2) plant cover was positively correlated with shrub density. The vegetation cover is higher with better moisture regimes, and lower with increased rock cover. Within the the independent variables, erosion is negatively correlated with slope. Very little strong correlation exists between the other dependent variables that show strong association that can be used as predictor variable, and also little correlation between the independent variables. However slope was consistently negatively correlated with erosion, that is, the flatter the slope, the lower the erosion potential. This general lack of correlation indicates that the vegetation and ecological factors are not in equilibrium, and that vegetation does not tend toward a "climax" community. Most environmental factors cannot be used to predict vegetation.

A T-test was used to determine if there is similarity in the vegetative cover values for pairs of transects. For the site the most similar off site transects was N-2, which had fairly high values. Although the cover values were similar, other environmental factors and plant species composition differed. Table 4.4 presents the results of the T-test.

Table 4.4. T- test for similarity of vegetative cover for paired transects

Transects	**T-Test**	**Transects**	**T-Test**	**Transects**	**T-Test**
A-1 to A-2	0.2610	A-2 to N-2	0.7951	R-1 to N-2	0.0000
A-1 to A-3	0.3514	A-2 to W-1	0.5782	R-1 to W-1	0.0000
A-1 to R-1	0.0002	A-2 to V-1	0.9070	R-1 to V-1	0.0075
A-1 to N-1	0.0019	A-3 to R-1	0.0000	N-1 to N-2	0.0013
A-1 to N-2	0.6871	A-3 to N-1	0.0000	N-1 to W-1	0.0001
A-1 to W-1	0.4387	A-3 to N-2	0.0027	N-1 to V-1	0.0497
A-1 to V-1	0.2677	A-3 to W-1	0.0312	N-2 to W-1	0.3185
A-2 to A-3	0.0157	A-3 to V-1	0.0275	N-2 to V-1	0.9373
A-2 to R-1	0.0004	R-1 to N-1	0.0969	W-1 to V-1	0.5584
A-2 to N-1	0.0088				

Vegetation Patterns: Occurrence of vegetation types and patterns of low vegetative cover were analyzed for both on site and off site transects. Nodes (repeat patterns) of low to high vegetation cover along the transects were determined to vary from 80 to 200 meters and had no consistent pattern on or off site. Some species were more prevalent on naturally exposed coal seams and soil derived from shale and coal, but the vegetation did not form a distinctive community on these locations. This result of a lack of vegetation patterns on the scarps and slopes around Dog Valley was consistent with the general lack of observable correlations with environmental or ecological factors. Areas with consistent high soil moisture and a high vegetative cover from springs, seeps or permanent streams are conspicuously lacking in Dog Valley. The vegetation was patchy and heterogeneous

4.2 Description of Dog Valley Drainage Around and Below Mine Site

The alluvial flats in Dog Valley below the J.B. King site is a broad drainage that in not incised for about one-half mile below the edge of the site. The soils are a dense, compacted sandy clay loam, that do not easily erode. The vegetation cover is composed principally of large greasewood shrubs and sparse clumps of grass (see Transect V1 for vegetation parameters). Ground cover is of weedy annuals, mainly halogeton, malcomia, and Russian thistle. The channel is first incised about 8 feet deep in a small scarp 0.5 miles down stream of the site, and the channel gradually becomes broader and deeper down valley north toward I-70. At the freeway the Dog Valley drainage is channelized and drops steeply to another broad valley to the east in the drainage of Middle Creek. This drainage was also dry in June of 1994.

Observations in the area to determine where bare areas existed in the natural vegetation showed occurrences, first, on large rock outcrops, generally sandstone on bluffs and upper flats; and second, on the lower alluvial flats in Dog Valley dominated by greasewood where the soil is a compacted sandy clay loam. The size and locations of these bare areas were related to natural features of severe erosion and dense soil types. Some bare areas have been enlarged or created by cattle grazing and bedding, and the construction of a stock pond. Bare areas on the reclaimed site were concentrated in the area of repeated disturbance by access roads and the reconstruction of the upper drainage ditches. These areas had seedlings and some vegetation, indicating a trend of greater vegetation cover. The ridge extending southwest from the refuse pile also had some bare areas, probably as a result of soil compaction and poor moisture retention. These on site bare areas were neither larger nor more conspicuous than off site areas, are are balanced by areas on the site with higher than normal cover (see Table 4.1).

There were natural coal seams on the sides of the valley and also in portions of the channel that were cut into the shale. These coal seams were eroding and contributing sediment to the soils. Noticeable coal debris was observed in the channel and in the alluvial soils in the valley. The species of plants most noted growing on exposed coal seams off the site were buckwheat (*Eriogonum corymbosum*), Gardner saltbush (*Atriplex gardneri*), pricklypear (*Opuntia polyacantha*), and Indian ricegrass (*Oryzopsis hymenoides*). Some of these same plants had become established in the coal refuse test plots on the site. There was a total of 16 species of plants observed growing in the exposed coal refuse test plot. Several large rubber rabbitbrush plants were growing directly in the coal refuse.

There were no wetlands observed, nor any seeps or springs along the valley floor. All of the channel were dry during early June and there was no standing water. Tamarisk was the only plants observed that grew near two deep plunge pools that were also dry. There were not special or sensitive habitats observed along the length of the drainage that was walked.

RECEIVED
AUG 22
DIV. OF OIL GAS & MINING

Response to 7/19/94 letter

TO: J.B. KING FILE

FROM: BUZZ ~~GERICK~~ [signature]

DATE: AUGUST 17, 1994

SUBJECT: QUALITATIVE AND QUANTITATIVE ANALYSIS OF ROCK MULCH MATERIAL PROPOSED FOR J.B. KING RECLAMATION

The rock mulch (rock aggregate) that has been acquired from the Utah Department of Transportation (DOT) for the J.B. King Mine reclamation project has the following general qualitative and quantitative characteristics:

Screen Analysis: Analysis performed by American Assay Laboratories Inc. (attached)

Size Fraction	(Kg) WT.	(%) Distribution
+ 1"	5.40	33.48
<1" to > 1/2"	1.49	9.24
<1/2" to > 1/4"	1.84	11.41
<1/4"	7.39	45.87
TOTAL	16.12 kg.	100%

The minus 1/4 inch component of the above screen analysis was further analyzed by Colorado Analytical Laboratory below:

Description	%
sand	71
silt	19
clay	10
TOTAL	100

USDA Texture = > Sandy Loam

In addition, the following chemical analyses were conducted on this sample:

Description	Amt.
pH	8.3
EC	2.2 MMHOS/CM
Saturation	22.5% or water holding capacity
SAR	1.3

Soluble cations:

Description	(MEQ/L) Amt.
Ca	10.35
Mg	11.65
Na	4.43

Based upon the results of the preceding lab tests for the minus 1/4" inch fraction of the proposed rock aggregate, the material is not an adequate plant growth medium and therefore, WSMC cannot guarantee any sustainable vegetative cover (i.e. or vegetative performance standard).

This material can be considered as a very effective erosion prevention medium, but will not sustain any permanent vegetative cover. Therefore, WSMC cannot and will not guarantee a vegetative performance standard on any area where this gravel is used.

Original test results are attached.

BAMBERG ASSOCIATES
Environmental Services

FACSIMILE TRANSMISSION

Date: 6-27-94 # of pages (including cover): 3

Attention: Bazz Grick

Company: WSM

Fax #: 1-702-856-1818

From: Sam Bamberg

Project #: JB King

Message: Results of lab tests on the sand/silt fraction of the borrow materials. The main problem with the soil is that it is draughty (water holding capacity (saturation %) is low at 22.5%) and texture is mostly sand (71%). The material is a good mulch, but is not a good plant growth medium. WSM can't guarantee what plant cover will be, and cannot accept this area for performance standards on the site.

Please contact (303) 690-7402 with any problems or comments regarding this transmission

COLORADO ANALYTICAL LABORATORY

SOIL WATER ENVIRONMENTAL

LABORATORY ANALYSIS REPORT

TO: SAM BAMBERG

LAB NO: 4778

COMPANY: BAMBERG ASSOCIATES
26050 E. JAMISON CIR.
AURORA, CO 80016

DATE RCVD: 06/07/94

REPORTED: 06/22/94

PROJECT: J.B. KING MINE SITE

PARAMETER	METHOD REFERENCE	MIN. REPORTING LIMIT	UNITS
TEXTURE - HYDROMETER	ASA1 43-5	1	PERCENT*
pH-PASTE	USDA60 6(21a)	0.1	UNITS
ELECTRICAL CONDUCTIVITY-EC	USDA60 6(3a)	0.01	MMHOS/CM
SATURATION PERCENTAGE	USDA60 6(27a)	0.1	PERCENT
SOLUBLE CATIONS	USDA60 6(3a)	0.1	MEQ/L
SODIUM ADSORPTION RATIO-SAR	USDA60 6(20b)	0.1	UNITS

MMHOS/CM = MILLIMHOS PER CENTIMETER
MEQ/L = MILLEQUIVALENTS PER LITER

ASA1 = "METHODS OF SOIL ANALYSIS, PART 1"; ASA NO. 9;
AMERICAN SOCIETY OF AGRONOMY; 2ND EDITION, 1965; C.A. BLACK
USDA60 = "DIAGNOSIS & IMPROVEMENT OF SALINE & ALKALI SOILS";
USDA HANDBOOK 60; UNITED STATES SALINITY LABORATORY STAFF;
2ND EDITION, 1969; L.A. RICHARDS

ANALYSIS SUPERVISED BY

DATA APPROVED FOR RELEASE BY

240 S. Main Street • Brighton, Colorado 80601 • (303) 659-2313
Mailing Address: P.O. Drawer 507, Brighton, CO 80601

COLORADO ANALYTICAL LABORATORY
SOIL WATER ENVIRONMENTAL

BAMBERG ASSOCIATES
SAM BAMBERG
06/22/94 PROJECT: J.B. KING MINE SITE
PAGE 2 OF 2

	J.B. KING BORROW MATERIAL
SAND (%)	71
SILT (%)	19
CLAY (%)	10
USDA TEXTURE	Sandy Loam
pH (UNITS)	8.3
EC (MMHOS/CM)	2.2
SATURATION (%)	22.5
SOLUBLE CATIONS:	
Ca (MEQ/L)	10.35
Mg (MEQ/L)	11.65
Na (MEQ/L)	4.43
SAR (UNITS)	1.3

240 S. Main Street • Brighton, Colorado 80601 • (303) 659-2313
Mailing Address: P.O. Drawer 507, Brighton, CO 80601

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American Assay Laboratories Inc.

Sparks Office
1500 Glendale Ave.
Nevada 89431
Box 71060
Reno, NV 89570
Telephone
(702) 356-0606
Fax
(702) 356-1413

Elko Office
2320 Last Chance Rd.
Nevada 89801
Box 2908
Elko, NV 89801
Telephone
(702) 738-9100
Fax
(702) 738-2594

REPORT OF ANALYSIS

Client:	WESTERN STATES MINERAL CORP. Mr. Buzz Gerick
AAL Ref:	SP029201
Report Date:	5-23-94
Samples received by:	Joe Young
Date Received:	5-20-94
Time Received:	10:30 am
Purchase Order Number:	02-13097
Samples Received:	1 Soil sample for screen analysis

Samples Labeled:
Soil and Rock

CLIENT: WESTERN STATES MINERAL
AAL REFERENCE: SP029201
ATTN: BUZZ GERICK

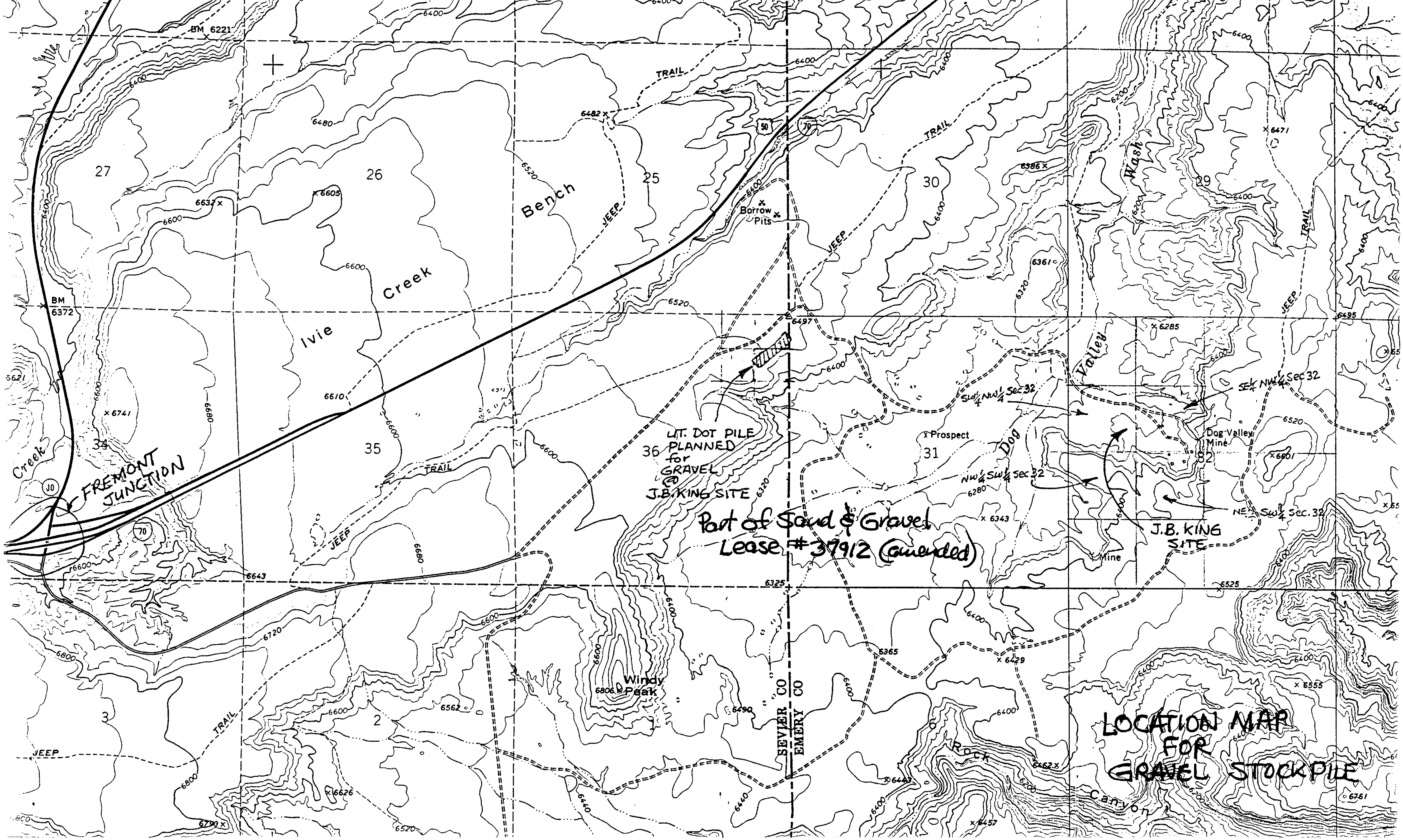
RECEIVED MAY 2 3 1994

TOTAL SAMPLE WEIGHT: 16.12 Kilograms

SCREEN FRACTION	WEIGHT (Kg)	DISTRIBUTION Percent (%)
+1"	5.40	33.48
<1" TO >1/2"	1.49	9.24
<1/2" TO >1/4"	1.84	11.41
<1/4" TO >1/16"	2.62	16.24
<1/16" TO >35 M	1.74	10.79
<35 M TO >48 M	0.81	5.02
<48 M TO >65 M	0.60	3.71
<65 M TO >100 M	0.65	4.03
<100 M TO >200 M	0.76	4.71
Minus 200 meah	0.22	1.36
TOTAL WEIGHT	16.13 Kg	99.99%

Joe Young
Metallurgist

American Assay Laboratories Inc.



LOCATION MAP
FOR
GRAVEL STOCKPILE
Part of Sand & Gravel
Lease #37912 (amended)
UT. DOT PILE
PLANNED
for
GRAVEL
@
J.B. KING SITE
J.B. KING
SITE
FREMONT
JUNCTION
SW¼ NW¼ Sec 32
SE¼ NW¼ Sec 32
NW¼ SW¼ Sec 32
NE¼ SW¼ Sec. 32
Ivie Creek Bench
Dog Valley Wash
Dog Valley Mine
Windy Peak
Rock Canyon
Borrow Pits
Prospect
Mine
SEVIER CO
EMERY CO
Creek
TRAIL
JEEP
BM 6221
BM 6372
27
26
25
30
29
34
35
36
31
32
3
2
1
6

Western States Minerals Corp.

DRILLING AND SAMPLING PROGRAM AT THE J. B. KING MINE

AUGUST 1994

HANSEN ALLEN & LUCE INC
SALT LAKE CITY, UTAH

DRILLING AND SAMPLING PROGRAM AT THE J. B. KING MINE

INTRODUCTION

A drilling and sampling program was conducted at the reclaimed J.B. King mine site from May 10 through May 12, 1994. There were three purposes for this program. The first was to obtain samples of material for geotechnical testing to determine acceptable sideslopes for proposed reclamation channels. The second purpose was to explore the material into which the proposed channels could potentially erode to determine if the material could cause acidic or toxic runoff. The third purpose was to determine if the refuse material buried on site is acid or toxic-forming. This program consisted of drilling and sampling eleven drill holes as approved by the Division. The locations of the drill holes are shown on the Reclamation Plan Revision Map contained in Appendix 1. The holes were drilled in sequential order (i.e. drill hole 1 was drilled first, drill hole 2 was drilled second, etc.).

METHODOLOGY

Drilling was accomplished using an ATV auger rig to eliminate the need for construction of access roads to the drill hole locations and to minimize disturbance to the site. The drill rig is owned and operated by Overland Drilling of West Jordan, Utah. The auger drilling method was employed with continuous sampling. Drill holes 1 through 5 and 11, located in the channel area, were drilled until natural inplace material or bedrock was encountered. Samples taken during the drilling of these holes were split for geotechnical and chemical analyses. Drill holes 6 through 10 were drilled through the refuse material.

A description of each sample recovered is provided in a field notebook. Each description includes the drill hole number, the sample number, the depth and interval from which the sample was recovered, and a visual description of the sample. After recovery, the samples were stored in plastic zip-lock bags. Each bag was labeled with the drill hole number and the sample number. The morning following the completion of drilling, one set of sample splits was taken to Chemtech Analytical Laboratory for preparation and chemical analyses. The analyses performed included: pH, EC, SAR, Selenium, Boron, and Acid/Base Potential according to the Division's "Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining", April 1988. Chemtech, using EPA approved methods, was able to analyze the samples for selenium to a detection limit of 5 parts per million. Efforts by Chemtech to lower the selenium detection limit by using graphite furnace techniques were unsuccessful. Splits of the samples were then sent to Colorado State University Soil Testing Lab which has been able to detect as low as 0.01 parts per million of selenium in soil samples. Raw data resulting from the laboratory analyses are contained in Appendix 2. The sample splits for geotechnical analysis were stored until the results of the chemical testing were available.

In order to provide enough sample material to the laboratory for analysis and to reduce the number of analyses required, some of the samples were composited. Table 1 indicates how individual samples (increments) were composited.

As indicated in Table 1, 44 samples (increments) were combined into 20 composites for testing. The results of the analyses of the composites were further combined by weighted averaging (based on the length of the increment interval) to develop a single sample description representative of the material in the channel area and a single sample description representative of the material in the refuse pile. As will be discussed, this is a conservative approach.

Erosion on the J.B. King site will not take place in a single isolated location but will take place, more or less, uniformly over the whole site. Thus the products of erosion from the refuse pile, for example, will be combined with other material eroded from the site and with material eroded from above the site. The area of the refuse pile is around 12.8 acres and the total area of the site is approximately 30 acres. It is, therefore, reasonable to assume that if the refuse material erodes it will constitute one-half or less of the total products of erosion from the site. It is inconceivable that erosion of the refuse pile would be concentrated on the location of one sample increment, with no erosion from any other part of the refuse pile or from the rest of the site. This provides justification for determining that the average characteristics of the products of erosion will more closely resemble the overall average characteristics of the on-site materials, rather than the characteristics of any individual increment of on-site material. However, to conservatively estimate the characteristics of the products of erosion, we have averaged the characteristics of the material in the channel area and the characteristics of the refuse material separately as though these materials would erode separately without mixing. In this way, the average characteristics of the products of erosion and the off-site impacts of just the refuse material can be determined without accounting for dilution or neutralization by erosional material from other parts of the site (such as from the channel area) or from materials eroded onto the site from upstream. This is the purpose of Tables 2 and 3.

RESULTS

Tables 2 and 3 show the development of two weighted average samples based on the raw data contained in Appendix 2.

TABLE 1
J.B. KING DRILLING SAMPLE COMPOSITES

Drill Hole #	Sample (Increment)#	Depth Interval	Composite #	Composite Length
1	1	0' - 4'	1/12	9'
	2	4' - 9'		
	3	9' - 14.25'	1/345	12'
	4	14.25' - 19'		
	5	19' - 21'		
2	1	0' - 4.5'	2/12	9.5'
	2	4.5' - 9.5'		
	3	9.5' - 19.5'	2/34	16.5'
	4	19.5' - 28.5'*		
3	1	0' - 4'	3/123	14'
	2	4' - 9'		
	3	9' - 14'		
4	1	0' - 4.5'	4/123	12.5'
	2	4.5' - 9.5'		
	3	9.5' - 12.5'		
5	1	0' - 4'	5/12	9'
	2	4' - 9'		
	3	9' - 14.5'	5/34	9.25'
	4	14.5' - 18.25'		
6	1	3' - 4.5'	6/12	6.5'
	2	4.5' - 9.5'		
	3	9.5' - 14.5'	6/34	10'
	4	14.5' - 19.5'		
	5	19.5' - 24.5'	6/56	8'
	6	24.5' - 27.5'		

TABLE 1 (Cont.)

Drill Hole #	Sample (Increment)#	Depth Interval	Composite #	Composite Length
7	1	2.7' - 4.5'	7/12	6.8'
	2	4.5' - 9.5'		
	3	9.5' - 14.5'	7/34	10'
	4	14.5' - 19.5'		
	5	19.5' - 24.5'	7/56	9.75'
	6	24.5' - 29.25		
8	1	3.1' - 4.5'	8/12	6.4'
	2	4.5' - 9.5'		
	3	9.5' - 14.5'	8/34	10'
	4	14.5' - 19.5'		
	5	19.5' - 24.5'	8/56	7.75'
	6	24.5' - 27.25'		
9	1	1.5' - 4.5'	9/12	6.75'
	2	4.5' - 8.25'		
10	1	2.25' - 4.5'	10/123	7.5'
	2	4.5' - 8.5'		
	3	8.5' - 9.75'		
11	1B	0' - 2.5'	11/12	4.5'
	2B	2.5' - 4.5'		

In order to compare the chemical properties of soil and refuse material on the J.B. King site with surrounding materials, two additional soil samples were taken by Dr. Sam Bamberg, a soils and vegetation consultant retained by Western States, on June 8. Each sample consisted of approximately two to three-foot composites of soil material from undisturbed sites adjacent to the J.B. King site. These samples were analyzed for the same parameters as shown in the Tables 2 and 3 above, the results of which are presented in Table 4.

TABLE 2
SAMPLE OF MATERIAL IN CHANNEL AREA

Composite #	Length	pH	Wt. pH	EC	Wt. EC	SAR	Wt. SAR	Sel.	Wt. Sel.	Boron	Wt. Boron	A/B Pot.	Wt. A/B Pot.
1/12	9'	6.92	62.28	4.310	38.79	0.71	6.39	0.48	4.32	17.7	159.3	20.6	185.40
1/345	12'	7.44	89.28	3.350	40.20	0.72	8.64	0.47	5.64	14.4	172.80	31.8	381.60
2/12	9.5'	6.46	61.37	2.850	27.08	0.84	7.98	0.40	3.80	14.4	136.80	3.8	36.10
2/34	16.5'	7.65	126.23	2.580	42.57	0.61	10.07	0.48	7.92	30.9	509.85	26.9	443.85
3/123	14'	8.05	112.70	2.570	35.98	5.80	81.20	0.70	9.80	14.5	203.00	305.0	4270.00
4/123	12.5'	7.79	97.38	1.831	22.89	1.80	22.50	1.12	14.00	24.0	300.00	143.0	1787.50
5/12	9'	7.54	67.86	2.450	22.05	0.11	0.99	0.45	4.05	51.8	466.20	51.4	462.60
5/34	9.25'	7.64	70.67	1.829	16.92	1.20	11.10	0.32	2.96	37.7	348.73	19.8	183.15
11/12	4.5'	7.85	35.33	1.194	5.37	0.76	3.42	0.71	3.20	28.5	128.25	200.0	900.00
Total	96.25'		723.10		251.85		152.29		55.69		2424.93		8650.20
Wt. Average			7.51		2.62		1.58		0.58		25.19		89.87

TABLE 3
SAMPLE OF MATERIAL IN REFUSE PILE

Composite #	Length	pH	Wt. pH	EC	Wt. EC	SAR	Wt. SAR	Sel.	Wt. Sel.	Boron	Wt. Boron	A/B Pot.	Wt. A/B Pot.
6/12	6.5'	7.38	47.97	3.180	20.67	2.40	15.60	0.25	1.63	49.3	320.45	-6.1	-39.65
6/34	10'	7.45	74.50	1.425	14.25	1.20	12.00	0.95	9.50	33.8	338.00	3.6	36.00
6/56	8'	3.71	29.68	1.499	11.99	2.40	19.20	0.43	3.44	30.1	240.80	-4.1	-32.80
7/12	6.8'	6.47	44.00	3.820	25.98	1.70	11.56	0.40	2.72	36.7	249.56	-1.2	-8.16
7/34	10'	7.63	76.30	2.110	21.10	1.90	19.00	0.31	3.10	45.8	458.00	-3.9	-39.00
7/56	9.75'	6.94	67.67	3.080	30.03	1.90	18.53	0.57	5.56	30.9	301.28	9.2	89.70
8/12	6.4'	6.83	43.71	3.090	19.78	1.40	8.96	0.57	3.65	67.1	429.44	-4.7	-30.08
8/34	10'	7.49	74.90	3.070	30.70	0.86	8.60	0.58	5.80	52.9	529.00	-2.3	-23.00
8/56	7.75'	6.89	53.40	3.600	27.90	1.20	9.30	1.51	11.70	31.4	243.35	-97.8	-757.95
9/12	6.75'	4.70	31.73	3.290	22.21	0.80	5.40	0.35	2.36	61.5	415.13	-12.9	-87.08
10/123	7.5'	7.23	54.23	3.800	28.50	1.10	8.25	0.56	4.20	55.7	417.75	118.0	885.00
Total	89.45'		598.09		253.11		136.40		53.66		3942.76		-7.02
Wt. Average			6.69		2.83		1.52		0.60		44.08		-0.08

HANSEN ALLEN & LUCE inc

TABLE 4
SAMPLES OF OFF-SITE MATERIAL

Sample #	Length	pH	EC	SAR	Sel.	Boron	A/B Pot.
Off-site 1	38"	7.87	1.766	5.028	<1	20.3	29.7
Off-site 2	24"	7.88	0.255	1.699	<1	21.2	70.5

The Division has developed a set of guidelines for classifying the suitability of a material as a plant growth medium. Table 5 shows the parameter ranges for each classification.

TABLE 5
CLASSIFICATION OF SOIL MATERIALS*

PARAMETER	pH	EC	SAR	Selenium	Boron	Acid/Base Potential
CLASSIFICATION						
Good	6.1-8.2	0-2	0-4	<0.1	<5.0	>-5
Fair	5.1-6.1 8.2-8.4	2-8	5-10	-	-	-
Poor	4.5-5.0 8.5-9.0	8-15	10-12	-	-	-
Unacceptable	<4.5 >9.0	>15	>12	>0.1	>5.0	<-5

*From: Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining, State of Utah Department of Natural Resources Division of Oil, Gas and Mining, April 1988, by James Leatherwood and Dan Duce.

The four materials sampled; the material in the channel area, the material in the refuse pile, and the two typical off-site materials, are compared in Table 6 using the Division's classification system contained in Table 5. Parameters which are classified as "unacceptable" by the Division's Guidelines are shaded in Table 6 to make comparison easier.

TABLE 6
CLASSIFICATION OF MATERIALS

Sample	pH	EC	SAR	Selenium	Boron	A/B Pot.
Channel	Good	Fair	Good	Unacceptable	Unacceptable	Good
Refuse	Good	Fair	Good	Unacceptable	Unacceptable	Good
Off-site 1	Good	Fair	Fair	Unacceptable	Unacceptable	Good
Off-site 2	Good	Good	Good	Unacceptable	Unacceptable	Good

The Channel material and the Refuse material have the same classifications, each with three "good" classifications, one "fair" classification, and two "unacceptable" classifications. The classifications for these two materials are the same for each parameter. One of the off-site undisturbed materials (Off-site 1) appears to have poorer classifications than the J.B. King materials with two "good" classifications, two "fair" classifications, and two "unacceptable" classifications. The other off-site material (Off-site 2) appears to have better classifications than the J.B. King materials with four "good" classifications and two "unacceptable" classifications. In all cases, both "on-site" and "off-site", the "unacceptable" classifications are for high selenium and boron concentrations.

GEOTECHNICAL TESTING

Splits of samples 1 through 5 and 11 were submitted to AGEC, a local geotechnical testing company, for analyses to determine stable side slope angles for the proposed channels. The result of these analyses are contained in Appendix 3. The result is that the channels should be constructed with a side slope angle of 2 horizontal to 1 vertical, with the understanding that as the constructed channels cut and meander the initial side slopes will fail naturally and ultimately the side slopes will attain the optimum natural side slope angle.

CONCLUSIONS

The conclusions which result from applying the Division's Guidelines to the above data are as follows:

- The Refuse material and the Channel material on the J.B. King site are similar in nature and both have similar classifications.
- The J.B. King materials are generally similar to off-site materials - one off-site sample has slightly poorer classifications than the J.B. King material and the other off-site sample has slightly better classifications.

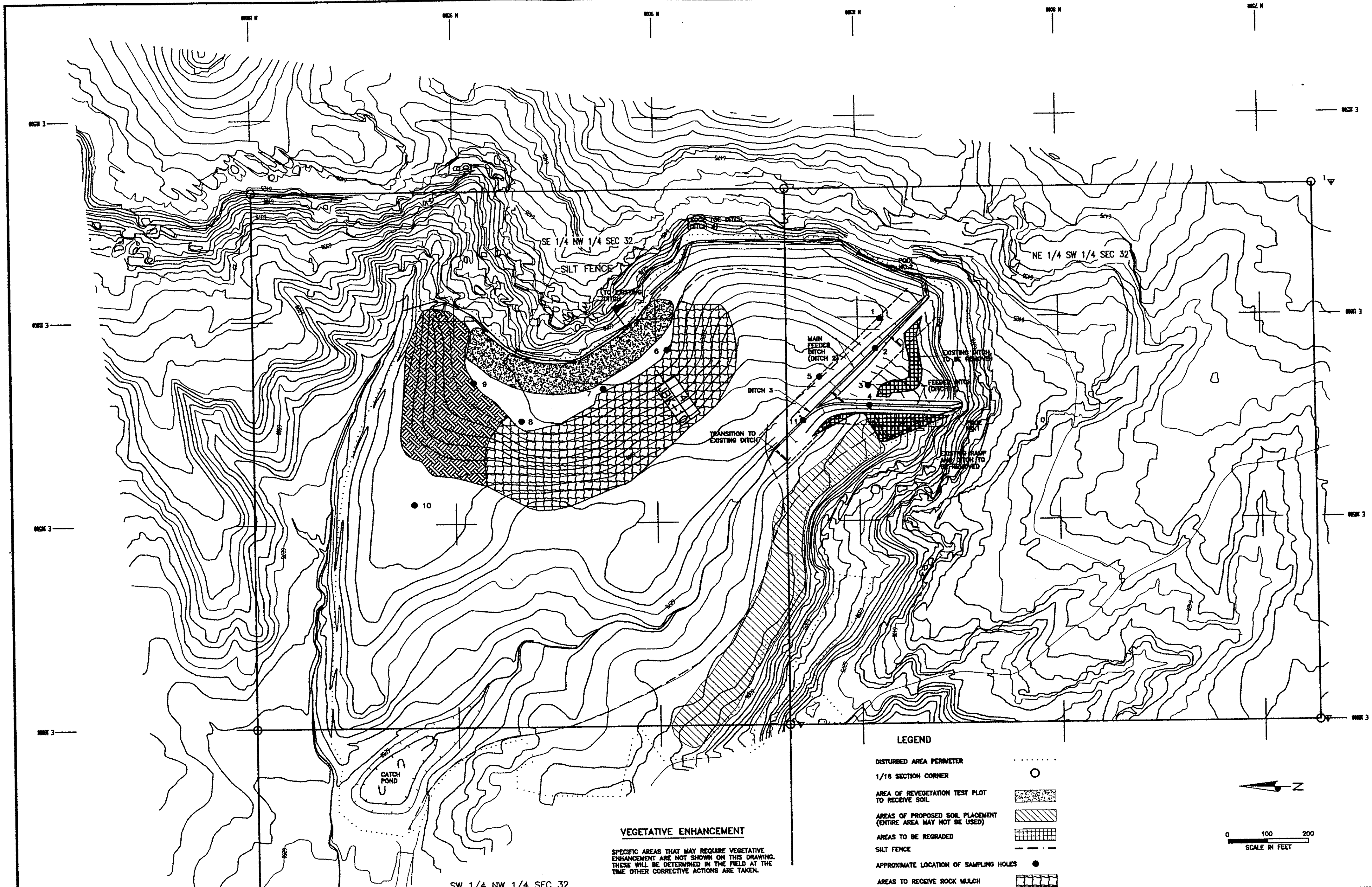
- Relative to the undisturbed material surrounding the site the J.B. King materials in the channel area and in the refuse pile are not, on average, acid-forming or toxic-forming.

- Since the materials on the J.B. King site are similar to the material surrounding the site, potential products of erosion which might escape from the J.B. King site should not adversely impact plant or wildlife off site.

- The proposed channels should be constructed with side slopes having an angle of 2h:1v. Natural erosion of the channels may cause the channel side slopes to become the optimum angle.

APPENDIX 1

Reclamation Plan Revision Map



WESTERN STATES MINERALS CORP.

TITLE: RECLAMATION PLAN REVISION

PROJECT: J.B.KING RECLAMATION

STATE: UTAH	COUNTY: EMERY
SCALE: 1"=100'	DRAWING NO.: JBK-5OJP
DATE: 2-18-1994	DRWN BY: DM/EO | REV.:

APPENDIX 2

Laboratory Analyses Results

CHEMTECH

ANALYTICAL LABORATORY

6100 S. STRATLER
MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #1 Sample #1&2	
LAB #:	U007180	DATE ANALYZED/METHOD
PARAMETER		
pH Units	6.92	5-25-94 EPA 9045
Conductivity, uhmos/cm	4,310	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	20.6	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	<.05	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	20.6	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	17.7	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	0.71	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	921	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	310	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	97.7	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: [signature]

CHEMTECH

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MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #1 Sample #3,4,&5	
LAB #:	U007181	DATE ANALYZED/METHOD
PARAMETER		
pH Units	7.44	5-25-94 EPA 9045
Conductivity, uhmos/cm	3,350	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	31.8	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	<.05	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	31.8	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	14.4	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	0.72	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	518	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	201	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	76.2	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: [signature]

CHEMTECH
ANALYTICAL LABORATORY

6100 S. STRATLER
MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #2 Sample #1&2	
LAB #:	U007182	DATE ANALYZED/METHOD
PARAMETER		
pH Units	6.46	5-25-94 EPA 9045
Conductivity, uhmos/cm	2,850	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	3.8	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	<.05	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	3.8	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	14.4	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	0.84	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	471	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	142	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	81.4	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: [signature]

CHEMTECH

ANALYTICAL LABORATORY

6100 S. STRATLER
MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #2 Sample #3&4	
LAB #:	U007183	DATE ANALYZED/METHOD
PARAMETER		
pH Units	7.65	5-25-94 EPA 9045
Conductivity, uhmos/cm	2,580	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	26.9	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	<.05	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	26.9	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	30.9	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	0.61	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	1,446	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	200	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	93.2	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: [signature]

CHEMTECH

ANALYTICAL LABORATORY

6100 S. STRATLER
MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #3 Sample #1,2&3	
LAB #:	U007184	DATE ANALYZED/METHOD
PARAMETER		
pH Units	8.05	5-25-94 EPA 9045
Conductivity, uhmos/cm	2,570	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	305	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	<.05	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	305	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	14.5	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	5.8	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	175	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	70.9	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	360	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: [signature]

CHEMTECH

ANALYTICAL LABORATORY

6100 S. STRATLER
MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #4 Sample #1,2&3	DATE
LAB #:	U007185	ANALYZED/METHOD
PARAMETER		
pH Units	7.79	5-25-94 EPA 9045
Conductivity, uhmos/cm	1,831	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	143	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	<.05	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	143	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	24.0	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	1.8	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	220	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	79.4	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	124	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: [signature]

CHEMTECH

ANALYTICAL LABORATORY

6100 S. STRATLER
MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #5 Sample #1&2	
LAB #:	U007186	DATE ANALYZED/METHOD
PARAMETER		
pH Units	7.54	5-25-94 EPA 9045
Conductivity, uhmos/cm	2,450	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	54.5	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	3.1	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	51.4	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	51.8	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	0.11	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	841	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	112	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	12.6	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: [signature]

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TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #5 Sample #3&4	
LAB #:	U007187	DATE ANALYZED/METHOD
PARAMETER		
pH Units	7.64	5-25-94 EPA 9045
Conductivity, uhmos/cm	1,829	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	22.0	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	2.2	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	19.8	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	37.7	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	1.2	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	270	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	74.2	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	86.7	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: [signature]

CHEMTECH

ANALYTICAL LABORATORY

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MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #6 Sample #1&2	
LAB #:	U007188	DATE ANALYZED/METHOD
PARAMETER		
pH Units	7.38	5-25-94 EPA 9045
Conductivity, uhmos/cm	3,180	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	19.5	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	25.6	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	-6.1	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	49.3	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	2.4	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	474	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	145	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	230	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: [signature]

CHEMTECH

ANALYTICAL LABORATORY

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MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #6 Sample #3&4	DATE
LAB #:	U007189	ANALYZED/METHOD
PARAMETER		
pH Units	7.45	5-25-94 EPA 9045
Conductivity, uhmos/cm	1,425	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	12.0	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	8.4	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	3.6	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	33.8	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	1.2	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	162	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	54.3	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	69.2	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: ______________________

CHEMTECH

ANALYTICAL LABORATORY

6100 S. STRATLER
MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #6 Sample #5&6	DATE
LAB #:	U007190	ANALYZED/METHOD
PARAMETER		
pH Units	3.71	5-25-94 EPA 9045
Conductivity, uhmos/cm	1,499	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	2.5	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	6.6	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	-4.1	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	30.1	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	2.4	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	70.9	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	18.6	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	88.2	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: ____________________

CHEMTECH

ANALYTICAL LABORATORY

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MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #7 Sample #1&2	
LAB #:	U007191	DATE ANALYZED/METHOD
PARAMETER		
pH Units	6.47	5-25-94 EPA 9045
Conductivity, uhmos/cm	3,820	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	9.1	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	10.3	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	-1.2	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	36.7	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	1.7	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	288	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	90.6	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	129	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: [signature]

CHEMTECH

ANALYTICAL LABORATORY

6100 S. STRATLER
MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #7 Sample #3&4	DATE
LAB #:	U007192	ANALYZED/METHOD
PARAMETER		
pH Units	7.63	5-25-94 EPA 9045
Conductivity, uhmos/cm	2,110	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	12.0	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	15.9	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	-3.9	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	45.8	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	1.9	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	317	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	72.2	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	146	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: [signature]

CHEMTECH

ANALYTICAL LABORATORY

6100 S. STRATLER
MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #7 Sample #5&6	
LAB #:	U007193	DATE ANALYZED/METHOD
PARAMETER		
pH Units	6.94	5-25-94 EPA 9045
Conductivity, uhmos/cm	3,080	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	15.8	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	6.6	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	9.2	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	30.9	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	1.9	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	264	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	88.3	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	110	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: [signature]

CHEMTECH

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MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #8 Sample #1&2	DATE
LAB #:	U007194	ANALYZED/METHOD
PARAMETER		
pH Units	6.83	5-25-94 EPA 9045
Conductivity, uhmos/cm	3,090	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	15.6	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	20.3	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	-4.7	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	67.1	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	1.4	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	592	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	184	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	152	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: [signature]

CHEMTECH
ANALYTICAL LABORATORY

6100 S. STRATLER
MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #8 Sample #3&4	DATE
LAB #:	U007195	ANALYZED/METHOD
PARAMETER		
pH Units	7.49	5-25-94 EPA 9045
Conductivity, uhmos/cm	3,070	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	14.3	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	16.6	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	-2.3	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	52.9	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	0.86	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	388	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	107	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	74.5	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: ____________

CHEMTECH

ANALYTICAL LABORATORY

6100 S. STRATLER
MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #8 Sample #5&6	
LAB #:	U007196	DATE ANALYZED/METHOD
PARAMETER		
pH Units	6.89	5-25-94 EPA 9045
Conductivity, uhmos/cm	3,600	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	5.2	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	103	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	-97.8	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	31.4	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	1.2	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	1,080	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	386	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	184	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: ____________

CHEMTECH

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MURRAY, UTAH 84107
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FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #9 Sample #1&2	DATE	
LAB #:	U007197	ANALYZED/METHOD	
PARAMETER			
pH Units	4.70	5-25-94	EPA 9045
Conductivity, uhmos/cm	3,290	5-25-94	EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	4.9	5-27-94	EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	17.8	5-27-94	EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	-12.9	5-27-94	EPA 2-78-054
Boron as B, mg/Kg	61.5	5-24-94	EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94	EPA 6010
Sodium Adsorption Ratio (SAR)	0.80	--	Calculation
Water Sol. Calcium as Ca, mg/Kg	1,077	5-20-94	EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	347	5-20-94	EPA 6010
Water Sol. Sodium as Na, mg/Kg	118	5-20-94	EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: ______________________

CHEMTECH

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MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #10 Sample #1,2,&3	DATE
LAB #:	U007198	ANALYZED/METHOD
PARAMETER		
pH Units	7.23	5-25-94 EPA 9045
Conductivity, uhmos/cm	3,800	5-25-94 EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	131	5-27-94 EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	13.1	5-27-94 EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	118	5-27-94 EPA 2-78-054
Boron as B, mg/Kg	55.7	5-24-94 EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94 EPA 6010
Sodium Adsorption Ratio (SAR)	1.1	-- Calculation
Water Sol. Calcium as Ca, mg/Kg	143	5-20-94 EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	49.2	5-20-94 EPA 6010
Water Sol. Sodium as Na, mg/Kg	57.8	5-20-94 EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: ____________

CHEMTECH

ANALYTICAL LABORATORY

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MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-01-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

DATE SUBMITTED: 5-13-94

CERTIFICATE OF ANALYSIS

SAMPLE ID:	Drill Hole #11B Sample #1B,2B	DATE	
LAB #:	U007199	ANALYZED/METHOD	
PARAMETER			
pH Units	7.85	5-25-94	EPA 9045
Conductivity, uhmos/cm	1,194	5-25-94	EPA 120.1
Neutralization Potential, tons $CaCO_3$/1000 tons soil	200	5-27-94	EPA 2-78-054
Acid Potential, tons $CaCO_3$/1000 tons soil	<.05	5-27-94	EPA 2-78-054
Acid Base Potential, tons $CaCO_3$/1000 tons soil	200	5-27-94	EPA 2-78-054
Boron as B, mg/Kg	28.5	5-24-94	EPA 6010
Selenium as Se, mg/Kg	<5	5-24-94	EPA 6010
Sodium Adsorption Ratio (SAR)	0.76	--	Calculation
Water Sol. Calcium as Ca, mg/Kg	162	5-20-94	EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	32.3	5-20-94	EPA 6010
Water Sol. Sodium as Na, mg/Kg	40.4	5-20-94	EPA 6010

NOTE: Sample temp. when submitted was 19.9°C not on ice.

Approved By: ____________

CHEMTECH

ANALYTICAL LABORATORY

6100 S. STRATLER
MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-30-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

SAMPLE ID: Lab #U009149

PROJECT: #Bamberg Associates, Offsite #1

DATE SAMPLED: 6-08-94

DATE SUBMITTED: 6-15-94

CERTIFICATE OF ANALYSIS

PARAMETER	DETECTED	DATE ANALYZED/METHOD	
pH Units	7.87	6-17-94	EPA 9045
Conductivity (1:1), uhmos/cm	1,766	6-22-94	EPA 120.1
Neut. Potential, Tons $CaCO_3$/1000 tons soil	29.7	6-28-94	**
Acid Potenital, Tons $CaCO_3$/1000 tons soil	<.05	6-28-94	**
Acid Base Potential, Tons $CaCO_3$/1000 tons soil	29.7	6-28-94	**
Boron as B, mg/Kg	20.3	6-22-94	EPA 6010
Selenium as Se, mg/Kg	<1	6-22-94	EPA 6010
SAR	5.028	Calculation	
Water Sol. Calcium as Ca, mg/Kg	89.9	6-23-94	EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	21.2	6-23-94	EPA 6010
Water Sol. Sodium as Na, mg/Kg	204	6-23-94	EPA 6010

NOTE: Sample temp. when submitted was 23.7°C not on ice.
** Method EPA 600/2-78-054

Approved By: ____________________

CHEMTECH
ANALYTICAL LABORATORY

6100 S. STRATLER
MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 6-30-94

TO: Hansen, Allen & Luce
6771 S. 900 E.
Midvale, Utah 84047

SAMPLE ID: Lab #U009150

PROJECT: #Bamberg Associates, Offsite #2

DATE SAMPLED: 6-08-94

DATE SUBMITTED: 6-15-94

CERTIFICATE OF ANALYSIS

PARAMETER	DETECTED	DATE ANALYZED/METHOD	
pH Units	7.88	6-17-94	EPA 9045
Conductivity (1:1), uhmos/cm	255	6-22-94	EPA 120.1
Neut. Potential, Tons $CaCO_3$/1000 tons soil	70.5	6-28-94	**
Acid Potenital, Tons $CaCO_3$/1000 tons soil	<.05	6-28-94	**
Acid Base Potential, Tons $CaCO_3$/1000 tons soil	70.5	6-28-94	**
Boron as B, mg/Kg	21.2	6-22-94	EPA 6010
Selenium as Se, mg/Kg	<1	6-22-94	EPA 6010
SAR	1.699	Calculation	
Water Sol. Calcium as Ca, mg/Kg	58.4	6-23-94	EPA 6010
Water Sol. Magnesium as Mg, mg/Kg	14.2	6-23-94	EPA 6010
Water Sol. Sodium as Na, mg/Kg	55.8	6-23-94	EPA 6010

NOTE: Sample temp. when submitted was 23.7°C not on ice.
** Method EPA 600/2-78-054

Approved By: [signature]

Barry Barnum
Hansen, Allen & luce
6771 S 900 East
Salt Lake City, UT 84121-0146

DATE RECEIVED: 06/21/94
DATE REPORTED: 07/19/94

Colorado State University
Soil, Water and Plant Testing Laboratory
Room 6, Vocational Education Building
Fort Collins, CO 80523
(303) 491-5061 FAX: 491-2930

BILLING:

JUL-19-94 TUE 14:23 CSU STL 3034912930 P.02

RESEARCH SOIL ANALYSIS

	Lab #	Sample ID #	mg/kg Total Se
R	8846	1/12	0.48
	8847	2/12	0.40
	8848	5/12	0.45
	8849	6/12	0.25
	8850	7/12	0.40
	8851	8/12	0.57
	8852	9/12	0.35
	8853	11/12	0.71
	8854	2/34	0.48
	8855	5/34	0.32
R	8856	6/34	0.95
	8857	7/34	0.31
	8858	8/34	0.58
	8859	6/56	0.43
	8860	7/56	0.57
	8861	8/56	1.51
	8862	3/123	0.70
	8863	4/123	1.12
	8864	10/123	0.56
	8865	1/345	0.47

Duplicates

	Lab #	Sample ID #	mg/kg Total Se
R	8850d	7/12	0.48
	8860d	7/56	0.61

Barry Barnum
Hansen, Allen & Luce
6771 S 900 E
Midvale, UT 84047

DATE RECEIVED: 07/29/94
DATE REPORTED: 08/18/94

Colorado State University
Soil, Water and Plant Testing Laboratory
Room 6, Vocational Education Building
Fort Collins, CO 80523
(303) 491-5061 FAX: 491-2930

BILLING:

RESEARCH SOIL ANALYSIS

	Lab #	Sample ID #	mg/kg Total Se
R	989	Offsite 1	0.31
	990	Offsite 2	0.15

APPENDIX 3

Geotechnical Testing Results

Applied Geotechnical Engineering Consultants, Inc.

August 19, 1994

Hansen, Allen and Luce, Inc.
6771 South 900 East
Midvale, Utah 84047-1436

Attention: Bill Bigelow

Subject: Drainage Ditch Excavation
J. B. King Mine
Emery County, Utah
Project No. 39794

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc. was requested to provide recommendations for cut slopes for drainage ditches to be excavated through existing fill material at the J. B. King Mine located in Emery County, Utah.

Proposed Construction

Drainage ditches are planned to be excavated at the J. B. King Mine as part of the reclamation project for the mine. We understand that there will be two drainage ditches which will connect to each other at the northwest end (see Figure 1). The proposed drainage ditches will have a length of approximately 500 feet. The ditches are planned to have a bottom ditch width of 5 feet and will be excavated to a depth of approximately 10 feet into the existing fill material. The drain ditches will connect into natural drainages at each end.

We understand that it is desired to excavate the ditches as steep as possible, but provide a stable slope at the time of excavation. Erosion of the ditches is anticipated after construction. We anticipate that erosion will extend into the constructed ditch walls, as well as the ditch bottom.

Subsurface Conditions

The subsurface conditions in the area of the proposed drain ditches were investigated by Hansen, Allen and Luce. Six test pits were excavated in the area of the proposed drain ditches. The excavations extended to depths of up to approximately 28½ feet. The logs provided to us indicate that fill was encountered to depths of up to approximately 24½ feet.

The fill generally consists of silty to clayey sand with gravel. Some zones of coal were encountered within the fill material. One of the test pits (#5) consisted of a significant amount of coal.

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Laboratory tests performed on samples of the existing fill within the zone of anticipated excavation depths indicate in-place moisture contents range from 3 to 7 percent. The samples were disturbed, therefore, in-place dry densities could not be determined. Gradation tests performed on samples of the fill are presented on Figures 2 through 4. A summary of the laboratory test results is presented on Table I.

Recommendations

The fill is relatively dry and will likely act like a granular material during excavation. Some sluffing can be expected at the angle of repose for the material. Based on the fill material encountered within the excavations, we recommend that the slopes for the excavations be constructed no steeper than 2 horizontal to 1 vertical. This slope should be flatter than the angle of repose and should provide a slightly greater than 1 safety factor against failure, thus, providing a stable slope for the excavation of the drainage ditch. Erosion of the side slopes and bottom of the drainage ditch can be expected over time.

If you have any questions, or if we can be of further service, please call.

Sincerely,

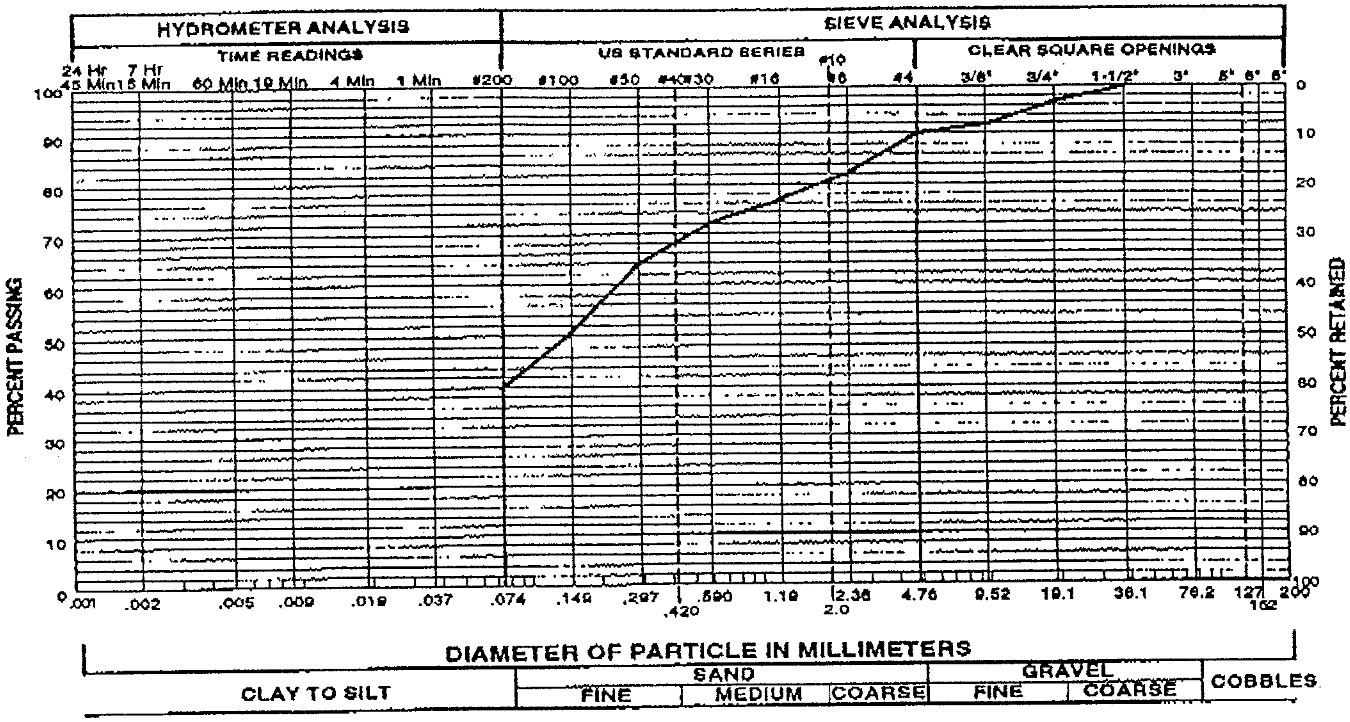
APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

LICENSED PROFESSIONAL ENGINEER
No. 260053
DOUGLAS R. HAWKES
8/19/94
STATE OF UTAH

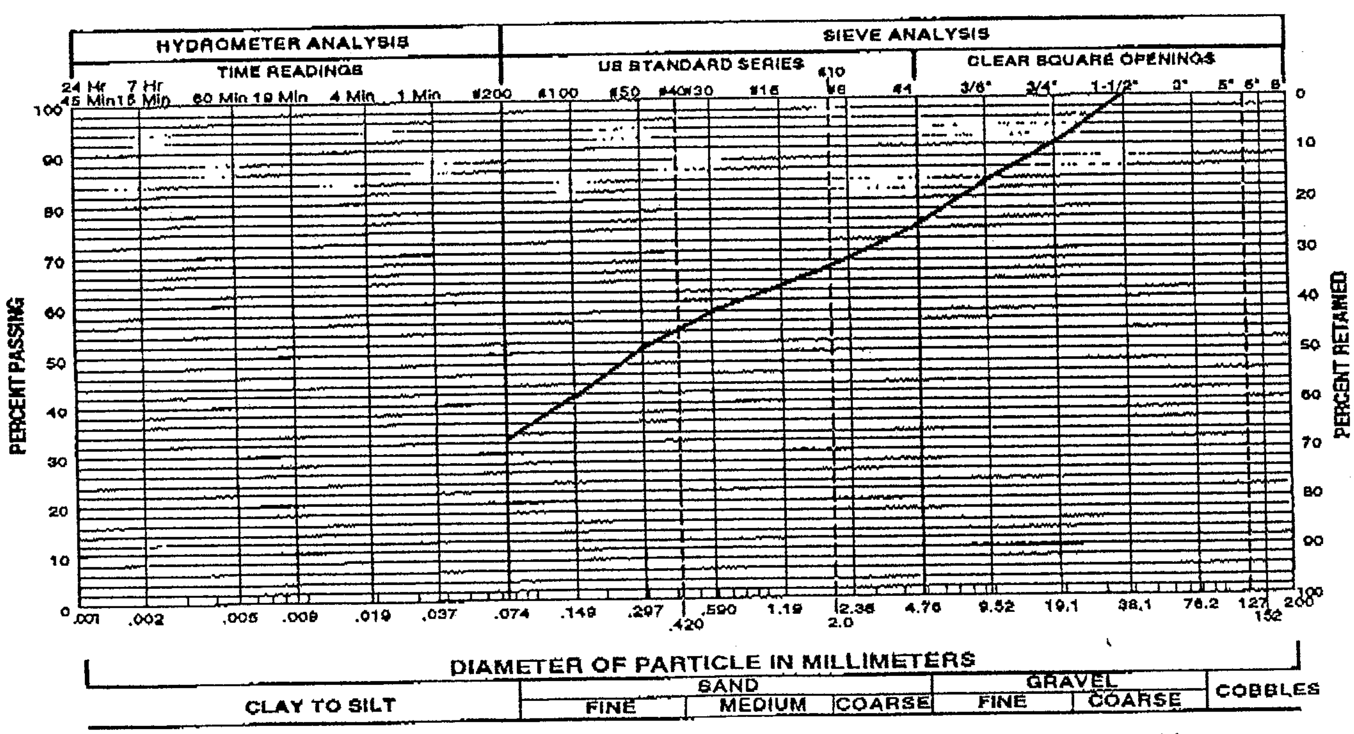
Douglas R. Hawkes, P.E., P.G.

DRH/cs
enclosures

Applied Geotechnical Engineering Consultants, Inc.



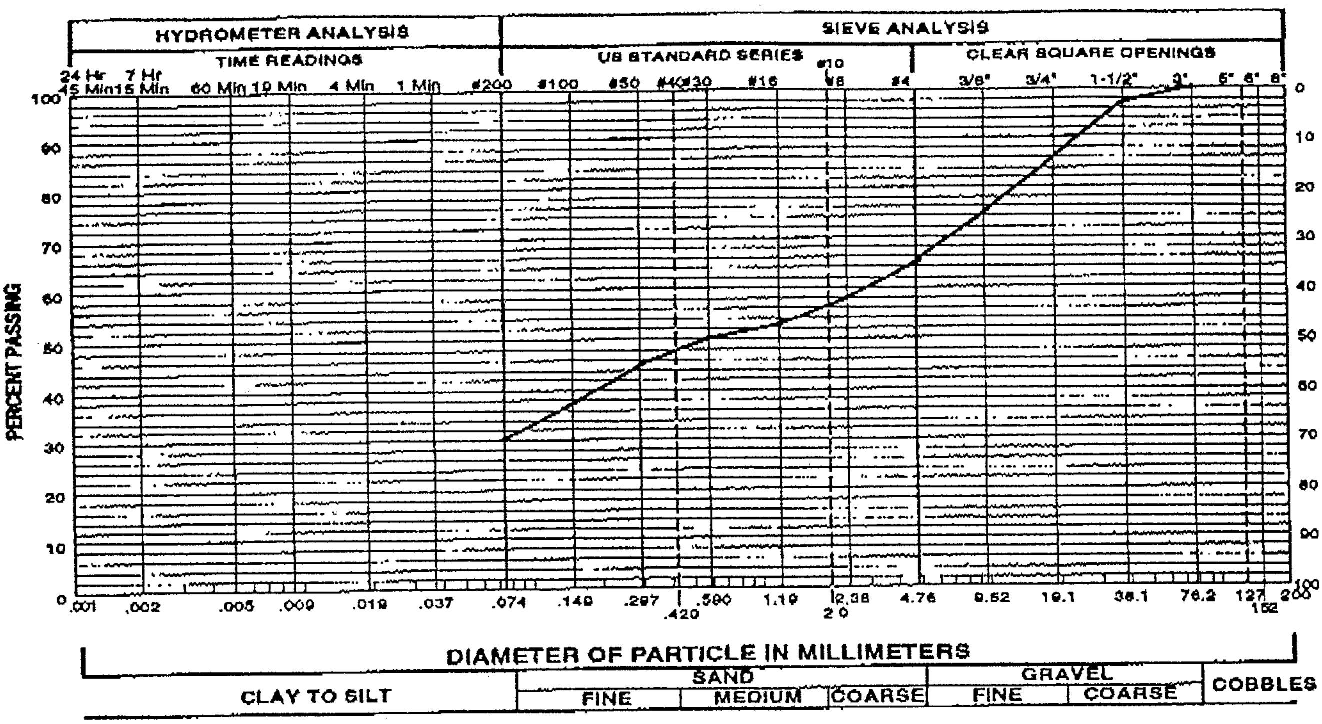
Gravel 10 % Sand 50 % Silt and Clay 40 %
Liquid Limit 23 % Plasticity Index 5 %
Sample of Fill; Silty Clayey Sand From Exploration #1 @ 0-4 feet



Gravel 26 % Sand 41 % Silt and Clay 33 %
Liquid Limit 25 % Plasticity Index 6 %
Sample of Fill; Silty Clayey Sand w/Gravel From Exploration #1 @ 4-9 feet

Project No. 39794 **GRADATION TEST RESULTS** Figure 2

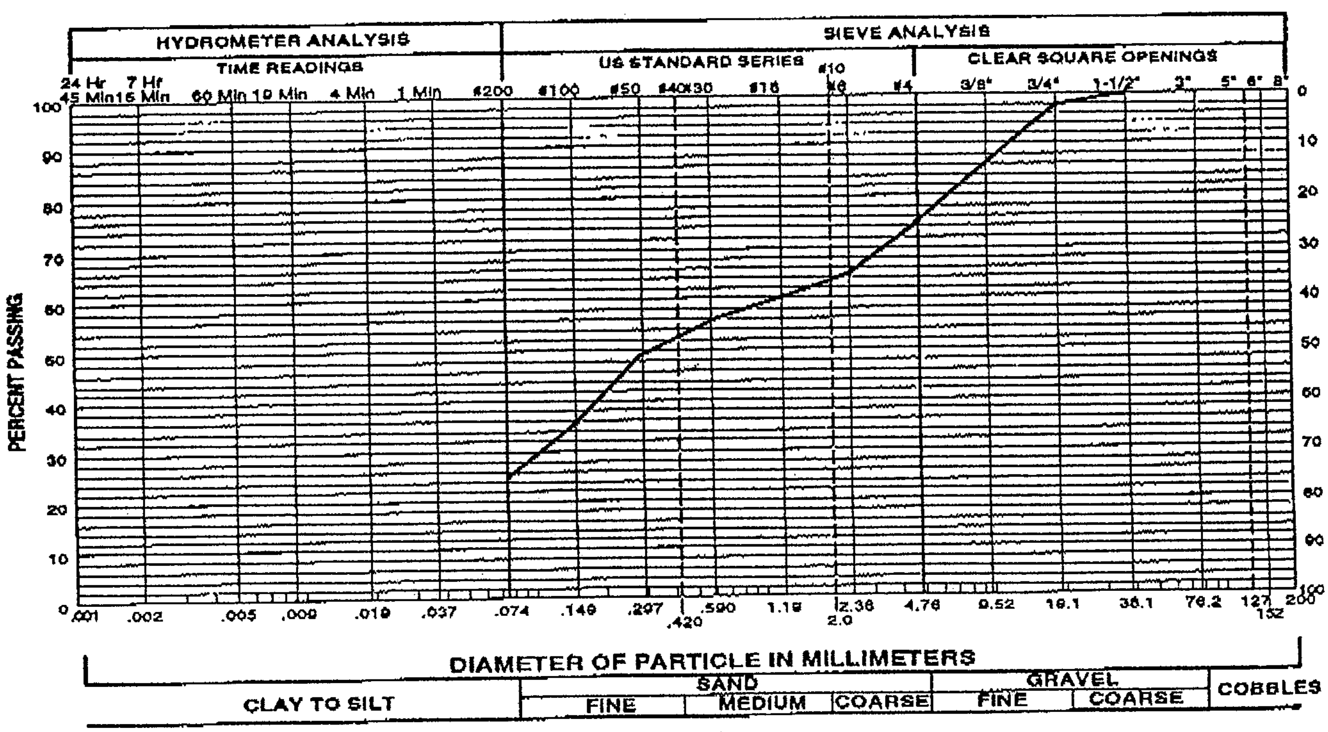
Applied Geotechnical Engineering Consultants, Inc.



Gravel 35 % Sand 35 % Silt and Clay 30 %

Liquid Limit ____ % Plasticity Index ____ %

Sample of Fill; Silty Clayey Sand w/Gravel From Exploration #2 @ 0-4½ feet



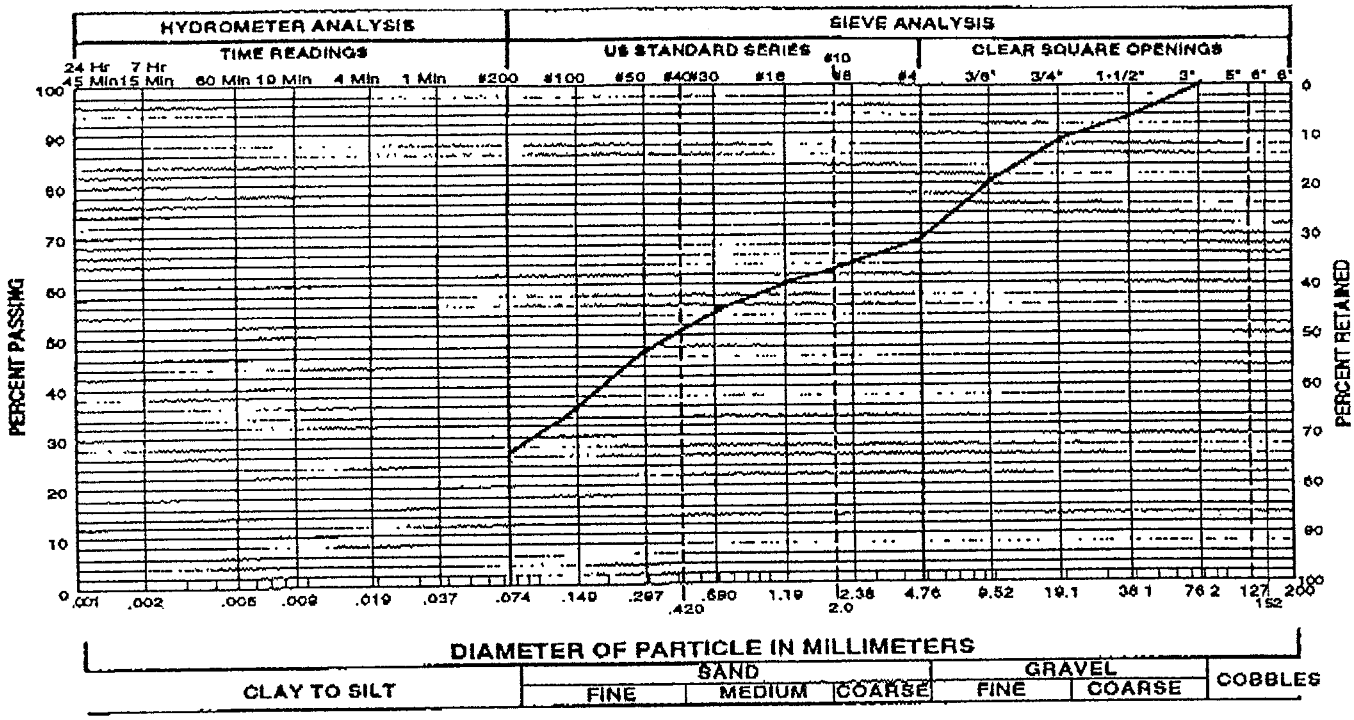
Gravel 25 % Sand 50 % Silt and Clay 25 %

Liquid Limit ____ % Plasticity Index Non-Plastic %

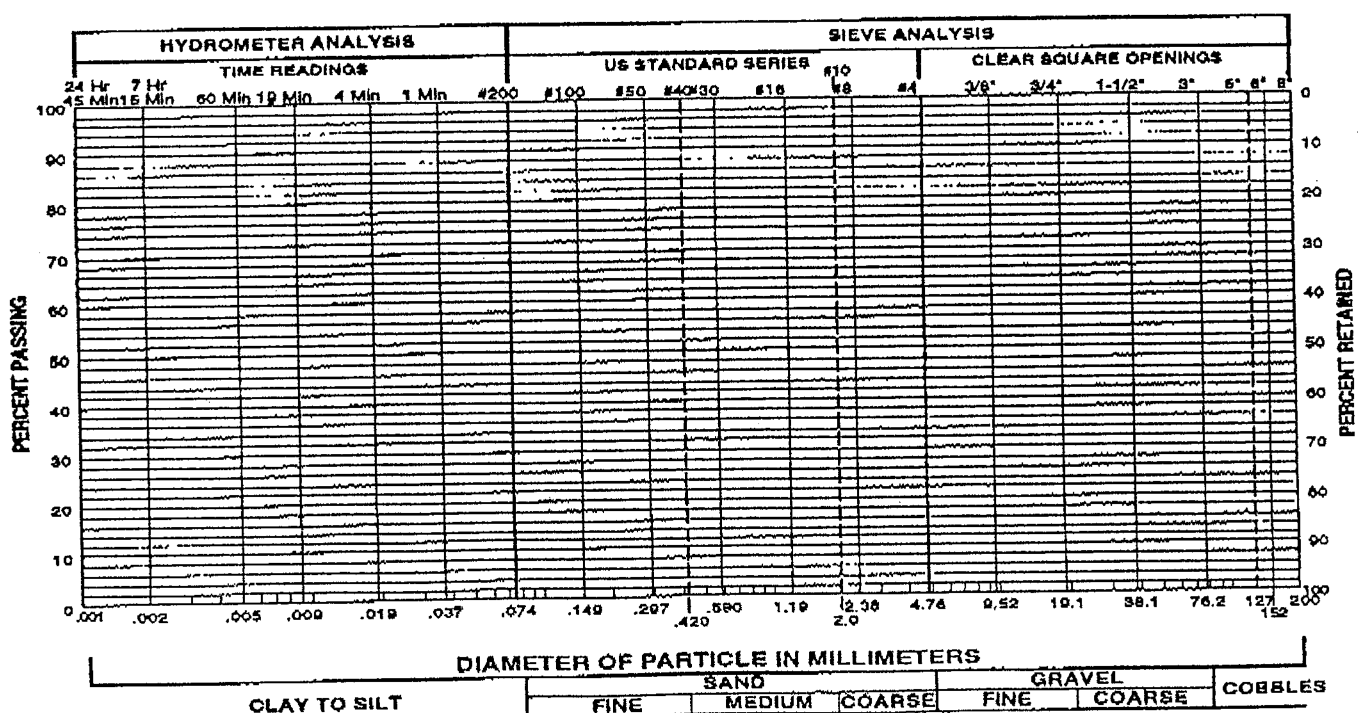
Sample of Fill; Silty Sand with Gravel From Exploration #4 @ 0-4½ feet

Project No. 39794 **GRADATION TEST RESULTS** Figure 3

Applied Geotechnical Engineering Consultants, Inc.



Gravel 31 % Sand 42 % Silt and Clay 27 %
Liquid Limit ______ % Plasticity Index ______ %
Sample of Fill; Clayey Sand w/Gravel (Coal) From Exploration #5 @ 0-4 feet



Gravel ______ % Sand ______ % Silt and Clay ______ %
Liquid Limit ______ % Plasticity Index ______ %
Sample of ______ From ______

Project No. 39794 **GRADATION TEST RESULTS** Figure 4

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

PROJECT NUMBER 39794

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (PCF)	GRADATION			ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	WATER SOLUBLE SULFATE (ppm)	SAMPLE CLASSIFICATION
TEST PIT	DEPTH (FEET)			GRAVEL (%)	SAND (%)	SILT/ CLAY (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)			
#1	0-4	7		10	50	40	23	5			Fill; Silty Clayey Sand
	4-9	4		26	41	33	25	6			Fill; Silty Clayey Sand w/Gravel
#2	0-4½	4		35	35	30					Fill; Silty Clayey Sand w/Gravel
#4	0-4½	3		25	50	25		Non-Plastic			Fill; Silty Sand w/Gravel
#5	0-4	4		31	42	27					Fill; Clayey Sand w/Gravel (Coal)