SECTION 1.0

INTRODUCTION

1.0 INTRODUCTION

UCM has maintained active ongoing coal mining and reclamation operations in the Hoseanna Creek Valley since the early 1970's, beginning with the Gold Run Pass mining area and the Poker Flats and Runaway Ridge areas progressing to Two Bull Ridge for additional reserves to support ongoing operations and meet contractual obligations. The Jumbo Dome mining area is a new mining area which will provide adequate reserves to support ongoing mining operations at a maximum rate of approximately 3.0 million tons of coal per year for the next 30 years.

Mining operations for the Jumbo Dome mine area will involve those activities necessary to access the mining area, effectively control surface and pit drainage, remove overburden and interburden materials to expose the minable coal seams, and recover and remove the coal. Reclamation of the associated mine disturbance areas will be an integral part of and will occur contemporaneously with the mining operations. The mine operation and reclamation plans as outlined in the following sections will be implemented for all mine disturbance areas within the Jumbo Dome mine area permit boundary as shown on Plate D2-1, General Facilities Layout and the conveyances and diversions as shown on Plate D9-1, Drainage and Sediment Control Plan.

It should be noted that the basic mining and reclamation methods described in the following sections will be utilized throughout the life of the Jumbo Dome mining operations; however, detailed pit layouts, backfill plans, and mining and reclamation sequencing have only been completed for the current permit term. Future mining blocks and disturbance areas have been identified and conceptual plans developed to determine the overall life-of-mine material balance and postmining configuration. Detailed planning and pit and reclamation sequencing will be completed for future mining areas prior to the permit term during which these areas will be mined. This approach provides the necessary flexibility to integrate current market factors, regulatory changes, enhancements in mining and reclamation technology, and the knowledge gained from mine operations into future plans so that the approved permit is an accurate reflection of actual operations.

Part D of this application addresses all requirements of the Alaska Surface Coal Mining Control and Reclamation Act (AS 27.21) as implemented through the Regulations Governing Coal Mining in Alaska including Sections 11 AAC Parts 90.071 through 101 and 90.301 through 501, as applicable. This section is organized as follows:

1.0 Introduction
2.0 Life of Mine Plan
3.0 Topsoil Handling
4.0 Blasting Plan
5.0 Pit Excavation Plan
6.0 Coal Removal and Storage
7.0 Roads and Transportation Systems
8.0 Existing Structures and Mine Facilities
9.0 Drainage and Sediment Control
10.0 Reclamation Plan
11.0 Fish and Wildlife Protection Plan
12.0 Protection of Hydrologic Balance and Water Quality
13.0 Air Pollution Control Plan
14.0 Protection of Public Parks and Historic Places
15.0 Responsible Parties

The reclamation plans and environmental protection measures discussed in this Part of the permit application are based on and reflect consideration of the baseline environmental resource information presented in Part C. As appropriate, cross-references are provided to relevant environmental resource information.

SECTION 2.0

LIFE OF MINE PLAN

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2.0 LIFE OF MINE PLAN

2.1 DESCRIPTION OF COAL RESERVES AND RESERVE AREA

The Jumbo Dome mine is located approximately nine miles north-northeast of the current Two Bull Ridge mine and Poker Flats mine. Exploration drilling to delineate coal reserves in this area began in 1974. This drilling program indicated the potential for large reserves of coal in the Suntrana formation in the vicinity of Marguerite Creek. Since that time, numerous exploration programs have been conducted at Jumbo Dome, including programs in 1975 (Amax Coal Company); 2007, 2008, and 2009 (UCM); and coal bulk sampling and characterization in conjunction with aquifer and material testing programs. The resulting information has delineated 83.3 million tons of proven and probable in-situ reserves in the Jumbo Dome area. These reserves are bounded on the west by outcrops and Marguerite Creek, on the south by faulting and other geologic features, and by steep terrain and overburden thickness along the east. The limits will periodically be adjusted and redefined by changes allowed in the application of available and best appropriate technology as determined by UCM. The reserves remain open to the west on the other side of Marguerite Creek, to the south, and to the northeast in the vicinity of Bonanza Creek.

The currently delineated reserves are the basis for the coal removal limits and permit boundary depicted on Plate D2-1, general facility arrangement.

Adequate exploration drilling has been completed for mine design in the proposed Jumbo Dome mine permit area, although UCM plans to conduct development drilling ahead of mining operations to aid in detailing structure and to provide coal quality information. Should the need arise to conduct additional exploratory drilling outside of the proposed permit area, a description of the drilling program will be submitted to the DNR for approval as an amendment to the current exploration program permit.

The Jumbo Dome coal reserves are similar to those in the Two Bull Ridge and Poker Flats mine areas, with minable reserves associated with the upper Suntrana formation as shown by Plates CII-1 through CII-5 and discussed in part C, Chapter II, Geology. The target coal reserves total approximately 83.3 million in-situ short tons consisting of the following: 6 seam - 5.1 million short tons; 5 seam - 7.5 million short tons; 4 seam - 41.4 million short tons; and 3 seam - 29.3 million

short tons. Current annual coal sales for UCM average 1.6 million short tons and are expected to increase to 3.0 million short tons. Based on anticipated sales levels of 3.0 million tons of clean coal per year, the mine life for the Jumbo Dome reserves is projected at 20 to 30 years. Production rates and recovery factors are expected to vary over the mine life to address coal quality and sales requirements.

2.2 MINING METHOD AND EQUIPMENT

The method of mining chosen for the proposed Jumbo Dome mine will utilize a combination of truck/shovel and dragline mining techniques. It is anticipated that the following mining equipment will be used:

- Dozers in the caterpillar size range of D8, D10, and D11
- Bucyrus Erie 1300w dragline
- Two drills for overburden/interburden and coal blasting operations
- Explosives prill truck
- Front-end loaders
- Two hydraulic excavators
- Haul trucks in the 95 ton and 150 ton size range
- Backhoes

In addition, a variety of ancillary equipment will be utilized for support and maintenance during mining and reclamation operations.

2.3 MINING LAYOUT AND DISTURBANCE AREAS

Prior to ground disturbing activities appropriate storm water best management practices will be installed. Mining will commence with a boxcut of approximately 3.7 million total cubic yards in the southwestern most portion of the mining area as indicated on Plate D2-2, mine plan layout. Overburden and interburden removed from the boxcut will be stockpiled just south of the boxcut near the Jumbo Dome facilities. Coal mined in the boxcut will come primarily from the 3 seam and 4 seam, with a small amount of 5 seam mined where the outcrop is encountered. Removal of

overburden and interburden material will be done mostly by truck/shovel, with the possibility of assistance from the dragline.

Upon completion of the boxcut, mining will continue with pits oriented generally on the dip of the formation, which is east-southeast to west-northwest. The majority of coal mined during the first permit term will come from the 3, 4, and 5 seams, with 6 seam mined where the outcrop is encountered. Overburden and interburden removed during mining will be backfilled first in the boxcut and then into the preceding pits. It will be placed approximately at post-mining grade in order to minimize the amount of regrading required and to assist with contemporaneous reclamation. The drainage and sediment control ponds and roads for access and coal hauling will be left in the spoils and reclaimed at the conclusion of mining.

2.4 TOPSOIL HANDLING

Prior to disturbance, all topsoil that is operationally salvageable will be recovered for use as a revegetation medium during reclamation. Topsoil material recovered from mine disturbance areas, including roads, sedimentation ponds, diversion ditches, mining areas, and out-of-pit spoil piles, will be either stockpiled for future reclamation use or directly replaced on backfilled and regraded areas. Salvageable topsoil will be removed a minimum of 50 feet and typically not exceeding 550 feet ahead of the advancing highwall. Dozers will remove the topsoil material and push it into temporary piles from which mobile loading units will load it into haul trucks. The haul trucks will transport the topsoil material to temporary stockpiles or replacement areas, where it will be spread by dozer and/or grader. Topsoil replacement will lag behind active backfilling and grading by up to 200 feet (see Figure D2-1). All of the salvaged topsoil material will be used during the various phases of reclamation work. A detailed discussion of topsoil removal, storage, and replacement practices is provided in Section D3, topsoil handling.

2.5 OVERBURDEN AND INTERBURDEN HANDLING

Following the topsoil removal operations, mine development and excavation will be initiated to remove overburden and interburden materials and expose the minable coal seams. Essentially all overburden and interburden material will be fragmented by drilling and blasting as described in Section D4.0, blasting plan, prior to excavation. Initial overburden and interburden removal may

involve either dragline or truck/shovel operations. To enhance operational efficiency, most of the overburden and interburden material will be removed using conventional truck-shovel mining methods with the dragline assisting where appropriate. As discussed in Part C, Chapter III, overburden and interburden assessment, evaluation of overburden and interburden materials for the Jumbo Dome mine area indicates that these materials are not potentially acid-forming, toxic-forming, or alkalinity-producing and, therefore, do not require special handling. In the absence of topsoil, the only limitation to the use of these materials as a growing medium is a minor textural limitation in surface gravel and coal underclay horizons, which will be addressed through the normal mixing that occurs during the mining process.

Placement of spoil materials generated by truck/shovel operations will be dependent on the availability of backfill space. The initial boxcut material will be placed in the out-of-pit stockpile located south of the mining area; near the Jumbo Dome mine facilities (see Plate D2-1). Material from subsequent cuts will be placed in existing open cuts and completed pit areas to the extent that adequate backfill space is available at or near designed final elevation in order to minimize regrading.

The majority of the material to be placed in the out-of-pit spoil piles will come from the boxcut since no backfill area will be available at the time of excavation. Construction of the out-of-pit spoil pile will involve removal of any deleterious material from spoil pile foundation areas, establishment of required surface diversions, foundation preparation which includes soil removal and ripping, and controlled placement of spoil materials in a series of horizontal lifts. The initial spoil lift will be established from the downslope toe of the spoil pile, and successive lifts will be placed on top of and extend upslope from this initial lift. Spoil pile outslopes will be established and graded to an effective grade of 3h:1v or less to promote effective drainage control and long-term stability. The out-of-pit spoil piles have been designed based on the geotechnical stability analysis presented in Section D5.0 (pit excavation plan) Appendix D5-1. As spoil pile construction progresses upward and away from the lower spoil pile slopes, lower slope areas will be reclaimed.

A detailed discussion of overburden and interburden removal, handling, storage, and placement is provided in Section D5.0, pit excavation plan.

2.6 COAL REMOVAL

Over the life of the jumbo dome mining operations, approximately 83.3 million short tons of in-situ coal will be mined. During the initial permit term, approximately 15 million short tons will be mined at an anticipated maximum annual rate of approximately 3.0 million short tons per year.

The proposed mining activities, including overburden and interburden removal and coal recovery, are designed to maximize utilization and conservation of the coal resource while minimizing potential adverse environmental impacts. Dragline and truck/shovel stripping operations remove the overburden and interburden materials to a level just above the top of each coal seam, and dozers are used for final material removal and cleaning of the top of the coal seams. This standard operating practice minimizes the loss of minable coal due to over-stripping. Drilling depths for overburden and interburden blasting are controlled so that the coal seams are not intercepted to further minimize the potential for coal loss.

Once the surface of the coal seam(s) is cleaned, the seam(s) will be drilled and blasted as described in Section D4.0, blasting plan, to fragment the coal for loading. Depending on operating conditions and equipment availability, a front-end loader, shovel, or backhoe may be used to load the coal into haulage trucks for transport to the coal-handling facility. The relationship of coal removal operations in the overall mining sequence is graphically illustrated by Figure D2-1, typical cross section for mining and reclamation. Since the run-of-mine coal quality meets existing customer requirements, processing is limited to crushing and sizing prior to shipment to coal customers. Section D6.0, coal removal and storage, provides additional details relative to coal-handling operations.

The coal-handling facility is an existing permitted facility located at the mouth of Hoseanna Creek and consists of a run-of-mine coal hopper, coal stockpiles, coal sizing and conveying facilities and equipment, and a coal tipple and loadout facility. The coal stockpiles allow segregation of different quality coal for blending purposes to meet contract specifications. All coal-handling facilities and operations are permitted under the Poker Flats mining and reclamation permit (permit no. 01-83-796) and are not considered to be a component of this permit application. Since the proposed Jumbo Dome mining operations will not result in any change in the operation or

permitted throughput capacity of the coal-handling facilities, no modification of the existing approved permit for these facilities is necessary.

2.7 BACKFILLING AND GRADING

Backfilling and grading operations will generally occur concurrently with ongoing mine development and advancement. Mine development and production spoil materials will be placed as backfill in excavated pit areas and regraded to achieve a final design configuration. With some exceptions, backfilling and grading of mined areas will lag behind the backfilled crest of the active pit by no more than 600 feet (see Figure D2-1). The exceptions will include haul road, ramps, and temporary roads that provide access for ongoing and future mining and reclamation operations. Other minor exception areas will include drainage ditches outside of the mining limits, temporary access roads, temporary storage areas, and any other small areas needed to support the mining operation. These areas will be reclaimed when they are no longer needed for access or other purposes.

Backfill placement methods will include blast casting, dragline side-cast spoiling, direct in-pit haulage and placement, dozer stripping and haulage, and placement of truck/shovel spoils to establish final post-mine contours. Because there are different placement methods, final swell factors (bank to re-compacted) may vary from approximately 15 to 35 percent, averaging 20 percent. Normal backfilling operations will result in effective coverage of any exposed coal seams. Currently, there are no plans to dispose of any solid wastes, coal processing wastes, or any materials other than mine spoils within the proposed Jumbo Dome mine area. Analysis of overburden and interburden materials indicates that these materials are not potentially acid-forming, toxic-forming, or alkalinity-producing; therefore, no special handling or disposal measures are necessary.

Final grading plans are designed to minimize erosion, prevent adverse changes in surface and ground water quality and quantity, minimize off-site effects, and support the planned post-mining land use of wildlife habitat. Final graded slopes will be established at the minimum slope feasible consistent with pre-mining slopes and will not exceed 3h:1v. Generally, final regrading of backfilled areas and out-of-pit spoils will limit effective slopes to 3h:1v. Regraded slopes for cuts in virgin ground will also not exceed 3h:1v. Regrading of out-of-pit spoil piles will occur on a

phased basis as spoil pile construction proceeds. Areas which will not be affected by future spoil placement will be regraded to overall slopes of 4h:1v or less and reclaimed.

The final regraded configuration and design post-mining topography is illustrated by Plate D10-1, approximate final reclamation contours and post-mining drainage control plan. This configuration meets the specific reclamation objectives of supporting long-term stability, eliminating significant depressions which could impound water, elimination of highwalls, reducing slopes to minimize erosion, and incorporating design post-mining drainages.

The general backfilling and grading configuration and sequence is graphically illustrated on Figure D2-1, typical cross section for mining and reclamation. Additional details relative to backfilling and grading plans and practices are presented in Section D5.0, pit excavation plan and Section D10.0, reclamation plan.

2.8 RECLAMATION

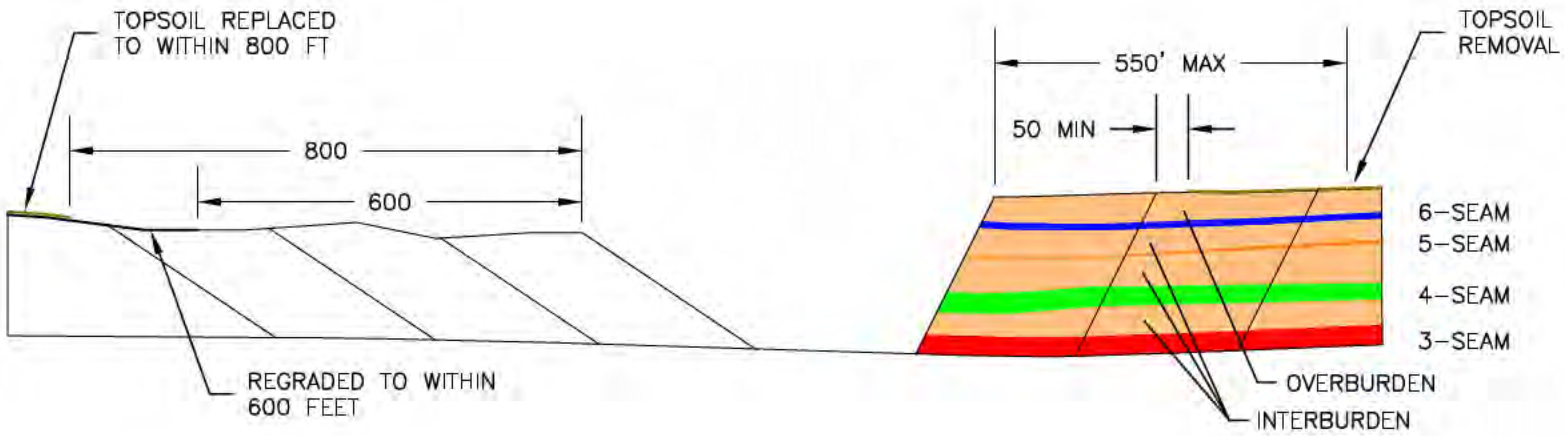
Reclamation of mining-related disturbance areas will occur as an integral part of ongoing mining operations. Reclamation will focus on backfilling of mine pits, elimination of any depressions which could impound significant quantities of water, establishment of stable post-mining slopes and drainage configuration, and establishment of a stable self-sustaining vegetation community consistent with the proposed post-mining land use. By the end of the first 5-year permit term, approximately 131 acres, or roughly 27% of the area disturbed during the first 5 years of mining, is scheduled to be reclaimed (see Plate D2-3, Reclamation Plan). This acreage includes the topsoil stockpile. This stockpile will be re-disturbed later in the mine life as additional topsoil is needed on reclaimed areas. However, erosion control measures (primarily seeding of the stockpile) will be maintained to the extent possible following topsoil removal from the stockpile. A detailed discussion of reclamation plans and practices is presented in Section D10.0, reclamation plan.

2.9 PERMIT TERMS

The permit application for the Jumbo Dome mine is for an initial permit term of five years as discussed and referenced in Part B of this application. Because the projected life-of-mine is expected to exceed 27 years, UCM anticipates filing applications for permit renewal for at least six more 5-year terms after the expiration of the first term. The requests for renewal will be filed at least 120 days prior to permit expiration and will follow the procedures outlined under 11 AAC 90.129. The portions of the Jumbo Dome mine anticipated to be covered by successive permit terms are illustrated on Plate B-1 in Part B of this application.

FIGURE D2-1

TYPICAL CROSS SECTION FOR MINING AND RECLAMATION



		DESIGNED:	MWH	PROJECT: JUMBO DOME MINE	REVISION: A
		DRAWN:	JMB	FIGURE: TYPICAL CROSS SECTION FOR MINING AND RECLAMATION	PROJECT NUMBER: 1005742
		CHECKED:	TEL		FIGURE: D2-1
		DATE:	11/09		

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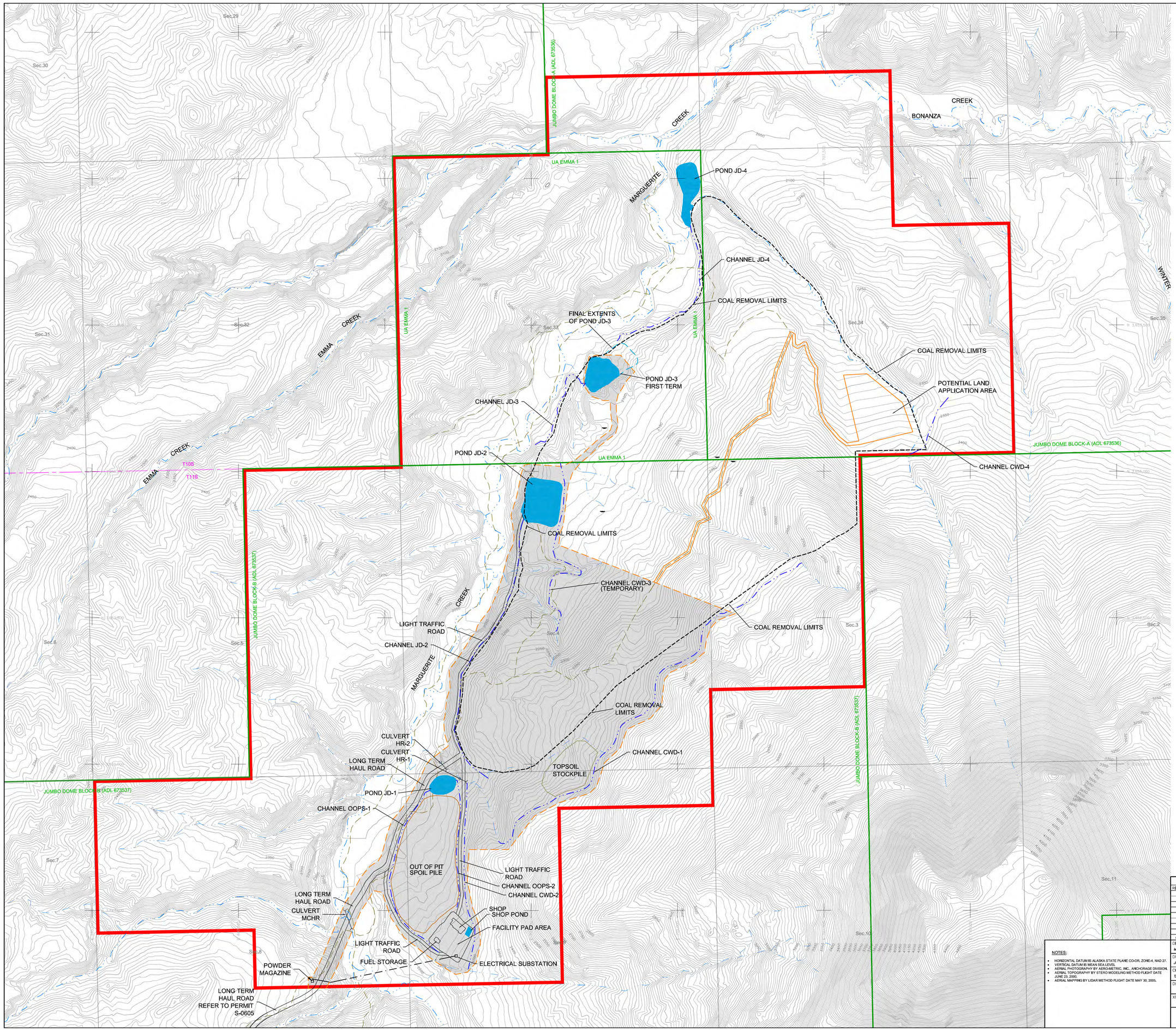
PLATE D2-1

GENERAL FACILITIES ARRANGEMENT



LEGEND

- PROPOSED PERMIT BOUNDARY
- COAL LEASE BOUNDARY
- SECTION LINE
- TOWNSHIP/RANGE LINE
- APPROXIMATE EXISTING CONTOUR AND ELEVATION, FT
- EXISTING STREAM/DRAINAGE
- EXISTING TRAIL
- PROPOSED INITIAL FIVE YEAR DISTURBANCE AREA
- POTENTIAL LAND APPLICATION AREA AND ACCESS
- PROPOSED MINING BOUNDARY
- PROPOSED POWERLINE
- PROPOSED DRAINAGE CHANNEL
- PROPOSED CULVERT

PROFESSIONAL ENGINEER'S STATEMENT

I, Thomas E. Leidich, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

10/25/11
DATE

STATE OF ALASKA 49TH THOMAS E. LEIDICH EM 12365 PROFESSIONAL ENGINEER

SCALE
500' 0 500' 1000'

NOTES:

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- VERTICAL DATUM IS MEAN SEA LEVEL
- AERIAL PHOTOGRAPHY BY AERO-METRIC, INC., ANCHORAGE DIVISION.
- AERIAL TOPOGRAPHY BY STERO MODELING METHOD FLIGHT DATE JUNE 23, 2000.
- AERIAL MAPPING BY LIDAR METHOD FLIGHT DATE MAY 30, 2005.

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DRAWN BY: JMB
CHECK BY: TEL
DWG FILE:
XREF DWG FILE:

USIBELLI COAL MINE, INC.

GENERAL FACILITIES ARRANGEMENT

JUMBO DOME MINE

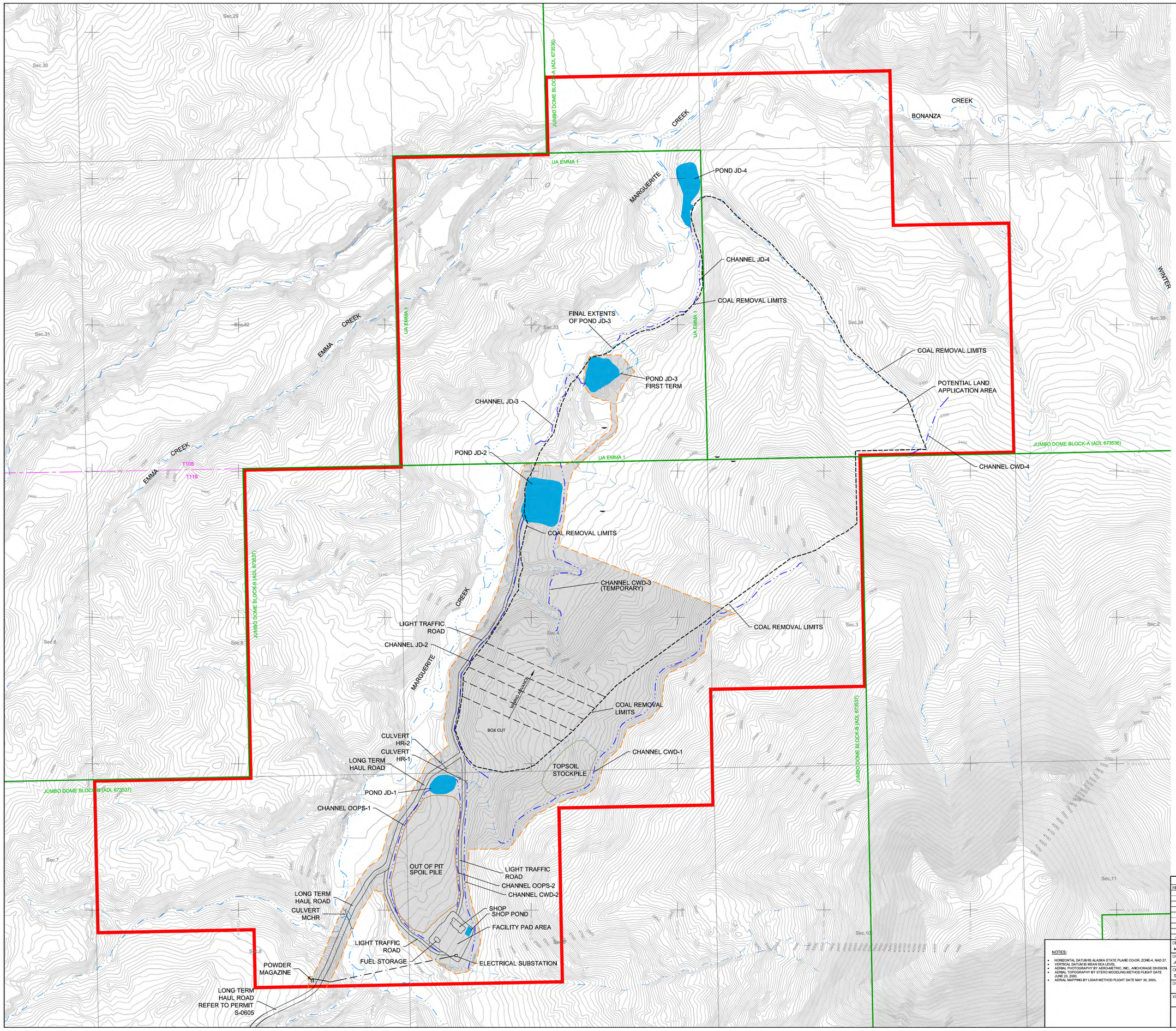
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. D2-1

REV. 1

PLATE D2-2

MINE PLAN LAYOUT



LEGEND

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- PROPOSED MINING BOUNDARY
- PROPOSED PIT ORIENTATION
- PROPOSED POWERLINE
- PROPOSED DRAINAGE CHANNEL
- PROPOSED CULVERT

PROFESSIONAL ENGINEER'S STATEMENT

I, Thomas E. Leidich, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

10/25/11
DATE

STATE OF ALASKA 49TH
THOMAS E. LEIDICH
EM 12365
REGISTERED PROFESSIONAL ENGINEER

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XREF DWG FILE:

USIBELLI COAL MINE, INC.

MINE PLAN LAYOUT

JUMBO DOME MINE

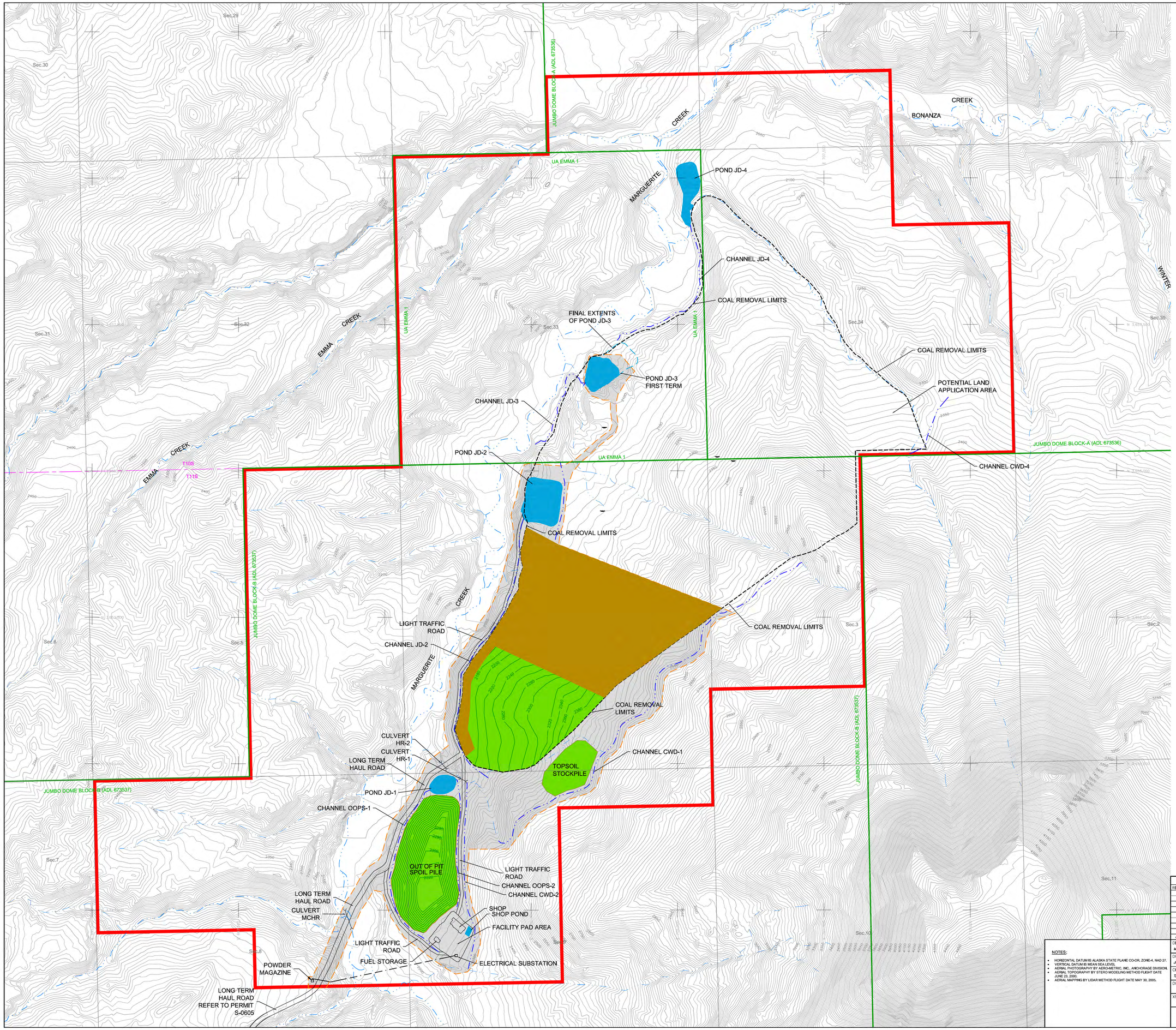
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. D2-2

REV. 1

PLATE D2-3

RECLAMATION PLAN



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- PROPOSED MINING BOUNDARY
- PROPOSED POWERLINE
- PROPOSED DRAINAGE CHANNEL
- PROPOSED CULVERT
- PROPOSED RECLAMATION AREA CONCLUSION OF 1ST 5-YR TERM
- PROPOSED ACTIVE MINING AREA CONCLUSION OF 1ST 5-YR TERM
- PROPOSED POST-MINING CONTOUR AND ELEVATION, FT

PROFESSIONAL ENGINEER'S STATEMENT

I, Thomas E. Leidich, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

10/25/11
DATE

STATE OF ALASKA 49TH T. THOMAS E. LEIDICH EM 12365 REGISTERED PROFESSIONAL ENGINEER

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XREF DWG FILE:

USIBELLI COAL MINE, INC.

RECLAMATION PLAN

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. D2-3

REV. 1

SECTION 3.0

TOPSOIL HANDLING

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3.0 TOPSOIL HANDLING

3.1 INTRODUCTION

As discussed in the soil resource assessment report (Part C, Chapter X), the Jumbo Dome mine area is at a higher elevation with cooler temperatures, slightly higher rainfall in June and July, and thicker vegetation cover compared to mine areas to the south. The average mean annual soil temperature is estimated to be less than 0C (32F). The parent material in the mine area is mainly sandstone that has very little buffering capacity due to its coarse texture. Because of the cooler temperatures and slightly higher rainfall, the rate of leaching under the spruce forest and the tundra vegetation is somewhat high causing the soils to be fairly acidic. Soil texture ranges from silt loam to extremely gravelly or cobbly sand loam to sand. When gravel exceeds 35% by volume, the topsoil material is not suitable for reclamation.

Although the chemical and physical properties of the soils on the Jumbo Dome area are not the most ideal, there is a viable topsoil resource that will be created through natural mixing during removal and replacement operations. However, the amount of salvageable material will be limited by factors such as slope, safety considerations, wetness, and the actual morphological, physical , and chemical properties that will be encountered during salvage operations.

3.2 REMOVAL METHODS

Before stripping begins, the smaller existing vegetation will be either hydra-axed or stripped directly along with the topsoil. It has been confirmed that the incorporation of native vegetation and surface root mat with the topsoil facilitates the regeneration of shrub cuttings such as willow and poplar. The medium size vegetation cover will be hydra-axed and/or chipped and also included within the topsoil. Where it has been determined that the trees are too large for incorporation with the topsoil, they may be grubbed off in advance of topsoil stripping and disposed of with overburden material or placed into slash piles. From time to time, UCM may make areas with larger diameter trees available for firewood salvage. If practicable, UCM will not perform tree removal activities during the migratory bird-nesting period.

Another clearing option that UCM is continuing to investigate is the use of a hydraulic brush axe. This will initially be tried on a limited area and evaluated for continued use. The maximum tree diameter that will be hydra-axed is yet to be determined.

After the vegetation has been cleared, topsoil will be removed by pushing it into piles with a bulldozer. In some instances, these piles may be left in place and a dozer used to push the material back onto final regarded areas. As an alternative, the material may be transported with the truck-shovel/loader fleet to either a temporary storage pile or to final regraded areas. Wetland topsoil may be segregated from other topsoil piles in order to enhance revegetation of wetlands.

3.3 STRIPPING SEQUENCE

Topsoil horizons targeted for salvage will be removed from the disturbance areas depicted on Plate D2-1 and as discussed in Section D2.3. Prior to initiating construction activities on the main haul road, topsoil will be removed from those portions of the corridor that contain salvageable material. The material will be temporarily stored along the edges of the road corridor during construction and then respread on the final graded slopes.

On the sedimentation pond sites and mine roads, available topsoil will also be salvaged prior to construction. Some of this material will be temporarily stored and used on the embankments to facilitate revegetation efforts. The remaining topsoil will be placed in the stockpile shown on Plate D2-1, General Facilities Arrangement. For diversion ditches and temporary access roads outside of the coal removal limits, topsoil will be removed and bermed for storage along the length of the structure and then seeded. At the end of the useful life of these structures, this material will be respread on the regraded area for final reclamation. If there are insufficient quantities of topsoil along these areas for final reclamation, the overburden will be used as substitute growth medium. Temporary topsoil stockpiles will be reseeded in a timely manner in order to control erosion.

For the mine area, salvageable topsoil will be removed a minimum of 50 feet, and typically 550 feet in advance of the active highwall. Topsoil that is not immediately placed on the regraded areas or bermed

around the perimeter of disturbance areas will be stockpiled in the locations shown on Plate D2-1 (see Section D2.0). Prior to placing any spoil material in the out-of-pit dump sites depicted on Plate D2-1, salvageable topsoil will be removed and stored in the designated stockpile area.

3.4 QUANTITIES AND CHARACTERISTICS

The native soils within the Jumbo Dome permit area have been identified and characterized as outlined in Part C, Chapter X: Soil Resources. Topsoil suitability criteria were evaluated from the known morphological, physical, and chemical properties of each soil type. These suitability criteria were then used to estimate the maximum depth of topsoil that could be salvaged within each mapping unit. To determine realistic volumes of salvageable topsoil from the disturbance areas, the probability of achieving the projected maximum salvage depths over the entire area of each mapping unit as well as operational limitations have to be considered.

Estimated volumes of salvageable topsoil for the life of mine disturbance area and the 5-year permit term disturbance area are presented in Table D3-1. The "maximum recoverable volumes" in this table are based on the entire life of mine disturbance area (excluding the sedimentation ponds and main haul road), and the estimated maximum salvage depths presented in the Soil Resources Chapter (See Part C, Chapter X). This volume simply assumes that the maximum salvageable depth will be achieved over the entire area of each respective mapping unit and does not account for any operational limitations. To account for these considerations, a recovery a factor of 75% was used to estimate the "anticipated recoverable volumes" and stripping depths presented in Table D3-1. This factor was based on site conditions, operational limitations, and UCM's experience with previous operations. It should be noted that the volumes presented in Table D3-1 are only preliminary estimates and should be treated as such. At a minimum, UCM believes that there should be enough topsoil available to replace an average of 12 inches on the final regraded areas.

3.5 STOCKPILING AND REPLACEMENT

Topsoil removed during box cut development, out of pit spoil dump construction, and initial pit development will be stockpiled for future replacement in the locations depicted on Plate D2-1. Stockpiled topsoil will be graded to maximum slopes of 3H:1V and seeded with a grass mixture to

minimize erosion. Long term topsoil stockpiles will be reseeded with the same grass seed mixture as discussed in Section D10.0 (Reclamation Plan). A cheaper seed mixture consisting of 50% Boreal Fescue, 46% Annual Ryegrass, and 4% Tobin Rape Seed will be used to control erosion on salvaged topsoil which is typically stockpiled for less than a year or two. The temporary seed mix will be applied at a rate of 50 pounds per acre. A typical cross-section of the topsoil stockpiles is shown on Figure D3-1. It will be the goal of the topsoil handling program to minimize topsoil stockpiling and haul topsoil directly to regraded areas for final placement.

Once final grading is accomplished the topsoil will be placed on the surface of the regraded overburden. By the end of the first 5-year permit term, topsoil is planned for replacement on 129 acres or roughly 28% of the area disturbed during the first 5 years of mining. No special preparation of the final regraded overburden surface will be necessary. The topsoil will be transported primarily with trucks and end dumped onto the regraded areas. Bulldozers will be used to spread the material to a minimum depth of 12 inches.

3.6 TOPSOIL MONITORING

Topsoil stripping operations will be monitored by field engineers to define appropriate salvage depths. The equipment operator will be given visual and approximate depth criteria for determination of the topsoil horizons to be salvaged. Depths will be measured at the perimeter of topsoil salvage areas to estimate quantities actually salvaged. Topsoil stockpiles will be inspected periodically for erosion. Any erosion features that may cause substantial loss of the topsoil resource will be repaired.

Table D3-1

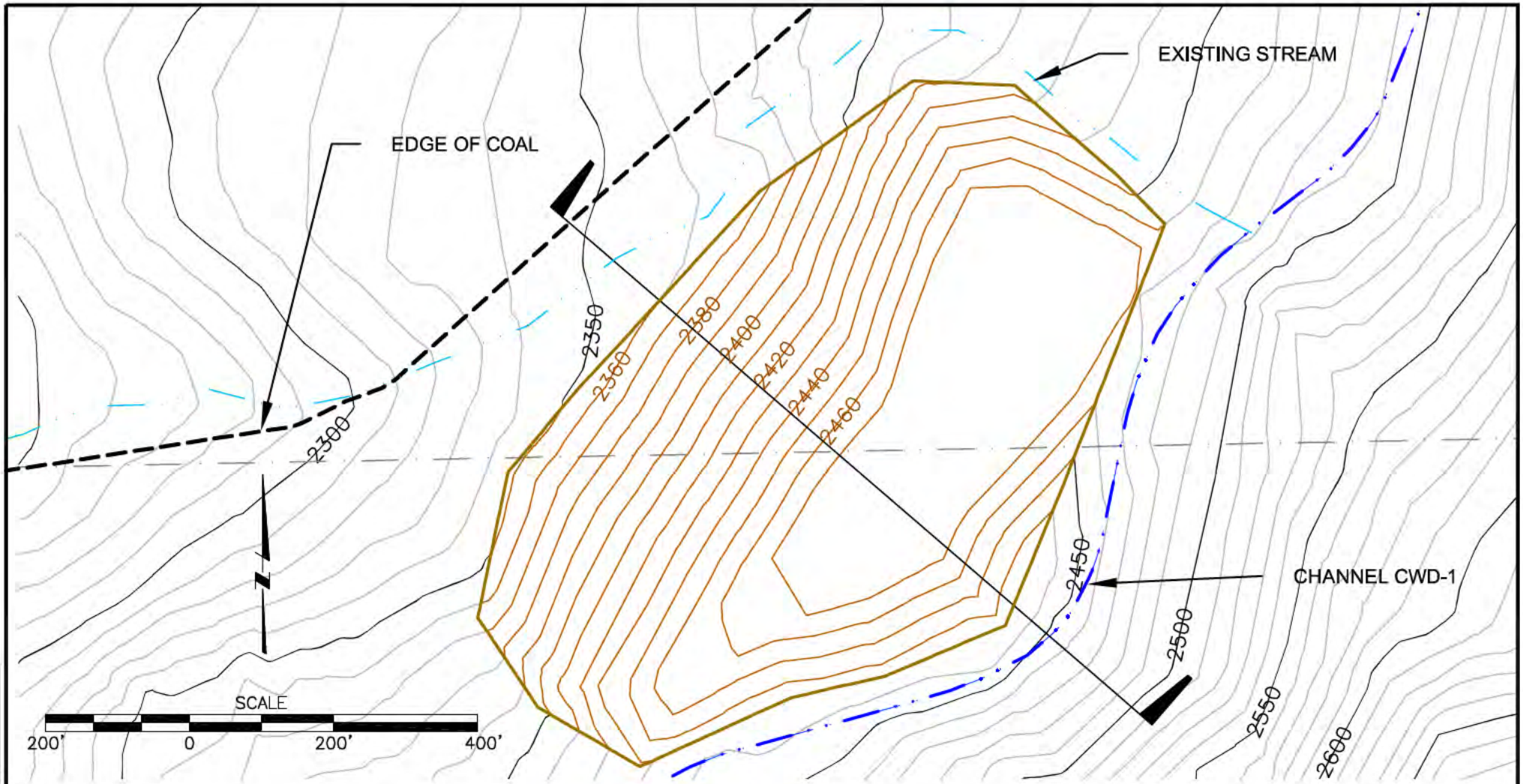
Estimated Salvageable Topsoil Volumes

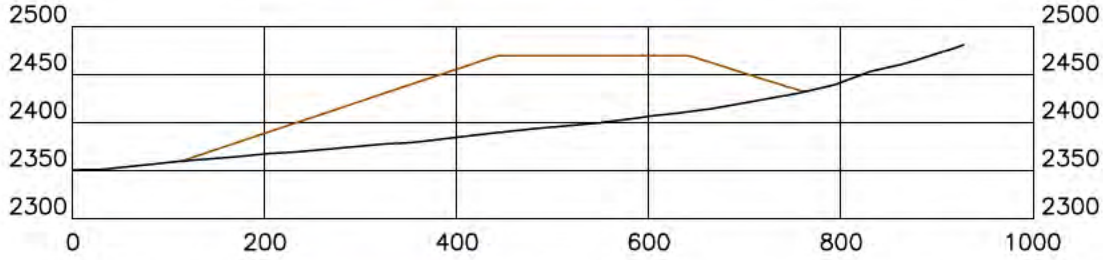
Five Year Permit Term:	Area (acres)	Maximum Recoverable Volume (cy)	Anticipated Recoverable Volume (cy)	Stripped Depth (ft)
Haul Road -	16.4	78,000	58,000	2.2
Facilities/Out of Pit Dump -	126.0	515,000	386,000	1.9
Pit	308.7	864,000	648,000	1.3
Pond JD2 –JD3FT	39.4	178,000	134,000	2.1
Sub Total	490.5	1,635,000	1,226,000	1.6

Remaining Life of Mine:	Area (acres)	Maximum Recoverable Volume (cy)	Anticipated Recoverable Volume (cy)	Stripped Depth (ft)
Future Pit -	595.0	2,432,000	1,824,000	1.9
Pond 3 -	14.1	69,000	52,000	2.3
Pond 4 -	12.0	49,000	37,000	1.9
Sub Total	621.1	2,550,000	1,913,000	1.9
Total	1111.6	4,185,000	3,139,000	1.8

FIGURE D3-1

TYPICAL TOPSOIL STOCKPILE CROSS-SECTION





	UNITELLI COAL MINE INC. UCM	DESIGNED:	MWH	PROJECT: JUMBO DOME MINE	REVISION: A
		DRAWN:	JMB	D3-1	PROJECT NUMBER: 1005742
		CHECKED:	TEL	TYPICAL TOPSOIL STOCKPILE CROSS SECTION	FIGURE: D3-1
		DATE:	11/09		

PROJECT NUMBER: 1005742

AutoCAD FILE:

SECTION 4.0

BLASTING PLAN

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4.0 BLASTING PLAN

The following section describes the general blasting procedures and methods that will be used at the Jumbo Dome Mine. These procedures will be used throughout the mine life for the blasting associated with overburden, interburden and coal removal.

4.1 DESCRIPTION OF BLASTING OPERATION

There are several different variations of blasting which occur for different reasons at UCM. There is overburden blasting for the purpose of loosening the material to help facilitate excavation. There is overburden blasting where the desired intent of the blast is to move material by way of explosive energy into its final spoil location (Cast blasting). The coal must also be blasted in order for it to be loaded into haul trucks. In all cases the width and length of the blast will vary between 100 to 200 feet and several 100 to several 1000 feet respectively.

The truck and shovel pre-striping operations usually require a shallow blast, less than 40 feet deep, to fracture the material. The blasted material must be loaded and hauled; therefore the desired result from the blast is to maximize fragmentation in order to optimize production rates. The powder factor will range from 0.5 to 1.0 lb. per cubic yard depending on the material type, depth, available excavating equipment, and desired muck-pile profile.

The dragline pits have overburden or interburden depths of up to 150 feet. In the case where the majority of the blasted material can be horizontally displaced into its final spoil location a blasting technique called cast blasting is implemented. Cast blasting requires the highest powder factor and will range from 1.0 to 2.0 lb. per cubic yard depending on the type of material being blasted. If dragline pits cannot take advantage of cast blasting and the material must be mechanically striped after blasting occurs, then a much lower powder factor of 0.5 to 1.0 lb. per cubic yard is used.

The coal seams must be blasted in order to be efficiently extracted and loaded into haul trucks. The idea in coal blasting is to minimally blast the coal to create uniform chunks which are easily loaded,

while being careful not to over blast and create excessive coal fines. The coal is blasted at a powder factor of about 0.35 lb. per ton.

In all blasting scenarios the drill holes are loaded with ANFO or an ANFO/Emulsion blend (Heavy ANFO); the amount is dictated by hole depth, diameter, and the pattern size. The powder factor and pattern will vary due to differing fragmentation objectives, overburden material properties, and the varying thickness of overburden and parting. Both vertical and angle holes ranging from 15 to 30 degrees from vertical are designed into specific patterns. Presplitting is used to define highwall slopes in selected areas. Presplitting involves detonating limited size explosive charges within angle holes to create a defined fracture plane that is the future sandstone highwall. Air deck presplitting will work best and produce the safest highwalls for the material type that will be encountered at Jumbo.

Figure D4-1 shows a typical blast pattern for consolidated overburden, with holes of 12 1/4 inch diameter drilled to 100 feet of depth on centers of 27 feet with a burden of 31 feet between rows. ANFO will be the blasting agent, with a powder factor of around 0.75 pound per cubic yard of consolidated overburden. For this case, an ANFO with a specific gravity of 0.85 in a 12 1/4 inch diameter hole yields an approximate explosive weight per foot of borehole of 42 pounds. Blasts will be initiated by cast boosters, non-electric shock tube and blasting cap or detonating cord, and electric or electronic blasting caps. Shots will be designed and delayed as necessary to maximize breakage, control fly rock, minimize air blast, and regulate ground vibration.

For an average overburden blast hole depth of 100 feet, 80 feet of the hole would be charged with approximately 3360 pounds of ANFO. The remainder of the blast hole, approximately 20 feet, will be stemmed with drill hole cuttings. Past experience in this type of overburden material indicates that this amount of stemming will be adequate to control air blast.

Coal will be blasted in 10 to 30 foot thickness on 12 to 27 foot centers depending upon seam thickness. When required, a water repellent emulsion mixture may be substituted for ANFO.
A typical blast pattern for coal is shown on Figure D4-2. For an average coal blast hole depth of 25 feet approximately 4 1/2 feet of the hole would be charged with 189 pounds of ANFO. The remainder of the blast hole, approximately 21 1/2 feet will be stemmed with drill hole cuttings. Blast initiation will be the same as for overburden.

4.2 EXPLOSIVE STORAGE

The explosive storage area is shown on Plate D2-1, General Facility Arrangement. The storage area location meets all the State and Federal laws for distance considerations. The explosive storage area will consist of several powder magazines, a heated emulsion tank, and other explosive support storage housing. All powder magazines will be double locked as required by law.

4.3 BLASTING CONTROL

The maximum weight of explosives calculated will be based on the minimum distance to the nearest building from the permit boundary as defined in 11 AAC 90.375. If UCM exceeds the limits established by the formulas contained in 11 AAC 90.379, then a seismograph will be used to monitor the ground vibration and air blast at the nearest structure not owned by the company. The maximum peak particle velocity of the ground motion will not exceed three quarters inch per second at the immediate location of any dwelling, public building, or privately owned buildings in the vicinity of the blast.

Alaska Department of Fish and Game (ADF&G) blasting standards defined in 11 AAC 95.248 state that “Without prior written approval from ADF&G, no person may discharge an explosive that produces or is likely to produce an instantaneous pressure change greater that 2.7 pounds per square inch (psi) in the swim bladder of a fish or produces or is likely to produce a peak particle velocity greater than 0.5 inches per second (ips) in a spawning bed during the early stage of egg incubation.” ADF&G draft publication Blasting Standards for the Protection of Fish dated

February 15, 1991 figures 5 through 7 show that setback requirements for the Office of Surface Mining Standards (OSM) are more stringent in all cases than ADF&G setback requirements. UCM is required to meet OSM standards and therefore will exceed setback requirements of ADF&G and will therefore be protective of fish.

Flyrock will be minimized by proper blasting design and will not be cast beyond the permit boundary. All practical precautions will be taken to prevent injury to persons and adverse effects to the surrounding public and environment.

4.4 BLASTING SCHEDULE AND PUBLIC NOTICE

A blasting schedule will be developed that describes the dates, locations, access control features, and audible warning systems for the blasting areas. At least 30 days prior to the commencement of blasting, this schedule will be published in the Fairbanks Daily News Miner and copies distributed to the Denali Borough, and Golden Valley Electric Association. A prototype blasting schedule for the Jumbo Dome mine is presented as Exhibit D4-1 (the prototype is from UCM's Two Bull Ridge Mine).. The schedule will be redistributed every 12 months. If revisions are required, they will be redistributed within 10 days prior to initiating blasting operations.

Blasting will be conducted only during the hours identified in the public notice except during situations where rain, lightning, other atmospheric conditions, or operator or public safety requirements dictate unscheduled detonations. The time set for blasting will be 6:00 a.m. until 9:00 p.m. or during daylight hours (whichever is greater). The proper officials of local governments and public utilities will be verbally notified of unscheduled blasts prior to executing the blasts.

In the future, a pre-blasting survey of any privately owned structure that may occur within a one-half mile radius of a blasting site may be conducted, if requested by the owner of the property or the Commissioner. A copy of the survey will be provided to the property owner and Commissioner.

4.5 BLASTING SIGNS, WARNING, AND ACCESS

Access to blast areas before, during and after shot firing will be controlled by signs and mine personnel. Access to blasting will be completely regulated ten minutes prior to detonation to prevent unauthorized entry and will remain guarded until the all-clear signal is given. At five minutes before the blast, two short audible signals will be sounded. At one minute before the shot, one long audible signal will be given. After the blast, one all-clear audible signal will be given. No one will be allowed back in the blasting area until the shot is inspected by a pit foreman or a certified blaster. The blasting signals will be audible in excess of a one-half mile range as required by AAC 90.377.

Blasting signs will be conspicuously placed at all mine entrances which state "Warning, Explosives In Use". The signs will clearly explain the pre-blast warnings and all-clear signals before and after the blast. Charged holes within the permit area will also be flagged or posted with signs that give clear warning of the blasting area.

4.6 RECORDS OF BLASTING

Records of all blasts will be kept for a minimum of three years following the date of any given blast. A sample blasting report is included as Exhibit D4-2. This report identifies all information required by 11 AAC 90.383. All blasting reports will be signed by the certified blaster who was in charge of the blast. These reports will be made available for inspection by the appropriate regulatory agencies and the public upon request.

FIGURE D4-1
OVERBURDEN BLAST PATTERN

FIGURE D4-1

OVERBURDEN BLAST PATTERN

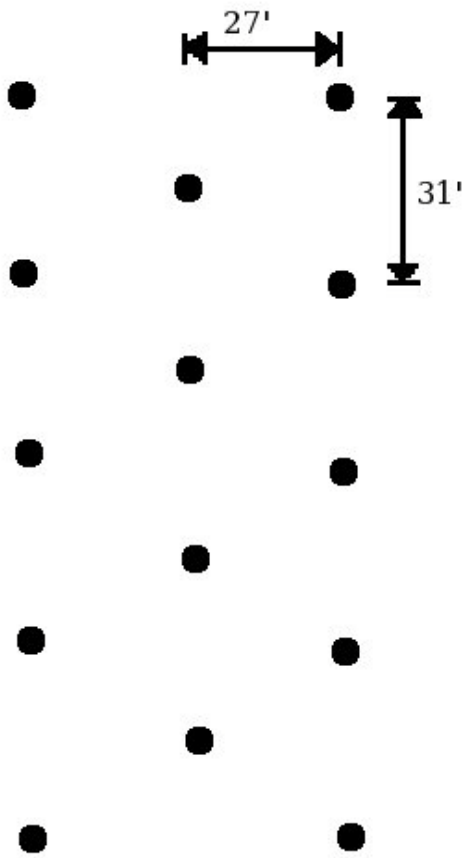

FIGURE D4-2
COAL BLAST PATTERN

FIGURE D4-2

COAL BLAST PATTERN

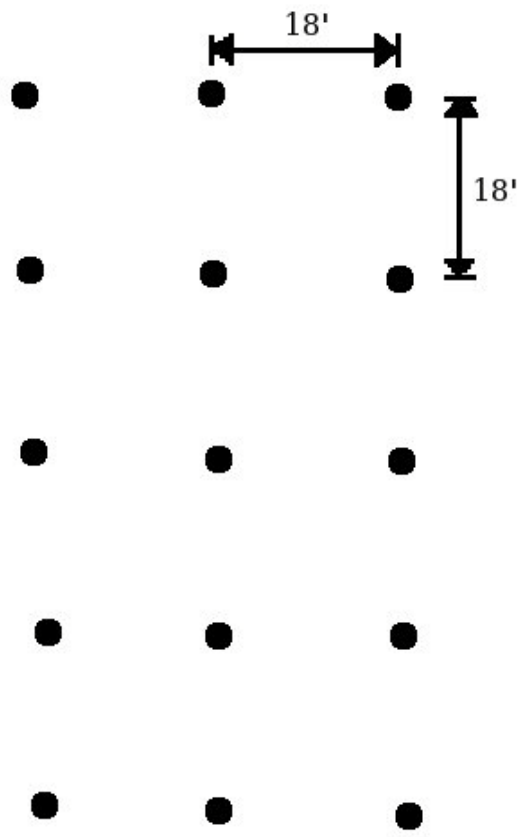

EXHIBIT D4-1
PUBLIC NOTICE OF BLASTING SCHEDULE

EXHIBIT D4-1

PUBLIC NOTICE OF BLASTING SCHEDULE (SAMPLE)

USIBELLI COAL MINE, INC.

BLASTING SCHEDULE

I) OPERATIONAL AREAS: **Gold Run Pass Mine**, T11S, R6W, Section 34 & 35; **Poker Flats Mine**, T12S, R7W, Sections 3, 4, 5, and 9; **Two Bull Ridge Mine**, T11S, R7W, Section 26, 33, 34, 35 and T12S, R7W, Section 3, 4, 5 referenced to the Fairbanks Meridian.

II) BLASTING TIMES: The hours of 6:00 a.m. until 9:00 p.m. or during daylight hours, whichever is longer, on a Monday through Sunday basis will be used to detonate explosive blasts within overburden. Explosive blasts in coal may be conducted 24 hours a day year-round on a Monday through Sunday basis.

III) METHODS OF CONTROL: All roads having immediate access to any blasting area will be clearly marked with a "BLASTING AREA" sign. Only authorized company individuals should enter areas marked with this sign.

IV) AUDIBLE WARNING SIGNALS: The following list and description of warning signals shall be utilized to alert individuals in or near a blasting area of the current blast status. A siren, air horn or other approved audible warning device, will be utilized to produce signals.

(2) Two SHORT BLASTS - 5 minutes before blasting
(1) One LONG BLAST - 1 minute warning before blasting - KEEP OUT!
(1) One SHORT BLAST - blasting area is safe to enter, all clear.

V) EFFECTIVE DATES OF NOTICE: This notice shall remain in effect from August 9th, 2004 for the next (12) calendar months. If major changes are made to the above schedule, a revision notice will be published prior to the normal expiration date of August 10th, 2005.

Charles P. Boddy

Charles P. Boddy
Vice President Of Governmental Relations

PUBLISH: August 9th - 13th, 2004 (5 days)

EXHIBIT D4-2
SAMPLE BLASTING REPORT

EXHIBIT D4-2

SAMPLE BLASTING REPORT

USIBELLI COAL MINE INC.

UCM

BLASTING REPORT

PO Box 1000, Healy Alaska 99743
Ph (907/683-2226) Fax (907/683-2253)

Date of blast: _____ Time of blast: _____ am/pm

Location of blast: _____

Number of people on blasting crew: _____

Blaster in charge: _____ License: _____

Direction and distance to nearest designated structure:
_____

Temperature: _____ Wind Direction: _____ Wind Velocity: _____

Material blasted: _____ Avg. Hole Depth: _____

Number of holes: _____ Diameter of holes: _____

Burden: _____ Spacing: _____

Type of explosive: _____ Weight of explosive/hole: _____

Max. Weight of explosives detonated within any 8 millisecond period: _____

Initiation System: _____ Type of stemming: _____
Length of stemming: _____

Mats or flyrock protection? _____

Unscheduled blast? Y / N

*Note: A **scheduled** overburden blast is between 6 a.m. to 9 p.m., or during daylight hours, whichever is longer. Coal shots may occur at any time.*

Section of typical blast hole:

Surface	
0-	
10-	
20-	
30-	
40-	
50-	
60-	
70-	
80-	
90-	
100-	
110-	

SIGNATURE:

_____

SECTION 5.0

PIT EXCAVATION

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5.0 PIT EXCAVATION PLAN

The Jumbo Dome Mine design consists primarily of a classic truck and shovel/dragline sidecasting/strip mine layout. Mining is initiated with a boxcut from which the overburden is removed and placed in a stockpile outside of the immediate mining area. The coal is then removed by backhoe, shovel, or front-end loader and transported by 95- or 150-ton trucks to the tipple facility. After the boxcut has been mined out, the adjacent bench(s) can be stripped, with the overburden material being placed into the previously mined-out bench. This is typically accomplished by dragline, truck/shovel, dozer, or a combination of the three. The remainder of this section details the methodology for overburden removal and disposal.

5.1 OVERBURDEN/INTERBURDEN REMOVAL

After a bench has had the salvageable topsoil removed and the material blasted, overburden removal will begin. A truck/shovel operation will be the primary tool for overburden removal.

Stripping of the overburden and interburden associated with the 3, 4, 5, and 6 seams will be performed with a multi-seam operation with the overburden/interburden being removed by truck/shovel or dragline. The actual amounts of overburden/interburden associated with each seam will vary depending on the adjacent pit width, floor dips, and available backfill space. The balance of overburden/interburden within each bench is typically removed with a truck/shovel or dozer. The dragline operates in a side-cast style from the highwall side of the pit on the upper bench(s) and from the spoil side of the pit on the lowest bench.

The specific stripping operation configuration may be adjusted periodically to optimize stripping operations. Bench widths within the mine area will vary from 100 feet, adjacent to the boxcut(s), to 300 feet as mining progresses away from the boxcut(s). When overburden thicknesses no longer allow economic extraction of the lowest mineable seam, a final set of upper benches will be stripped. Bench widths in this case may approach or exceed 200 feet.

Overburden removal will be carried out in nearly horizontal lifts averaging 30 feet in height. Most of the material to be handled by the truck/shovel operation will consist of sandstone, with a small percentage of gravels and minimal amounts of permafrost. Gravels will be used, as

needed, to surface the haul roads. If unstable permafrost is encountered, it will be placed in cells for containment.

In addition to the above, dozers will be employed to assist with overburden/interburden removal. They will also be used in final stripping and cleaning of the coal hanging wall. In some instances, particularly following cast blasting of an upper bench, dozers may remove a significant portion, if not all, of the overburden by pushing into the adjacent mined-out pit.

5.2 OVERBURDEN/INTERBURDEN STORAGE

Spoil placement and storage will vary with the removal method. For dragline operations, placement will be generally confined to simple side-casting. On a typical upper bench, the dig/drag axis will be parallel to the bench highwall with spoil being dumped 90 degrees into the adjacent mined-out bench.

This material will be leveled out by dozers to form a spoil side dragline pad. To excavate the lower bench, the dragline will utilize the spoil-side pad. Here, the dig/drag axis will be roughly perpendicular to the bench highwall and spoil will be placed at 90 to 120 degrees from the axis beside the previous dragline spoil, as it retreats down the length of the bench. Once dragline operations have been initiated and have sufficiently advanced within the mine area, truck spoils will be placed on top of the dragline spoil peaks to facilitate final grading operations.

The truck/shovel operation will have more flexibility in spoil placement. In the initial stage of mining, truck spoil will be placed in the out-of-pit spoil pile south of the active pit area (see Plate D2-1, General Facilities Arrangement). The stability of the spoil site was confirmed through a geotechnical evaluation and is further discussed in Section D5.4 and Appendix D5-1. The analysis of final out-of-pit spoil design topography provides recommendations regarding placement operations for achievement of a minimum 1.5 long-term static factor of safety. These recommendations will be followed during and after backfilling of mined-out areas at the Jumbo Dome Mine. Typical cross sections of the out-of-pit spoil pile are presented on Plate D5-1, Out-of-Pit Spoil Pile Design. After excavation of the initial boxcut is complete, truck spoil will be placed at or near the final designed elevation to minimize regrading and assist with contemporaneous reclamation.

Stability of the backfill is important for both operational efficiency and long-term stability after completion of mining. The proposed mining limits avoid or entirely encompass any areas of existing unstable slopes. Therefore, the stability of the backfill is primarily dependent upon backfill condition, post-mining configuration, and foundation characteristics. An analysis of post-mining topography (backfill stability) has been performed (see Appendix D5-1). This analysis provides recommendations for backfill operations to achieve a minimum 1.3 long-term static factor of safety for backfilled spoils. These recommendations will be followed during and after backfilling of mined-out areas at the Jumbo Dome Mine.

5.3 SWELL FACTORS

Swell factors used in the design stage vary depending on the material and the method of overburden removal. The values of these factors are based initially on past laboratory and published values and have been adjusted according to mining experience in the local formation.

Higher powder factors are required in blasting for shovel stripping operations than those required for standard dragline stripping. Experience has shown that blasting, excavation, and dumping of sandstone spoil under current practices with truck/shovel generates swell factors in the range of 1.2 to 1.25 in relation to in-situ density. In standard dragline side-casting, swell factors range from 1.15 to 1.2. When blast casting is performed in advance of dragline stripping, powder factors are about twice those used for shovel stripping and more than double the standard dragline powder factors.

This can create swell factors in the range of 1.25 to 1.35; however, some re-compaction does occur in the material handling process and disposal, which reduces the effective swell.

5.4 MATERIALS BALANCE AND OUT-OF-PIT SPOIL DISPOSAL

To provide a post-mining topography that promotes long-term stability of the backfill and allows for contemporaneous reclamation, there will be an out-of pit spoil pile. A stable disposal site was identified for out-of-pit spoil disposal, which has more than adequate volume for the required spoil (see Plate D2-1).

At the end of mine life, UCM plans to backfill the final pit utilizing the backfilled spoil and potentially the out-of-pit spoil pile.

The Jumbo Dome post-mining topography and out-of-pit spoil pile have been designed to accommodate all of the overburden and interburden materials that will be removed from the entire mining area.

5.4.1 Out-of-Pit Spoil Pile

The out-of-pit spoil pile will be located just outside the 3 Seam sub-crop to the south of the Jumbo Dome mine area (see Plate D2-1, General Facilities Arrangement). The design criteria specify a 3H:1V slope with a maximum height of 150 feet. With these criteria, the dump is capable of storing 5.3M LCY of spoil. Prior to construction, the ground surface will be prepared by removing the vegetation and salvageable topsoil (see Section D3, Topsoil Handling Plan), exposing sandstone and/or sands and gravels similar to those encountered during the 2009 field investigation program of the area. Gravels may be excavated below the topsoil prior to spoil placement for use in haul road construction. If seeps are encountered a French drain will be installed under the pile to keep any water from coming in contact with the spoils pile. Spoil placement will then begin with a truck/shovel method. After placement, the spoil will be regraded, topsoil replaced, and revegetation initiated to complete dump construction.

The primary requirements for the construction of the out-of-pit spoil pile will be three-fold: development of a foundation layer consisting of free-draining and/or solid-strength, coarse-grained material, truck-dumped spoils placement in thin lifts in a damp to moist condition to assist with compaction efforts, and avoidance of large areas with concentrations of ice-rich or saturated spoil material.

Construction of the lower spoil pile lifts over a free-draining material will enhance the ability of the pile to efficiently transfer subsurface water flows along or below the existing ground surface and toward Marguerite Creek. This will minimize seepage into the spoil pile and maintain a phreatic surface below the pile itself. Borehole logs 09JD11 and 09JD12 (see Appendix D5-1) show that below a surface layer of silts and organics (to be pre-stripped prior to spoil pile construction, as discussed above) there lies a coarse-grained zone of Suntrana sands, gravels, and

sandstone with some local layers of Jumbo Dome talus. All of these material types represent good foundation materials for the construction of the out-of-pit spoil pile, as proposed.

Similar to other UCM out-of-pit spoil pile structures at the Hoseanna Valley mining properties, active efforts to control several important aspects of the construction process will be employed. These include placing as thin a lift as practicable, not allowing for the concentration of ice-rich or saturated spoil material within focused areas, and enhancing compaction of placed material using dozer-spreading techniques and allowing for layer consolidation, especially of the weaker, finer-grained spoil material.

These simple construction methods have been successfully employed by UCM for the Two Bull Ridge valley-fill spoils dump. Similarly for Jumbo Dome, it will be important to maintain a low phreatic surface (i.e., no pore pressure build-up for the spoils themselves) while maximizing efforts for material compaction during spoil placement, thereby ensuring a factor of safety of 1.5 can be maintained for the pile.

Based upon a review of similar UCM geotechnical studies and technical field and lab data obtained from the Jumbo Dome area (see Appendix D5-1), the stability evaluation utilized the 7 different types of materials and engineering properties provided in Table D5-1.

TABLE D5-1

MATERIAL PARAMETERS USED IN STABILITY ANALYSES

MATERIAL	DENSITY(pcf)	COHESION(psf)	FRICTION ANGLE (°)	COMMENTS
Spoil, truck-dumped	125	0	35	Drier fill, compacted
Spoil, dragline	105	0	32	Uncompacted, damp to moist fill
Sands and Gravels	115	0	30	In-place sands and gravels
Coal	95	0	40	In-place seam
Sandstone	125	0	37	In-place foundation
Schist	140	0	30	In-place foundation
Footwall Clays	115	0	11	In-place

5.4.2 Reclamation and Drainage Control

Surface water from above the out-of-pit spoil pile will be diverted around the pile by channel JD-3, as depicted on Plate D9-1, Drainage and Sediment Control Plan. The fill area will be as free as possible of standing water. Completed dump lifts will be graded east toward channel JD-3 for self-drainage purposes.

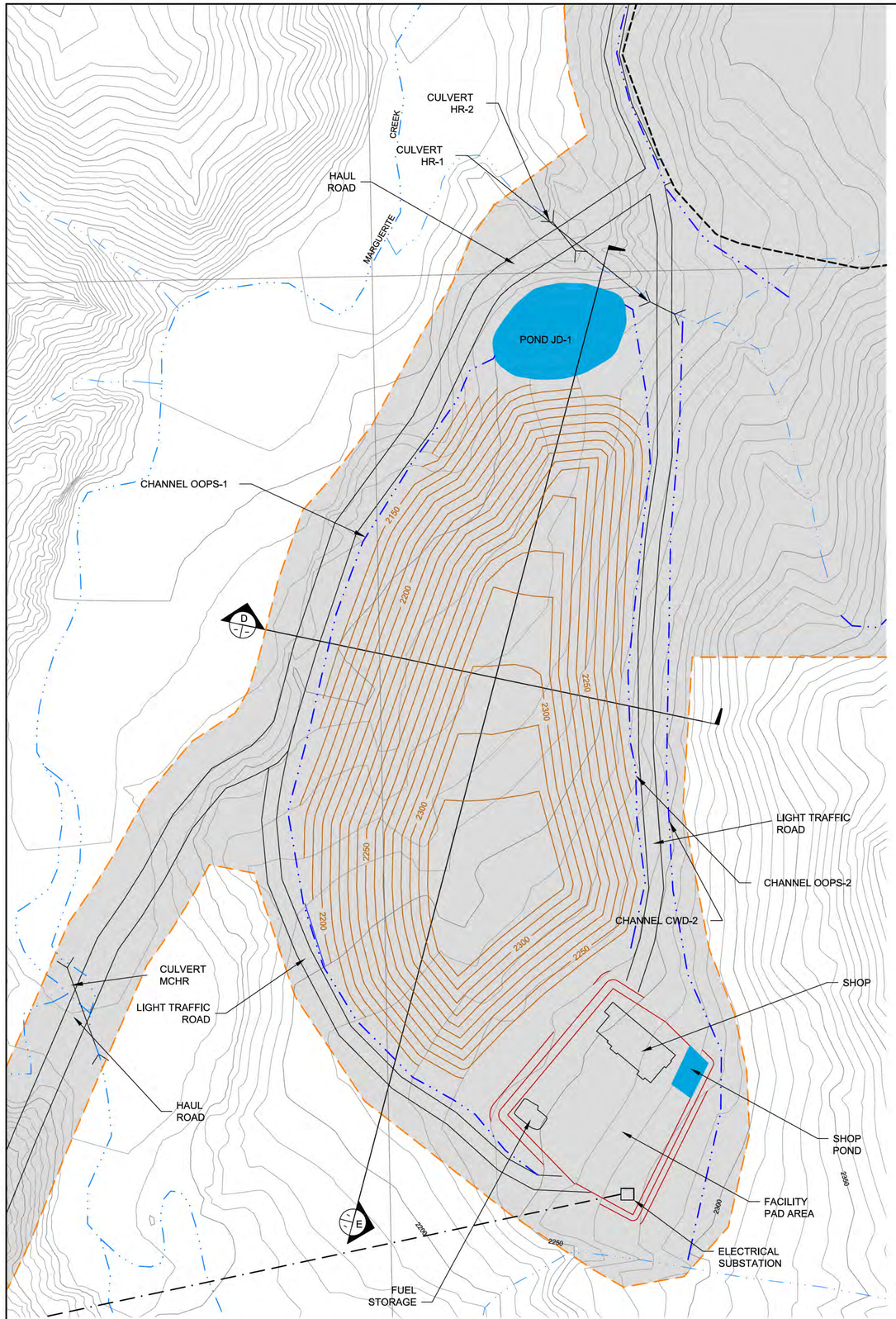
As construction of the fill progresses, each lift will be set back from the previous lift, allowing contemporaneous grading of the slope as the dump is being built. After grading and terrace construction, any topsoil salvaged from the active mine area will be hauled and spread on the outslope of the fill.

5.4.3 Stability Summary and Construction Inspection

A stability analysis was performed for both the in-pit backfill spoils (post-mining topography surface) and the out-of-pit spoil pile structure, and they have been designed for a long-term static factor of safety in excess of the 1.3 and 1.5 regulatory design requirement, respectively. The results of the stability analysis, in fulfillment of 11 AAC 90.391, are attached in Appendix D5-1. In fulfillment of 11 AAC 90.391 (g) and 11 AAC 90.397 (a), (b), and (c), construction of the spoil dumps will be inspected by a professional engineer or a qualified person under the engineer's direction. Inspections will be conducted at least quarterly during construction. The primary product of the inspections will be confirmation that the vegetation mat and organic (silty) soil layer have been adequately removed from the foundation area prior to spoil placement. In addition, the engineer will periodically note lift heights as they are being placed and the general nature of the placed material. The engineer will also note the progress and status of rough regrading, topsoil placement on the reclaimed slope, reseeding operations, and construction of post-mining drainage controls.

PLATE D5-1

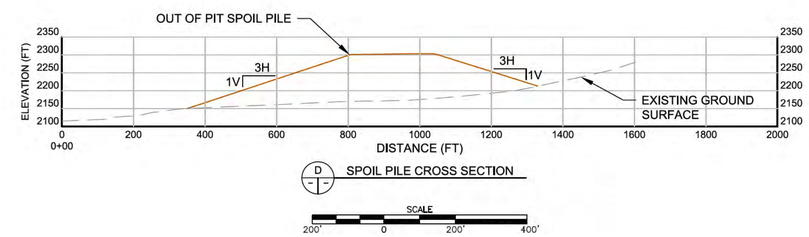
OUT OF PIT SPOIL PILE DESIGN



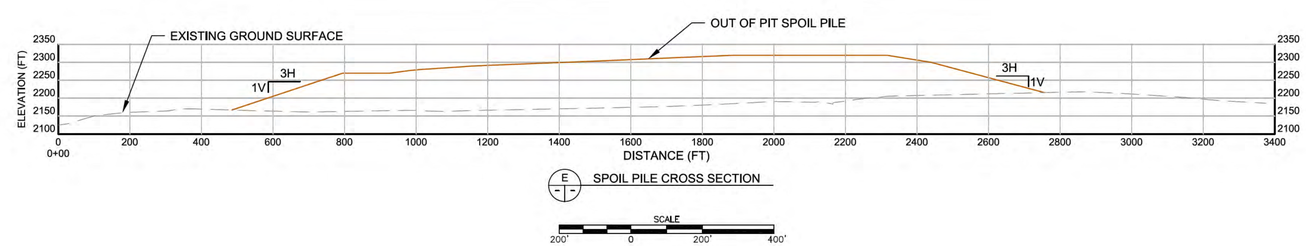
PLAN VIEW PERMANENT OUT OF PIT SPOIL PILE

LEGEND

- PROPOSED PERMIT BOUNDARY
- COAL LEASE BOUNDARY
- SECTION LINE
- TOWNSHIP/RANGE LINE
- 2000 — APPROXIMATE EXISTING CONTOUR AND ELEVATION, FT
- EXISTING STREAM/DRAINAGE
- PROPOSED INITIAL FIVE YEAR DISTURBANCE AREA
- PROPOSED MINING BOUNDARY
- PROPOSED POWERLINE
- PROPOSED DRAINAGE DITCH
- PROPOSED CULVERT
- 2000 — PROPOSED OUT OF PIT SPOIL PILE CONTOUR AND ELEVATION, FT
- 2000 — PROPOSED FACILITIES AREA PAD CONTOUR AND ELEVATION, FT



D SPOIL PILE CROSS SECTION



E SPOIL PILE CROSS SECTION

PROFESSIONAL ENGINEER'S STATEMENT

I, Thomas E. Leidich, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

10/25/11
DATE

STATE OF ALASKA 49TH THOMAS E. LEIDICH EM 12365 REGISTERED PROFESSIONAL ENGINEER

SCALE
200' 0 200' 400'

NOTES:

- HORIZONTAL DATUM IS ALASKA STATE PLANE CO-OR. ZONE-4, NAD 27.
- VERTICAL DATUM IS MEAN SEA LEVEL.
- AERIAL PHOTOGRAPHY BY AERO-METRIC, INC., ANCHORAGE DIVISION.
- AERIAL TOPOGRAPHY BY STERO MODELING METHOD FLIGHT DATE JUNE 23, 2000.
- AERIAL MAPPING BY LIDAR METHOD FLIGHT DATE MAY 30, 2005.

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
1	06/11	TEL	UPDATED SUBMITTAL
0	1/10	TEL	ORIGINAL SUBMITTAL

DESIGN BY: MWH
DRAWN BY: JMB
CHECK BY: TEL
DWG FILE:
XREF DWG FILE:

OUT OF PIT SPOIL PILE DESIGN

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. D5-1

REV. 1

APPENDIX D5-1

GEOTECHNICAL EVALUATION REPORT, JUMBO DOME MINE

Prepared for:

USIBELLI COAL MINE, INC.
P.O. Box 1000
Healy, Alaska 99743

GEOTECHNICAL EVALUATION REPORT
JUMBO DOME MINE

Healy, Alaska

STATE OF ALASKA
49TH
ALAN E. RENSHAW
CE 9774
REGISTERED PROFESSIONAL ENGINEER

January 2010

Prepared by:

AJAX
28828 Cedar Circle
Evergreen, Colorado 80439

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JD-GEO-2	Jumbo Dome Geotechnical Cross-sections Through Pits (3 Sheets)
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	Moisture and Density – ASTM D 2216 & 2937
	Mechanical (Sieve) Analysis – ASTM D 1140
	Moisture and Density – ASTM D 2216
	Mechanical (Sieve) Analysis – ASTM D 6913
	Atterberg Limits – ASTM D 4318
	Direct Shear – ASTM D 3080
C	*Slide* Computer Printouts

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

Usibelli Coal Mine, Inc. (UCM) proposes to commence development of a new mining operation at the Jumbo Dome area of their Hoseanna Valley properties located near Healy, Alaska on the northern flanks of the Alaska Range. This new mining area is located northeast of the UCM Office and the Poker Flats and Two Bull Ridge Mining Areas and north of Hoseanna Creek and the Gold Run Pass Mining Area. It is anticipated that mining may utilize a combination of dragline and truck/shovel methods. Development of this new mining area will require permit approval in accordance with the requirements of the Alaska Surface Mining Control and Reclamation Act (ASMCRA). The ASMCRA geotechnical requirements relate to design of the out-of-pit spoil piles (minimum Factor of Safety (FS) of 1.5) and post-mining slopes (backfilled pit) (minimum FS of 1.3).

The new mine plan includes an 83.3Mt open pit coal target with a strip ratio of approximately 2.4:1, designed with 250 feet wide pits mined at up to 3Mt per year. The average pit duration is approximately 6 months before the next pit to the north will be mined. Initially, during the first box cut and furthest pits to the south, spoils will be hauled to an out-of-pit spoil pile to be constructed over a predominantly schist exposure south of the proposed mine. The out-of-pit spoil pile has been designed to contain approximately 5.3 Mt. A shop pad involving approximately 50K cy of earthwork will also be constructed south of the open pit.

1.2 PURPOSE AND SCOPE OF WORK

The purpose of the geotechnical investigation summarized in this report was to collect, verify, and test for geotechnical information from representative subsurface material samples and perform slope stability analyses to confirm design of geotechnical structures and post-mining conditions so that slope recommendations can be incorporated into the mine design. The scope of work included review of historic geotechnical data from nearby UCM properties, completion of field and laboratory geotechnical evaluations, analysis of static slope stability in accordance with ASMCRA guidelines, and development of geotechnical material data and recommendations for use in preliminary project planning and the early stages of the mine operation.

This study included a geotechnical field investigation assisted by a UCM geological engineer who conducted subsurface drilling programs between 2007 and 2009 at select locations within the proposed Jumbo Dome mining limits and at the out-of-pit spoil location. In July 2008, a limited number of surface and subsurface material samples were collected from UCM's 2008 Exploration Drilling Program. The study also included a preliminary geotechnical laboratory testing program after both the 2008 and 2009 sampling efforts.

2.0 FIELD INVESTIGATIONS

A total of 35 drillholes were completed by UCM between 2007 and 2009, 9 of which have been used to collect specific geotechnical field and lab data. 19 of the drillholes were drilled within the anticipated pit area, while 16 more were drilled outside the 83.3Mt pit limits, two of which were drilled at the proposed out-of-pit spoils site. These 2 drillholes were driven and sampled solely for geotechnical purposes (09JD11 and 09JD12). Standpipe monitoring wells were installed when conditions warranted, as described in Section 2.4, in order to allow for monitoring and sampling of stabilized groundwater levels.

The field program was completed in the Jumbo Dome mining area during summer and fall of 2007, 2008, and 2009. The drilling was performed by Tester Drilling Services, Inc. of Anchorage, Alaska, using track-mounted Mobile Nodwell B-61 drill rigs. All drilling was monitored by UCM engineering interns who logged the recovered soils and recorded indicators of drilling conditions. Soils encountered were classified according to the Unified Soil Classification System in the lab. The coordinates and elevations of the drillholes are summarized on the logs. The locations of the subsurface excavations were determined using UCM survey equipment.

2.1 EXPLORATION RC DRILLING, CORING, AND AUGERING

All drilling was performed by Tester Drilling Services, Inc. (Tester) of Anchorage, Alaska. Three drilling methods were utilized between 2007 and 2009: reverse circulation (RC), core, and auger drilling. The coring and augering was completed with a track-mounted Mobile Nodwell B-61 drill rig.

RC drilling was completed using an air rotary drill rig. The rotary drill rig had an inner drill stem and outer casing. Tricone bits were used for most of the drilling. Installation of the 2-inch diameter monitoring wells required drilling a 5.25-inch diameter borehole. To allow for detection of groundwater, the holes were drilled using air as the drilling fluid until groundwater was detected. Once groundwater was detected, the boreholes were advanced an additional 10 to 20 feet to allow for sufficient depth to install the well screen.

During drilling, samples of soil were collected every five to ten feet. The sample was typically taken by grabbing the cuttings produced by the circulation of air. The sampling method was dependent on the hardness of the formation. Samples were placed in plastic bags. All samples were logged in the field by an engineer, and sample descriptions were recorded on log forms.

Coring was completed with the auger using 3.25-inch inside diameter (I.D.) hollow stem augers that created a 6-inch diameter hole. This system extracted 2.25-inch diameter core samples. This system used a 5-ft long core barrel and was typically unable to retrieve core in the upper 10 to 15-ft of the drillhole. Continuous auger sampling was accomplished by advancing the augers into the ground while a soil core rode up into the

long split core barrel contained within the bottom hollow-stem auger flight. The core barrel was connected to the drill rods by a bearing assembly that rotated under torque from the drill head, thereby allowing the core barrel to remain stationary while the augers turned. The core barrel was typically retrieved after a 2 to 5 ft. hole advancement and split open lengthwise to reveal the recorded sample. The distance between the tip of the core barrel shoe and the drill bit was adjustable. Adjustments were made as needed to balance recovery with drilling efficiency.

Hollow-stem augering, while used to obtain core samples as described above, was also the preferred method for obtaining geotechnical drive samples of the soils encountered in two of the drillholes. The method of driving heavy duty standard penetration test (SPT) split-spoon samplers at 5 feet intervals enabled UCM to obtain additional undisturbed soil ahead of the augers while also obtaining blow counts. SPT samples were sealed in their SPT brass sleeves. This drilling was also monitored by a UCM engineer who logged the recovered soils and recorded indicators of drilling conditions. Soils encountered were classified according to the USCS in the lab. SPTs were performed approximately every 5 feet, if possible. The drive sampler was driven 18 inches into the soil with a 140-lb hammer free falling 30 inches. The number of blows to drive the sampler every 6 inches over an 18-inch interval was recorded. The blow counts recorded over the last 12 inches have been recorded on the two drillhole logs as representation of the N-value.

Eleven monitoring wells were constructed during the 2007 and 2008 drilling programs. No monitoring wells were constructed during the 2009 exploration program. Monitoring wells were also installed by Tester under supervision of UCM using 2-inch outside diameter flush threaded schedule 40 polyvinylchloride (PVC) pipe. The screened interval in each monitoring well consisted of either a ten or twenty foot length of slotted PVC pipe with .010 inch milled openings. The screened interval was typically placed in the coal seam. Each well was completed with No. 8 to No. 10 washed silica sand around the screened interval. A seal of bentonite pellets extended upwards from the sand pack to a distance of approximately two feet. The drill cuttings were used to backfill the hole from above the bentonite seal to a depth of two to three feet below grade. A cuttings-bentonite seal extended the remaining distance to the surface. A steel, above-ground protective monument was set in the ground surface seal. The PVC casing extended approximately two to three feet above grade in each well monument and was covered with a PVC slip cap. The steel monument had a locking cover affixed.

3.0 SITE DESCRIPTION AND GROUND CONDITIONS

Geologic mapping of the Jumbo Dome area was carried out by reviewing existing geologic maps and reports, interpreting stereo pairs of aerial photographs and conducting reconnaissance level field geologic mapping. The purpose of the mapping was to identify geomorphic features that may impact mine operations caused largely by slope instability. Significant features such as landslides, seeps, and faults were identified and mapped by UCM staff. Topographic relief is moderately steep with elevations ranging from 1,900 feet at the confluence of Marguerite and Emma Creeks to 2,500 feet along the eastern limits of the proposed Jumbo Dome Mining Area.

3.1 REGIONAL GEOLOGY

The coal bearing group in the Nenana Coal field is of Tertiary age, overlain in some areas by several thousand feet of Tertiary gravels, termed the Nenana Gravels. In areas mined by surface methods, the Nenana Gravels are eroded off, and up to one hundred feet of Quaternary outwash gravels can overlay the coal bearing formations. The coal bearing group is divided into five formations: Healy Creek, Sanctuary, Suntrana, Lignite, and Grubstake.

The Suntrana Formation, within which the mineable reserves at Jumbo Dome reside, is a repeated sequence of pebbly sandstone near the bottom grading through fine sandstone to a clay bed immediately below a coal seam cap. There are six coal seams in the Suntrana Formation designated by numbers one through six (the lower seam being number one). Only the top four layers are proposed to be mined at Jumbo Dome with the No. 4 and No. 3 being the only economically mineable seams, at this time.

Portions of the undisturbed Suntrana Formation are overlain by recent landslide rubble (Jumbo Dome Rubble). The surface is overlain by a very thin layer of loess, spruce trees, and vegetative matter termed muskeg. In one major area the rubble is now exposed at the ground surface, where it was previously below the surface muskeg (silts and organics).

The sandstone of the Suntrana Formation is composed primarily of gray poorly consolidated silty to pebbly sandstone. The footwall clays can be described as highly plastic clays to silty clays. It has been reported that they contain 30 to 50 percent montmorillonite (TerraMatrix, 1994).

The proposed Jumbo Dome mining area is located in the Suntrana Formation in the Northern Foothills physiographic province of the Alaska Range. The Suntrana Formation is the same formation being mined at the other UCM properties and has been described by Wahrhaftig (1970) as “interbedded, poorly consolidated, white-weathering, cross bedded, pebbly quartz sandstone, silty claystone, and blocky-fracturing subbituminous coal in thick, laterally persistent beds.”

The structural geology of the mining area consists of broad folds with a north-south trending fold axis. Coal seams in the proposed mining area generally dip gently to the

northwest. Detailed structural geology of the coal bearing rocks is contained in other reports including Wahrhaftig (1970) and UCM databases, and is not reproduced herein.

3.2 SITE GEOLOGY

The Jumbo Dome area slopes of the proposed mining area trend to the west and northwest towards Marguerite Creek. The upper eastern slopes in the area drain to the west due to the sloping topography, dipping coal seams and outcrops, gravelly surface deposits, and the presence of nearby deeply incised creeks. The area was glaciated in the lake Quaternary. Although permafrost is prevalent in this region on north-facing slopes, parts of the proposed mining area of Jumbo Dome are free of permafrost due to the predominantly west and southwest -facing orientations. The vegetation is mostly deciduous but includes scattered spruce trees. Thickness of the surface organic mat is generally less than 6 inches.

The subsurface geology of the Hoseanna Creek Valley immediately to the south of the Jumbo Dome mining area is well documented in Wilbur (1995). He noted that the Suntrana Formation has relatively thick, continuous coal beds, with fining upward sequences of clay horizons, and thick sequences of poorly consolidated but moderately sorted to well sorted, fine- to coarse-grained, cross-bedded, quartz-rich sandstone.

The west-facing slopes of the Jumbo Dome mining area include at least one sign of instability that has been documented by UCM along the upper eastern flanks of Marguerite Creek, within the limits of the proposed 85Mt pit.

As part of UCM's proposed mining operations at Jumbo Dome, spoil material will be placed in an out-of-pit site on the surface which has been identified to comprise of a weathered schist.

3.2.1 Silt and Organics

Silts and organics have been logged at the surface for several areas explored within the proposed mining area. Some of this material may have also been classified as topsoil by W.H. Pacific, a UCM wetlands subconsultant. This material has also been logged by UCM personnel to often lie within an upper permafrost zone. Due to poor recoveries of this material zone, samples were not available for laboratory testing and material classification. Depending on the location of excavations within the proposed pit limits, the silts and organics range in thickness from less than 1.0 foot to several feet thick.

3.2.2 Sand and Gravel

The top surface of the local stratigraphic sequence typically consists of a sand and gravel layer underlying a permafrost and/or muskeg layer. The sand and gravel layer is often frozen and averages about 10 feet thick.

3.2.3 Riprap

The Rubble of Jumbo Dome was well mapped by Wahrhaftig (1970) as shown on Figure CII-1 of the permit application. This material type is clearly observed both from aerial photography and in the field. It can be over ten feet thick and cover several acres, as discovered by UCM in several dozer trenches excavated in the general vicinity of drillhole 09JD01. The riprap is reportedly easily exposed underneath a thin surface layer of loose vegetation and muskeg, and can be excavated with standard heavy construction equipment. The riprap rocks can vary up to approximately pick-up truck size. In some locations, UCM personnel have been able to hear strong evidence of concentrated subsurface water flows within and/or beneath the rubble layer.

During its preparation of drill pads and for the dozer trench excavations, UCM has exposed several acres of Jumbo Dome tallus that had not been previously mapped by Wahrhaftig.

3.2.4 Sandstone

As discussed previously, the subsurface materials at the site primarily consist of three major (and mineable) coal seams, and overburden and interburden sandstones of the Suntrana Formation. The sandstone is often a poorly consolidated, gravely to pebbly quartz sandstone. Small layers of silty claystone can occur in the interburden layers. The sandstone is typically gray and brown and compact to dense. In most instances, the interburden sandstone is consolidated and frozen. Depending on the location of excavations within the proposed pit limits, the sandstones average 55 feet thick. The sandstone can include varying concentrations of scattered black coal fragments. On occasion, some burned red coal fragments have been observed (see drillhole logs in the Appendix CII-1 of the permit application). The sandstone of the 4 seam overburden is generally non plastic with more sand and gravel -sized fragments, while the sandstone of the 4/3 seam interburden tests as a more plastic material with a greater silt-sized fraction.

3.2.5 Coal

Four coal seams were encountered in the drillholes, seams 6 (top), 5, 4, and 3 (lowest encountered). All four coal seams are economic targets for the current mine plan. Each coal seam is usually underlain by a footwall clay layer. Depending on the location of excavations within the proposed pit limits, the 3 and 4 coal seams have an average thickness of approximately of 31.0 and 40.0 feet.

3.2.6 Clay

Each coal seam is usually underlain by a footwall clay layer. This footwall clay layer is, at times, discontinuous across the proposed mining area. The clay is typically high in moisture, as it is observed elsewhere throughout the Hoseanna Creek Valley mining properties. It is often described as a wet sandy or silty clay. Small layers of clay can occur in the interburden sandstone layers especially in 3 Seam where a clay parting has been observed. The clay is typically gray or brown and moist to wet. In some instances, the footwall clays are not frozen. Depending on the location of excavations within the

proposed pit limits, the footwall clays average in thickness from 5.0 to 7.0 feet thick underlying 4 and 3 seam, respectively. The 4 Seam footwall clay has more silt than 3 Seam footwall clay.

3.2.7 Schist

Schist of the Keevy Peak Formation occurs both at the surface and below an alluvial sand layer south and southwest of the proposed mining area. According to Wahrhaftig (1970) the schist does not adjoin the lower limits of the 83.3Mt mining area but according to UCM exploration programs and this field investigation, it is clearly observed to the immediate south of the proposed pit limits. It is in this location that UCM proposes to establish its out-of-pit spoils pile dump. The schist formation is unconsolidated in the upper few feet and consists of a fine sand to silt with occasional coarser fragments interbedded within its structure. Under wet conditions, the unconsolidated schist appears significantly weakened (at one point in 09JD12 the augers themselves fell through the schist with little to no frictional resistance). Below the unconsolidated schist is a more competent, bedrock schist layer that is far less weathered and appears to better retain its material strength and density, and is often frozen at depth. In drillhole 09JD11, the material encountered was non plastic and was typically sandy with decreasing moisture contents with depth (50% in the upper 10 feet to 15% below 25 feet). In drillhole 09JD12, the unconsolidated schist was encountered between approximately 20 and 30 feet with a more competent bedrock schist encountered below that layer to 50 feet (the depth of the drillhole).

4.0 GEOTECHNICAL LABORATORY TESTING

Laboratory tests were performed on select samples collected from the 2007, 2008, and 2009 drilling programs to measure the index and strength properties of selected samples. Results of this testing are summarized in Appendix B, as noted in the following sections.

Grab samples, shelby tubes, and brass liner (SPT) samples from the drillholes were taken for various laboratory analyses. The majority of the geotechnical testing of field samples were performed in the soils testing laboratory at Advanced Terra Testing, Lakewood, Colorado. The various tests performed included:

- USCS Classification, ASTM D 2487.
- Moisture Content, ASTM D 2216.
- Moisture Content and Density, ASTM D 2937.
- Grain Size Analysis, ASTM D 422, D 1140, D 2487, and D 6913.
- Atterberg Limits, ASTM D 4318.
- Direct Shear, ASTM D 3080.

The results of the index tests were used to classify the site soils according to the USCS. The index test results and the resultant soil classifications are summarized in Table 5. The full details of the test results are presented in Appendix B.

It is important to note that the soil samples collected for index testing represent only the grain sizes generally limited to about 1 to 3 inches, the inside diameter of the core or SPT barrels and typical of the RC cuttings.

4.1 INDEX PROPERTIES TESTING

The laboratory testing program was conducted to evaluate the properties of the materials obtained during the field investigation program. Results of the laboratory testing are presented on the raw lab data sheets in Appendix B.

Soil index tests were first performed to determine the moisture content, density, grain size distribution, and Atterberg limits of selected samples. Index testing was performed in order to correlate similar materials across the site and between other Healy Valley mining areas.

Review of the materials encountered during the field investigation indicated that they could generally be grouped into two categories: 1) granular, non-plastic sands (SP, SW), silty sands (SM) to sandy silts (SP-SM) and 2) low to medium plasticity clays (CL) and clayey silts (ML).

4.1.1 Atterberg Limits Results

Atterberg Limits are a fundamental measure of the engineering behavior of fine-grained soils. These test results are based on the concept that fine-grained soil exists in one of

four states, depending upon moisture content: solid, semisolid, plastic, and liquid. These states reflect decreasing inter-particle interaction as the material changes from solid to liquid states and they are generally related to strength and compressibility.

The samples collected from the 4-to-3 Seam interburden (generally SM, ML) tend to indicate a relationship between the presence of groundwater (perhaps from the 3 Seam water table confining pressures) and materials where lower shear strengths could be anticipated. Therefore, with a larger database of testing it should be possible to use Atterberg Limits testing and groundwater conditions as an indication of areas where lower strength material and troublesome in-pit conditions may be encountered during mining. The footwall clays both exhibit higher plasticity, with the 4 Seam footwall clay indicating that it may have slightly lower strength than the 3 Seam footwall clay, perhaps from the additional influence of the 3 Seam water level (under up to 80 feet of confining pressure) and the overlying 4 Seam water level. It may therefore experience higher pore pressures and hence reduced strength. According to the results of the Atterberg Limits testing, 2 of the 7 tests resulted in an in-situ moisture content at or above the Liquid Limit of the material itself, implying its potential to act more like a liquid than a solid under certain adverse conditions.

The results of all classification testing are provided in Table 1 below.

TABLE 1
SUMMARY OF GEOTECHNICAL CLASSIFICATION TEST RESULTS

Material	USCS Symbol	Moisture Content (%)		Dry Density (pcf)		Atterberg Limits		
		Range	Avg.	Range	Avg.	LL	PL	PI
6 or 4 Seam Overburden	SM	0.8 – 15.5	5.7	-	-	Non Plastic		
4/3 Seam Interburden	SM or ML	0.8 – 31.6	16.5	88.4 – 113.5	100.8	34.8	25.2	9.6
4 Seam Footwall	CL	15.7 – 50.5	30.3	118	118	50.7	23.1	27.6
3 Seam Footwall	CL	14.6 – 37.4	23.9	113.6 – 115.5	114.8	45.8	22.1	23.7
Schist	-	10.1 – 15.7	12.2	122 – 128.2	125.5	Non Plastic		

4.2 ENGINEERING PROPERTIES TESTING

The intent of the strength testing on the materials encountered was to determine their correlation with similar materials from the nearby UCM mining properties. Laboratory strength tests were conducted on core samples using the Direct Shear (ASTM D 3080) method. Table 2 in Section 5.1 summarizes the material parameters to be used in the stability analyses.

The standard Direct Shear test method was used to perform consolidated, drained tests. The test was performed by deforming a specimen at a controlled strain rate on or near a single shear plane. Test conditions, including normal stress and moisture environment,

were selected to represent the field conditions being investigated (according to factors of overburden conditions). The rate of shearing was limited to ensure drained conditions; therefore, the Direct Shear test results presented in Appendix B are in terms of effective shear strength.

4.2.1 Direct Shear Results

The results indicate that the granular materials (SM, SP, Schist) will behave in a drained fashion and exhibit typical strength properties for granular materials ($\phi \geq 30^o$). The plastic silts and clays (ML, CL) exhibit fairly high strength parameters under effective stress conditions (effective ϕ = 25-35º) and reduced total strength or residual strength parameters (total ϕ = 10-15º) which is more representative of UCM's prior findings of around 11 degrees.

These results are very significant when considering the stability of the proposed mine. In general, the shear strength of the intact footwall materials can be relatively high. However, disturbing the material and allowing it to swell and/or saturate under low overburden pressures may result in a considerably weaker material.

The schist has a relatively unimpacted residual strength with a friction angle of approximately 30 degrees and little to no cohesion. However, the schist is considerably weaker in its weathered and heavily disturbed state, as observed at surface exposures in the proposed out-of-pit spoils area.

5.0 GEOTECHNICAL ANALYSES

Static slope stability analyses have been conducted for the typical cross-sections shown on Drawing JD-GEO-3 (out-of-pit spoil pile) and Plate No. D10-2 (post mining topography) in the permit application. The slopes presented on Drawing JD-GEO-2 show typical cross-sections cut through the entire mined formation (3, 4, 5, and 6 Seams) of the open pit. The bottom of the pit is represented by the top of the 3 Seam footwall clay layer and the top of the pit daylights above 6 Seam in the sandstone overburden. The individual layers have fixed thicknesses. The slope angles for each coal seam and each footwall clay layer were also fixed as vertical cuts of varying thicknesses.

Phreatic surfaces internal to the cross-sectional geometry and above each coal seam were also analyzed in the stability runs to evaluate the sensitivity of the out-of-pit spoil pile and post mining slopes to pore water pressure variations. We have assumed any drainage collected at the top of the footwall clay layers will be properly maintained by UCM Operations so that the area will generally be in a relatively dry state.

5.1 MATERIAL CHARACTERIZATION

Estimating appropriate properties for design is subject to considerable judgment that should be tempered by future mine planning. Consequently, the values discussed below are considered appropriate for initial analyses of site stability. However, they should be reconfirmed and may require modification, once the actual mining limits and methods are determined and underway.

Based on our understanding of preliminary mining concepts, we estimated the strength parameters presented below, which are expected to be units that will be critical to operational and post-mining stability.

- **3 Seam and 4 Seam Footwall Clays.** The 3 Seam footwall is the proposed base of mining at Jumbo Dome. Consequently, the residual strength of these materials will be a significant factor in the stability analyses. Therefore, the presence of lower strength materials and the likely disturbance of the exposed footwall during mining, make it appropriate to use the residual strength for a disturbed material. The strength of the 4 Seam footwall is expected to be significant in stability analyses. Direct shear tests that were performed on block samples (Golder, 1992) indicate a lower residual shear strength than for the 3 Seam footwall. Therefore, for both 3 and 4 Seam Footwall Clay layers, the following material parameters (friction angle, cohesion, moist density) have been used:
    - $\phi = 11^{o}$, c = 0 psf, $\gamma = 115$ pcf.

- **Overburden/Interburden.** The shear strength parameters for interburden and overburden sandstone layers are not considered to be critical to stability analyses. The overburden of the Suntrana formation varies in consistency from silty sand to sand and gravel. The interburden consists of mixed layers of siltstone and sandstone, which is typical of the Suntrana formation, and includes material

overlying 4 Seam coal. Previous testing at Poker Flats (Golder, 1992) indicates that the strength of the interburden materials are sensitive to insitu moisture content and loading sequence when spoiled. This sensitivity to moisture content (via pore pressure) and compaction during placement and over time, was also a critical factor in spoil stability for the Poker Flats Outslope and for the Badlands Valley Fill. Therefore, the following material parameters have been used for the sandstone:

- $\phi = 37^o$, c = 0 psf, γ = 125 pcf.

- **Schist.** The shear strength for the underlying weathered and unweathered bedrock in the vicinity of the proposed location for the out-of-pit spoil pile has been developed from one Direct Shear test conducted in 2009 and from a database review of various rock mechanics references. Stability analyses will also have to assume clearing and grubbing is conducted to eliminate any potentially weak basal layers under the pile (i.e. weathered and/or disturbed schist)
    - $\phi = 30^o$, c = 0 psf, γ = 125 pcf.

In addition, based upon a review of similar previous UCM geotechnical studies (Golder, 1985a, 1985b, 1993), this stability evaluation has utilized the following 3 different types of materials and engineering properties:

- Coal Seam: Golder (1985a) provides material properties for the coal bedding layer of $\phi = 40^o$, c = 0 psf, γ = 95 pcf and for the coal/footwall interface of $\phi = 10^o$, c = 500 psf.

- Sands and Gravels: Generally a mix of silty SAND and rock and most commonly found intermixed as layers within the sandstone of the inter/overburden. $\phi = 18^o$ (lower limit), 32° (upper limit), c = 0 psf, γ = 115 pcf.

- Spoils: Generally either truck-dumped or dragline spoils. Extensive testing at UCM yields a stronger spoil material if it is truck-dumped because of the implied compaction and thinner lifts ($\phi = 35^o$, c = 0 psf, γ = 125 pcf) versus a dragline placement ($\phi = 32^o$, c = 0 psf, γ = 105 pcf).

Site conditions in the Jumbo Dome Mining Area can be characterized by a higher frequency of permafrost, higher groundwater levels than other areas at UCM, and a less favorable structure orientation, i.e. down dip towards the outcrop. These conditions will need to be monitored and understood by UCM Operations in order to maintain acceptable levels of operational and post-mining stability. As noted above, there are materials present in the mining area (mainly footwall clays and some silty sandstones) where lower than average strengths may be encountered. In addition, mining operations that cause critical footwall materials to be disturbed or become saturated and swell may reduce material strengths.

Table 2 summarizes the material parameters used in the stability analyses.

TABLE 2 MATERIAL PARAMETERS USED IN STABILITY ANALYSES				
MATERIAL	DENSITY (pcf)	COHESION (psf)	FRICTION ANGLE (°)	COMMENTS
Spoil, truck-dumped	125	0	35	Drier fill, compacted
Spoil, dragline	105	0	32	Uncompacted, damp to moist fill
Sands and Gravels	115	0	30	In-place sands and gravels
Coal	95	0	40	In-place seam
Sandstone	125	0	37	In-place foundation
Schist	140	0	30	In-place foundation
Footwall Clays	115	0	11	In-place

5.2 SLOPE STABILITY ANALYSES

The two-dimensional model *Slide 5.0* was used to estimate factors of safety for interbench and overall failure scenarios. Spencer's method of slices was used in conjunction with a search routine to estimate the lowest possible factor of safety for the given input conditions for circular, non-circular, and composite large-scale failure surfaces. Spencer's method of slices satisfies conditions of static equilibrium, including horizontal and vertical force imbalance and moment imbalance. The factor of safety is defined as the ratio of the average available strength and average mobilized shear stress along a given failure surface. The shear surfaces were identified using the iterative search routines of *Slide* to calculate the factor of safety under each pit configuration and loading condition. Shallow failure surfaces (less than 50-ft thick) were not analyzed since the massive overall slope failure is considered critical in driving the design and confirming the ability of the out-of-pit spoil pile and post mining topographic surface to remain stable.

Both circular and non-circular failure modes have been reviewed during the analysis. The circular failure mode exhibited the lowest FS in the models developed and therefore governs the stability of the structure for the proposed conditions.

5.2.1 Out of Pit Spoil Pile Stability

According to the modeling performed for the proposed 3H:1V out-of-pit spoil pile configuration, the likelihood for a large scale failure will be dependent on the level of compaction of the placed spoil material and the pore pressure within the dump. For a shallow, total slope failure, the static FS increases from 1.42 to 1.83 as the pore pressure conditions improve from a moist condition to dry condition and as the level of compaction improves from a relatively uncompacted state to a compacted state using the required lift thicknesses of no more than 4 feet. For a deeper-seated pile failure through the foundation strata and for a similar improvement in moisture and compaction conditions, the stability of the pile for the truck-dumped spoil in maximum 4 feet thick lifts results in a static FS of over 2. These results for the proposed 3H:1V configuration

meet the ASMCRA requirements for long-term stability of an out-of-pit spoils pile (minimum FS of 1.5). The graphical outputs for these analyses are provided in Appendix C as Figures C1 through C4.

Prior to construction, the ground surface should be prepared by removing the vegetation and topsoil, exposing free-draining, coarse-grained material such as sands and gravels similar to those encountered in drillholes 09JD11 and 09JD12. Construction of the lower spoil pile lifts over a free-draining material will enhance the ability of the pile to efficiently transfer subsurface water flows along or below the existing ground surface and toward Marguerite Creek. This will minimize seepage into the spoil pile and maintain a static phreatic surface below the pile itself. Drillhole logs 09JD11 and 09JD12 (see Appendix A) show that below a surface layer of silts and organics (to be pre-stripped prior to spoil pile construction, as discussed above) there lies a coarse-grained zone of Suntrana sands, gravels, and sandstone with some local layers of Jumbo Dome talus. All of these material types represent good foundation materials for the construction of the out-of-pit spoil pile, as proposed. Similar to other UCM out-of-pit spoil pile structures at the Healy Valley mining properties, active efforts to control several important aspects of the construction process will be employed. These include placing as thin a lift as practicable and no greater than that required by ASMCRA, not allowing for the concentration of ice-rich or saturated spoil material within focused areas, and enhancing compaction of placed material using dozer-spreading techniques and allowing for layer consolidation, especially of the weaker, finer-grained spoil material.

5.2.2 Stability of Post Mining Topography

According to the modeling performed for the proposed post mining slopes, the likelihood for a large scale failure will be largely dependent on footwall clay removal in the pits. For a large-scale slope failure, the static FS increases from 1.69 to 2.04 as the water table drops to the top of the foundation layer. It is unlikely that the water table can rise much higher than the level assumed for the analysis that resulted in an FS of 1.69. Each of the results for the proposed slope configuration meets the ASMCRA requirements for long-term stability of the post mining slopes (backfilled pit) (minimum FS of 1.3). The graphical output for these analyses are provided in Appendix C as Figures C5 through C6.

These preliminary stability analyses for the post mining topography indicate that UCM will not need to remove the 3 Seam footwall clay layer during mining. Naturally, any removal of the 3 Seam footwall clay layer by UCM should improve long-term stability for the spoil backfill area.

<u>Hydrologic Balance of the Post Mining Backfilled Area</u>

We understand that a mining plan will be developed for the Jumbo Dome Mine with the goal of preserving the hydrologic balance of the area. This will be done by the reestablishment of the approximate pre-mining topography by the placement of the sandstone spoil material into the mining pit. The following is a discussion of the expected hydrologic consequences of the operation.

The removal down to the 3 Seam coal will effectively remove the water in this system including the recharge area and discharge route (Marguerite Creek). The excavated area will then be progressively filled with the previously-excavated Suntrana sandstone material. This redeposited spoil is expected to have a similar or slightly higher permeability than the original in-place material.

During the removal of 3 Seam, the present downward movement of groundwater to 2 Seam may reverse. The removal of the high head in 3 Seam may create a reversed head gradient, which will result in an upward movement of groundwater through the Suntrana sandstone above 2 Seam. This could result in leakage of water from below into the base of the mine excavation, particularly in areas where the 3 Seam footwall clay layer has been removed.

After placement of the spoil to the approximate pre mining topography, it is expected that two hydrologic processes will act to create a new hydrogeologic system in the area. Precipitation recharge on the surface on the spoil will infiltrate into the spoil and slowly saturate it. This infiltration will move downward and may perch at the base of the spoil material which is underlain by a lower-permeability material. The potential for upward leakage of groundwater from 2 Seam will also act to slowly saturate the spoil material. Both of these processes will contribute to the creation of the new hydrogeologic system. The water level may rise, over time, to the level of the present potentiometric surface of 3 Seam. It will rise above this level if the spoil surface infiltration rate is greater than the pre mining rate, which is not expected. As the water level in the spoil rises, the groundwater will eventually seek to discharge at a topographic low, probably in the vicinity of the existing Marguerite Creek. This discharge will produce baseflow surface water drainage, probably similar in quantity to the present stream channel.

The length of time required for the re-establishment of the hydrogeologic system in the spoil and a surface water discharge from the spoil is expected to be very long. The rates of downward recharge and potential for upward leakage into the spoil are expected to be sufficiently low that many years will be required for the re-establishment of the hydrologic balance through the mined area.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions summarize the results of the report:

- The footwall clays consist of varying percentages of silt and/or clay particles. Medium plasticity clays appear to be typical. The clay-sized particles appear to consist mostly of clay minerals, given the Plasticity Index and Liquid Limit values recorded in laboratory tests (Table 1). The footwall clays (and some silty sandstones) will exhibit lower than average strengths when they are disturbed or become saturated and swell.

- The sandstones consist of approximately 75 percent coarse particles (generally sands) and less than 25 percent fine-grained particles (generally silts). Overall, the sandstone interburden layers are composed of randomly placed, somewhat discontinuous layers of widely variable materials from different sources (sandstones, sands, some gravels).

- The schist encountered at depth has an acceptable friction angle of approximately 30 degrees and little to no cohesion. However, the schist is considerably weaker in its weathered and heavily disturbed state, as observed at surface exposures in the proposed out-of-pit spoils area.

- Groundwater within the existing, unmined area appears to exist in the coal seams and is laterally continuous, related to the northwest-trending dip of the coal seam structure and the overlying topography. Relatively major quantities of groundwater may be encountered during mining, which may emanate from both the coal seams and from within and under the rubble and tallus layers that have been observed at the site.

- Site conditions in the Jumbo Dome Mining Area can be characterized by a higher frequency of permafrost, higher groundwater levels than other areas at UCM, and a less favorable structure orientation, i.e. down dip mining towards the outcrop. This is similar to the mining operation employed at Runaway Ridge. These conditions will need to be monitored and understood by UCM Operations in order to maintain acceptable levels of operational and post-mining stability. As noted above, there are materials present in the mining area (mainly footwall clays and some silty sandstones) where lower than average strengths may be encountered. In addition, mining operations that cause critical footwall materials to be disturbed or become saturated and swell may reduce material strengths.

- At present, there is no observed evidence of significant slope stability issues associated with the majority of the existing, unmined slopes of the proposed mining area.

- Based on the field investigation results and a review of historical data, slope profiles composed of 6 stratigraphic units were established. These slope profiles represent refined slope cross-sections that can be used in further evaluation of the stability of the slopes.

We performed a variety of slope stability analyses for the proposed configurations of the out-of-pit spoils pile and the post mining topography. The static slope stability was modeled utilizing the critical cross-sections presented on Drawings JD-GEO-2 and Plate D10-2 in the permit application.

Using the proposed 3H:1V slope configuration for the out-of-pit spoil pile, the static FS was between 1.83 and 2.03 for shallow, total slope and deep-seated, foundation failures, respectively. These FS values will meet ASMCRA guidelines for long-term stability. Additional sensitivity analyses were performed for varying design parameters such as water table elevation and material strengths. Typical of the performance of UCM sandstones spoils, the stability of the pile will be largely dependent on compaction and pore pressure, which are themselves dependent on lift thicknesses (a ASMCRA requirement) and material moisture contents.

Using the proposed slope configuration for the post mining topography, the static FS was between 1.69 and 2.04. These FS values will meet ASMCRA guidelines for long-term stability. Additional sensitivity analyses were performed for varying design parameters such as water table elevation and material strengths. The phreatic level is considered to be the most critical design parameter that can be controlled over the long-term for maintaining an acceptable FS for slope stability. Clearly, the proposed post mining slopes are no steeper than current pre mining slopes.

The truck and shovel operation will have more flexibility with spoil placement and will result in higher strength material upon placement. In the initial stages of mining, truck spoil will be placed in the permanent out-of-pit spoil pile south of the active pit area. The preparation of a cleared and grubbed pile footprint with the preferred exposure of available free-draining granular material, as observed in the two geotechnical drillholes, will be important prior to placement of the lower spoil lift. Stability of backfill (post mining topography) is also important for both operational efficiency and long-term stability after completion of mining. The initial backfill will also likely be placed with the truck operation. The proposed mining limits appear to avoid existing unstable slopes. Therefore, the stability of the backfill is primarily dependent upon backfill condition, post mining configuration, and foundation characteristics. The analysis of post mining topography (backfill stability) indicates that preferred conditions include low moisture spoils, compacted lifts, and removal of disturbed 3 Seam footwall clays, if any.

7.0 REFERENCES

Alaska Department of Natural Resources, Division of Mining, Land, and Water, 2009. *Alaska Surface Coal Mining Program, Regulations Governing Coal Mining in Alaska*, 11 AAC 90. Dated April 24.

Alaska Department of Natural Resources, Division of Mining, Land, and Water, 2006. *Permit to Conduct Surface Coal Mining Activities, Jumbo dome Mine Road Corridor, S-0605*, Surface Mining Permit Application, Final Findings of Fact and Decision – Usibelli Coal Mine, Inc., Healy, Alaska. Dated December 21.

Alaska Division of Geological and Geophysical Surveys, 2006. *Geologic Ground-Truth Inventory of Liberty Bell, Western Bonnifield Mining District Geophysical Survey Tract*, by Jennifer E. Athey, Fairbanks, Alaska. Vol. 9, No. 1, Alaska GeoSurvey News. Dated February.

Bieniawski, Z.T., 1973, *Engineering Classification Of Jointed Rock Masses*: The Civil Engr. In So. Africa, So. African Instit. of Civil Engrs., Transvaal, So. Africa.

Golder Associates, Inc. 1985a. *Stability Analysis of Proposed Spoil and Highwall Slopes at Runaway Ridge*. A report prepared for Usibelli Coal Mine, Inc., Healy, Alaska. Anchorage, Alaska. Dated August.

Golder Associates, Inc. 1985b. *Stability Analysis of Highwall Slopes at Poker Flats – Phase I*. A report prepared for Usibelli Coal Mine, Inc., Healy, Alaska. Anchorage, Alaska. Dated September.

Golder Associates, Inc. 1992. *Re-Evaluation of In-Pit Spoil Pile Stability, Poker Flats Mining Area*. A report prepared for Usibelli Coal Mine, Inc., Healy, Alaska. Anchorage, Alaska. Dated February.

Golder Associates, Inc. 1993. *Highwall Stability, Gold Run Pass, Phase V*. A report prepared for Usibelli Coal Mine, Inc., Healy, Alaska. Anchorage, Alaska. Dated January.

Linnell, K.A. and Kaplar, C.W., 1966, *Description and Classification of Frozen Soils:* U.S. Army Cold Regions Res. Eng. Lab. Tech Rep. 150

Rocscience, "Slide" Computer Program, Version 5.0, Alberta, Canada.

Shannon & Wilson, Inc. 1990a. *Stability Assessment of Proposed Post-Mining Slopes for the Runaway Ridge Mining Area*. A report prepared for Usibelli Coal Mine, Inc., Healy, Alaska. Fairbanks, Alaska. Dated September.

Shannon & Wilson, Inc. 1990b. *Geotechnical Evaluation of Proposed Out of Pit Spoil Facility, Usibelli Coal Mine*. A report prepared for Usibelli Coal Mine, Inc., Healy, Alaska. Fairbanks, Alaska. Dated September.

TerraMatrix, Inc., 1995. *Geotechnical Study and Proposed Remediation Design for the Poker Flats North-facing Outslope, Usibelli Coal Mine, Alaska, Task 600*. A report prepared for Usibelli Coal Mine, Inc., Healy, Alaska. Lakewood, Colorado. Dated January.

Usibelli Coal Mine, Inc., 1999. *TBR-FR Permit Application 02-86-795, Permit Revision Application*, Healy, Alaska. Dated July.

Usibelli Coal Mine, Inc., 2002. *Hoseanna Creek and Emma Creek, Coal Exploration Permit 02-86-795, Permit Revision Application*, Healy, Alaska. Dated July.

Usibelli Coal Mine, Inc., unpublished and proprietary in-house data.

Wahrhaftig, C., 1970, *Geologic Map of the Healy D-4 Quadrangle, Alaska*: U.S.Geological Survey Map GQ-806, scale 1:63,360.

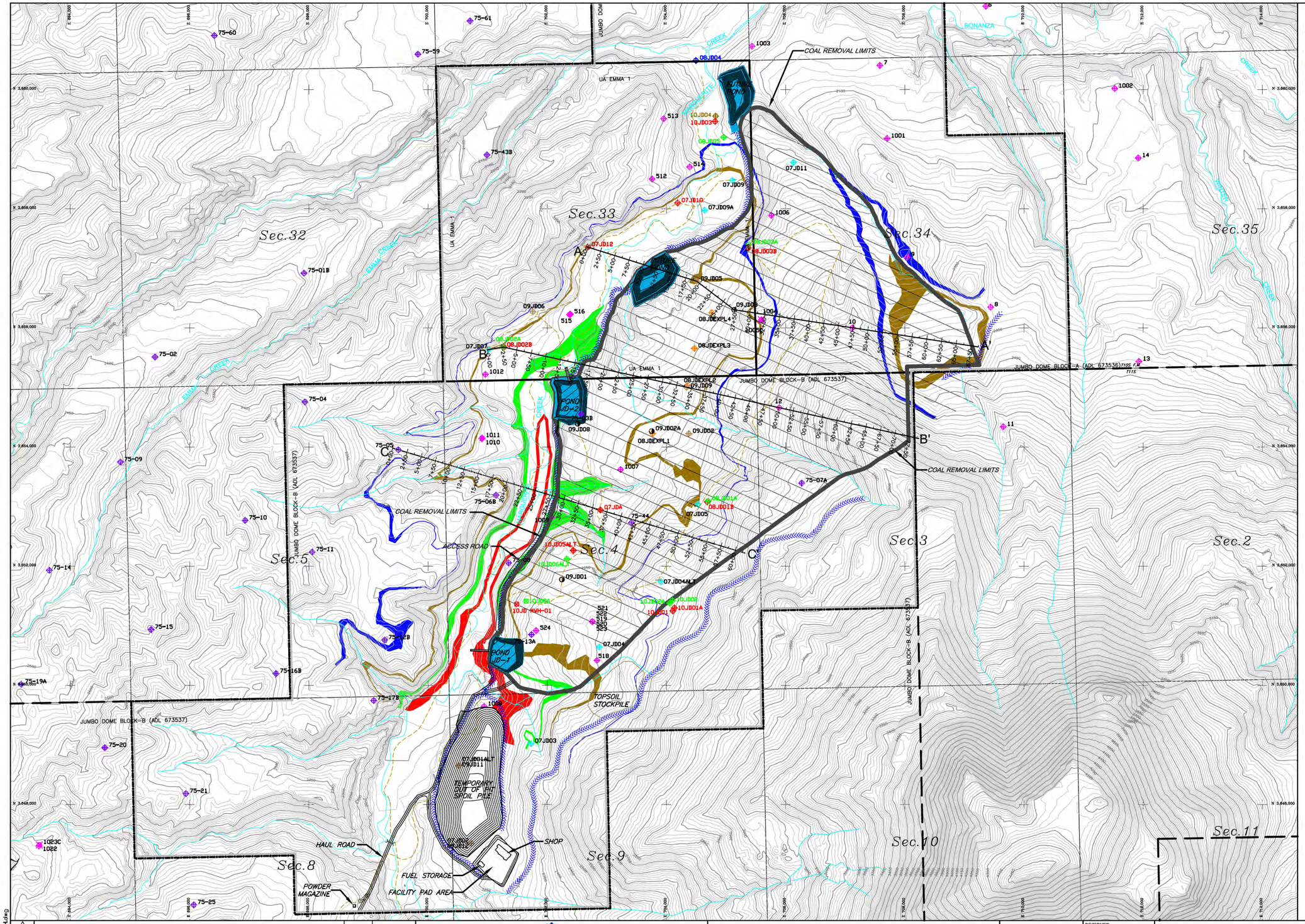
Wahrhaftig, C., and Birman, J.H., 1954, *Stripping Coal Deposits on Lower Lignite Creek, Nenana Coal Field, Alaska*: U.S.Geological Survey Circular 310, 11p.

Wilbur, S.C., 1995, *Fluvial and Hillside Geomorphology of Hoseanna Creek Watershed, Central Alaska*, a Thesis. University of Alaska, Fairbanks, Alaska. Dated December.

Limitations:

Professional judgments on subsurface conditions and engineering properties of geologic materials are presented in this report. They are based partially on the evaluation of the technical information gathered from this study, partially on our understanding of the characteristics of the site, and partially on our experience with subsurface conditions in the surrounding area. We do not guarantee the performance of the project in any respect; only that our engineering work and judgments rendered meet the standard of care for our profession. Variations from the conditions portrayed, which are not indicated by the test explorations or laboratory testing, may occur. Judgments made should consider this potential variability. If different conditions are encountered during future mining excavations, it is necessary that we be contacted so that our recommendations can be reviewed. We represent that our services are performed within the limits set forth by UCM, in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation to UCM, expressed or implied, and no warranty or guarantee is included or intended.

DRAWINGS



LEGEND

- 6-SEAM OUTCROP
- 5-SEAM OUTCROP
- 4-SEAM OUTCROP
- 3-SEAM OUTCROP
- ORIGINAL TOPOGRAPHY
- POND DESIGN TOPOGRAPHY
- SPOIL PILE DESIGN TOPOGRAPHY
- COAL REMOVAL LIMITS
- NATURAL DRAINAGE
- DIVERSION DITCH
- TRAIL
- LEASE BOUNDARY
- PERMIT BOUNDARY
- 07JD12 — 3 SEAM WELL
- 08JD05 — 4 SEAM WELL
- 10JD04 — 5 SEAM WELL
- 08JD05 — 6 SEAM WELL
- 1007 — AMAX 1974 DRILL HOLE
- 75-44 — AMAX 1975 DRILL HOLE
- 07JD05 — UCM 2007 DRILL HOLE
- 08JDEXPL8 — UCM 2008 DRILL HOLE
- 09JD02 — UCM 2009 DRILL HOLE
- 09JD01 — BOREHOLE USED FOR OVERBURDEN AND INTERBURDEN SAMPLING

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NOTES:

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2. VERTICAL DATUM IS BASED ON MEAN SEA LEVEL.

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AJAX — 28828 CEDAR CIRCLE, EVERGREEN, CO 80439, (303) 241-2057

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DATE	2/17/11

USIBELLI COAL MINE

JUMBO DOME GEOTECHNICAL PROFILE AND CROSS-SECTION LOCATIONS

REVISION 1

PROJECT NO.

DRAWING JD-GEO-1

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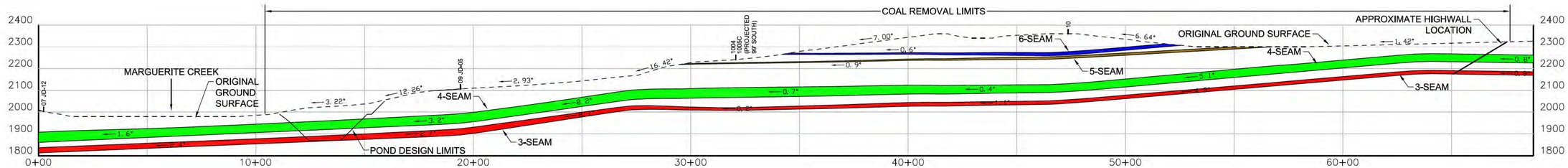

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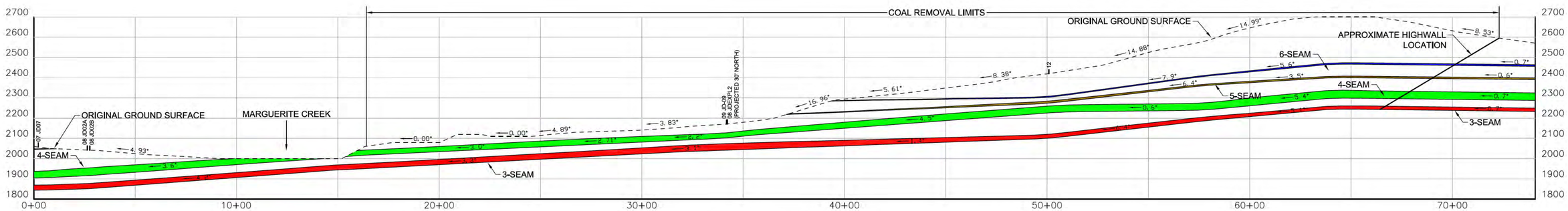

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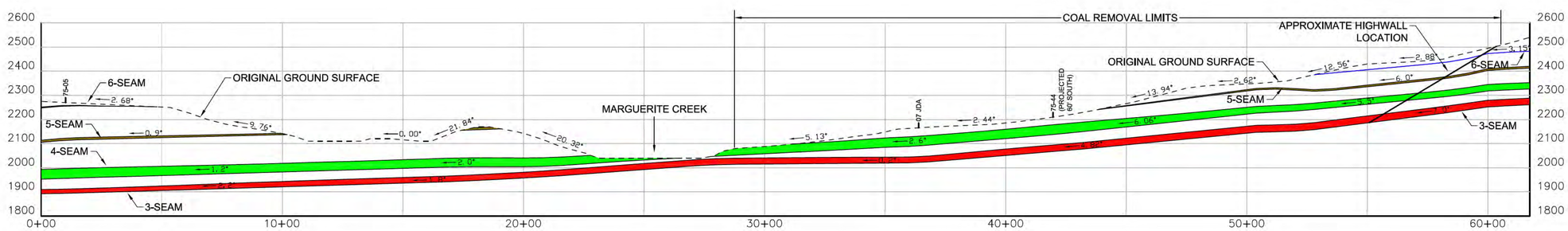

PROFILE C - C'

LEGEND

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- 4-SEAM OUTCROP
- 3-SEAM OUTCROP
- ORIGINAL GROUND SURFACE
- HIGHWALL LOCATION (APPROXIMATE)

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JUMBO DOME GEOTECHNICAL PROFILES

REVISION 1

PROJECT NO.

DRAWING JD-GEO-1

SHEET 2 OF 2

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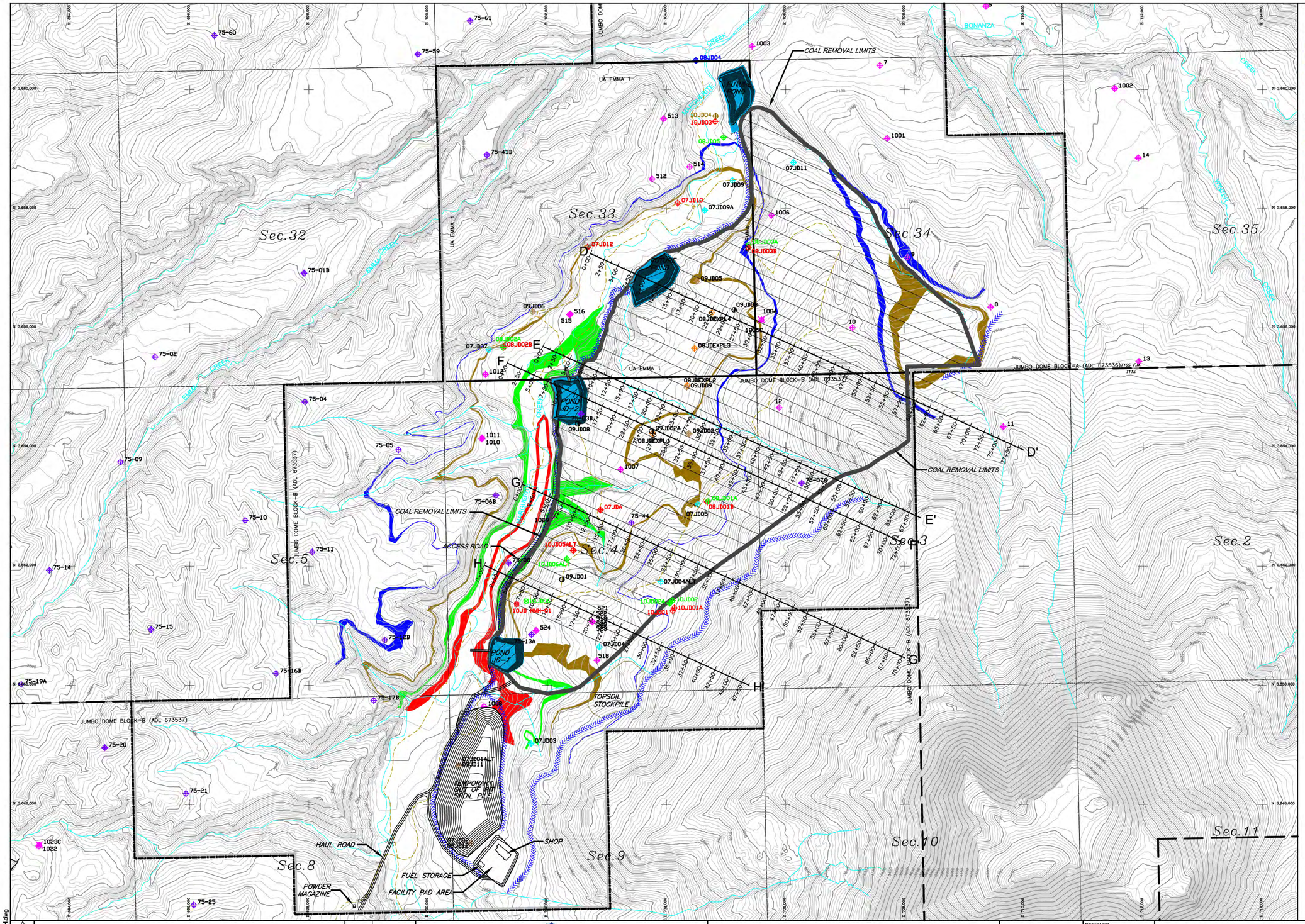

LEGEND

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SCALE

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NOTES:

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WARNING
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CLIENT
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USIBELLI COAL MINE

JUMBO DOME GEOTECHNICAL PROFILE AND CROSS-SECTION LOCATIONS

REVISION 1

PROJECT NO.

DRAWING JD-GEO-2

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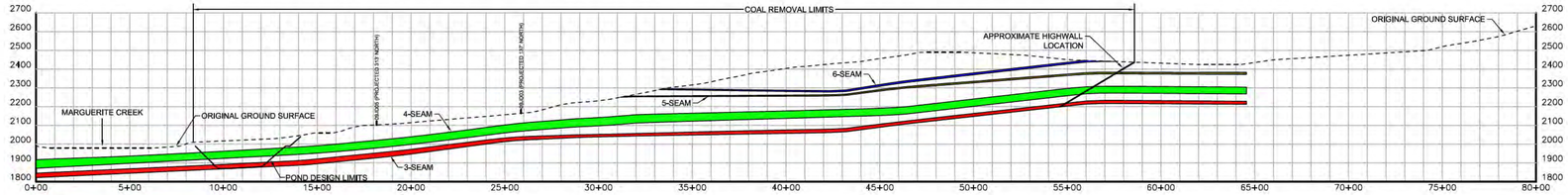

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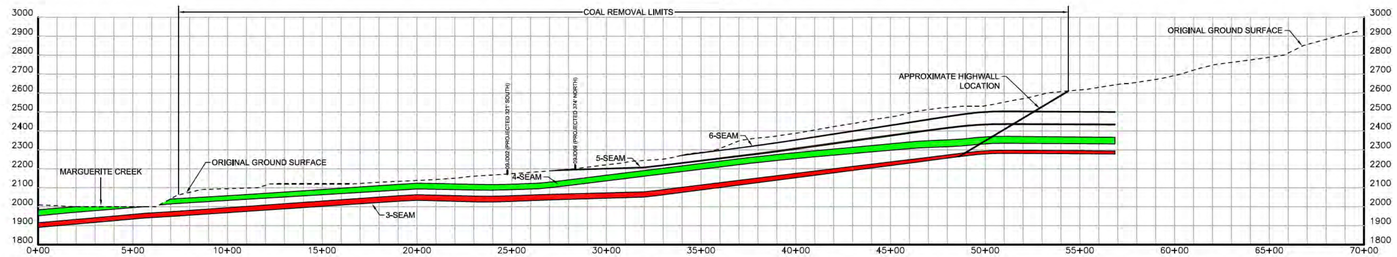

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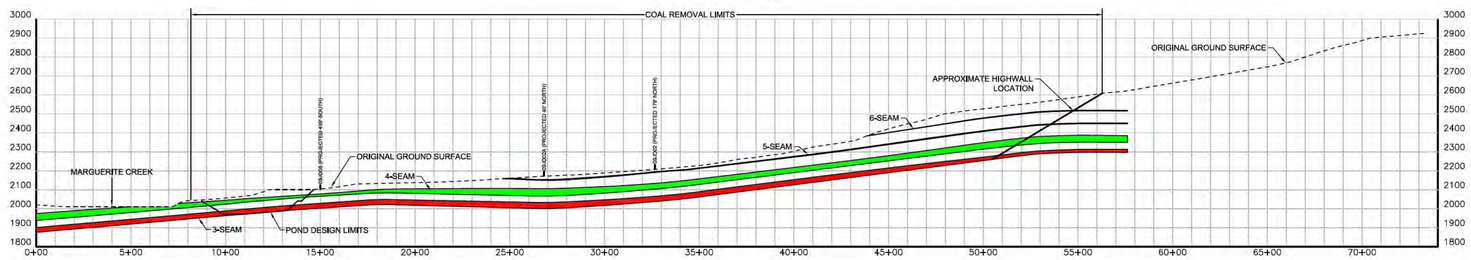

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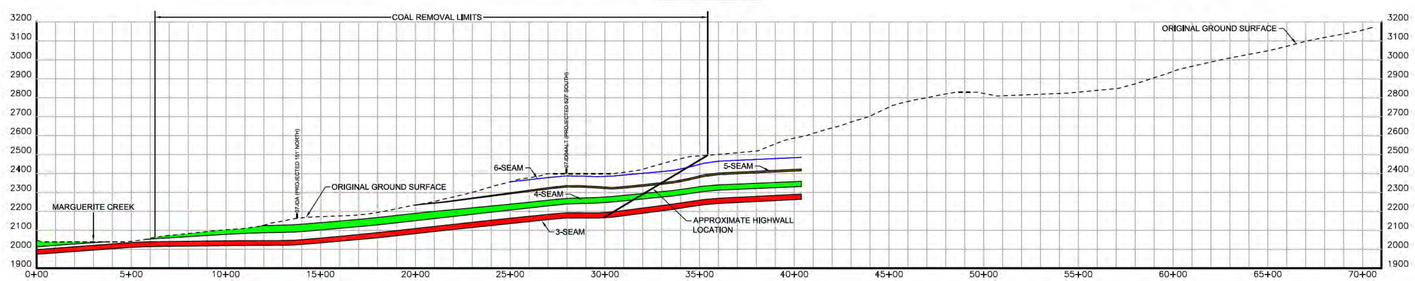
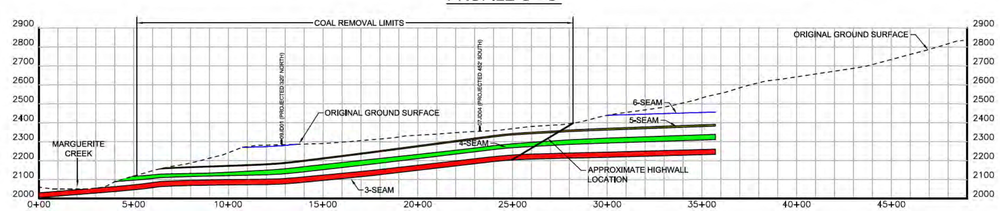


PROFILE G - G'



PROFILE H - H'

LEGEND

- 6-SEAM OUTCROP
- 5-SEAM OUTCROP
- 4-SEAM OUTCROP
- 3-SEAM OUTCROP
- ORIGINAL GROUND SURFACE
- HIGHWALL LOCATION (APPROXIMATE)

SCALE

400' 0 400' 800'

CONTOUR INTERVAL: N/A

NOTES:

1. HORIZONTAL DATUM IS BASED ON ALASKA STATE PLANE COORDINATES, ZONE-4, NAD 27, AS EXPRESSED IN U.S. SURVEY FEET.
2. VERTICAL DATUM IS BASED ON MEAN SEA LEVEL.

REV	DESCRIPTION OF REVISION	BY	DATE
1	REVISION 1	RLM	2/11
0	DRAFT	RLM	12/09

AutoCAD FILE: JD_GEOTECH.dwg

USIBELLI COAL MINE, INC.

AJAX
28828 CEDAR CIRCLE
EVERGREEN, CO 80439
(303) 241-2057

WARNING
0 0.5 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED
DRAWN RLM
CHECKED AJH
REVIEWED
CLIENT
DATE 2/17/11

USIBELLI COAL MINE

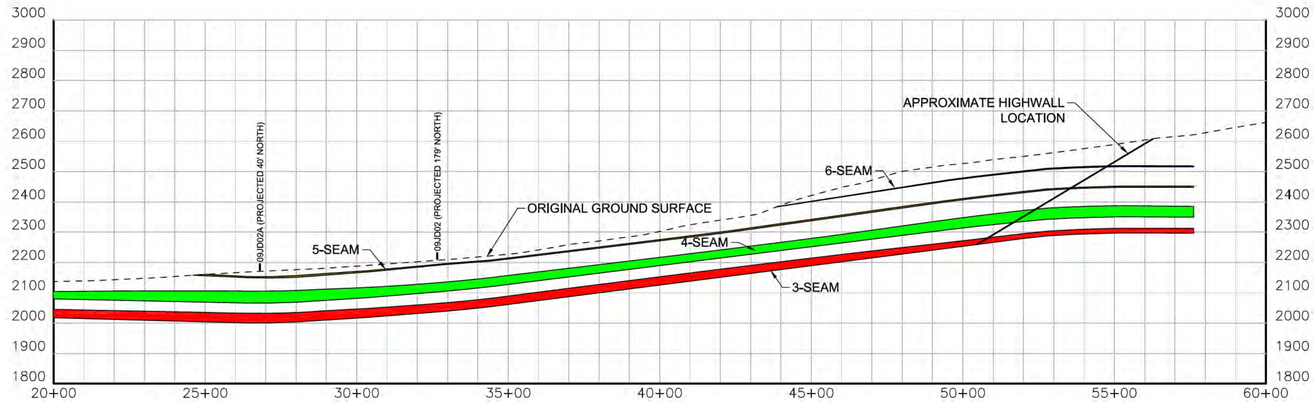
JUMBO DOME GEOTECHNICAL PROFILES

REVISION 1

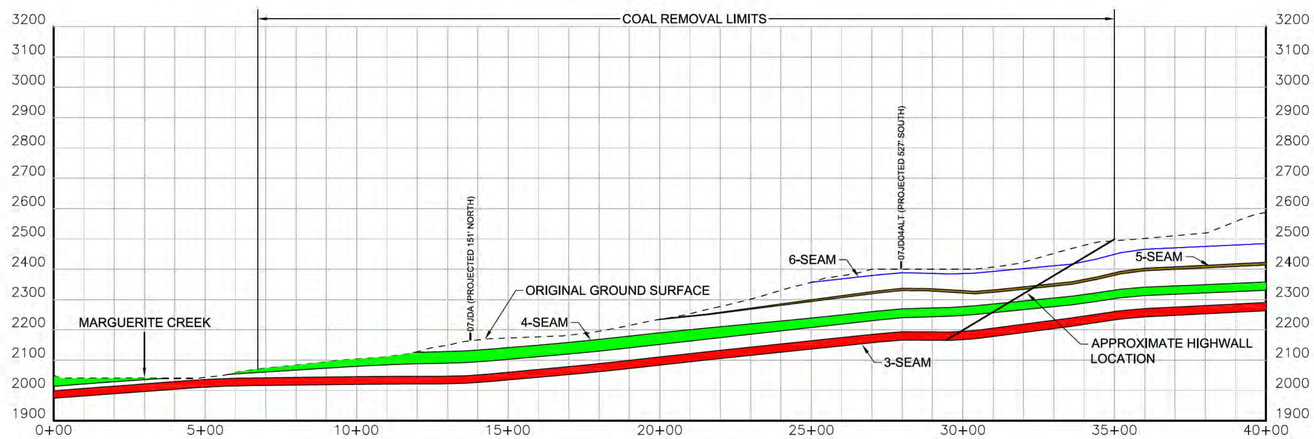
PROJECT NO.

DRAWING JD-GEO-2

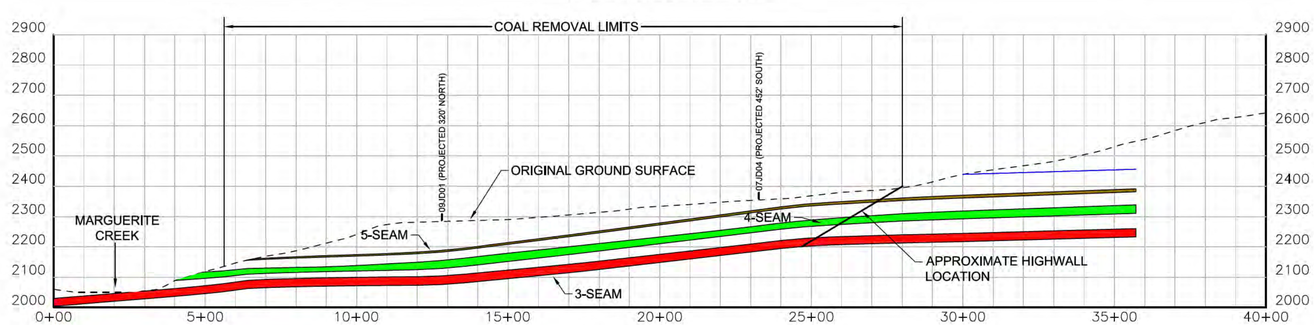
SHEET 2 OF 3



PROFILE F - F'



PROFILE G - G'



PROFILE H - H'

LEGEND

- 6-SEAM OUTCROP
- 5-SEAM OUTCROP
- 4-SEAM OUTCROP
- 3-SEAM OUTCROP
- ORIGINAL GROUND SURFACE
- HIGHWALL LOCATION (APPROXIMATE)

SCALE

250' 0 250' 500'

CONTOUR INTERVAL: N/A

NOTES:

1. HORIZONTAL DATUM IS BASED ON ALASKA STATE PLANE COORDINATES, ZONE-4, NAD 27, AS EXPRESSED IN U.S. SURVEY FEET.
2. VERTICAL DATUM IS BASED ON MEAN SEA LEVEL.

REV	DESCRIPTION OF REVISION	BY	DATE
1	REVISION 1	RLM	2/11
0	DRAFT	RLM	12/09

AutoCAD FILE: JD_GEOTECH.dwg

UCM USIBELLI COAL MINE, INC.

AJAX
28828 CEDAR CIRCLE
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(303) 241-2057

WARNING
0 0.5 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED	
DRAWN	RLM
CHECKED	AJH
REVIEWED	
CLIENT	
DATE	2/17/11

USIBELLI COAL MINE

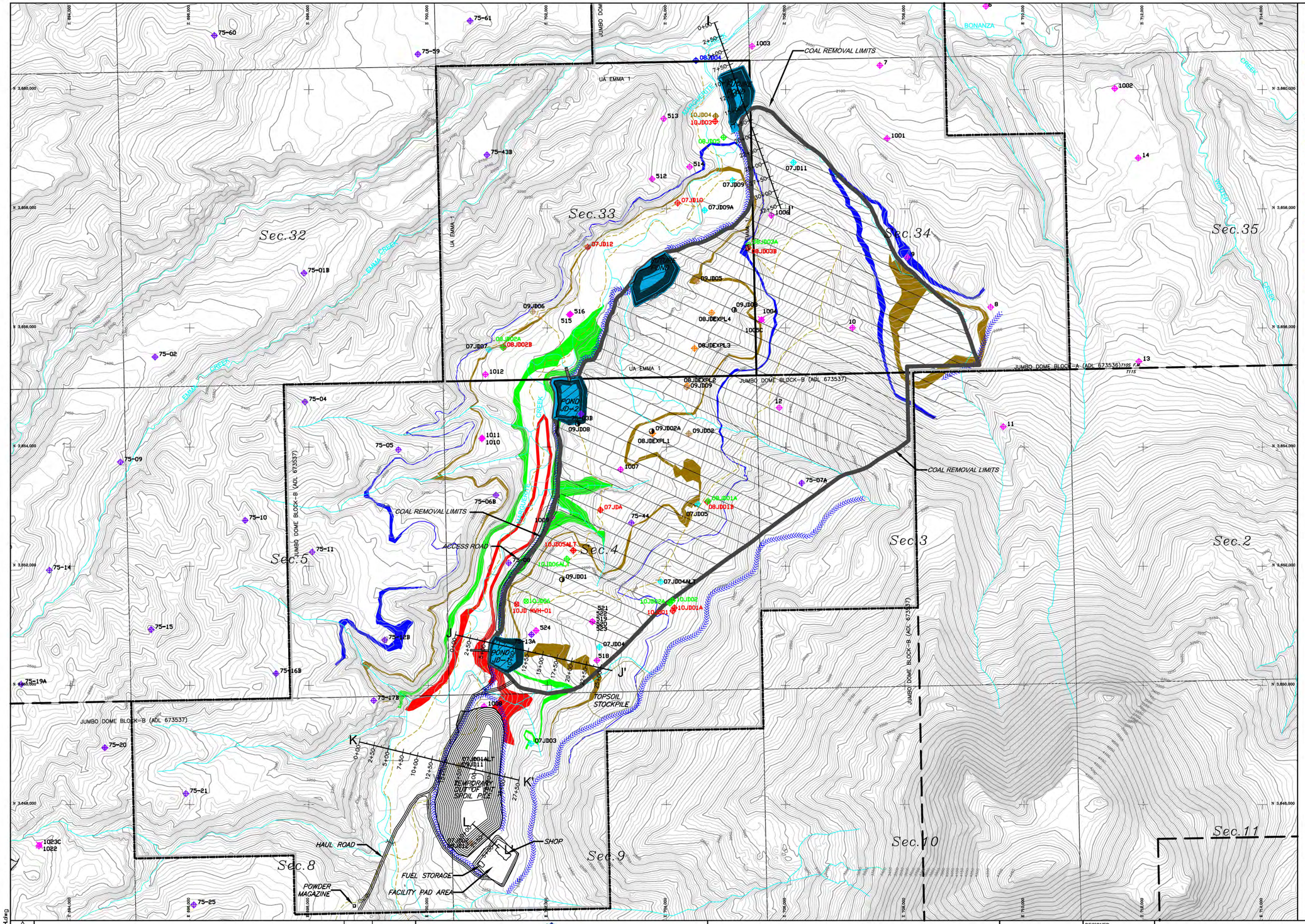
JUMBO DOME GEOTECHNICAL PROFILES

REVISION 0

PROJECT NO.

DRAWING JD-GEO-2

SHEET 3 OF 3



LEGEND

- 6-SEAM OUTCROP
- 5-SEAM OUTCROP
- 4-SEAM OUTCROP
- 3-SEAM OUTCROP
- ORIGINAL TOPOGRAPHY
- POND DESIGN TOPOGRAPHY
- SPOIL PILE DESIGN TOPOGRAPHY
- COAL REMOVAL LIMITS
- NATURAL DRAINAGE
- DIVERSION DITCH
- TRAIL
- LEASE BOUNDARY
- PERMIT BOUNDARY
- 07JD12 — 3 SEAM WELL
- 08JD05 — 4 SEAM WELL
- 10JD04 — 5 SEAM WELL
- 08JD05 — 6 SEAM WELL
- 1007 — AMAX 1974 DRILL HOLE
- 75-44 — AMAX 1975 DRILL HOLE
- 07JD05 — UCM 2007 DRILL HOLE
- 08JDEXPL8 — UCM 2008 DRILL HOLE
- 09JD02 — UCM 2009 DRILL HOLE
- 09JD01 — BOREHOLE USED FOR OVERBURDEN AND INTERBURDEN SAMPLING

N

SCALE

800' 0 800' 1600'

CONTOUR INTERVAL: 10 FT

NOTES:

1. HORIZONTAL DATUM IS BASED ON ALASKA STATE PLANE COORDINATES, ZONE-4, NAD 27, AS EXPRESSED IN U.S. SURVEY FEET.
2. VERTICAL DATUM IS BASED ON MEAN SEA LEVEL.

REV	DESCRIPTION OF REVISION	BY	DATE
1	REVISION 1	RLM	2/11
0	DRAFT	RLM	12/09

AutoCAD FILE: JD_GEOTECH.dwg

UCM — USIBELLI COAL MINE, INC.

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EVERGREEN, CO 80439
(303) 241-2057

WARNING
0 0.5 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED	
DRAWN	RLM
CHECKED	AJH
REVIEWED	
CLIENT	
DATE	2/17/11

USIBELLI COAL MINE

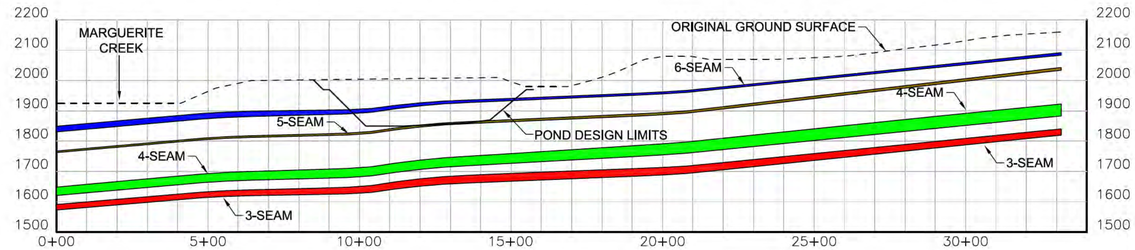
JUMBO DOME GEOTECHNICAL PROFILE AND CROSS-SECTION LOCATIONS

REVISION 1

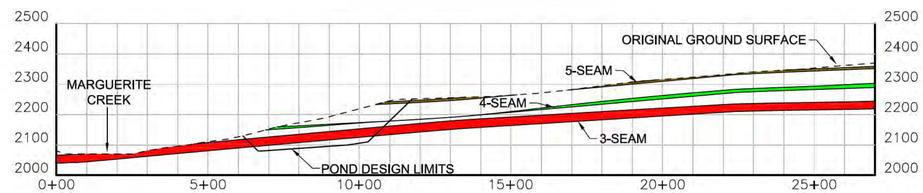
PROJECT NO.

DRAWING JD-GEO-3

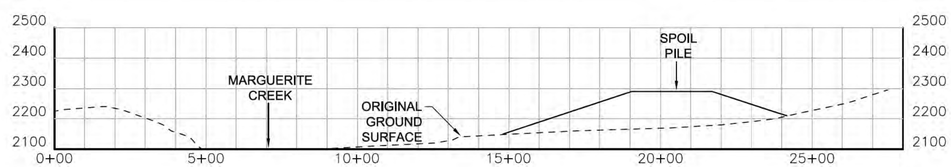
SHEET 1 OF 2



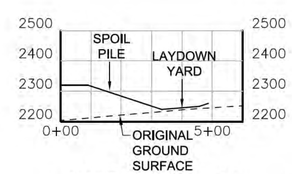
PROFILE I - I'



PROFILE J - J'



PROFILE K - K'



PROFILE L - L'

LEGEND

- 6-SEAM OUTCROP
- 5-SEAM OUTCROP
- 4-SEAM OUTCROP
- 3-SEAM OUTCROP
- ORIGINAL GROUND SURFACE
- HIGHWALL LOCATION (APPROXIMATE)

SCALE

250' 0 250' 500'

CONTOUR INTERVAL: N/A

NOTES:

1. HORIZONTAL DATUM IS BASED ON ALASKA STATE PLANE COORDINATES, ZONE-4, NAD 27, AS EXPRESSED IN U.S. SURVEY FEET.
2. VERTICAL DATUM IS BASED ON MEAN SEA LEVEL.

REV	DESCRIPTION OF REVISION	BY	DATE
1	REVISION 1	RLM	2/11
0	DRAFT	RLM	12/09

UCM USIBELLI COAL MINE, INC.

AJAX
28828 CEDAR CIRCLE
EVERGREEN, CO 80439
(303) 241-2057

WARNING
0 0.5 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED	
DRAWN	RLM
CHECKED	AJH
REVIEWED	
CLIENT	
DATE	2/17/11

USIBELLI COAL MINE

JUMBO DOME GEOTECHNICAL PROFILES

REVISION 1

PROJECT NO.

DRAWING JD-GEO-3

SHEET 2 OF 2

AutoCAD FILE: JD_GEOTECH.dwg

APPENDICES

APPENDIX A
GEOTECHNICAL DRILLHOLE LOGS
(Out of Pit Spoil Pile Location)

Location: UCM, Healy, AK
Recorded By: Alec Venechuk
Drilling Company: Tester Drilling Services, Inc.
Driller Name: Pete Tester
Drilling Method: Hollow-Stem Auger

Surface Elevation: 2160
Northing: 3648650
Easting: 700513.30
Total Depth: 31'
Start Date /Time: 9/1/09 / 11:00 a.m.
Completion Date /Time: 9/1/09 / 3:10 p.m.

SUBSURFACE PROFILE			SAMPLE				
Depth (ft)	Soil	Soil Description	USCS	Type	SPT blows	Moisture Content (%)	Comments
0		Organic silt; permafrost.	MH				
		Med. grain sand to clays present; Suntrana Formation.	SC	SPT	71		Some bits of coal present, loosely packed, frozen.
10		Med. grain sand to clays.	SC	SPT	68		Some bits of coal, loosely packed, frozen.
		Sleeves: 3.1; 20/50+ impen Med. sand to clay first 6", then coarse gravels are encountered.	GM	SPT			After 6", ground becomes impenetrable.
20		Sleeves: 4.1; 38/impen Pebbly coarse sand, some fines.	GM	SPT			Gravel is hard and coarse until 19', then loosens up.
		Sleeves: 5.1, 5.2; 25/50+ Med. to fine sand.	SW	SPT	75+		First 6" sandstone's well, then ground hardens up again. Frozen ground, no gravel.
30		Sleeves: 6.1; 15/75+ Med. to fine sand. Material is coarsening, would not drive any farther.	SW	SPT			Frozen ground, material is coarsening into fine gravel.
40							

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, Alaska 99743
(907) 683-2226

Log Drafted By: AJAX Ltd.
Filename:
Checked By: AJH

Location: UCM, Healy, AK
Recorded By: Alec Venechuk
Drilling Company: Tester Dilling Services, Inc.
Driller Name: Pete Tester
Drilling Method: Hollow-Stem Suger

Surface Elevation: 2214.50
Northing: 3647346
Easting: 700731
Total Depth: 50'
Start Date /Time: 09/02/09
Completion Date /Time: 09/02/09 / 1:00 p.m.

SUBSURFACE PROFILE			SAMPLE				
Depth (ft)	Soil	Soil Description	USCS	Type	SPT blows	Moisture Content (%)	Comments
0		Organic silt, no permafrost.	MH				
		Med-Fine sand, quartz, b. chert, some brown material	SW	SPT	11		Driven 18", only recovered 12"
10		Organic silt on top, overall ,material a fine silt with melns, sanctuary?	MH	SPT	16		
		Coarse pebbles, sand, JD Tallus angular grains	GP	SPT	40		12" recovered.
20		Fine sand to silt, Tsn pkg	SM	SPT	55		12" recovered.
		Top 12" Sandstone. Last 6" fines sand to schist.	GW	SPT	38		
		White schist					Hard, cold, not frozen, auger falls through schist
30		Schist		SPT	84+		
		Schist		SPT	34		Schist, graphitic/micacous, 12" recovered
40							

Usibelli Coal Mine, Inc.
P.O. Box 1000
Healy, Alaska 99743
(907) 683-2226

Log Drafted By: AJAX Ltd.
Filename:
Checked By: AJH

APPENDIX B
LABORATORY TEST RESULTS

UCM - Jumbo Dome Mine Permit
GEOTECHNICAL LAB TESTING RESULTS 2007-9

Borehole No.	Sample Depth (feet)	Geologic Unit	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Dry Density (pcf)	Wet Density (pcf)	USCS Classification			Full Sieve Analysis						Direct Shear-PEAK		Direct Shear-RESID.		USCS Symbol	Lab Descr.
									Fines %	Sand %	Gravel %	#200	#40	#10	#4	3/4"	3"	Fr. Angle (deg)	Cohesion (psf)	Fr. Angle (deg)	Cohesion (psf)		
4SBS-08	Trench	4 Seam Overburden	15.5	NP	NP	NP			26.3	73.7	0.0	26.3			73.7		0.0					SM	Silty SAND
07JDA	83-118	4/3 Interburden	3.4						31.5	99.2	0.0	31.5	80.5	98.0	99.2	100.0	100.0					SM	Silty SAND
07JD07	10-28	4 Seam Overburden	0.8						2.8	38.1	0.0	2.8	6.1	15.4	38.1	92.6	100.0					GS	Sandy GRAVEL
08JD02B	77-82	4 Seam Overburden		NP	NP	NP			25.5	74.5	0.0	25.5			74.5		0.0					SM	Silty SAND
	82-92	4 Seam Overburden	0.9						16.8	99.5	0.0	16.8	41.1	92.2	99.5	100.0	100.0					SM	Silty SAND
	127-132	4 Seam Footwall	60.6	44.9	22.9	22.0			88.9	11.2	0.0	88.9			11.2		0.0					CL	Lean CLAY
	152-162	4/3 Interburden	0.8						4.8	93.4	0.0	4.8	25.0	79.3	93.4	98.8	100.0					SW	Well-graded SAND
	193-196	3 Seam Footwall	36.0	49.7	16.7	33.0																CL	Silty CLAY
08JD03B	193-196	6/4 Interburden	62.8	81.1	16.6	34.5			94.4	5.6	0.0	94.4			5.6		0.0					CL/CH	Fat CLAY
	238-242 (a)	4 Seam Footwall	31.6	47.8	22.6	25.2			98.6	1.4	0.0	98.6			1.4		0.0					CL	Lean CLAY
	238-242 (b)	4 Seam Footwall	23.2	46.0	24.1	21.9																CL	Lean CLAY
	296-298	3 Seam Footwall	37.4	47.3	26.2	21.1																CL	Silty CLAY *
SCHIST-1	Surface	Schist		21.9	11.8	10.1			57.9	42.1	0.0	57.9			42.1		0.0					CL	Sandy Lean CLAY
SCHIST-2	Surface	Schist	18.5	NP	NP	NP			19.7	80.3	0.0	19.7			80.3		0.0					SM	Silty SAND
09JD03	104-105.5	4 Seam Footwall	15.7	49.8	19.8	29.8	119.0	136.5														CL	Silty CLAY *
	110-110.5	4/3 Interburden	31.6	31.8	23.4	8.1	88.4	116.3														ML	Clayey SILT
	115-115.5	4/3 Interburden	22.5	45.1	31.2	13.9	100.4	123.0														ML	Clayey SILT
	120-120.5	4/3 Interburden	17.1	27.8	21.0	6.8	113.5	132.9														CL-ML	CLAY and SILT
	168.5-169	3 Seam Footwall	16.1	38.7	20.9	17.8	113.6	131.9										30.4	2787.6	25.0	504.3	CL	Silty CLAY *
09JD05	165-166 **	4 Seam Footwall		55.0	24.0	31.0																CL	Lean CLAY
	179-188	4/3 Interburden	19.8						28.3	98.9	0.0	28.3	93.4	88.0	98.9	100.0	100.0					SM	Silty SAND
	222-223	3 Seam Footwall	14.8	44.4	22.3	22.1	115.5	132.4										29.9	3403.4	35.1	0.0	CL	Silty CLAY
09JD09	68 **	4 Seam Footwall		61.0	25.0	36.0																CL	Lean CLAY
	88-90	4/3 Interburden	20.2																			SM	Silty SAND
	132.5-134.5	3 Seam Footwall	15.3	48.8	24.6	24.2	115.2	132.8										32.8	178.1	18.8	1620.6	CL	Silty CLAY
09JD11	5-5.5	Sand	44.2	NP	NP	NP	77.3	111.5														Sand	Sand
	5.5-6	Sandy Clay	60.0				81.2	97.9														CL	Sandy Clay
	6-6.5	Sand	53.7	NP	NP	NP																Sand	Sand
	10-10.5	Sand	52.7	NP	NP	NP	85.0	99.3														Sand	Sand
	10.5-11	Sand	34.9	NP	NP	NP	94.6	127.6														Sand	Sand
	11-11.5	Sand	34.9	NP	NP	NP	80.6	108.7														Sand	Sand
	15-15.5	Sandy Clay	26.3				64.0	80.8														CL	Sandy Clay
	20-20.5	Sand	17.2				100.1	117.3														Sand	Sand
	25-25.5	Sand	15.8				100.8	116.7														Sand	Sand
	30-30.5	Sand	13.3				106.8	121.0														Sand	Sand
09JD12	10-10.5	Sand	19.8				110.3	132.1														Sand	Sand
	10.5-11	Sandy Clay	57.3				59.7	93.9														CL	Sandy Clay
	40-40.5	Schist	10.8				128.2	142.0														Schist	Schist
	45-45.5	Schist	10.1				122.0	134.3										30.1	337.5	30.2	284	Schist	Schist
	50-50.5	Schist	15.7				126.4	146.2														Schist	Schist

Notes:
All lab results by Advanced Terra Testing, Lakewood, CO, with the following exceptions:
* Classification by Energy Labs, Billings, MT
** Testing by Shannon & Wilson, Fairbanks, AK

USCS CLASSIFICATION
ASTM D 2487

CALCULATION WORKSHEET
USCS Classification
D 2487

CLIENT	Ajax	JOB NO.	2692-03
BORING NO.	08JD03B	SAMPLED	
DEPTH	193.0-196.0'	DATE TESTED	08-01-08 TMR
SAMPLE NO.		WASH SIEVE	Yes
SOIL DESCR.	Jumbo Dome	DRY SIEVE	No
LOCATION	Usibelli Coal Mine, AK		

ATTERBERG CLASSIFICATION: CH

% Gravel =	0.00
% Sand =	5.57
% Fines =	94.43

D60 =	N/A
D30 =	N/A
D10 =	N/A

Cu =	N/A
Cc =	N/A

Classification = CH, Fat clay

Data entered by: SR
Data checked by: BKL
FileName: AJSUD03B

Date: 08/05/2008
Date: 8.7.08

ADVANCED TERRA TESTING, INC. ATT

CALCULATION WORKSHEET
USCS Classification
D 2487

CLIENT	Ajax	JOB NO.	2692-03
BORING NO.	08JD03B	SAMPLED	
DEPTH	238.0-242.0'	DATE TESTED	07-31-08 TMR
SAMPLE NO.	Footwall Clay	WASH SIEVE	Yes
SOIL DESCR.	Jumbo Dome	DRY SIEVE	No
LOCATION	Usibelli Coal Mine, AK		

ATTERBERG CLASSIFICATION: CL

% Gravel =	0.00
% Sand =	1.42
% Fines =	98.58

D60 =	N/A
D30 =	N/A
D10 =	N/A

Cu =	N/A
Cc =	N/A

Classification = CL, Lean Clay

Data entered by: SR
Data checked by: BW
FileName: AJSU2382

Date:
Date: 8.7.08

08/07/2008

ADVANCED TERRA TESTING, INC. ATT

CALCULATION WORKSHEET
USCS Classification
D 2487

CLIENT	Ajax	JOB NO.	2692-03
BORING NO.	08JD02B	SAMPLED	
DEPTH	77.0-82.0'	DATE TESTED	07-30-08 TMR
SAMPLE NO.	0B	WASH SIEVE	Yes
SOIL DESCR.	Jumbo Dome	DRY SIEVE	No
LOCATION	Usibelli Coal Mine, AK		

ATTERBERG CLASSIFICATION: ML

% Gravel =	0.00
% Sand =	74.48
% Fines =	25.52

D60 =	N/A
D30 =	N/A
D10 =	N/A

Cu =	N/A
Cc =	N/A

Classification = SM, Silty sand

Data entered by: SR
Data checked by: BKL
FileName: AJMUD02B

Date: 08/05/2008
Date: 8-7-08

ADVANCED TERRA TESTING, INC. ATT

CALCULATION WORKSHEET
USCS Classification
D 2487

CLIENT	Ajax	JOB NO.	2692-03
BORING NO.	08JD02B	SAMPLED	
DEPTH	127.0-132.0'	DATE TESTED	08-01-08 TMR
SAMPLE NO.	IB	WASH SIEVE	Yes
SOIL DESCR.	Jumbo Dome	DRY SIEVE	No
LOCATION	Usibelli Coal Mine, AK		

ATTERBERG CLASSIFICATION: CL

% Gravel =	0.00
% Sand =	11.15
% Fines =	88.85

D60 =	N/A
D30 =	N/A
D10 =	N/A

Cu =	N/A
Cc =	N/A

Classification = CL, Lean Clay

Data entered by: SR
Data checked by: BKL
FileName: AJSU1271

Date: 08/06/2008
Date: 8.7.08

ADVANCED TERRA TESTING, INC. ATT

CALCULATION WORKSHEET
USCS Classification
D 2487

CLIENT	Ajax	JOB NO.	2692-03
BORING NO.	4SBS-OB	SAMPLED	
DEPTH	Trench	DATE TESTED	08-01-08 TMR
SAMPLE NO.		WASH SIEVE	Yes
SOIL DESCR.	Jumbo Dome	DRY SIEVE	No
LOCATION	Usibelli Coal Mine, AK		

ATTERBERG CLASSIFICATION: ML

% Gravel =	0.00
% Sand =	73.73
% Fines =	26.27

D60 =	N/A
D30 =	N/A
D10 =	N/A

Cu =	N/A
Cc =	N/A

Classification = SM, Silty sand

Data entered by: SR
Data checked by: BCL
FileName: AJSUB4OB

Date: 08/07/2008
Date: 8·7·08

ADVANCED TERRA TESTING, INC. ATT

CALCULATION WORKSHEET
USCS Classification
D 2487

CLIENT	Ajax	JOB NO.	2692-03
BORING NO.	Schist - 1	SAMPLED	
DEPTH	Surface	DATE TESTED	08-01-08 TMR
SAMPLE NO.		WASH SIEVE	Yes
SOIL DESCR.	Jumbo Dome	DRY SIEVE	No
LOCATION	Usibelli Coal Mine, AK		

ATTERBERG CLASSIFICATION: CL

% Gravel =	0.00
% Sand =	42.06
% Fines =	57.94

D60 =	N/A
D30 =	N/A
D10 =	N/A

Cu =	N/A
Cc =	N/A

Classification = CL, Sandy lean clay

Data entered by: SR
Data checked by: BKL
FileName: AJSUSCH1

Date: 08/05/2008
Date: 8.7.08

ADVANCED TERRA TESTING, INC. ATT

CALCULATION WORKSHEET
USCS Classification
D 2487

CLIENT	Ajax	JOB NO.	2692-03
BORING NO.	Schist - 2	SAMPLED	
DEPTH	Surface	DATE TESTED	08-01-08 TMR
SAMPLE NO.		WASH SIEVE	Yes
SOIL DESCR.	Jumbo Dome	DRY SIEVE	No
LOCATION	Usibelli Coal Mine, AK		

ATTERBERG CLASSIFICATION: ML

% Gravel =	0.00
% Sand =	80.27
% Fines =	19.73

D60 =	N/A
D30 =	N/A
D10 =	N/A

Cu =	N/A
Cc =	N/A

Classification = SM, Silty sand

Data entered by: SR
Data checked by: BKL
FileName: AJSUSCH2

Date: 08/05/2008
Date: 8-7-08

ADVANCED TERRA TESTING, INC. ATT

MOISTURE & DENSITY
ASTM D 2216 & 2937

Moisture Content Determinations
ASTM D 2216

CLIENT: Ajax Ltd.
LOCATION: UCM, Jumbo Dome

JOB NO.: 2692-14

BORING	08JD03B	08JD02B	08JD03B
SAMPLE DEPTH	296.0-298.0	193.0-196.0	238.0-242.0
SAMPLE NO.			
DATE SAMPLED			
DATE TESTED	09/05/09 WAR	09/05/09 WAR	09/05/09 WAR
SOIL DESCRIPTION			
MOISTURE DETERMINATIONS			
Wt. of Wet Soil & Dish (gms)	113.16	119.17	142.12
Wt. of Dry Soil & Dish (gms)	83.25	88.45	116.06
Net Loss of Moisture (gms)	29.91	30.72	26.06
Wt. of Dish (gms)	3.29	3.13	3.77
Wt. of Dry Soil (gms)	79.96	85.32	112.29
Moisture Content (%)	37.4	36.0	23.2

Data entered by: MLM Date: 09/08/2009
Data checked by: BKL Date: 9/9/09
FileName: AJN00302

Moisture & Density Determinations
ASTM D 2216 & D 2937

CLIENT: Ajax Ltd.
LOCATION: UCM, Jumbo Dome

JOB NO.: 2692-14

BORING	09JD03	09JD03	09JD03	09JD03
SAMPLE DEPTH	110.0-110.5'	115.0-115.5'	120.0-120.5'	104.0-105.5'
SAMPLE NO.				
DATE SAMPLED		07/17/09	07/18/09	
DATE TESTED	09/14/09 MLM	09/14/09 MLM	09/14/09 MLM	09/14/09 MLM
SOIL DESCRIPTION				
DENSITY DETERMINATIONS				
Sample Height (IN)	5.119	5.000	5.000	5.000
Sample Diameter (IN)	1.408	1.408	1.408	1.408
Wt of Wet Soil (GMs)	243.58	251.31	271.45	279.11
Sample Volume (CU Ft)	0.00461	0.00451	0.00451	0.00451
WET DENSITY (PCF)	116.4	123.0	132.8	136.6
DRY DENSITY (PCF)	88.4	100.4	113.5	118.0
MOISTURE DETERMINATIONS				
Wt. of Wet Soil & Dish (gms)	242.72	60.58	284.83	292.80
Wt. of Dry Soil & Dish (gms)	186.37	50.97	245.32	254.93
Net Loss of Moisture (gms)	56.35	9.61	39.51	37.87
Wt. of Dish (gms)	8.21	8.29	13.96	14.20
Wt. of Dry Soil (gms)	178.16	42.68	231.36	240.73
Moisture Content (%)	31.6	22.5	17.1	15.7

BORING	09JD09
SAMPLE DEPTH	88.0-90.0'
SAMPLE NO.	
DATE SAMPLED	
DATE TESTED	09/14/09 MLM
SOIL DESCRIPTION	
DENSITY DETERMINATIONS	
Sample Height (IN)	
Sample Diameter (IN)	
Wt of Wet Soil (GMs)	
Sample Volume (CU Ft)	
WET DENSITY (PCF)	
DRY DENSITY (PCF)	
MOISTURE DETERMINATIONS	
Wt. of Wet Soil & Dish (gms)	444.61
Wt. of Dry Soil & Dish (gms)	371.12
Net Loss of Moisture (gms)	73.49
Wt. of Dish (gms)	8.12
Wt. of Dry Soil (gms)	363.00
Moisture Content (%)	20.2

Data entered by: MLM
Data checked by: TMR
FileName: AJMDD039

Date: 09/15/2009

Date: 9/16/09

ADVANCED TERRA TESTING, INC. ATT

Moisture & Density Determinations
ASTM D 2216 & D 2937

CLIENT: Ajax Ltd.
LOCATION: Usibelli Coal Mine, Jumbo Dome

JOB NO.: 2692-16

BORING	09JD12	09JD12	09JD12	09JD12
SAMPLE DEPTH	10.0-10.5'	10.5-11.0'	40.0-40.5'	45.0-45.5'
SAMPLE NO.	2.1	2.2	8.1	9.1
DATE SAMPLED				
DATE TESTED	10/17/09 LB	10/17/09 LB	10/17/09 LB	10/17/09 LB
SOIL DESCRIPTION				
DENSITY DETERMINATIONS				
Sample Height (IN)	0.662	0.806	0.958	0.939
Sample Diameter (IN)	1.392	1.403	1.384	1.399
Wt of Wet Soil (GMs)	34.95	30.74	53.74	50.87
Sample Volume (CU Ft)	0.00058	0.00072	0.00083	0.00084
WET DENSITY (PCF)	132.2	94.0	142.0	134.3
DRY DENSITY (PCF)	110.3	59.7	128.2	122.0
MOISTURE DETERMINATIONS				
Wt. of Wet Soil & Dish (gms)	36.73	32.52	55.51	52.64
Wt. of Dry Soil & Dish (gms)	30.94	21.32	50.27	47.97
Net Loss of Moisture (gms)	5.78	11.20	5.24	4.67
Wt. of Dish (gms)	1.77	1.78	1.77	1.76
Wt. of Dry Soil (gms)	29.17	19.54	48.50	46.21
Moisture Content (%)	19.8	57.3	10.8	10.1

BORING	09JD12	09JD11	09JD11	09JD11
SAMPLE DEPTH	50.0-50.5'	5.0-5.5'	5.5-6.0'	6.0-6.5'
SAMPLE NO.	10.1	1.1	1.2	1.3
DATE SAMPLED				
DATE TESTED	10/17/09 LB	10/15/09 LB	10/15/09 LB	10/15/09 LB
SOIL DESCRIPTION				
DENSITY DETERMINATIONS				
Sample Height (IN)	0.638	0.650	1.286	
Sample Diameter (IN)	1.403	1.398	1.400	Density not possible
Wt of Wet Soil (GMs)	37.89	29.20	50.85	
Sample Volume (CU Ft)	0.00057	0.00058	0.00115	
WET DENSITY (PCF)	146.3	111.5	97.9	
DRY DENSITY (PCF)	126.4	77.3	61.2	
MOISTURE DETERMINATIONS				
Wt. of Wet Soil & Dish (gms)	39.64	31.00	52.61	33.28
Wt. of Dry Soil & Dish (gms)	34.48	22.04	33.55	22.27
Net Loss of Moisture (gms)	5.16	8.95	19.06	11.01
Wt. of Dish (gms)	1.75	1.79	1.76	1.78
Wt. of Dry Soil (gms)	32.74	20.25	31.79	20.48
Moisture Content (%)	15.7	44.2	60.0	53.7

Data entered by: MLM Date: 10/19/2009
Data checked by: LB Date: 10/20/09
FileName: AJMDJD12

ADVANCED TERRA TESTING, INC. ATT

Moisture & Density Determinations
ASTM D 2216 & D 2937

CLIENT: Ajax Ltd.
LOCATION: Usibelli Coal Mine, Jumbo Dome

JOB NO.: 2692-16

BORING	09JD11	09JD11	09JD11
SAMPLE DEPTH	10.0-10.5'	10.5-11.0'	11.0-11.5'
SAMPLE NO.	2.1	2.2	2.3
DATE SAMPLED			
DATE TESTED	10/17/09 LB	10/17/09 LB	10/17/09 LB
SOIL DESCRIPTION			
DENSITY DETERMINATIONS			
Sample Height (IN)	0.962	0.675	0.848
Sample Diameter (IN)	1.408	1.409	1.413
Wt of Wet Soil (GMs)	39.04	35.25	37.95
Sample Volume (CU Ft)	0.00087	0.00061	0.00077
WET DENSITY (PCF)	99.3	127.6	108.7
DRY DENSITY (PCF)	65.0	94.6	80.6
MOISTURE DETERMINATIONS			
Wt. of Wet Soil & Dish (gms)	40.83	36.99	39.72
Wt. of Dry Soil & Dish (gms)	27.36	27.86	29.90
Net Loss of Moisture (gms)	13.47	9.13	9.82
Wt. of Dish (gms)	1.79	1.74	1.78
Wt. of Dry Soil (gms)	25.57	26.12	28.12
Moisture Content (%)	52.7	34.9	34.9

Data entered by: MLM Date: 10/19/2009
Data checked by: LB Date: 10/20/09
FileName: AJMD11JD

ADVANCED TERRA TESTING, INC. ATT

Moisture & Density Determinations
ASTM D 2216 & D 2937

CLIENT: Ajax Ltd.
LOCATION: Usibelli Coal Mine, Jumbo Dome

JOB NO.: 2692-16

BORING	09JD11	09JD11	09JD11	09JD11
SAMPLE DEPTH	30.0-30.5	15.0-15.5	25.0-25.5	20.0-20.5
SAMPLE NO.	6.1	3.1	5.1	4.1
DATE SAMPLED				
DATE TESTED	10/14/09 TMR	10/14/09 TMR	10/14/09 TMR	10/14/09 TMR
SOIL DESCRIPTION				
DENSITY DETERMINATIONS				
Sample Height (IN)	5.000	6.000	5.000	5.000
Sample Diameter (IN)	1.420	1.420	1.420	1.420
Wt of Wet Soil (GMs)	251.51	201.62	243.74	242.80
Sample Volume (CU Ft)	0.00458	0.00550	0.00458	0.00458
WET DENSITY (PCF)	121.0	80.8	117.3	116.8
DRY DENSITY (PCF)	106.8	64.0	100.1	100.8
MOISTURE DETERMINATIONS				
Wt. of Wet Soil & Dish (gms)	277.57	208.91	280.98	265.70
Wt. of Dry Soil & Dish (gms)	245.92	167.15	240.75	230.32
Net Loss of Moisture (gms)	31.65	41.76	40.23	35.38
Wt. of Dish (gms)	8.12	8.17	6.75	6.86
Wt. of Dry Soil (gms)	237.80	158.98	234.00	223.46
Moisture Content (%)	13.3	26.3	17.2	15.8

Data entered by: MLM
Data checked by: LB
FileName: AJMDJD11

Date: 10/20/09

Date: 10/15/2009

ADVANCED TERRA TESTING, INC. ATT

Moisture & Density Determinations
ASTM D 2216 & D 2937

CLIENT: Ajax Ltd.
LOCATION: Usibelli Coal Mine, Jumbo Dome

JOB NO.: 2692-16

BORING	09JD12	09JD12	09JD12	09JD12
SAMPLE DEPTH	15.5-16.0'	5.5-6.0'	20.5-21.0'	35.5-36.0'
SAMPLE NO.	3.2	1.2	4.2	7.2
DATE SAMPLED				
DATE TESTED	10/12/09 TMR	10/12/09 TMR	10/12/09 TMR	10/12/09 TMR
SOIL DESCRIPTION				
DENSITY DETERMINATIONS				
Sample Height (IN)	1.420	1.420	1.420	1.420
Sample Diameter (IN)	6.000	6.000	6.000	6.000
Wt of Wet Soil (GMs)	274.95	232.17	313.99	357.27
Sample Volume (CU Ft)	0.02323	0.02323	0.02323	0.02323
WET DENSITY (PCF)	26.1	22.0	29.8	33.9
DRY DENSITY (PCF)	23.7	18.7	26.3	29.7
MOISTURE DETERMINATIONS				
Wt. of Wet Soil & Dish (gms)	281.76	238.72	320.04	365.73
Wt. of Dry Soil & Dish (gms)	256.73	203.25	283.59	321.45
Net Loss of Moisture (gms)	25.03	35.47	36.45	44.28
Wt. of Dish (gms)	8.12	6.73	6.71	8.25
Wt. of Dry Soil (gms)	248.61	196.52	276.88	313.20
Moisture Content (%)	10.1	18.0	13.2	14.1

Data entered by: MLM Date: 10/13/2009
Data checked by: LB Date: 10-15-09
FileName: AJMD09JD

ADVANCED TERRA TESTING, INC. ATT

MECHANICAL ANALYSIS
ASTM D 1140
MOISTURE & DENSITY
ASTM D 2216

MECHANICAL ANALYSIS - SIEVE TEST DATA - ASTM D 1140
MOISTURE AND DENSITY DETERMINATIONS - ASTM D 2216

CLIENT Ajax

JOB NO. 2692-03

BORING NO.	08JD03B
DEPTH	193.0-196.0'
SAMPLE NO.	
SOIL DESCR.	Jumbo Dome
LOCATION	Usibelli Coal Mine, AK

SAMPLED	
DATE TESTED	08-01-08 TMR
WASH SIEVE	Yes
DRY SIEVE	No

MOISTURE DATA

Wt. Wet Soil & Pan (g)	551.2
Wt. Dry Soil & Pan (g)	345.4
Wt. Lost Moisture (g)	205.8
Wt. of Pan Only (g)	16.0
Wt. of Dry Soil (g)	329.4
Moisture Content %	62.5

WASH SIEVE ANALYSIS

Wt. Wet Soil & Pan Before Washing (g)	551.2
Wt. Dry Soil & Pan Before Washing (g)	345.4
Weight of Pan (g)	16.0
Wt. of Dry Soil Before Washing	329.4
Wt. Dry Soil & Pan After Washing (g)	34.4
Wt. of Dry Soil After Washing (g)	18.4
-#200 Wash. Out %	94.4

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
#200	16.04	34.40	18.36	18.36	5.6	94.4

Data entered by: SR Date: 08/05/2008
Data checked by: BKL Date: 8-7-08
FileName: AJSUD03B

ATT

MECHANICAL ANALYSIS - SIEVE TEST DATA - ASTM D 1140
MOISTURE AND DENSITY DETERMINATIONS - ASTM D 2216

CLIENT Ajax

JOB NO. 2692-03

BORING NO.	08JD03B
DEPTH	238.0-242.0'
SAMPLE NO.	Footwall Clay
SOIL DESCR.	Jumbo Dome
LOCATION	Usibelli Coal Mine, AK

SAMPLED	
DATE TESTED	07-31-08 TMR
WASH SIEVE	Yes
DRY SIEVE	No

MOISTURE DATA

Wt. Wet Soil & Pan (g)	470.7
Wt. Dry Soil & Pan (g)	361.1
Wt. Lost Moisture (g)	109.6
Wt. of Pan Only (g)	14.2
Wt. of Dry Soil (g)	347.0
Moisture Content %	31.6

WASH SIEVE ANALYSIS

Wt. Wet Soil & Pan Before Washing (g)	470.7
Wt. Dry Soil & Pan Before Washing (g)	361.1
Weight of Pan (g)	14.2
Wt. of Dry Soil Before Washing	347.0
Wt. Dry Soil & Pan After Washing (g)	19.1
Wt. of Dry Soil After Washing (g)	4.9
-#200 Wash. Out %	98.6

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
#200	14.16	19.07	4.91	4.91	1.4	98.6

Data entered by: SR Date: 08/07/2008
Data checked by: BKL Date: 8.7.08
FileName: AJSU2382

MECHANICAL ANALYSIS - SIEVE TEST DATA - ASTM D 1140
MOISTURE AND DENSITY DETERMINATIONS - ASTM D 2216 & ASTM D 2937

CLIENT Ajax

JOB NO. 2692-03

BORING NO.	08JD02B
DEPTH	77.0-82.0'
SAMPLE NO.	0B
SOIL DESCR.	Jumbo Dome
LOCATION	Usibelli Coal Mine, AK

SAMPLED	
DATE TESTED	07-30-08 TMR
WASH SIEVE	Yes
DRY SIEVE	No

WASH SIEVE ANALYSIS

Wt. Wet Soil & Pan Before Washing (g)	663.4
Wt. Dry Soil & Pan Before Washing (g)	600.0
Weight of Pan (g)	14.0
Wt. of Dry Soil Before Washing	586.1
Wt. Dry Soil & Pan After Washing (g)	450.5
Wt. of Dry Soil After Washing (g)	436.5
-#200 Wash. Out %	25.5

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
#200	13.98	450.49	436.51	436.51	74.5	25.5

Data entered by: SR Date: 08/05/2008
Data checked by: BKL Date: 8.7.08
FileName: AJMUD02B

MECHANICAL ANALYSIS - SIEVE TEST DATA - ASTM D 1140
MOISTURE AND DENSITY DETERMINATIONS - ASTM D 2216

CLIENT Ajax

JOB NO. 2692-03

BORING NO.	08JD02B
DEPTH	127.0-132.0'
SAMPLE NO.	IB
SOIL DESCR.	Jumbo Dome
LOCATION	Usibelli Coal Mine, AK

SAMPLED	
DATE TESTED	08-01-08 TMR
WASH SIEVE	Yes
DRY SIEVE	No

MOISTURE DATA

Wt. Wet Soil & Pan (g)	670.2
Wt. Dry Soil & Pan (g)	450.4
Wt. Lost Moisture (g)	219.9
Wt. of Pan Only (g)	15.0
Wt. of Dry Soil (g)	435.4
Moisture Content %	50.5

WASH SIEVE ANALYSIS

Wt. Wet Soil & Pan Before Washing (g)	670.2
Wt. Dry Soil & Pan Before Washing (g)	450.4
Weight of Pan (g)	15.0
Wt. of Dry Soil Before Washing	435.4
Wt. Dry Soil & Pan After Washing (g)	63.6
Wt. of Dry Soil After Washing (g)	48.6
-#200 Wash. Out %	88.8

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
#200	15.00	63.55	48.55	48.55	11.2	88.8

Data entered by: SR Date: 08/06/2008
Data checked by: KEL Date: 8.7.08
FileName: AJSU1271

MECHANICAL ANALYSIS - SIEVE TEST DATA - ASTM D 1140
MOISTURE AND DENSITY DETERMINATIONS - ASTM D 2216

CLIENT Ajax

JOB NO. 2692-03

BORING NO.	4SBS-OB
DEPTH	Trench
SAMPLE NO.	
SOIL DESCR.	Jumbo Dome
LOCATION	Usibelli Coal Mine, AK

SAMPLED	
DATE TESTED	08-01-08 TMR
WASH SIEVE	Yes
DRY SIEVE	No

MOISTURE DATA

Wt. Wet Soil & Pan (g)	504.1
Wt. Dry Soil & Pan (g)	438.5
Wt. Lost Moisture (g)	65.6
Wt. of Pan Only (g)	14.0
Wt. of Dry Soil (g)	424.5
Moisture Content %	15.5

WASH SIEVE ANALYSIS

Wt. Wet Soil & Pan Before Washing (g)	504.1
Wt. Dry Soil & Pan Before Washing (g)	438.5
Weight of Pan (g)	14.0
Wt. of Dry Soil Before Washing	424.5
Wt. Dry Soil & Pan After Washing (g)	327.0
Wt. of Dry Soil After Washing (g)	313.0
-#200 Wash. Out %	26.3

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
#200	14.01	326.96	312.95	312.95	73.7	26.3

Data entered by: SR
Data checked by: BKL
FileName: AJSUB4OB

Date: 08/07/2008
Date: 8.7.08

ADVANCED TERRA TESTING, INC. ATT

MECHANICAL ANALYSIS - SIEVE TEST DATA - ASTM D 1140
MOISTURE AND DENSITY DETERMINATIONS - ASTM D 2216

CLIENT Ajax

JOB NO. 2692-03

BORING NO.	Schist - 1
DEPTH	Surface
SAMPLE NO.	
SOIL DESCR.	Jumbo Dome
LOCATION	Usibelli Coal Mine, AK

SAMPLED	
DATE TESTED	08-01-08 TMR
WASH SIEVE	Yes
DRY SIEVE	No

MOISTURE DATA

Wt. Wet Soil & Pan (g)	1018.2
Wt. Dry Soil & Pan (g)	1004.5
Wt. Lost Moisture (g)	13.7
Wt. of Pan Only (g)	814.8
Wt. of Dry Soil (g)	189.7
Moisture Content %	7.2

WASH SIEVE ANALYSIS

Wt. Wet Soil & Pan Before Washing (g)	1018.2
Wt. Dry Soil & Pan Before Washing (g)	1004.5
Weight of Pan (g)	814.8
Wt. of Dry Soil Before Washing	189.7
Wt. Dry Soil & Pan After Washing (g)	894.6
Wt. of Dry Soil After Washing (g)	79.8
-#200 Wash. Out %	57.9

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
#200	814.83	894.60	79.77	79.77	42.1	57.9

Data entered by: SR
Data checked by: BK
FileName: AJSUSCH1

Date: 08/05/2008
Date: 8.7.08

ADVANCED TERRA TESTING, INC. ATT

MECHANICAL ANALYSIS - SIEVE TEST DATA - ASTM D 1140
MOISTURE AND DENSITY DETERMINATIONS - ASTM D 2216

CLIENT Ajax

JOB NO. 2692-03

BORING NO.	Schist - 2
DEPTH	Surface
SAMPLE NO.	
SOIL DESCR.	Jumbo Dome
LOCATION	Usibelli Coal Mine, AK

SAMPLED	
DATE TESTED	08-01-08 TMR
WASH SIEVE	Yes
DRY SIEVE	No

MOISTURE DATA

Wt. Wet Soil & Pan (g)	932.9
Wt. Dry Soil & Pan (g)	789.4
Wt. Lost Moisture (g)	143.4
Wt. of Pan Only (g)	15.6
Wt. of Dry Soil (g)	773.8
Moisture Content %	18.5

WASH SIEVE ANALYSIS

Wt. Wet Soil & Pan Before Washing (g)	932.9
Wt. Dry Soil & Pan Before Washing (g)	789.4
Weight of Pan (g)	15.6
Wt. of Dry Soil Before Washing	773.8
Wt. Dry Soil & Pan After Washing (g)	636.8
Wt. of Dry Soil After Washing (g)	621.1
-#200 Wash. Out %	19.7

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
#200	15.64	636.78	621.14	621.14	80.3	19.7

Data entered by: SR Date: 08/05/2008
Data checked by: BKL Date: 8.7.08
FileName: AJSUSCH2

MECHANICAL ANALYSIS
ASTM D 6913

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D-6913

CLIENT Ajax Ltd.

JOB NO. 2692-14

BORING NO. 09JD05
DEPTH 179.0-186.0'
SAMPLE NO.
SOIL DESCR.
LOCATION UCM, Jumbo Dome

SAMPLED
DATE TESTED 09/16/09 PW
WASH SIEVE Yes
DRY SIEVE No

MOISTURE DATA

Wt. Wet Soil & Pan (g)	1359.4
Wt. Dry Soil & Pan (g)	1303.9
Wt. Lost Moisture (g)	55.5
Wt. of Pan Only (g)	1024.0
Wt. of Dry Soil (g)	279.9
Moisture Content %	19.8

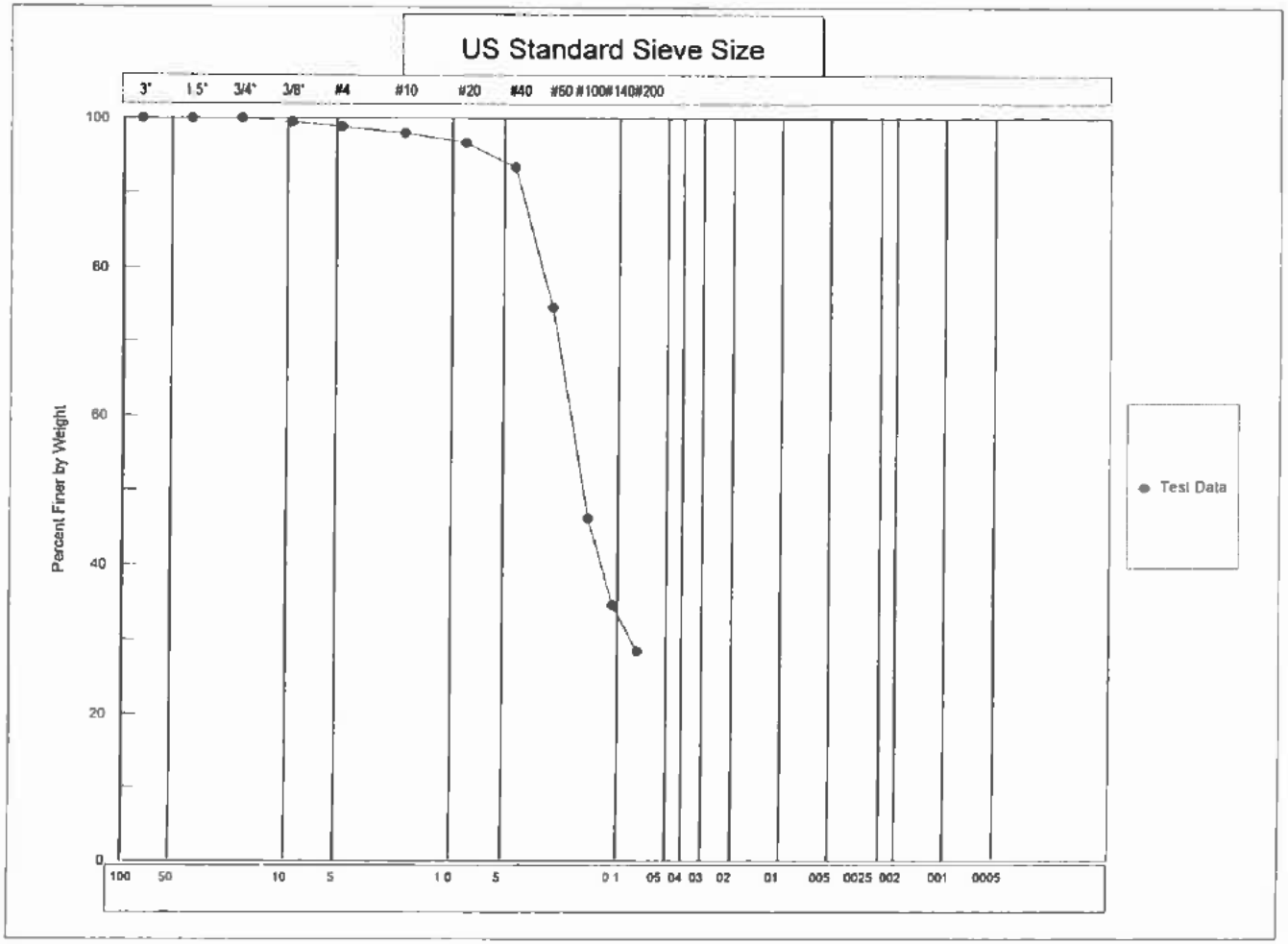
WASH SIEVE ANALYSIS

Wt. Wet Soil & Pan Before Washing (g)	1359.4
Wt. Dry Soil & Pan Before Washing (g)	1303.9
Weight of Pan (g)	1024.0
Wt. of Dry Soil Before Washing	279.9
Wt. Dry Soil & Pan After Washing (g)	1224.6
Wt. of Dry Soil After Washing (g)	200.6
-#200 Wash. Out %	28.3

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	3.08	4.49	1.41	1.41	0.5	99.5
#4	3.03	4.80	1.77	3.18	1.1	98.9
#10	2.96	5.37	2.41	5.59	2.0	98.0
#20	3.05	6.71	3.66	9.25	3.3	96.7
#40	2.96	12.11	9.15	18.40	6.6	93.4
#60	3.00	55.97	52.97	71.37	25.5	74.5
#100	2.97	82.20	79.23	150.60	53.8	46.2
#140	2.97	35.44	32.47	183.07	65.4	34.6
#200	2.97	20.48	17.51	200.58	71.7	28.3

Data entered by: MLM Date: 09/22/2009
Data checked by: TMR Date: 9/22/09
FileName: AJM01798

ADVANCED TERRA TESTING, INC. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	CRS	MEDIUM	FINE	

USCS

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE		

WENTWORTH

Client: Ajax Ltd
Job Number: 2692-14
Classification: N/A

Boring No. 09JD05
Depth: 179.0-186.0'

Sample No.

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 6913

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	07JD07	SAMPLED	
DEPTH	10.0-28.0'	DATE+#4 WASHED	09/18/09 MLM
SAMPLE NO.		DATE -#4 WASHED	09/16/09 PW
SOIL DESCR.		WASH SIEVE	Yes
LOCATION	UCM, Jumbo Dome	DRY SIEVE	No

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No

Wt. Wet Soil & Pan (g)	442.84
Wt. Dry Soil & Pan (g)	439.20
Wt. Lost Moisture (g)	3.64
Wt. of Pan Only (g)	8.15
Wt. of Dry Soil (g)	431.05
Moisture Content %	0.8

Wt. Partial -#4 Sample Wet (g)	350.07
Wt. Partial Sample Dry (g)	347.14

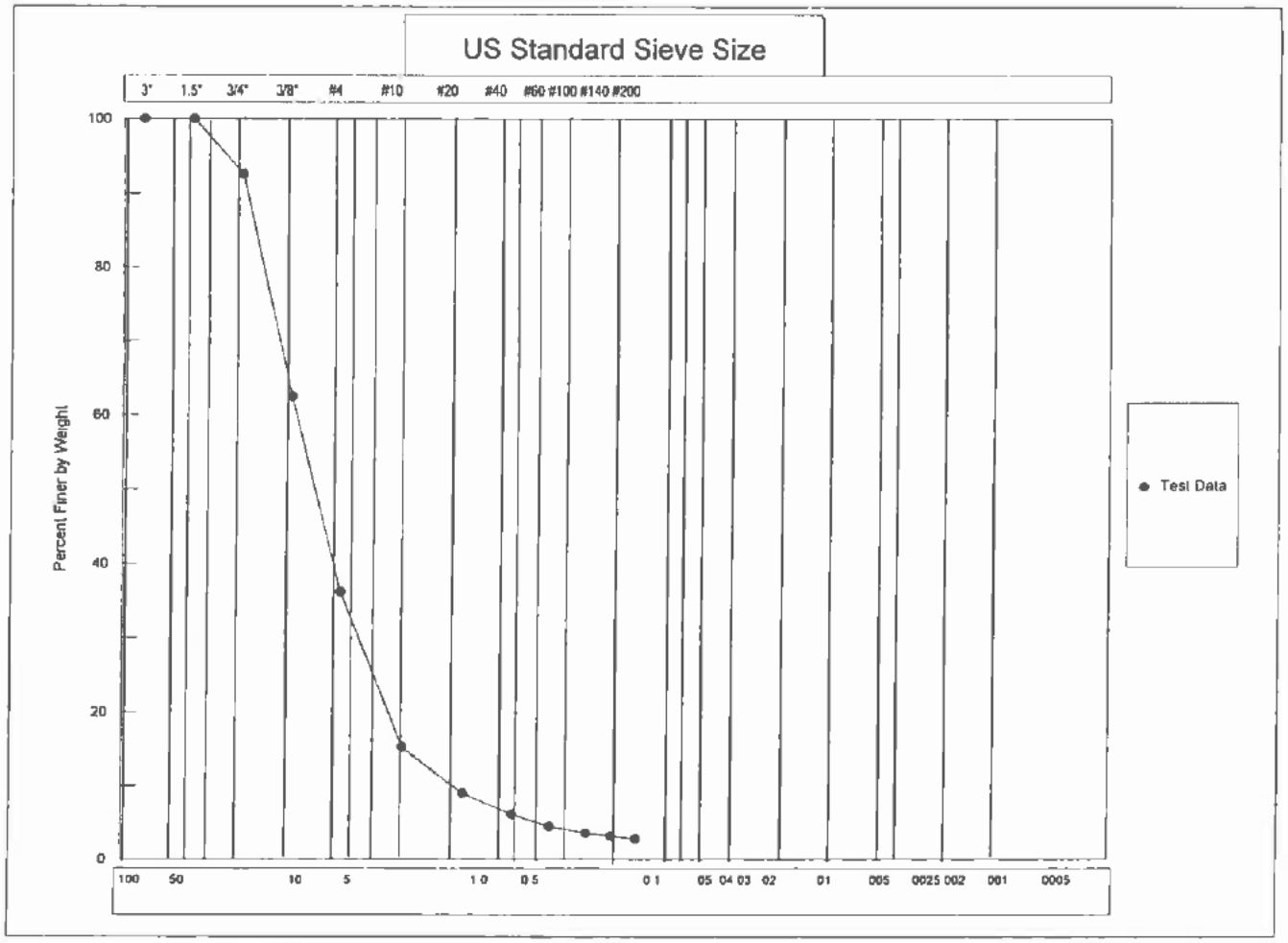
WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	10033.00
Weight of + #4 Before Washing (g)	6741.00
Weight of + #4 After Washing (g)	6387.73
Weight of - #4 Wet (g)	3292.00
Weight of - #4 Dry (g)	3614.75
Wt. Total Sample Dry (g)	10002.48
Calc. Wt. "W" (g)	960.58
Calc. Mass + #4	613.44

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	741.43	741.43	741.43	7.4	92.6
3/8"	0.00	3017.80	3017.80	3759.23	37.6	62.4
#4	0.00	2628.50	2628.50	6387.73	63.9	36.1
#10	6.89	206.16	199.27	199.27	84.6	15.4
#20	3.19	64.81	61.62	260.89	91.0	9.0
#40	3.20	30.39	27.19	288.08	93.9	6.1
#60	3.11	18.98	15.87	303.95	95.5	4.5
#100	3.26	12.18	8.92	312.87	96.4	3.6
#140	3.32	7.26	3.94	316.81	96.8	3.2
#200	3.19	6.54	3.35	320.16	97.2	2.8

Data entered by: MLM Date: 09/21/2009
Data checked by: TMR Date: 9/22/09
FileName: AJM0JD07

ADVANCED TERRA TESTING, INC. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	CRS	MEDIUM	FINE	

USCS

COBBLES	PEBBLE GRAVEL				SAND			SILT	CLAY
TO BOULDERS	COARSE	MED	FINE	GRAN	COARSE	MED	FINE		

WENTWORTH

Client Ajax Ltd
Job Number 2692-14
Classification **Classification Not Performed**

Boring No 07JD07
Depth 10.0-28.0'

Sample No

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 6913

CLIENT Ajax Ltd.

JOB NO. 2692-14

BORING NO.	08JD02B	SAMPLED	
DEPTH	82.0-92.0'	DATE+#4 WASHED	09/16/09 PW
SAMPLE NO.		DATE -#4 WASHED	09/16/09 PW
SOIL DESCR.		WASH SIEVE	Yes
LOCATION	UCM, Jumbo Dome	DRY SIEVE	No

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No

Wt. Wet Soil & Pan (g)	492.81
Wt. Dry Soil & Pan (g)	488.66
Wt. Lost Moisture (g)	4.15
Wt. of Pan Only (g)	8.20
Wt. of Dry Soil (g)	480.46
Moisture Content %	0.9

Wt. Partial -#4 Sample Wet (g)	331.44
Wt. Partial Sample Dry (g)	328.60

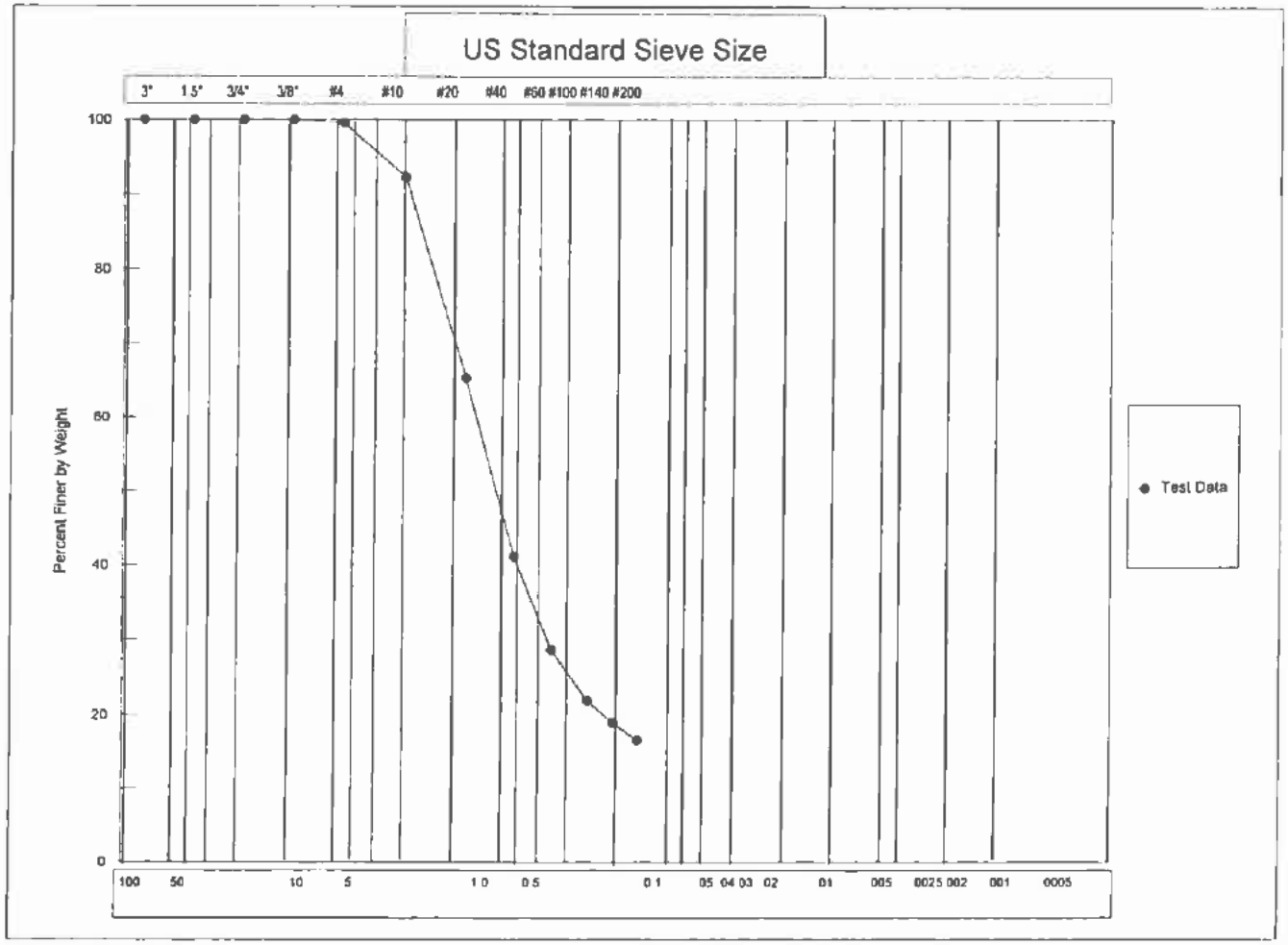
WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	8600.24
Weight of + #4 Before Washing (g)	59.24
Weight of + #4 After Washing (g)	40.13
Weight of - #4 Wet (g)	8541.00
Weight of - #4 Dry (g)	8486.80
Wt. Total Sample Dry (g)	8526.93
Calc. Wt. "W" (g)	330.16
Calc. Mass + #4	1.55

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	0.99	0.99	0.99	0.0	100.0
#4	0.00	39.14	39.14	40.13	0.5	99.5
#10	3.25	27.48	24.23	24.23	7.8	92.2
#20	3.77	92.77	89.00	113.23	34.8	65.2
#40	3.15	82.87	79.72	192.95	58.9	41.1
#60	3.20	44.35	41.15	234.10	71.4	28.6
#100	3.15	25.45	22.30	256.40	78.1	21.9
#140	3.19	12.87	9.68	266.08	81.1	18.9
#200	3.20	10.96	7.76	273.84	83.4	16.6

Data entered by: MLM Date: 09/18/2009
Data checked by: tMR Date: 9/22/09
FileName: AJM08292

ADVANCED TERRA TESTING, Inc. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	CRS	MEDIUM	FINE	

USCS

COBBLES	PEBBLE GRAVEL				SAND			SILT	CLAY
TO BOULDERS	COARSE	MED	FINE	GRAN	COARSE	MED	FINE		

WENTWORTH

Client Ajax Ltd
Job Number 2692-14
Classification

Boring No 08JD02B
Depth 82.0-92.0'

Sample No

Classification Not Performed

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 6913

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	08JD02B	SAMPLED	
DEPTH	152.0-162.0'	DATE+#4 WASHED	09/16/09 PW
SAMPLE NO.		DATE -#4 WASHED	09/16/09 PW
SOIL DESCR.		WASH SIEVE	Yes
LOCATION	UCM, Jumbo Dome	DRY SIEVE	No

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No

Wt. Wet Soil & Pan (g)	460.99
Wt. Dry Soil & Pan (g)	457.60
Wt. Lost Moisture (g)	3.39
Wt. of Pan Only (g)	6.49
Wt. of Dry Soil (g)	451.11
Moisture Content %	0.8
Wt. Partial -#4 Sample Wet (g)	337.69
Wt. Partial Sample Dry (g)	335.17

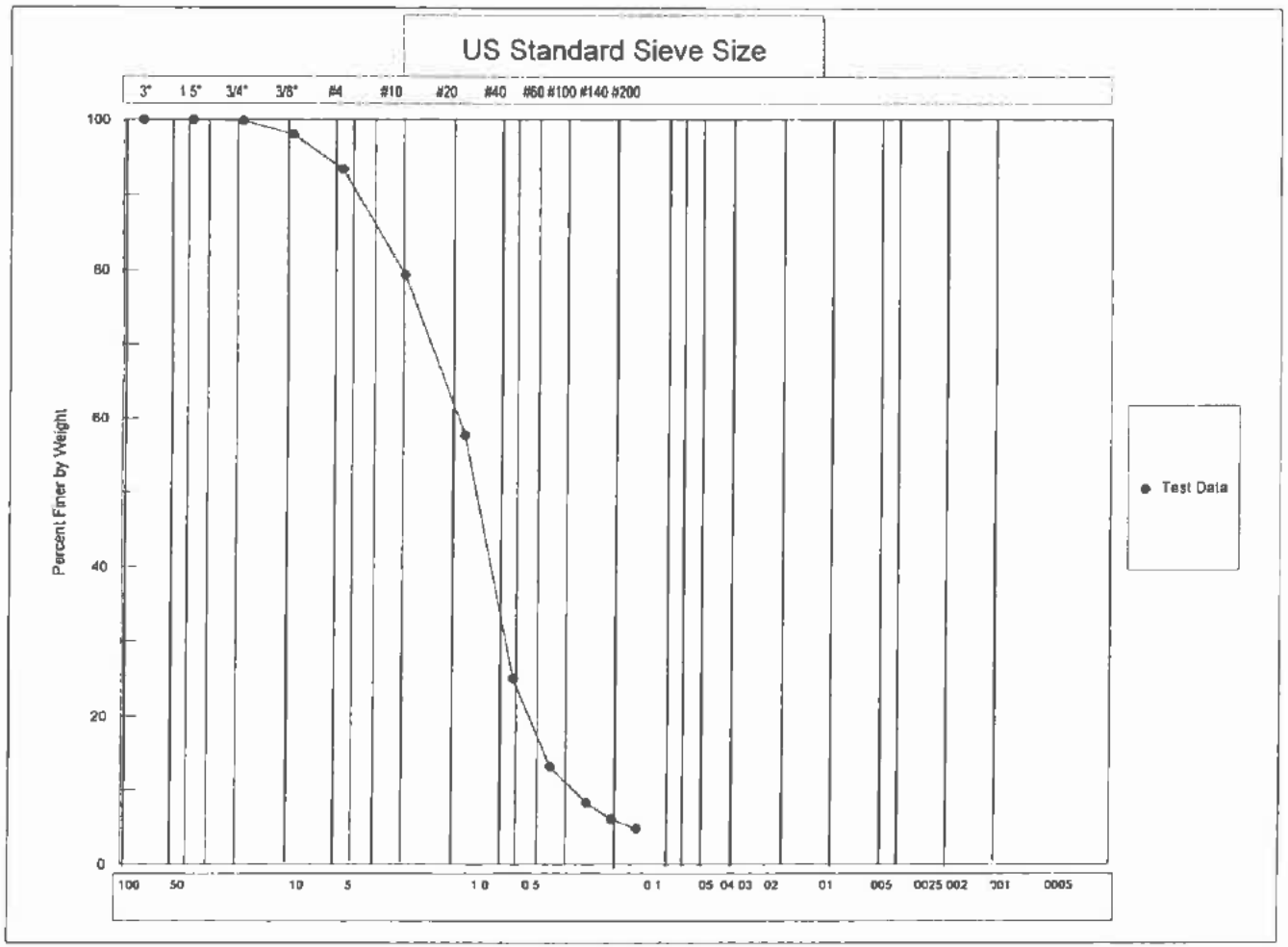
WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	10376.52
Weight of + #4 Before Washing (g)	710.52
Weight of + #4 After Washing (g)	678.74
Weight of - #4 Wet (g)	9666.00
Weight of - #4 Dry (g)	9625.45
Wt. Total Sample Dry (g)	10304.19
Calc. Wt. "W" (g)	358.81
Calc. Mass + #4	23.63

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	17.98	17.98	17.98	0.2	99.8
3/8"	0.00	191.09	191.09	209.07	2.0	98.0
#4	0.00	469.67	469.67	678.74	6.6	93.4
#10	3.12	53.77	50.65	50.65	20.7	79.3
#20	3.67	81.36	77.69	128.34	42.4	57.6
#40	3.25	120.27	117.02	245.36	75.0	25.0
#60	3.30	45.73	42.43	287.79	86.8	13.2
#100	3.10	21.28	18.18	305.97	91.9	8.1
#140	3.26	11.09	7.83	313.80	94.0	6.0
#200	3.77	8.05	4.28	318.08	95.2	4.8

Data entered by: MLM Date: 09/18/2009
Data checked by: TMR Date: 9/22/09
FileName: AJM01526

ADVANCED TERRA TESTING, INC. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	CRS	MEDIUM	FINE	

USCS

COBBLES	PEBBLE GRAVEL				SAND			SILT	CLAY
TO BOULDERS	COARSE	MED	FINE	GRAN	COARSE	MED	FINE		

WENTWORTH

Client Ajax Ltd
Job Number 2692-14
Classification

Boring No 08JD02B
Depth 152.0-162.0'

Sample No

Classification Not Performed

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 6913

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	07JDA	SAMPLED	
DEPTH	83.0-118.0'	DATE+#4 WASHED	09/16/09 PW
SAMPLE NO.		DATE -#4 WASHED	09/16/09 PW
SOIL DESCR.		WASH SIEVE	Yes
LOCATION	UCM, Jumbo Dome	DRY SIEVE	No

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No

Wt. Wet Soil & Pan (g)	428.07
Wt. Dry Soil & Pan (g)	414.17
Wt. Lost Moisture (g)	13.90
Wt. of Pan Only (g)	8.16
Wt. of Dry Soil (g)	406.01
Moisture Content %	3.4

Wt. Partial -#4 Sample Wet (g)	283.55
Wt. Partial Sample Dry (g)	274.16

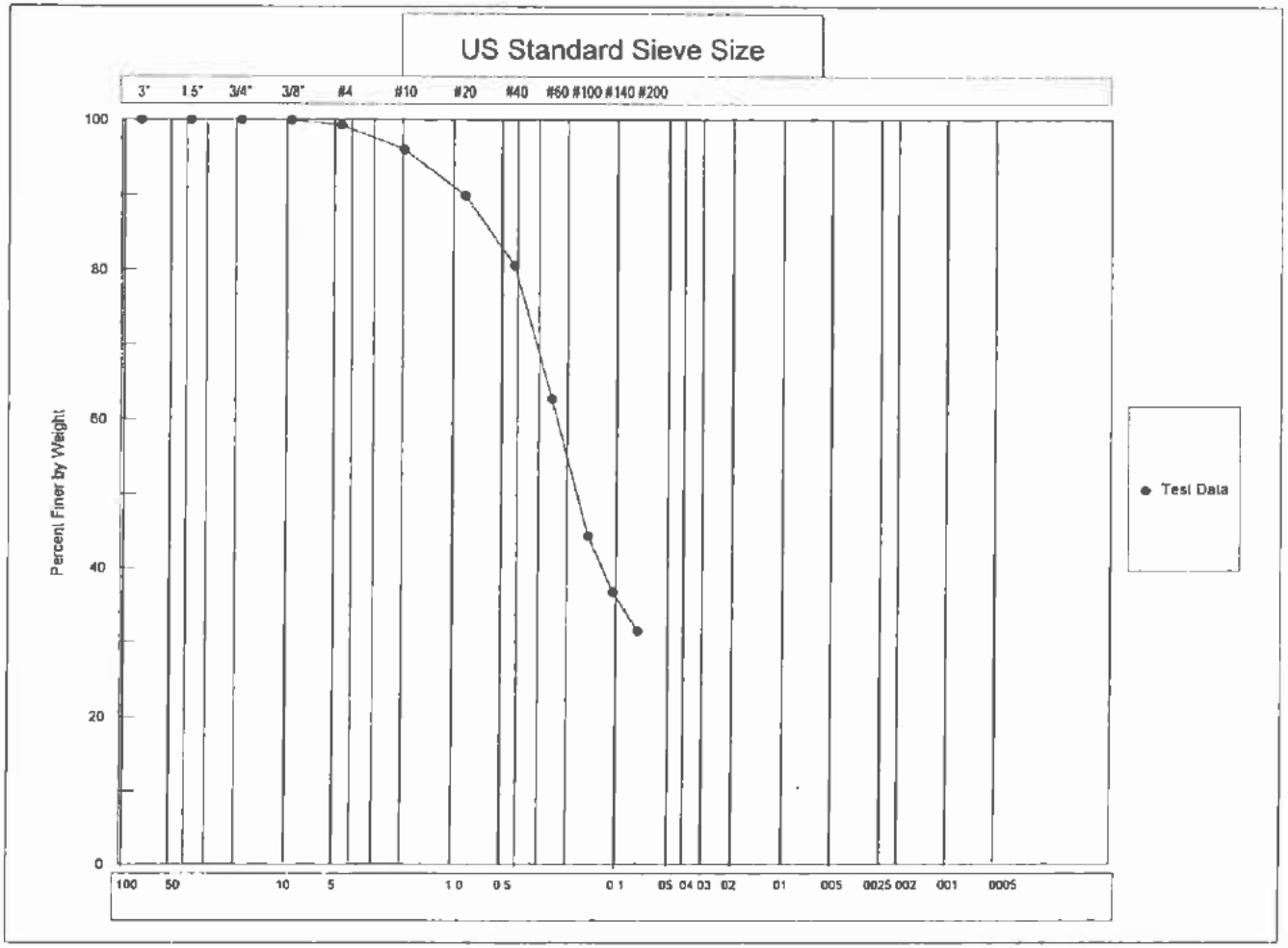
WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	8373.65
Weight of + #4 Before Washing (g)	87.65
Weight of + #4 After Washing (g)	64.06
Weight of - #4 Wet (g)	8286.00
Weight of - #4 Dry (g)	8034.52
Wt. Total Sample Dry (g)	8098.58
Calc. Wt. "W" (g)	276.35
Calc. Mass + #4	2.19

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	3.39	3.39	3.39	0.0	100.0
#4	0.00	60.67	60.67	64.06	0.8	99.2
#10	3.24	11.97	8.73	8.73	4.0	96.0
#20	3.25	20.26	17.01	25.74	10.1	89.9
#40	3.24	29.14	25.90	51.64	19.5	80.5
#60	3.04	52.42	49.38	101.02	37.3	62.7
#100	3.27	54.00	50.73	151.75	55.7	44.3
#140	3.28	24.34	21.06	172.81	63.3	36.7
#200	3.03	17.38	14.35	187.16	68.5	31.5

Data entered by: MLM Date: 09/22/2009
Data checked by: TMR Date: 9/22/09
FileName: AJM08318

ADVANCED TERRA TESTING, INC. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	CRS	MEDIUM	FINE	

USCS

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE		

WENTWORTH

Client: Ajax Ltd
Job Number: 2692-14
Classification: **Classification Not Performed**

Boring No. 07JDA
Depth: 83.0-118.0'

Sample No

ATTERBERG LIMITS
ASTM D 4318

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax	JOB NO.	2692-03
BORING NO.	08JD03B	DATE SAMPLED	
DEPTH	193.0-196.0'	DATE TESTED	08-01-08 MLM
SAMPLE NO.			
SOIL DESCR.	Jumbo Dome		
LOCATION	Usibelli Coal Mine, AK		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	10.36	10.66	11.15
Wt Dish & Dry Soil	9.06	9.27	9.75
Wt of Moisture	1.30	1.39	1.40
Wt of Dish	1.14	1.14	1.12
Wt of Dry Soil	7.92	8.13	8.63
Moisture Content	16.41	17.10	16.22

Liquid Limit Determination — Device Number 0860

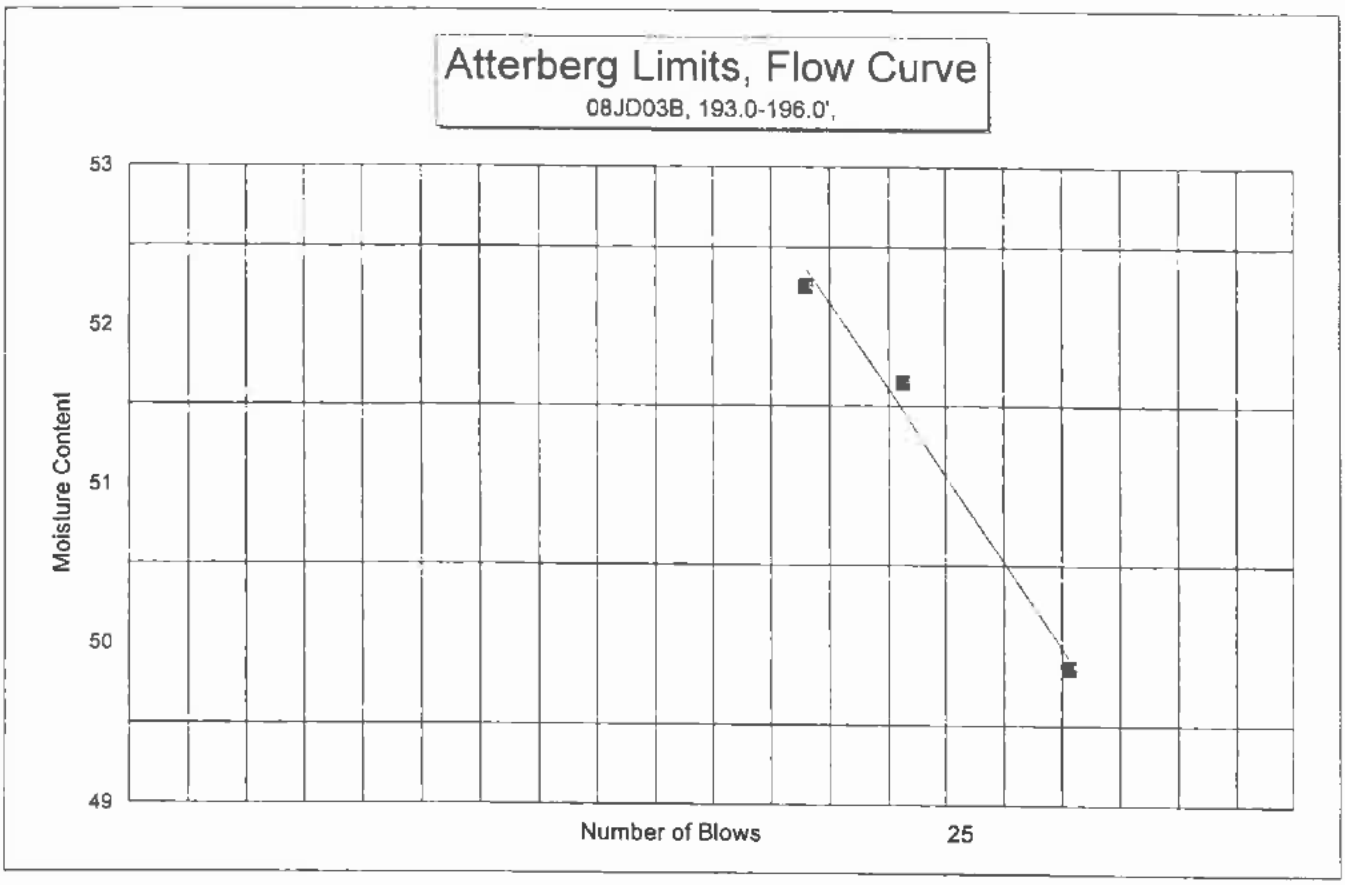
	1	2	3
Number of Blows	32	19	23
Wt Dish & Wet Soil	11.42	10.25	9.42
Wt Dish & Dry Soil	8.00	7.12	6.60
Wt of Moisture	3.42	3.13	2.82
Wt of Dish	1.14	1.13	1.14
Wt of Dry Soil	6.86	5.99	5.46
Moisture Content	49.85	52.25	51.65

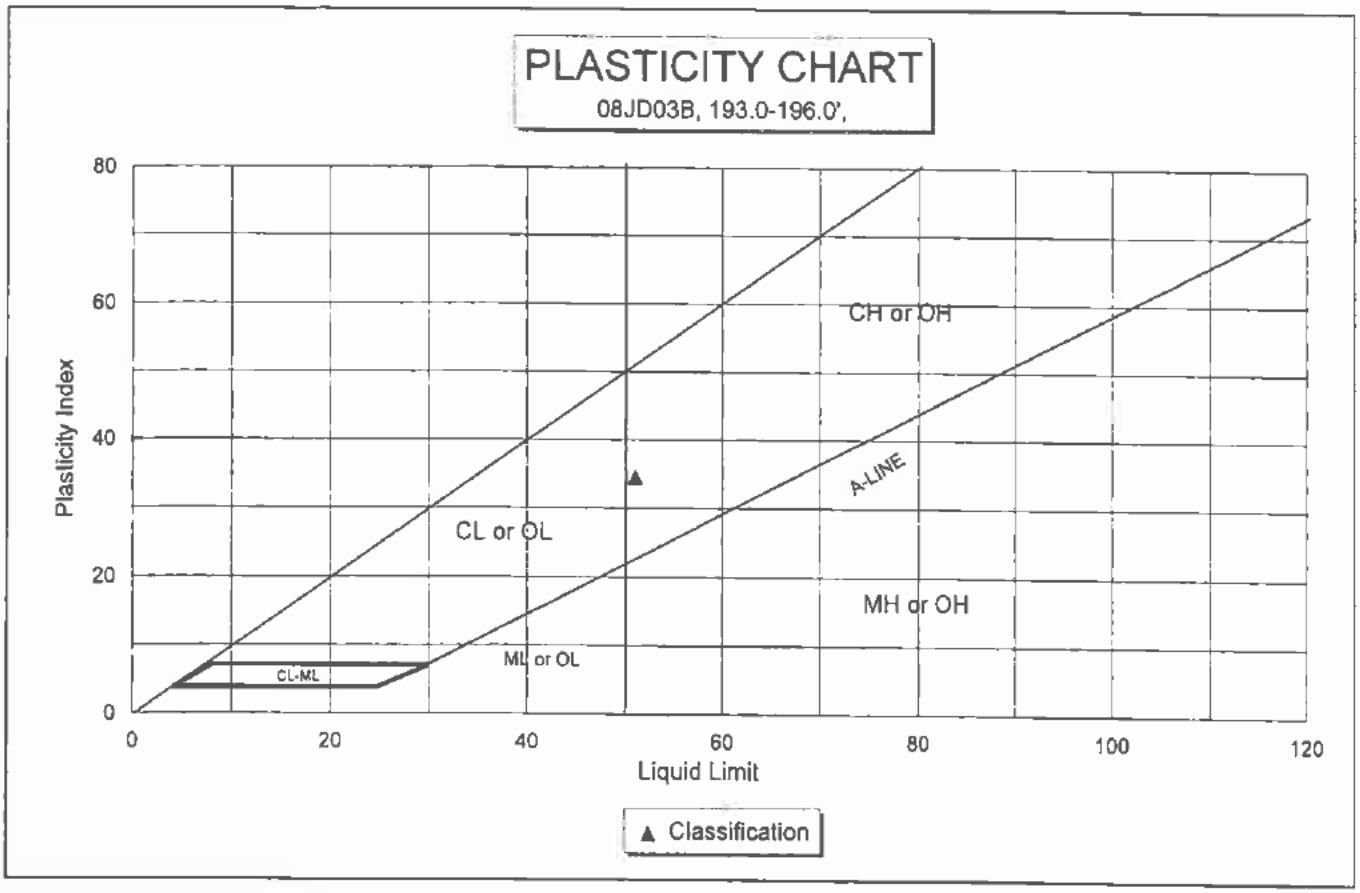
Liquid Limit	51.1
Plastic Limit	16.6
Plasticity Index	34.5

Atterberg Classification CH

Data entry by: SR Date: 08/07/2008
Checked by: BKL Date: 8.7.08
FileName: AJG0JD03

ADVANCED TERRA TESTING, INC. ATT


Atterberg Limits, Flow Curve
08JD03B, 193.0-196.0',
53
52
51
50
49
Moisture Content
Number of Blows
25


PLASTICITY CHART
08JD03B, 193.0-196.0',
80
60
40
20
0
Plasticity Index
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
▲ Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax	JOB NO.	2692-03
BORING NO.	08JD03B	DATE SAMPLED	
DEPTH	238.0-242.0'	DATE TESTED	08-01-08 MLM
SAMPLE NO.	Footwall Clay		
SOIL DESCR.	Jumbo Mine		
LOCATION	Usibelli Coal Mine, AK		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	9.54	11.00	8.64
Wt Dish & Dry Soil	8.01	9.16	7.26
Wt of Moisture	1.53	1.84	1.38
Wt of Dish	1.14	1.14	1.13
Wt of Dry Soil	6.87	8.02	6.13
Moisture Content	22.27	22.94	22.51

Liquid Limit Determination — Device Number 0860

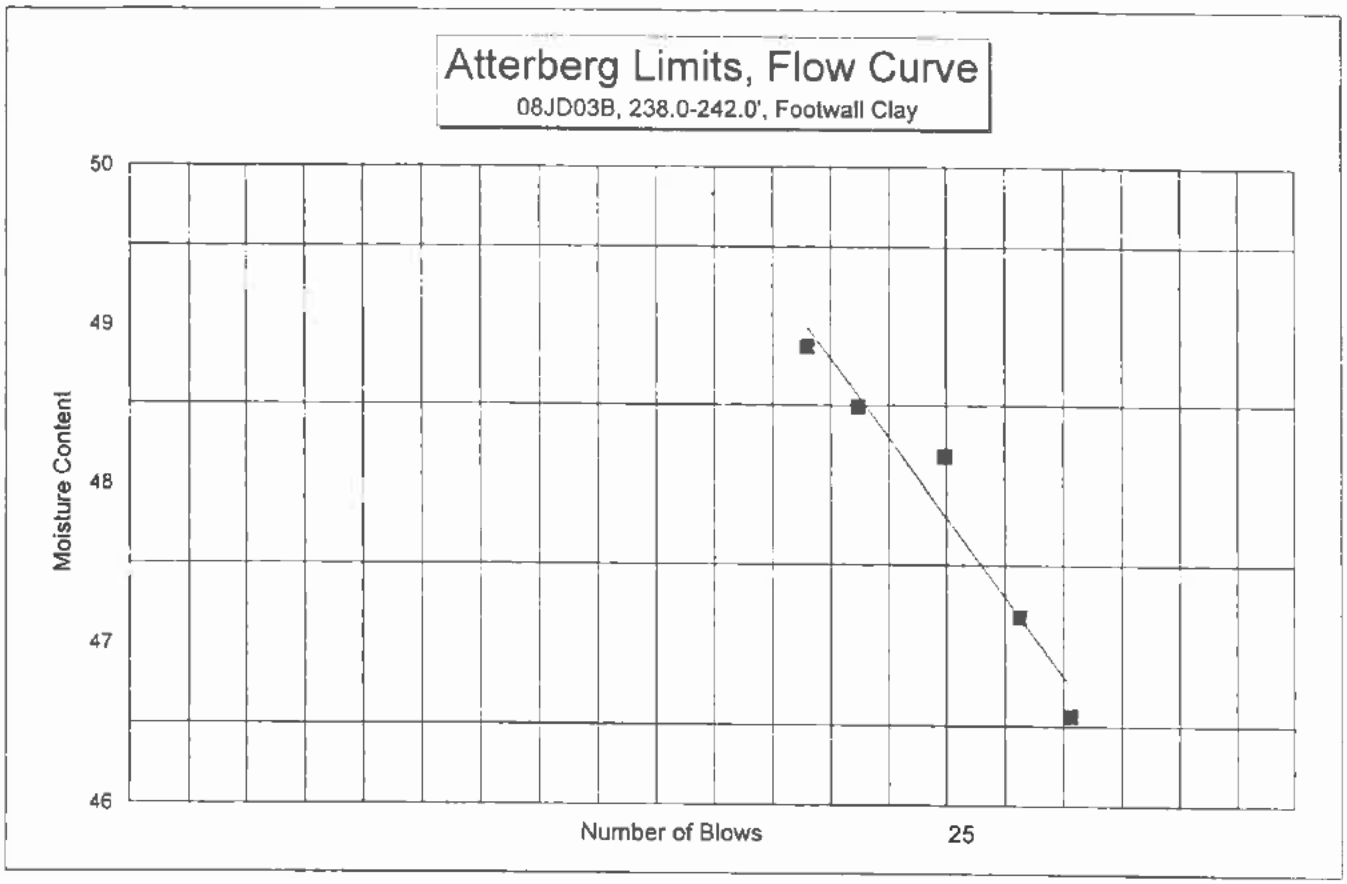
	1	2	3	4	5
Number of Blows	32	29	25	21	19
Wt Dish & Wet Soil	9.45	10.25	8.89	9.99	9.67
Wt Dish & Dry Soil	6.81	7.33	6.37	7.10	6.87
Wt of Moisture	2.64	2.92	2.52	2.89	2.80
Wt of Dish	1.14	1.14	1.14	1.14	1.14
Wt of Dry Soil	5.67	6.19	5.23	5.96	5.73
Moisture Content	46.56	47.17	48.18	48.49	48.87

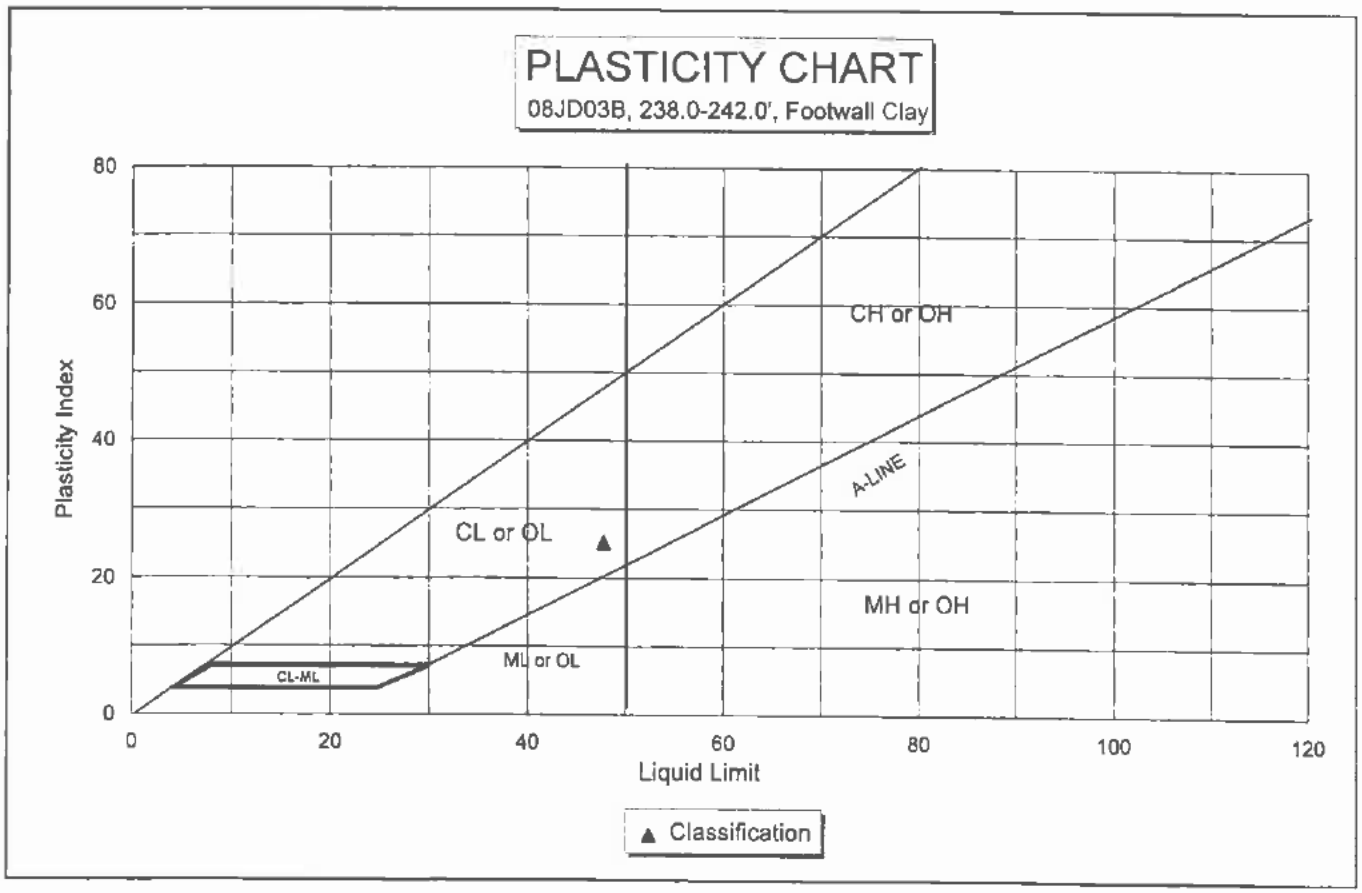
Liquid Limit	47.8
Plastic Limit	22.6
Plasticity Index	25.2

Atterberg Classification CL

Data entry by: SR Date: 08/05/2008
Checked by: BKL Date: 8.7.08
FileName: AJG02380

ADVANCED TERRA TESTING, INC. ATT


Atterberg Limits, Flow Curve
08JD03B, 238.0-242.0', Footwall Clay
Moisture Content
50
49
48
47
46
Number of Blows
25


PLASTICITY CHART
08JD03B, 238.0-242.0', Footwall Clay
Plasticity Index
80
60
40
20
0
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax	JOB NO.	2692-03
BORING NO.	08JD02B	DATE SAMPLED	
DEPTH	77.0-82.0'	DATE TESTED	08-04-08 WAR
SAMPLE NO.	OB		
SOIL DESCR.	Jumbo Mine		
LOCATION	Usibelli Coal Mine, AK		

Plastic Limit
Determination

Wt Dish & Wet Soil
Wt Dish & Dry Soil
Wt of Moisture
Wt of Dish NON-PLASTIC
Wt of Dry Soil
Moisture Content

Liquid Limit Device Number 0860
Determination

Number of Blows

Wt Dish & Wet Soil
Wt Dish & Dry Soil
Wt of Moisture
Wt of Dish NON-PLASTIC
Wt of Dry Soil
Moisture Content

Liquid Limit	NP
Plastic Limit	NP
Plasticity Index	NP

Atterberg Classification NP

Data entry by: SR Date: 08/05/2008
Checked by: BKL Date: 8.7.08
FileName: AJG07708

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax	JOB NO.	2692-03
BORING NO.	08JD02B	DATE SAMPLED	
DEPTH	127.0-132.0'	DATE TESTED	08-01-08 MLM
SAMPLE NO.	IB		
SOIL DESCR.	Jumbo Mine		
LOCATION	Usibelli Coal Mine, AK		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	8.41	8.50	8.75
Wt Dish & Dry Soil	7.07	7.13	7.31
Wt of Moisture	1.34	1.37	1.44
Wt of Dish	1.13	1.14	1.11
Wt of Dry Soil	5.94	5.99	6.20
Moisture Content	22.56	22.87	23.23

Liquid Limit Determination — Device Number 0860

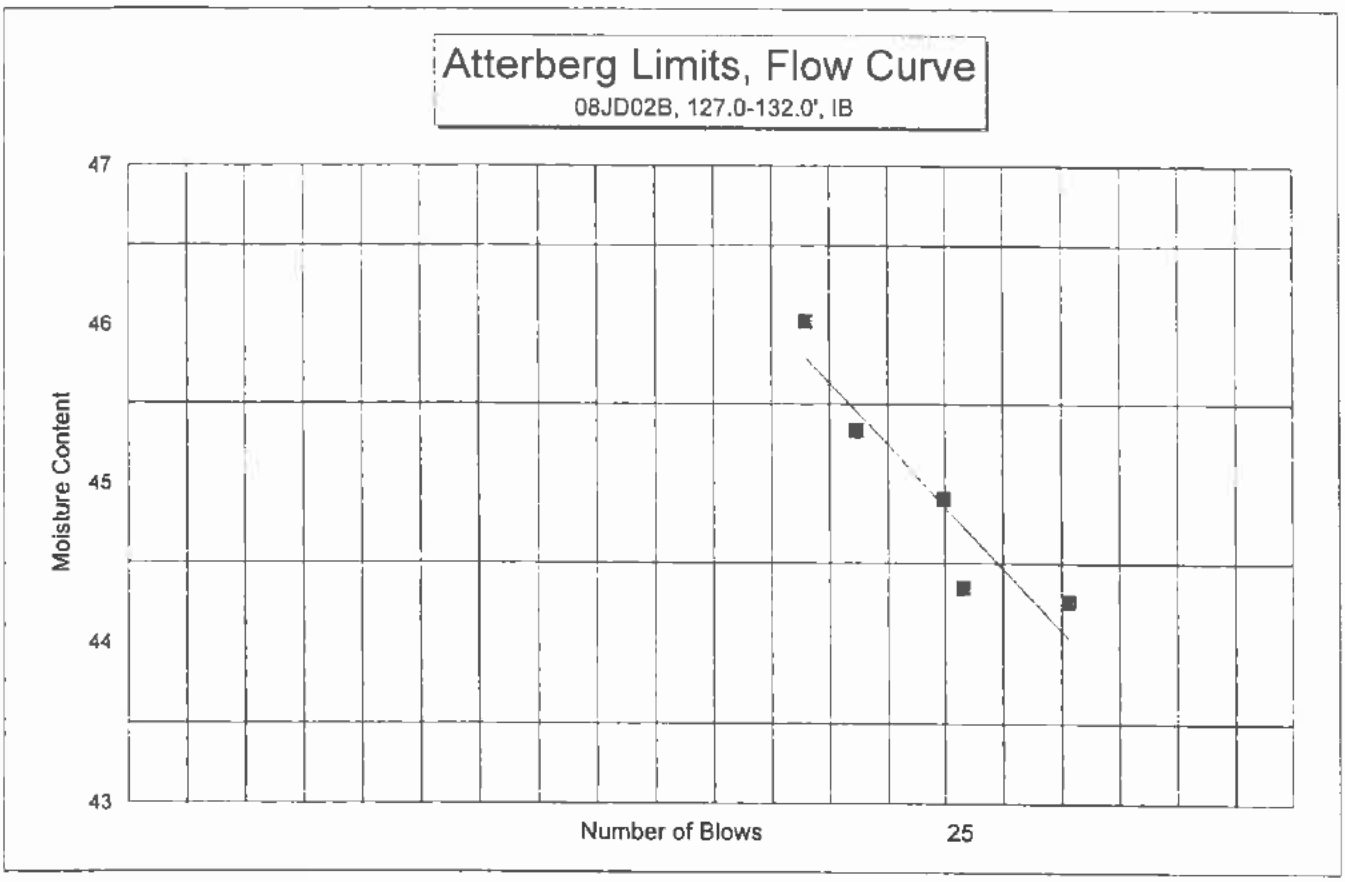
	1	2	3	4	5
Number of Blows	26	32	25	21	19
Wt Dish & Wet Soil	11.24	9.94	10.22	9.84	9.20
Wt Dish & Dry Soil	8.14	7.24	7.40	7.12	6.54
Wt of Moisture	3.10	2.70	2.82	2.72	2.66
Wt of Dish	1.15	1.14	1.12	1.12	0.76
Wt of Dry Soil	6.99	6.10	6.28	6.00	5.78
Moisture Content	44.35	44.26	44.90	45.33	46.02

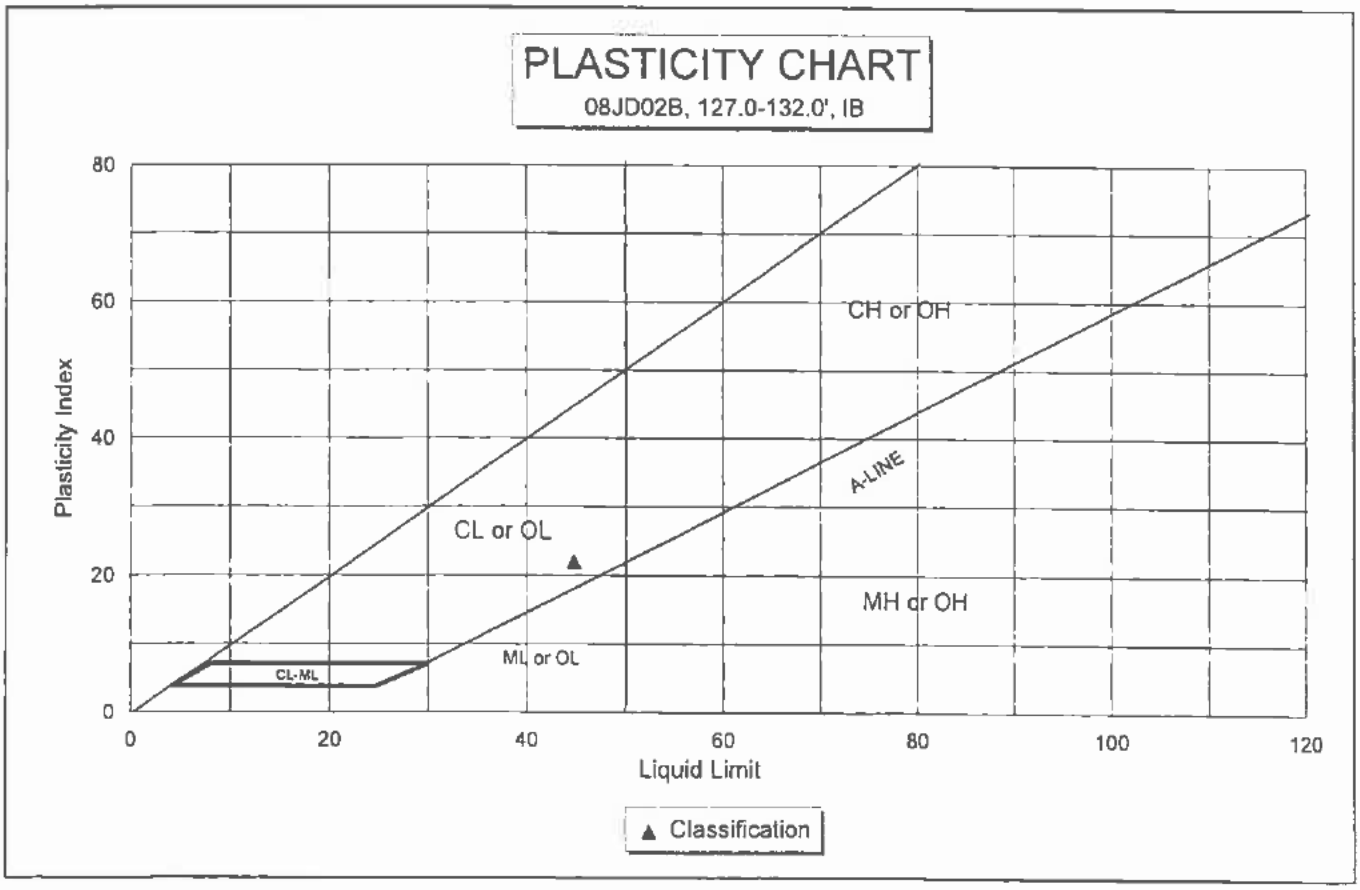
Liquid Limit	44.9
Plastic Limit	22.9
Plasticity Index	22.0

Atterberg Classification CL

Data entry by: SR Date: 08/05/2008
Checked by: JMK Date: 8/5/08
FileName: AJG01271

ADVANCED TERRA TESTING, INC. ATT


Atterberg Limits, Flow Curve
08JD02B, 127.0-132.0', IB
Moisture Content
47
46
45
44
43
Number of Blows
25


PLASTICITY CHART
08JD02B, 127.0-132.0', IB
Plasticity Index
80
60
40
20
0
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax	JOB NO.	2692-03
BORING NO.	4SBS-0B	DATE SAMPLED	
DEPTH	Trench	DATE TESTED	07-31-08 QRS
SAMPLE NO.			
SOIL DESCR.	Jumbo Dome		
LOCATION	Usibelli Coal Mine, AK		

Plastic Limit
Determination

Wt Dish & Wet Soil
Wt Dish & Dry Soil
Wt of Moisture
Wt of Dish — NON-PLASTIC
Wt of Dry Soil
Moisture Content

Liquid Limit Determination — Device Number 0860

Number of Blows

Wt Dish & Wet Soil
Wt Dish & Dry Soil
Wt of Moisture
Wt of Dish — NON-PLASTIC
Wt of Dry Soil
Moisture Content

Liquid Limit	NP
Plastic Limit	NP
Plasticity Index	NP

Atterberg Classification — NP

Data entry by: SR Date: 08/01/2008
Checked by: BKL Date: 8.7.08
FileName: AJG04SBS

ADVANCED TERRA TESTING, INC. ATT

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax	JOB NO.	2692-03
BORING NO.	Schist - 1	DATE SAMPLED	
DEPTH	Surface	DATE TESTED	07-31-08 MLM
SAMPLE NO.			
SOIL DESCR.	Jumbo Dome		
LOCATION	Usibelli Coal Mine, AK		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	12.54	13.16	12.95
Wt Dish & Dry Soil	11.31	11.90	11.71
Wt of Moisture	1.23	1.26	1.24
Wt of Dish	1.14	1.14	1.14
Wt of Dry Soil	10.17	10.76	10.57
Moisture Content	12.09	11.71	11.73

Liquid Limit Determination — Device Number 0860

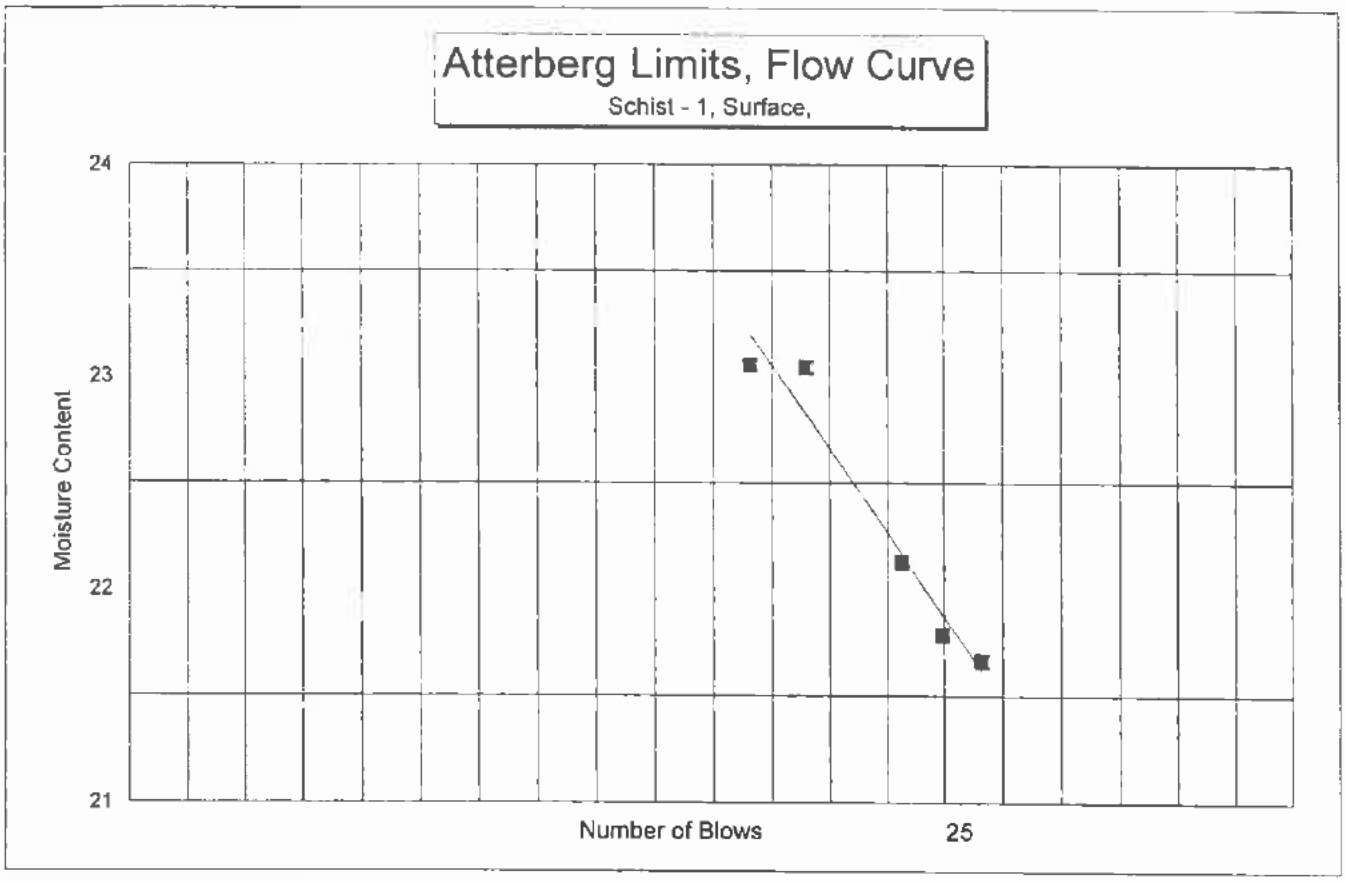
	1	2	3	4	5
Number of Blows	27	25	23	19	17
Wt Dish & Wet Soil	10.79	11.36	11.03	12.29	13.47
Wt Dish & Dry Soil	9.07	9.53	9.24	10.20	11.16
Wt of Moisture	1.72	1.83	1.79	2.09	2.31
Wt of Dish	1.13	1.13	1.15	1.13	1.14
Wt of Dry Soil	7.94	8.40	8.09	9.07	10.02
Moisture Content	21.66	21.79	22.13	23.04	23.05

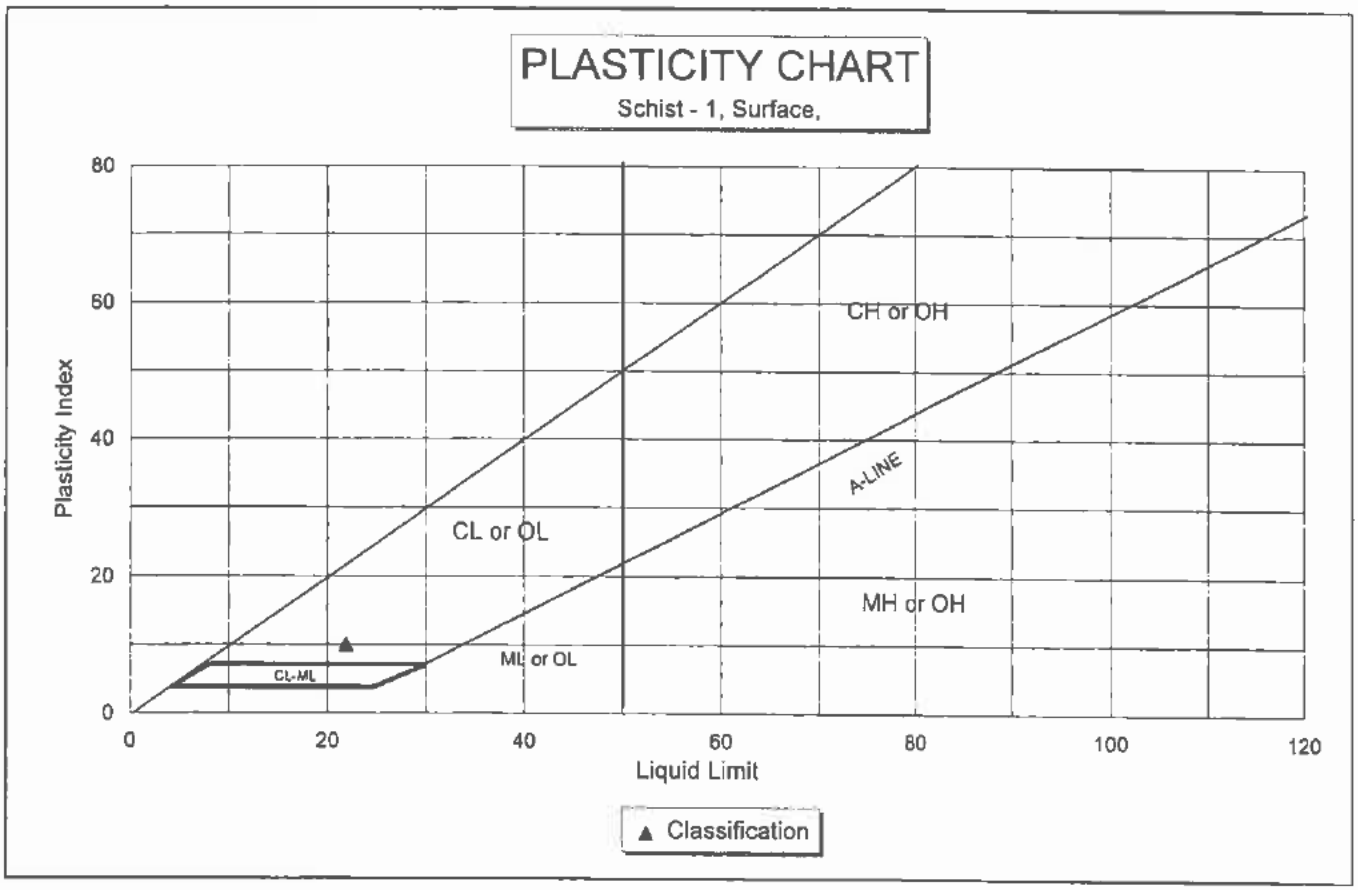
Liquid Limit	21.9
Plastic Limit	11.8
Plasticity Index	10.0

Atterberg Classification CL

Data entry by: SR Date: 08/07/2008
Checked by: BRL Date: 8.7.08
FileName: AJG0SCH1

ADVANCED TERRA TESTING, INC. ATT


Atterberg Limits, Flow Curve
Schist - 1, Surface,
Moisture Content
24
23
22
21
Number of Blows
25


PLASTICITY CHART
Schist - 1, Surface,
Plasticity Index
80
60
40
20
0
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax	JOB NO.	2692-03
BORING NO.	Schist - 2	DATE SAMPLED	
DEPTH	Surface	DATE TESTED	07-31-08 QRS
SAMPLE NO.			
SOIL DESCR.	Jumbo Dome		
LOCATION	Usibelli Coal Mine, AK		

Plastic Limit
Determination

Wt Dish & Wet Soil	
Wt Dish & Dry Soil	
Wt of Moisture	
Wt of Dish	NON-PLASTIC
Wt of Dry Soil	
Moisture Content	

Liquid Limit Device Number 0860
Determination

Number of Blows

Wt Dish & Wet Soil	
Wt Dish & Dry Soil	
Wt of Moisture	
Wt of Dish	NON-PLASTIC
Wt of Dry Soil	
Moisture Content	

Liquid Limit	NP
Plastic Limit	NP
Plasticity Index	NP

Atterberg Classification NP

Data entry by: SR Date: 08/01/2008
Checked by: [illegible] Date: 8.7.08
FileName: AJG0SCH2

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	09JD09	DATE SAMPLED	
DEPTH	132.5-134.5'	DATE TESTED	09/26/09 MLM
SAMPLE NO.			
SOIL DESCR.			
LOCATION	UCM, Jumbo Dome		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	12.53	13.52	13.91
Wt Dish & Dry Soil	10.31	11.06	11.39
Wt of Moisture	2.22	2.46	2.52
Wt of Dish	1.15	1.16	1.14
Wt of Dry Soil	9.16	9.90	10.25
Moisture Content	24.24	24.85	24.59

Liquid Limit Determination — Device Number 0966

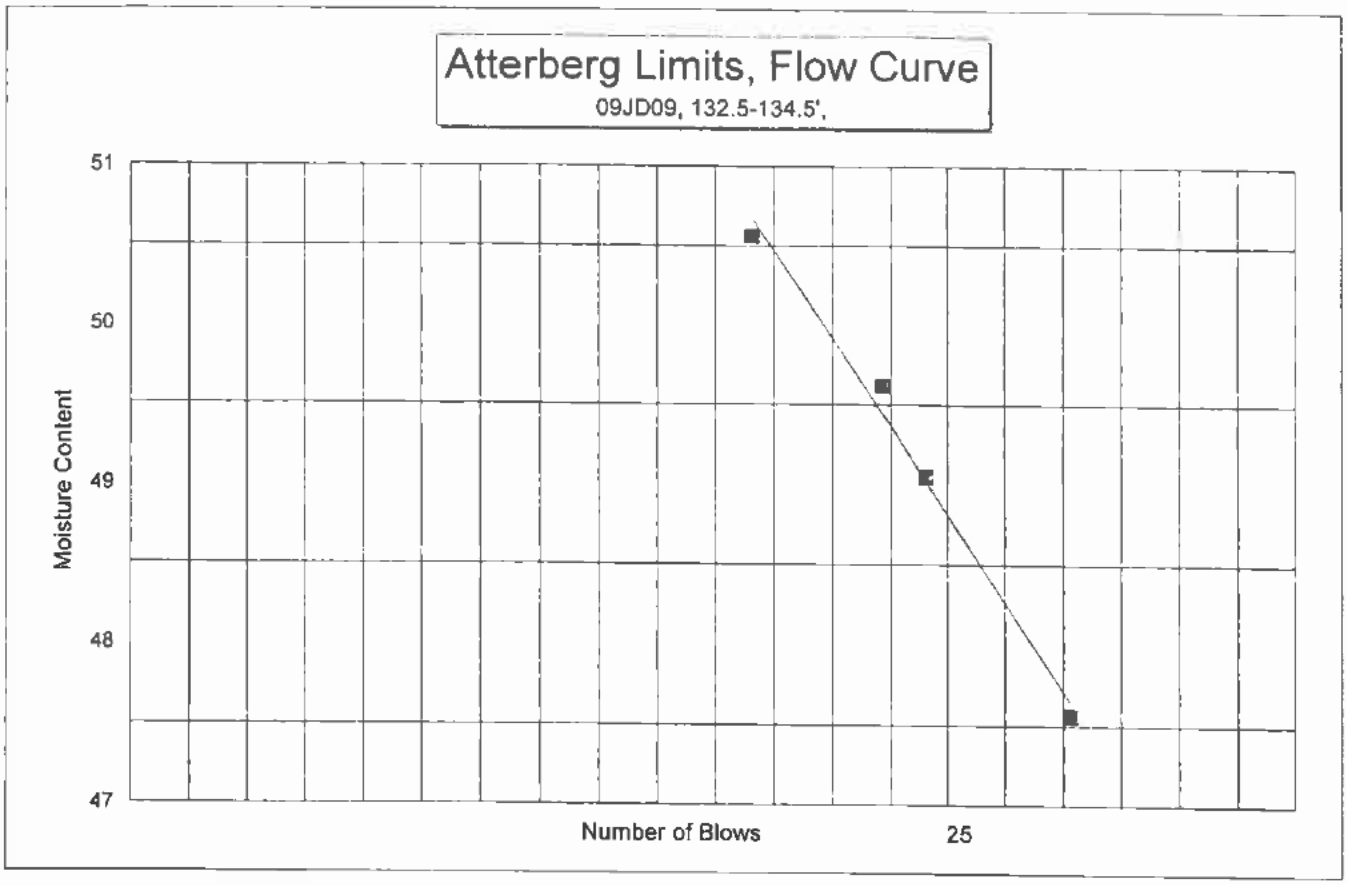
	1	2	3	4
Number of Blows	17	32	24	22
Wt Dish & Wet Soil	10.57	9.61	9.81	14.79
Wt Dish & Dry Soil	7.40	6.88	6.96	10.27
Wt of Moisture	3.17	2.73	2.85	4.52
Wt of Dish	1.13	1.14	1.15	1.16
Wt of Dry Soil	6.27	5.74	5.81	9.11
Moisture Content	50.56	47.56	49.05	49.62

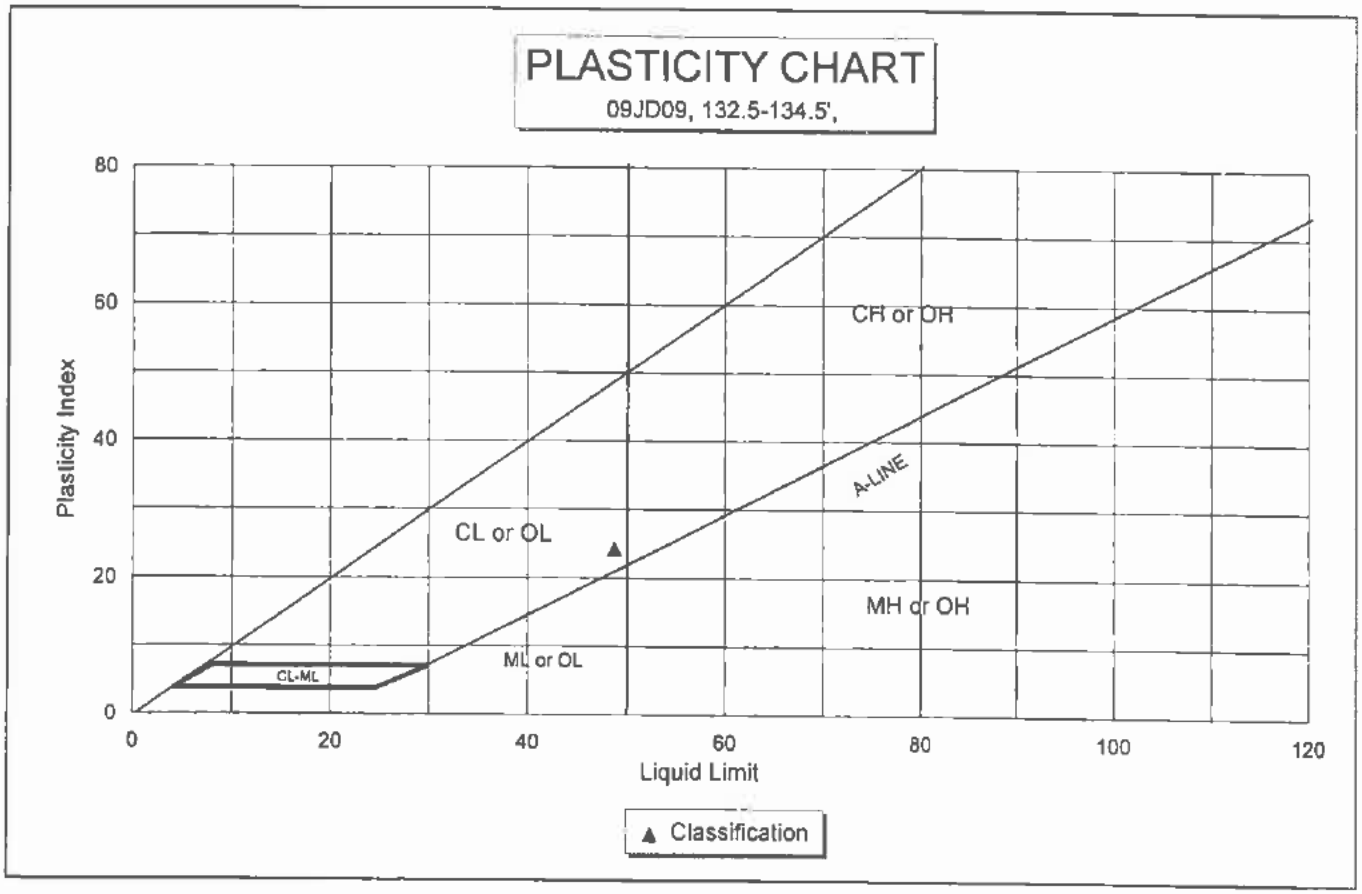
Liquid Limit	48.8
Plastic Limit	24.6
Plasticity Index	24.3

Atterberg Classification CL

Data entry by: MLM Date: 09/28/2009
Checked by: LB Date: 9-30-09
FileName: AJG01325

ADVANCED TERRA TESTING, INC. ATT


Atterberg Limits, Flow Curve
09JD09, 132.5-134.5',
51
50
49
48
47
Moisture Content
Number of Blows
25


PLASTICITY CHART
09JD09, 132.5-134.5',
80
60
40
20
0
Plasticity Index
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	09JD03	DATE SAMPLED	
DEPTH	168.5-169.0'	DATE TESTED	09/22/09 PW
SAMPLE NO.			
SOIL DESCR.	UCM, Jumbo Dome		
LOCATION			

Plastic Limit Determination

	1	2
Wt Dish & Wet Soil	10.33	10.36
Wt Dish & Dry Soil	8.74	8.76
Wt of Moisture	1.59	1.60
Wt of Dish	1.12	1.15
Wt of Dry Soil	7.62	7.61
Moisture Content	20.87	21.02

Liquid Limit Determination — Device Number 0966

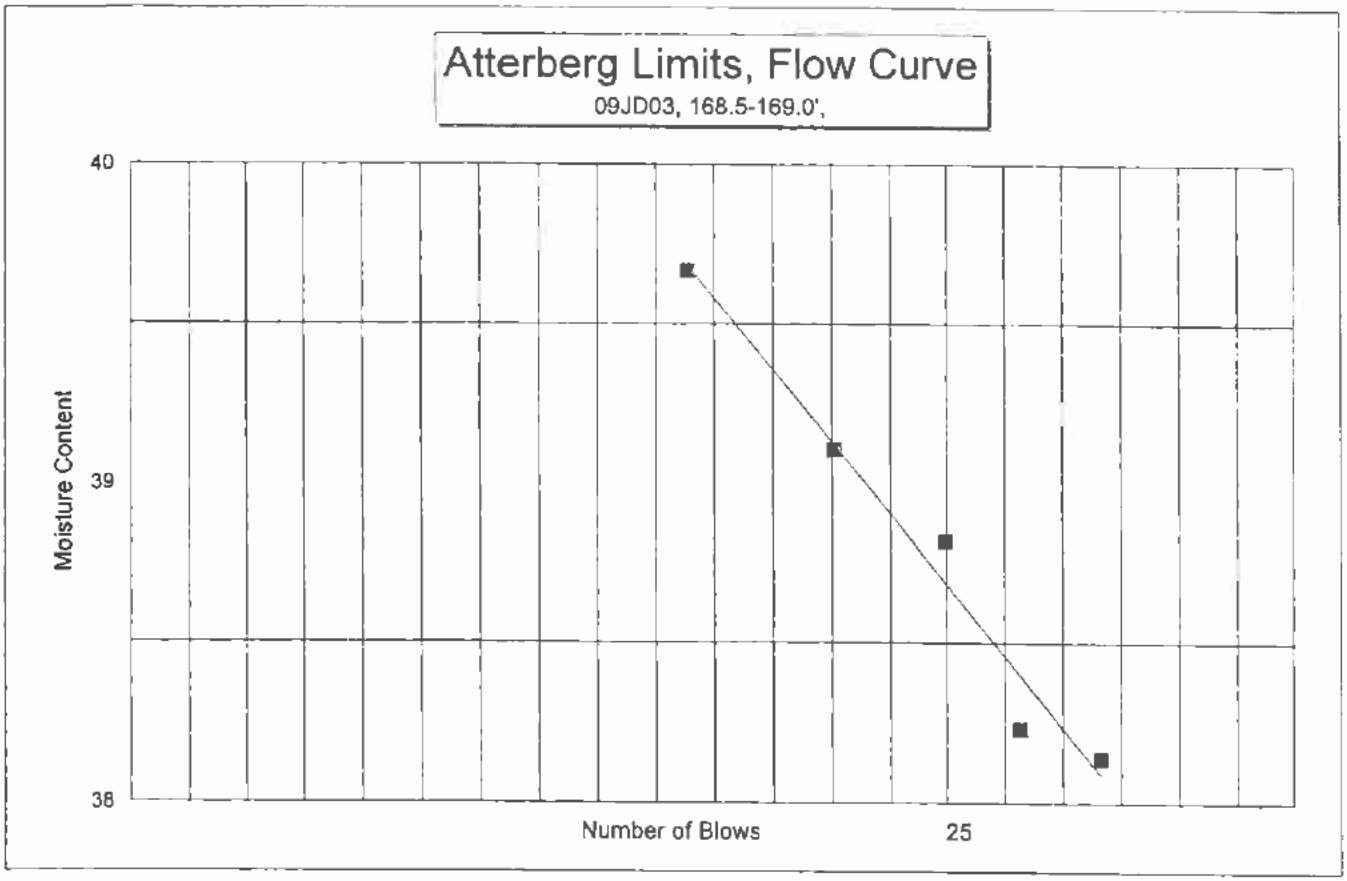
	1	2	3	4	5
Number of Blows	34	29	25	20	15
Wt Dish & Wet Soil	16.01	14.12	15.48	15.76	16.21
Wt Dish & Dry Soil	11.91	10.53	11.47	11.65	11.93
Wt of Moisture	4.10	3.59	4.01	4.11	4.28
Wt of Dish	1.16	1.14	1.14	1.14	1.14
Wt of Dry Soil	10.75	9.39	10.33	10.51	10.79
Moisture Content	38.14	38.23	38.82	39.11	39.67

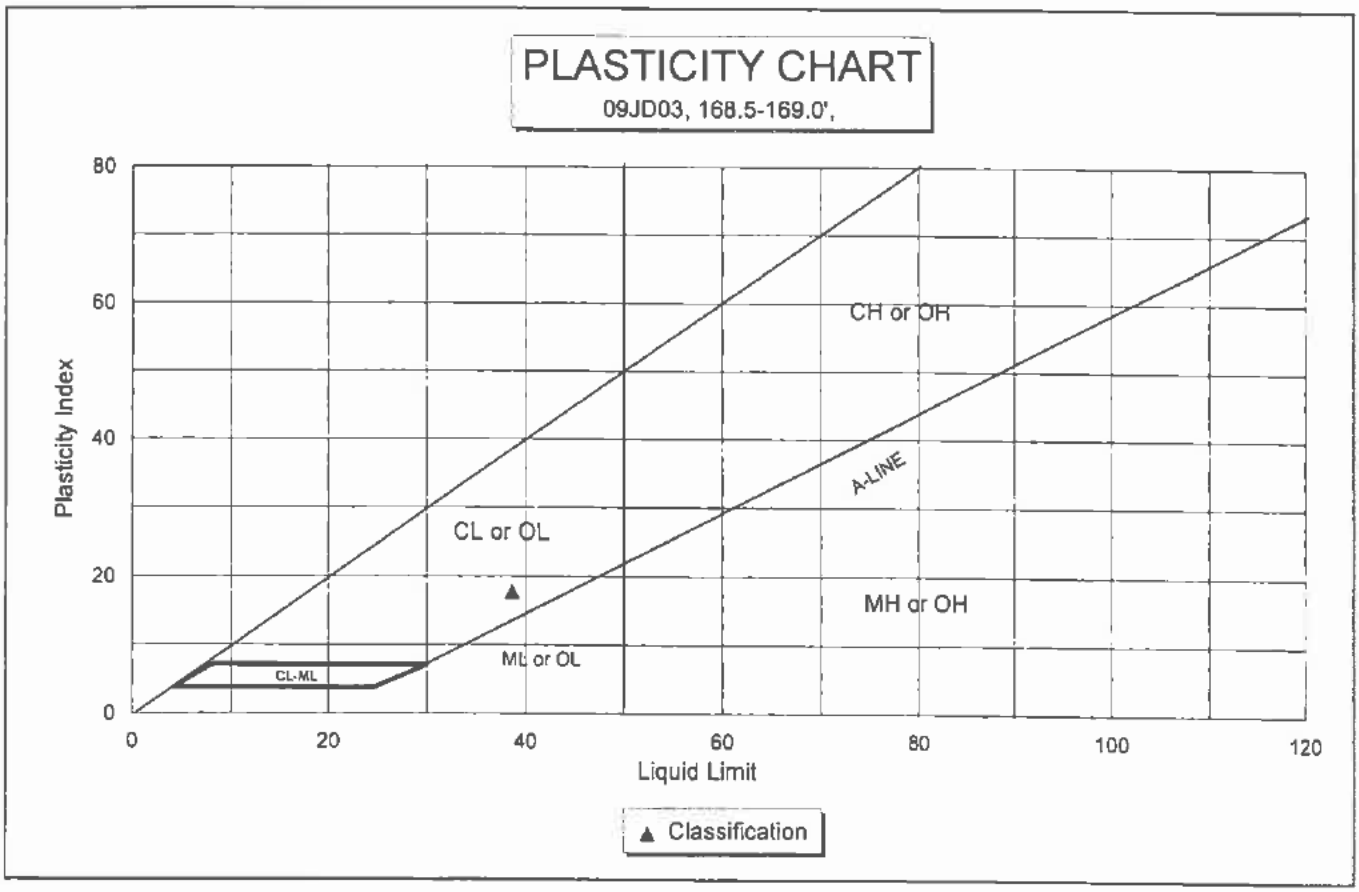
Liquid Limit	38.7
Plastic Limit	20.9
Plasticity Index	17.7

Atterberg Classification CL

Data entry by: MLM Date: 09/23/2009
Checked by: TMR Date: 9/24/09
FileName: AJG00916

ADVANCED TERRA TESTING, INC. ATT


Atterberg Limits, Flow Curve
09JD03, 168.5-169.0',
40
39
38
Moisture Content
Number of Blows
25


PLASTICITY CHART
09JD03, 168.5-169.0',
80
60
40
20
0
Plasticity Index
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	09JD05	DATE SAMPLED	
DEPTH	222.0-223.0'	DATE TESTED	09/22/09 MLM
SAMPLE NO.			
SOIL DESCR.	UCM, Jumbo Dome		
LOCATION			

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	10.70	11.13	11.00
Wt Dish & Dry Soil	8.96	9.32	9.19
Wt of Moisture	1.74	1.81	1.81
Wt of Dish	1.12	1.12	1.15
Wt of Dry Soil	7.84	8.20	8.04
Moisture Content	22.19	22.07	22.51

Liquid Limit Determination — Device Number 0966

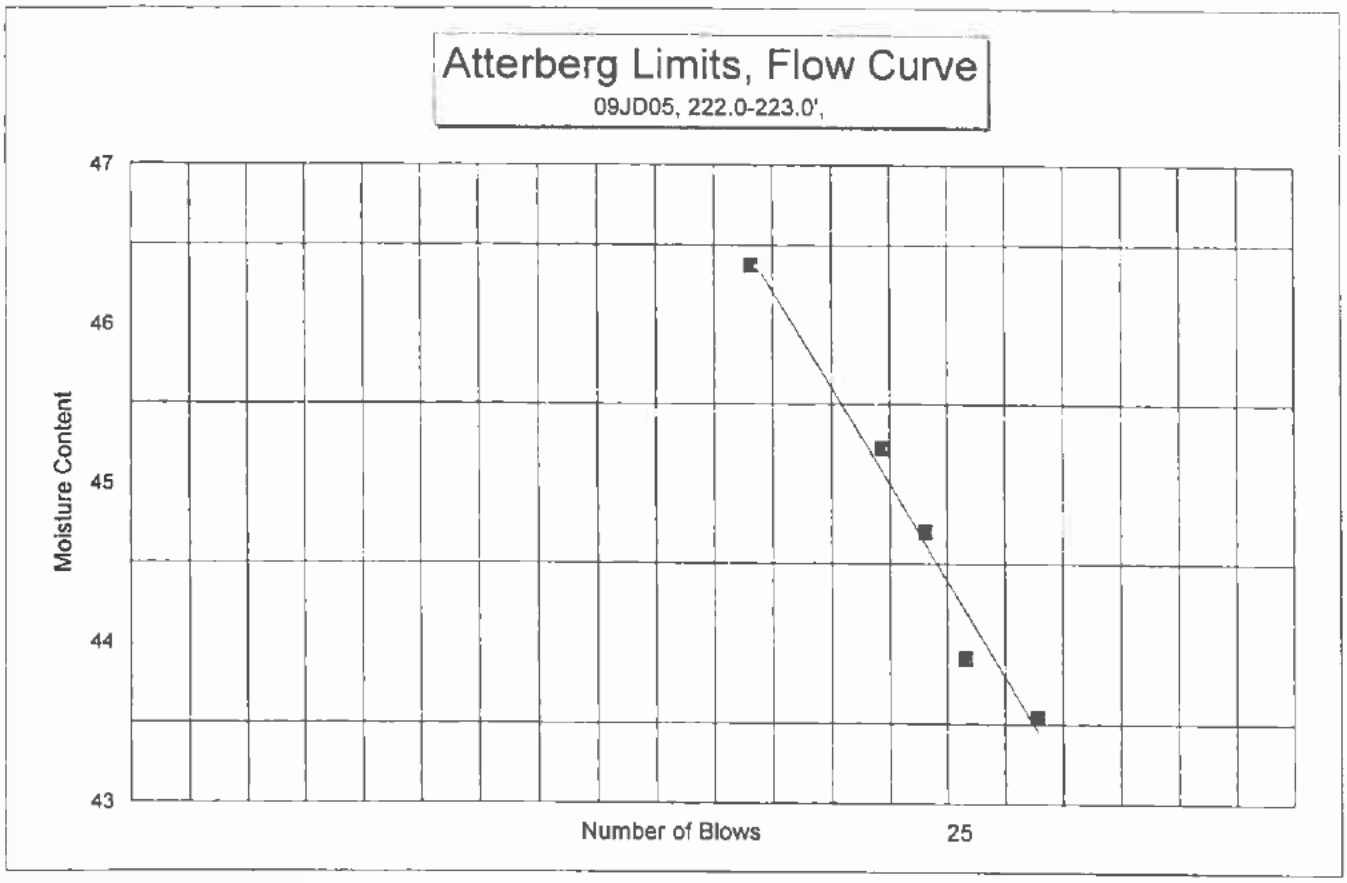
	1	2	3	4	5
Number of Blows	26	30	17	24	22
Wt Dish & Wet Soil	12.13	13.16	11.46	11.66	12.70
Wt Dish & Dry Soil	8.78	9.52	8.07	8.41	9.10
Wt of Moisture	3.35	3.64	3.39	3.25	3.60
Wt of Dish	1.15	1.16	0.76	1.14	1.14
Wt of Dry Soil	7.63	8.36	7.31	7.27	7.96
Moisture Content	43.91	43.54	46.37	44.70	45.23

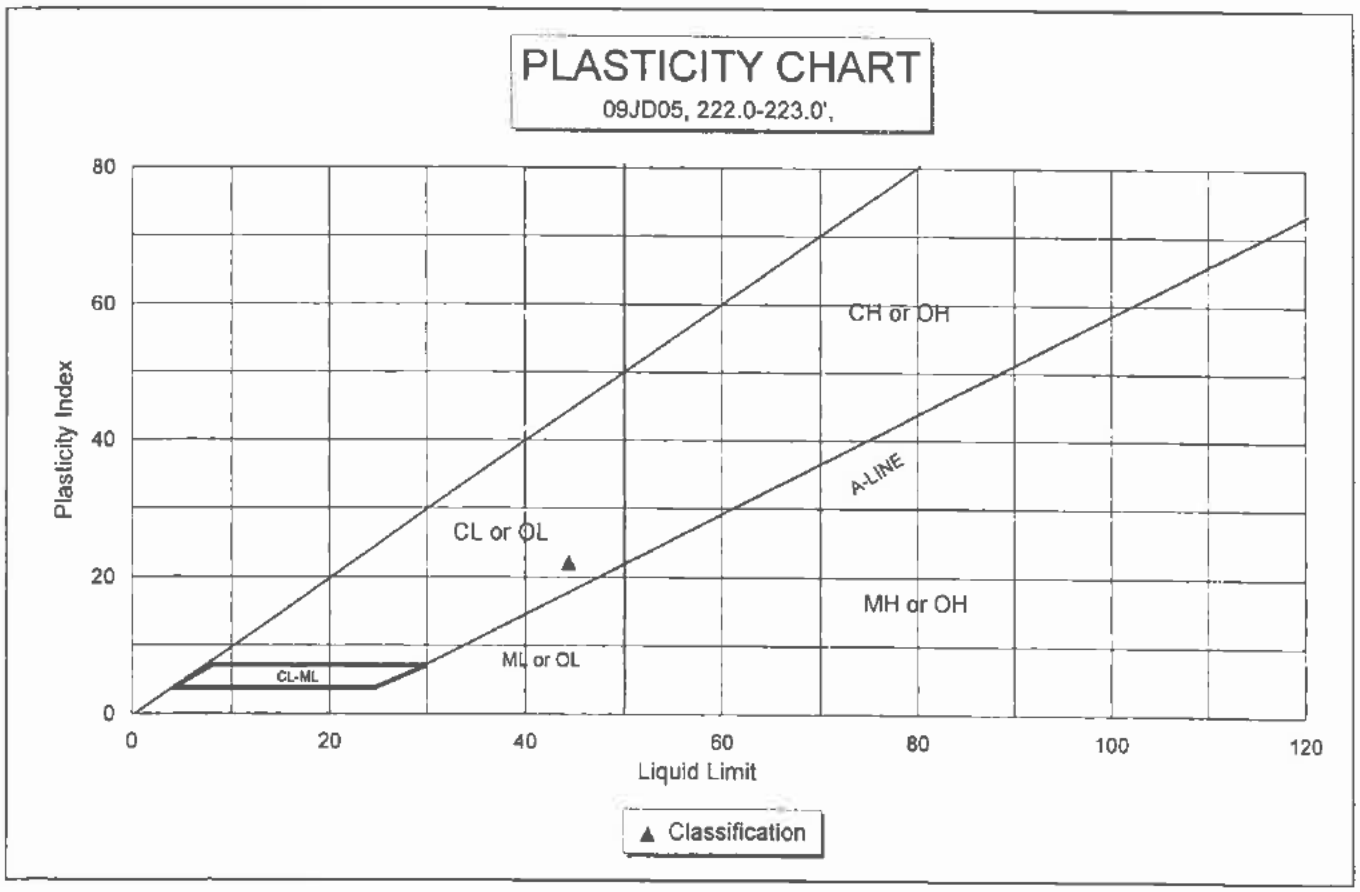
Liquid Limit	44.4
Plastic Limit	22.3
Plasticity Index	22.1

Atterberg Classification CL

Data entry by: MLM Date: 09/23/2009
Checked by: JMR Date: 9/24/09
FileName: AJG00905

ADVANCED TERRA TESTING, INC. ATT


Atterberg Limits, Flow Curve
09JD05, 222.0-223.0',
Moisture Content
47
46
45
44
43
Number of Blows
25


PLASTICITY CHART
09JD05, 222.0-223.0',
Plasticity Index
80
60
40
20
0
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	09JD03	DATE SAMPLED	
DEPTH	120.0-120.5'	DATE TESTED	09/18/09 MLM
SAMPLE NO.			
SOIL DESCR.			
LOCATION	UCM, Jumbo Dome		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	9.28	13.83	14.01
Wt Dish & Dry Soil	7.88	11.60	11.77
Wt of Moisture	1.40	2.23	2.24
Wt of Dish	1.12	1.15	1.13
Wt of Dry Soil	6.76	10.45	10.64
Moisture Content	20.71	21.34	21.05

Liquid Limit Determination — Device Number 0966

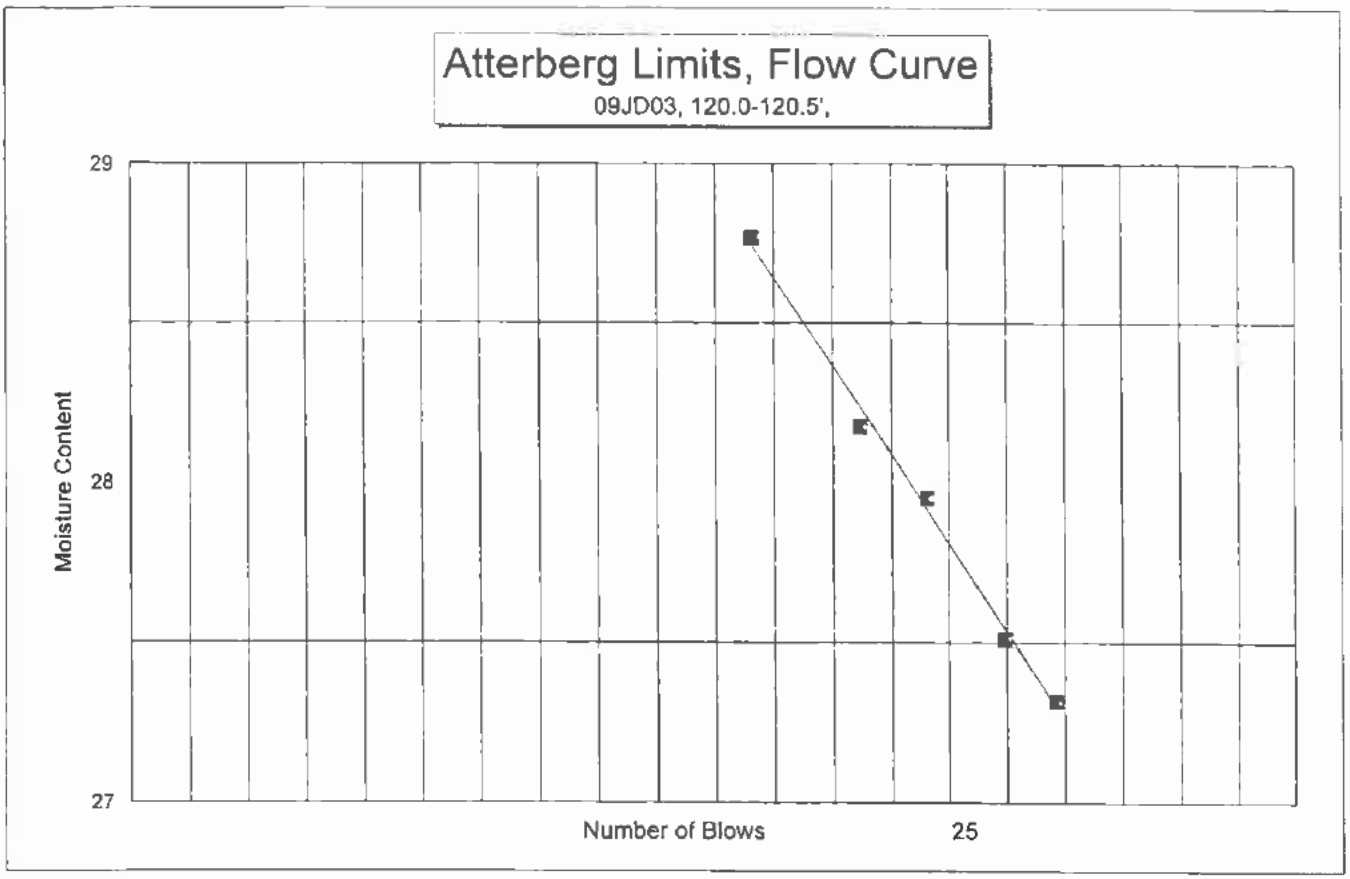
	1	2	3	4	5
Number of Blows	21	24	31	28	17
Wt Dish & Wet Soil	11.75	9.68	11.36	10.83	10.45
Wt Dish & Dry Soil	9.42	7.81	9.15	8.72	8.37
Wt of Moisture	2.33	1.87	2.21	2.11	2.08
Wt of Dish	1.15	1.12	1.06	1.05	1.14
Wt of Dry Soil	8.27	6.69	8.09	7.67	7.23
Moisture Content	28.17	27.95	27.32	27.51	28.77

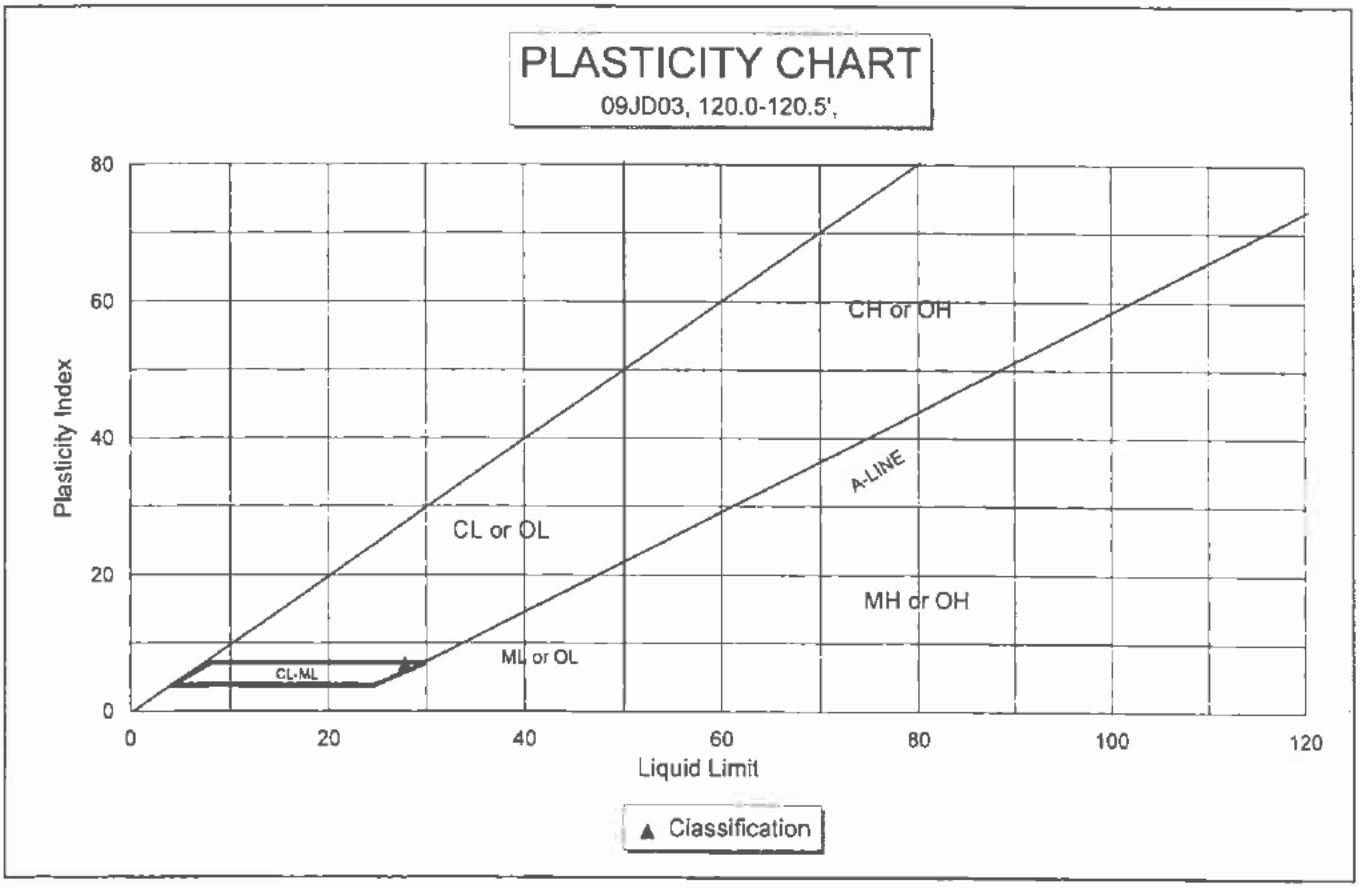
Liquid Limit	27.8
Plastic Limit	21.0
Plasticity Index	6.8

Atterberg Classification CL-ML

Data entry by: MLM Date: 09/21/2009
Checked by: TMR Date: 9/22/09
FileName: AJG00903

ADVANCED TERRA TESTING, INC. ATT


Atterberg Limits, Flow Curve
09JD03, 120.0-120.5',
29
28
27
Moisture Content
Number of Blows
25


PLASTICITY CHART
09JD03, 120.0-120.5',
80
60
40
20
0
Plasticity Index
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	09JD03	DATE SAMPLED	
DEPTH	104.0-105.5'	DATE TESTED	09/17/09 LB
SAMPLE NO.			
SOIL DESCR.			
LOCATION	UCM, Jumbo Dome		

Plastic Limit Determination

	1	2
Wt Dish & Wet Soil	6.17	6.33
Wt Dish & Dry Soil	5.33	5.48
Wt of Moisture	0.84	0.85
Wt of Dish	1.12	1.14
Wt of Dry Soil	4.21	4.34
Moisture Content	19.95	19.59

Liquid Limit Determination — Device Number 0860

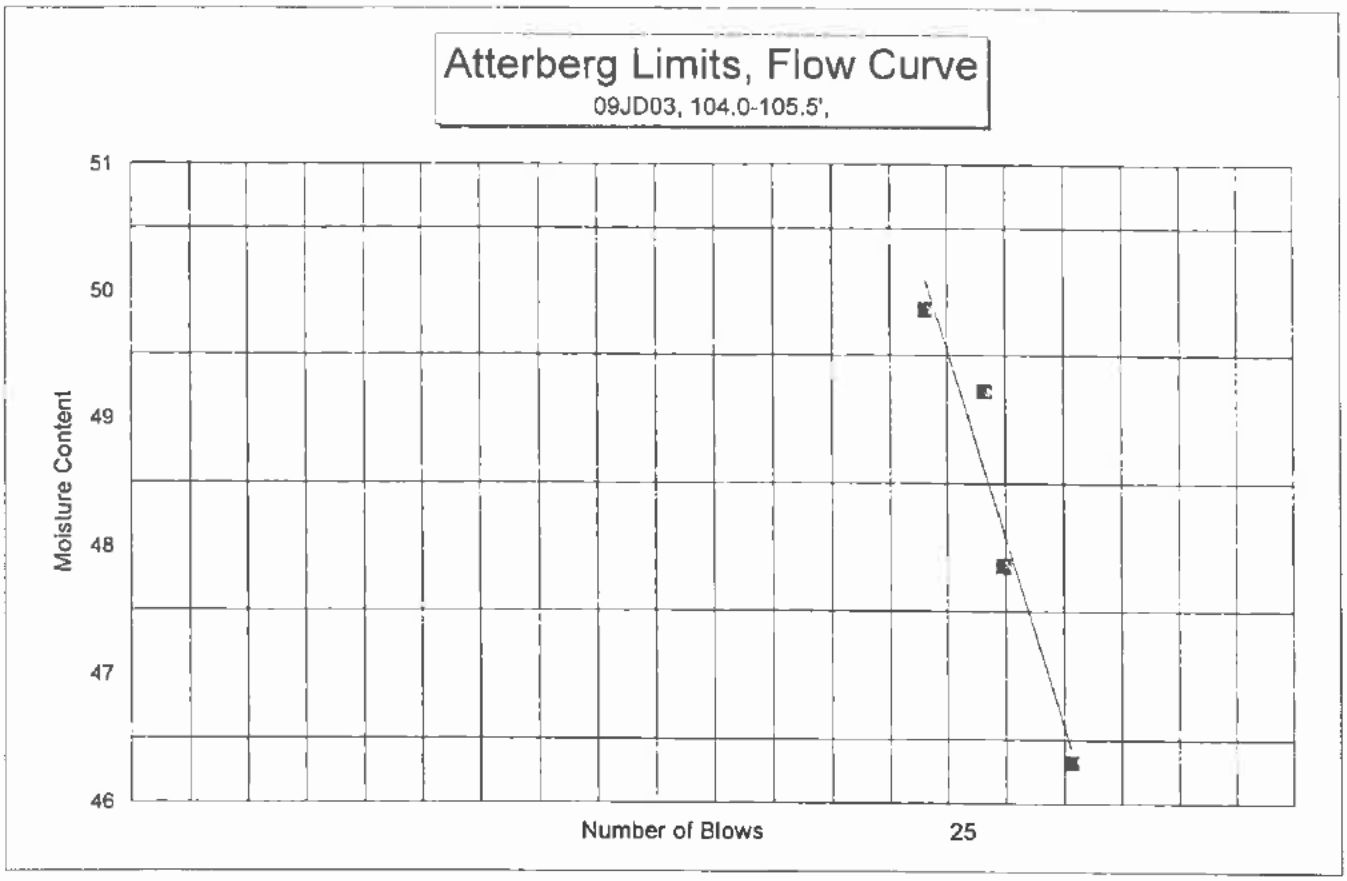
	1	2	3	4
Number of Blows	32	24	27	28
Wt Dish & Wet Soil	11.29	11.80	11.68	11.50
Wt Dish & Dry Soil	8.08	8.25	8.21	8.15
Wt of Moisture	3.21	3.55	3.47	3.35
Wt of Dish	1.15	1.13	1.16	1.15
Wt of Dry Soil	6.93	7.12	7.05	7.00
Moisture Content	46.32	49.86	49.22	47.86

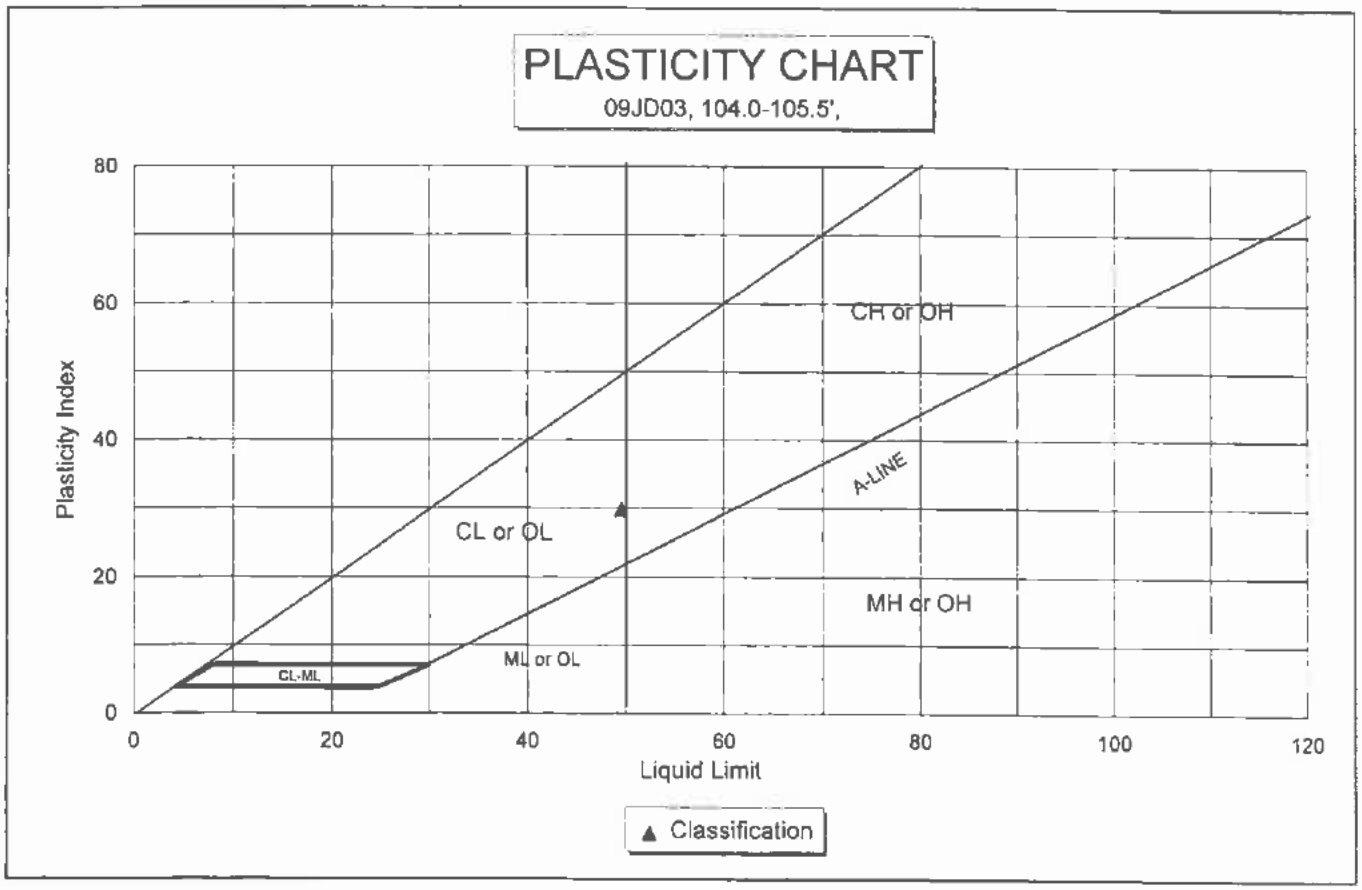
Liquid Limit	49.6
Plastic Limit	19.8
Plasticity Index	29.8

Atterberg Classification CL

Data entry by: MLM Date: 09/18/2009
Checked by: TMR Date: 9/22/09
FileName: AJG01045

ADVANCED TERRA TESTING, INC. ATT


Atterberg Limits, Flow Curve
09JD03, 104.0-105.5',
Moisture Content
51
50
49
48
47
46
Number of Blows
25


PLASTICITY CHART
09JD03, 104.0-105.5',
Plasticity Index
80
60
40
20
0
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	09JD03	DATE SAMPLED	
DEPTH	110.0-110.5'	DATE TESTED	09/16/09 MLM
SAMPLE NO.			
SOIL DESCR.			
LOCATION	UCM, Jumbo Dome		

Plastic Limit Determination

	1	2
Wt Dish & Wet Soil	9.61	9.08
Wt Dish & Dry Soil	8.02	7.56
Wt of Moisture	1.59	1.52
Wt of Dish	1.14	1.13
Wt of Dry Soil	6.88	6.43
Moisture Content	23.11	23.64

Liquid Limit Determination — Device Number 0860

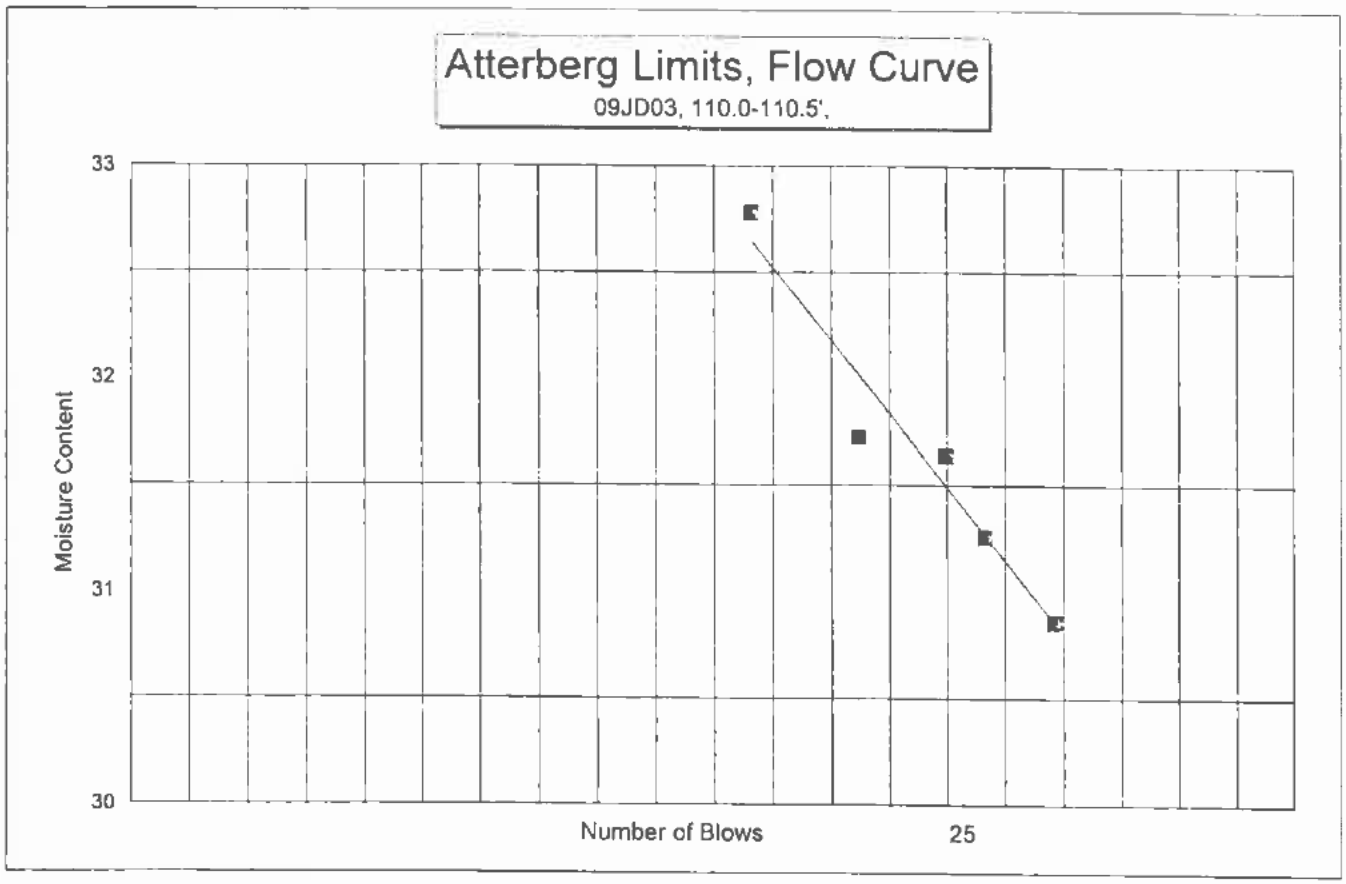
	1	2	3	4	5
Number of Blows	21	27	31	25	17
Wt Dish & Wet Soil	12.06	11.70	11.18	11.22	10.75
Wt Dish & Dry Soil	9.43	9.19	8.81	8.79	8.37
Wt of Moisture	2.63	2.51	2.37	2.43	2.38
Wt of Dish	1.14	1.16	1.13	1.11	1.11
Wt of Dry Soil	8.29	8.03	7.68	7.68	7.26
Moisture Content	31.72	31.26	30.86	31.64	32.78

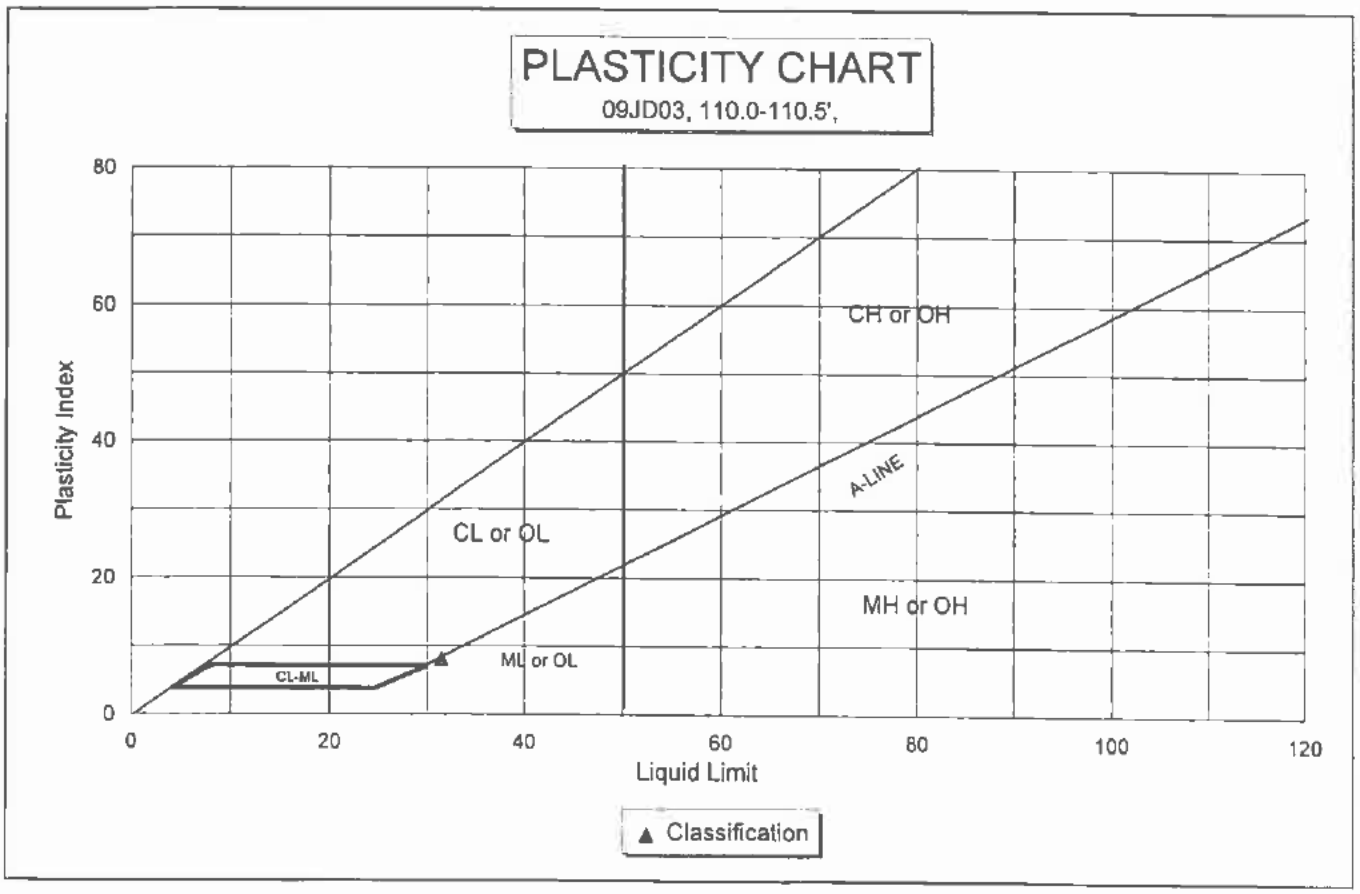
Liquid Limit	31.5
Plastic Limit	23.4
Plasticity Index	8.1

Atterberg Classification ML

Data entry by: MLM Date: 09/18/2009
Checked by: TMR Date: 9/22/09
FileName: AJG01105

ADVANCED TERRA TESTING, INC. ATT


Atterberg Limits, Flow Curve
09JD03, 110.0-110.5',
Moisture Content
33
32
31
30
Number of Blows
25


PLASTICITY CHART
09JD03, 110.0-110.5',
Plasticity Index
80
60
40
20
0
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	09JD03	DATE SAMPLED	
DEPTH	115.0-115.5'	DATE TESTED	09/16/09 MLM
SAMPLE NO.			
SOIL DESCR.			
LOCATION	UCM, Jumbo Dome		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	10.43	10.60	10.29
Wt Dish & Dry Soil	8.16	8.25	8.04
Wt of Moisture	2.27	2.35	2.25
Wt of Dish	0.81	0.82	0.83
Wt of Dry Soil	7.35	7.43	7.21
Moisture Content	30.88	31.63	31.21

Liquid Limit Determination — Device Number 0860

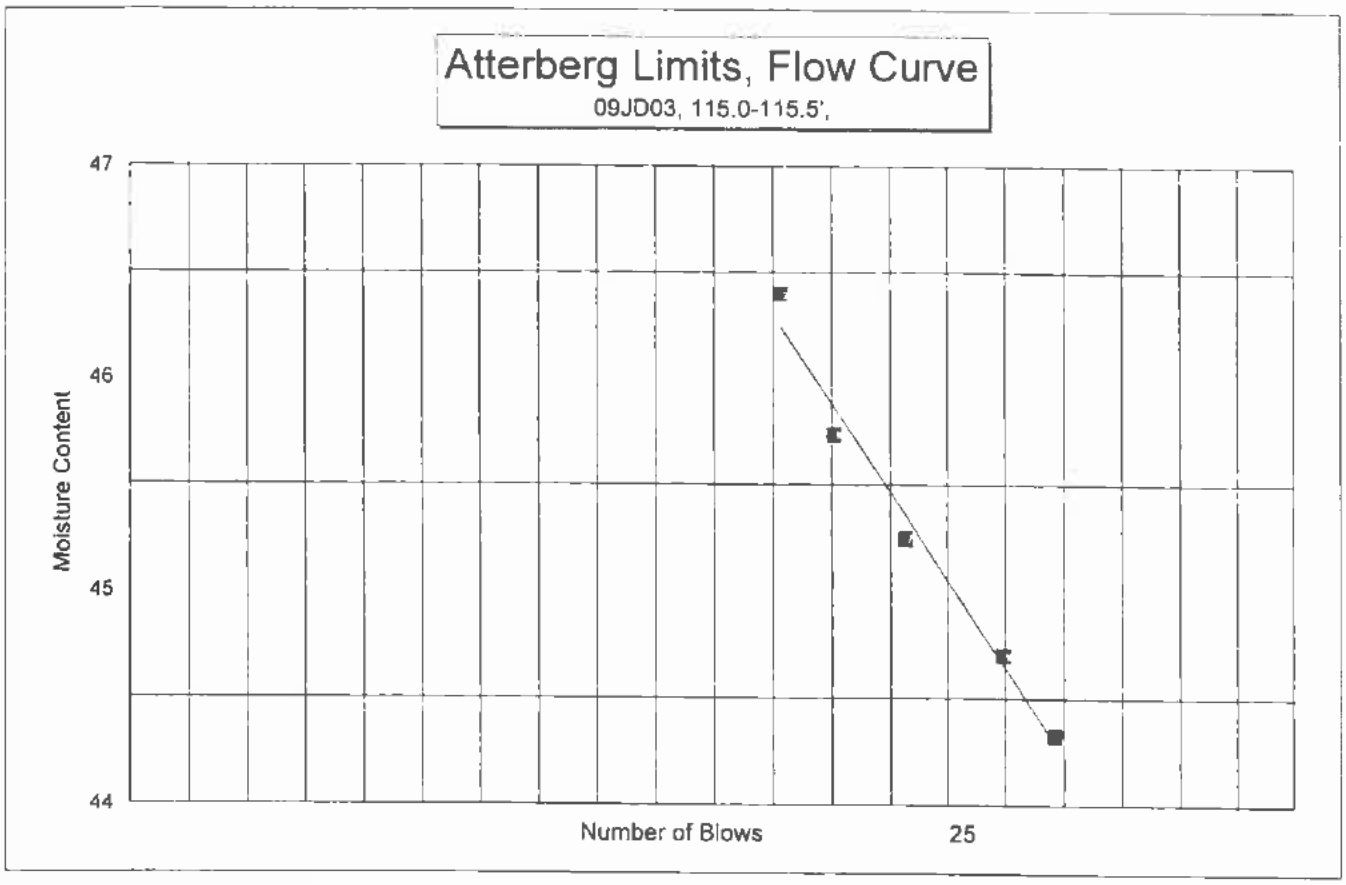
	1	2	3	4	5
Number of Blows	18	20	23	28	31
Wt Dish & Wet Soil	9.55	10.37	9.67	10.23	8.77
Wt Dish & Dry Soil	6.78	7.37	6.91	7.32	6.31
Wt of Moisture	2.77	3.00	2.76	2.91	2.46
Wt of Dish	0.81	0.81	0.81	0.81	0.76
Wt of Dry Soil	5.97	6.56	6.10	6.51	5.55
Moisture Content	46.40	45.73	45.25	44.70	44.32

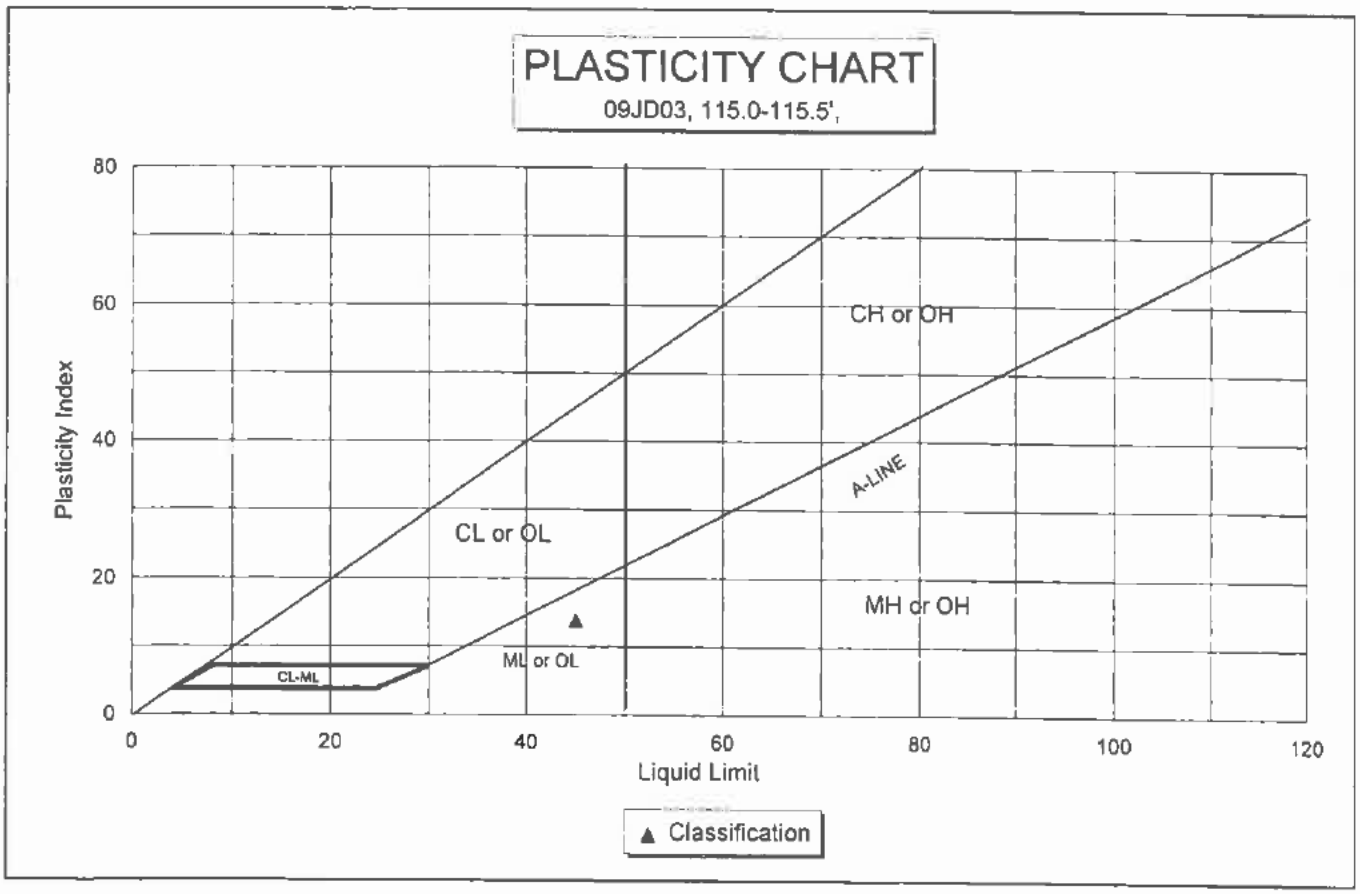
Liquid Limit	45.1
Plastic Limit	31.2
Plasticity Index	13.8

Atterberg Classification ML

Data entry by: MLM Date: 09/18/2009
Checked by: TMP Date: 9/22/09
FileName: AJG01155

ADVANCED TERRA TESTING, INC. ATT


Atterberg Limits, Flow Curve
09JD03, 115.0-115.5',
47
46
45
44
Moisture Content
Number of Blows
25


PLASTICITY CHART
09JD03, 115.0-115.5',
80
60
40
20
0
Plasticity Index
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	08JD03B	DATE SAMPLED	
DEPTH	238.0-242.0'	DATE TESTED	09/13/09 MLM
SAMPLE NO.			
SOIL DESCR.			
LOCATION	UCM, Jumbo Dome		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	7.13	7.05	7.38
Wt Dish & Dry Soil	5.95	5.88	6.17
Wt of Moisture	1.18	1.17	1.21
Wt of Dish	1.05	1.06	1.13
Wt of Dry Soil	4.90	4.82	5.04
Moisture Content	24.08	24.27	24.01

Liquid Limit Determination — Device Number 0860

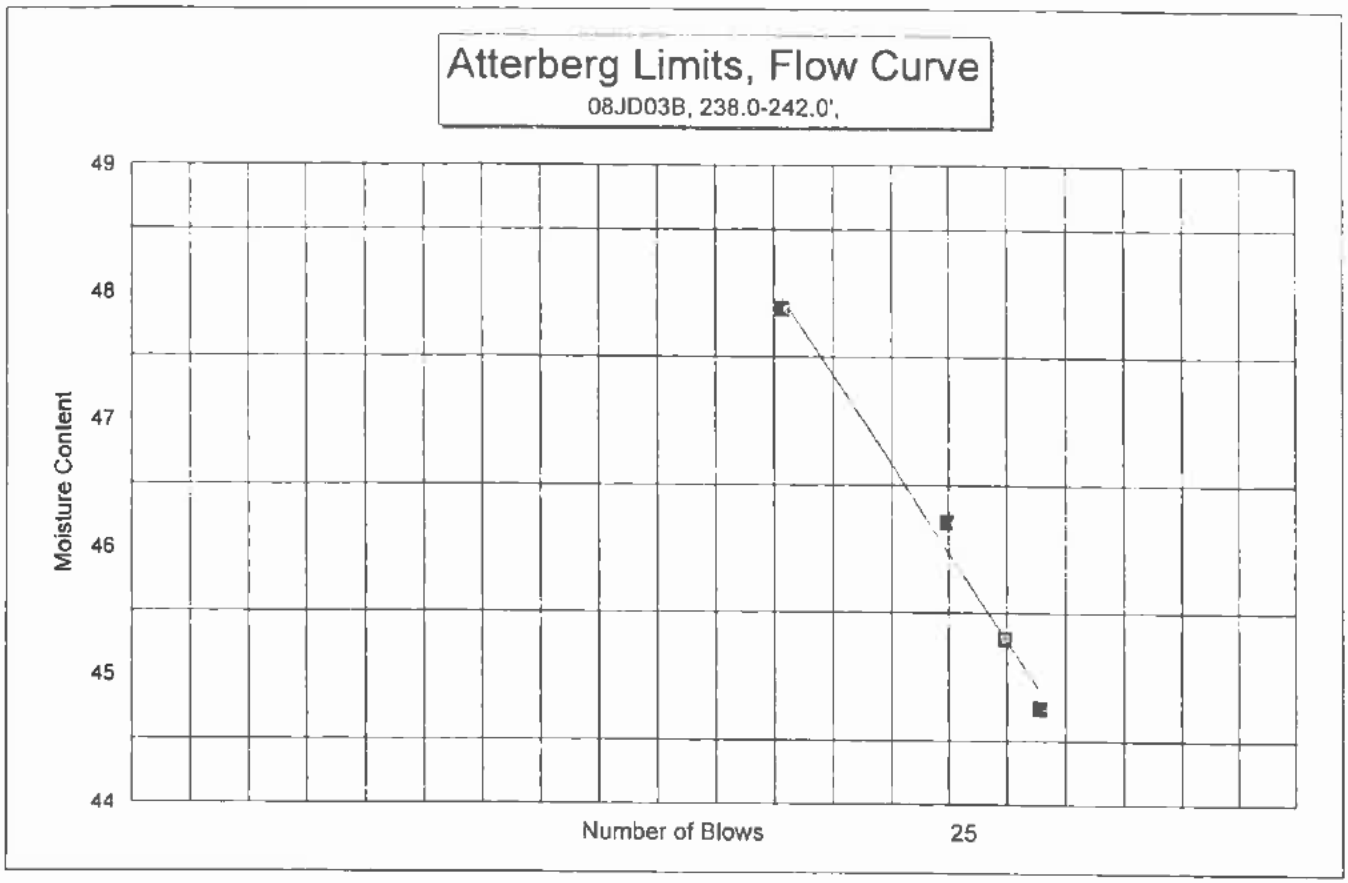
	1	2	3	4
Number of Blows	30	28	18	25
Wt Dish & Wet Soil	13.14	14.24	12.64	12.92
Wt Dish & Dry Soil	9.43	10.15	8.92	9.20
Wt of Moisture	3.71	4.09	3.72	3.72
Wt of Dish	1.14	1.12	1.15	1.15
Wt of Dry Soil	8.29	9.03	7.77	8.05
Moisture Content	44.75	45.29	47.88	46.21

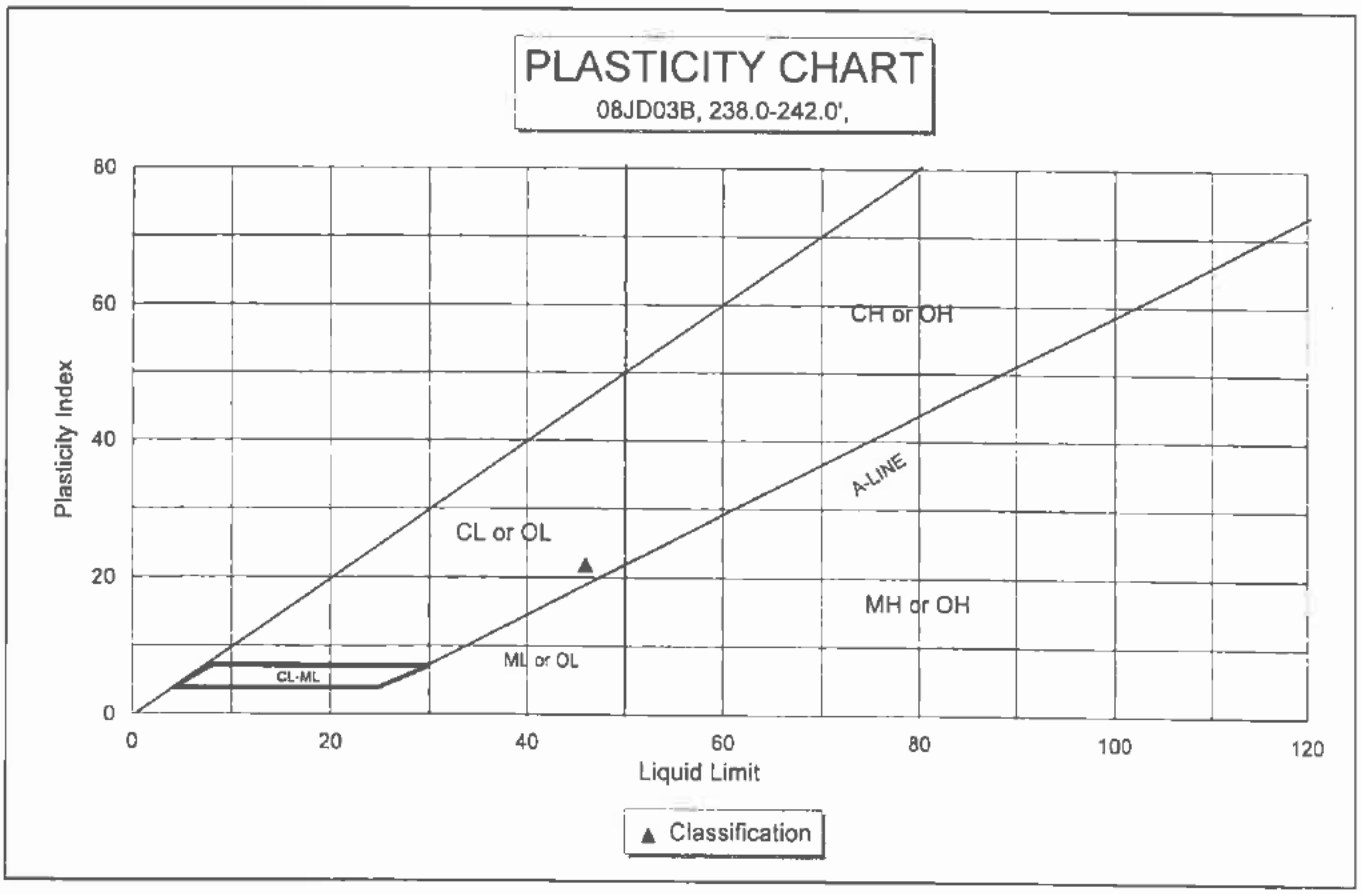
Liquid Limit	46.0
Plastic Limit	24.1
Plasticity Index	21.9

Atterberg Classification CL

Data entry by: MLM Date: 09/14/2009
Checked by: TMR Date: 9/16/09
FileName: AJG008JD

ADVANCED TERRA TESTING, INC. ATT


Atterberg Limits, Flow Curve
08JD03B, 238.0-242.0',
Moisture Content
49
48
47
46
45
44
Number of Blows
25


PLASTICITY CHART
08JD03B, 238.0-242.0',
Plasticity Index
80
60
40
20
0
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	08JD03B	DATE SAMPLED	
DEPTH	296.0-298.0'	DATE TESTED	09/13/09 MLM
SAMPLE NO.			
SOIL DESCR.			
LOCATION	UCM, Jumbo Dome		

Plastic Limit Determination

	1	2
Wt Dish & Wet Soil	6.97	6.85
Wt Dish & Dry Soil	5.75	5.65
Wt of Moisture	1.22	1.20
Wt of Dish	1.11	1.05
Wt of Dry Soil	4.64	4.60
Moisture Content	26.29	26.09

Liquid Limit Determination — Device Number 0860

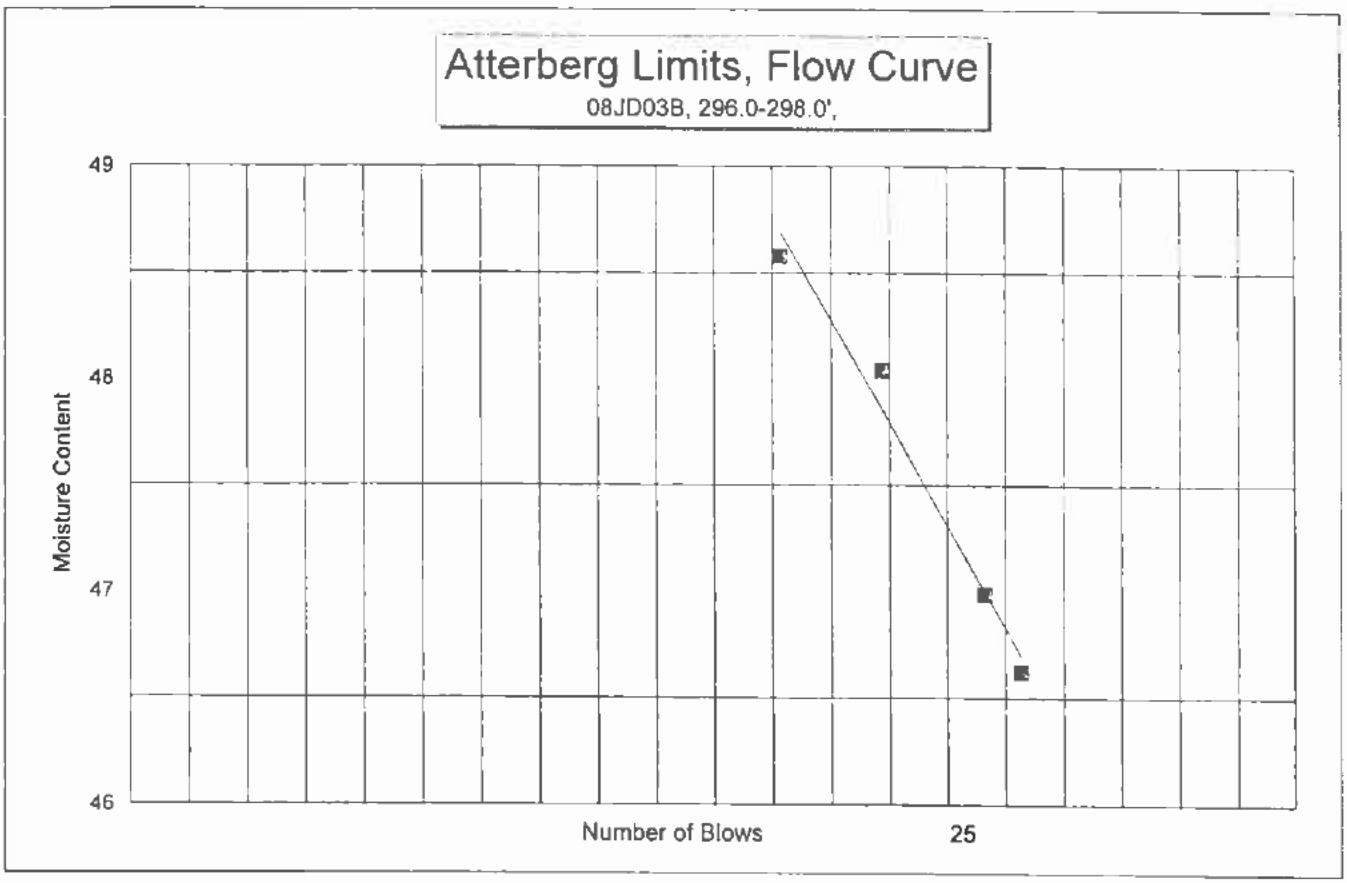
	1	2	3	4
Number of Blows	18	29	27	22
Wt Dish & Wet Soil	12.63	11.99	10.58	12.83
Wt Dish & Dry Soil	8.87	8.54	7.54	9.03
Wt of Moisture	3.76	3.45	3.04	3.80
Wt of Dish	1.13	1.14	1.07	1.12
Wt of Dry Soil	7.74	7.40	6.47	7.91
Moisture Content	48.58	46.62	46.99	48.04

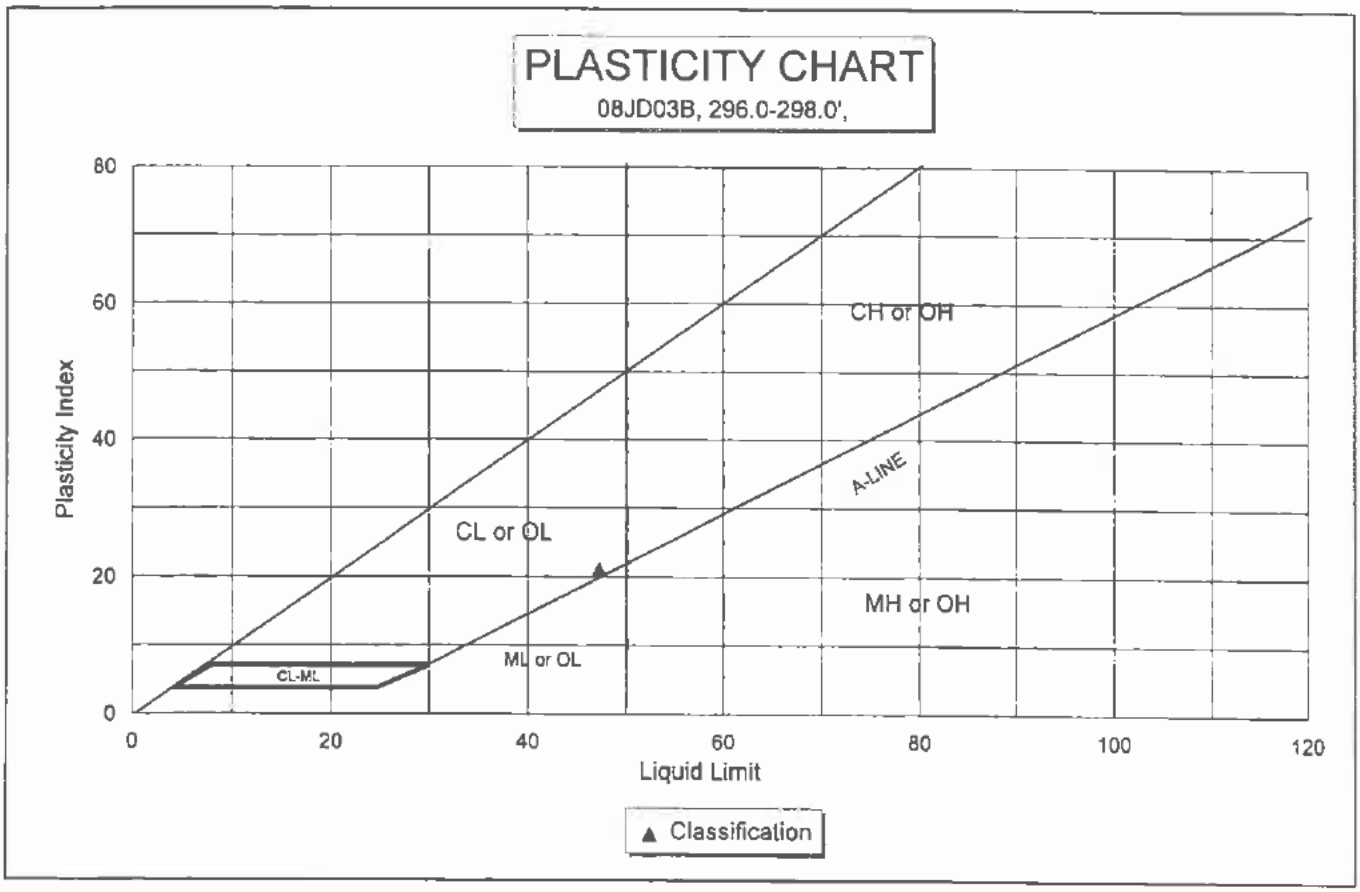
Liquid Limit	47.3
Plastic Limit	26.2
Plasticity Index	21.1

Atterberg Classification CL

Data entry by: MLM Date: 09/14/2009
Checked by: JMR Date: 9/16/09
FileName: AJG0D03B

ADVANCED TERRA TESTING, INC. ATT


Atterberg Limits, Flow Curve
08JD03B, 296.0-298.0',
Moisture Content
49
48
47
46
Number of Blows
25


PLASTICITY CHART
08JD03B, 296.0-298.0',
Plasticity Index
80
60
40
20
0
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	08JD02B	DATE SAMPLED	
DEPTH	193.0-196.0'	DATE TESTED	09/12/09 LB
SAMPLE NO.			
SOIL DESCR.			
LOCATION	UCM, Jumbo Dome		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	6.03	6.23	6.59
Wt Dish & Dry Soil	5.33	5.51	5.80
Wt of Moisture	0.70	0.72	0.79
Wt of Dish	1.15	1.13	1.14
Wt of Dry Soil	4.18	4.38	4.66
Moisture Content	16.75	16.44	16.95

Liquid Limit Determination — Device Number 0860

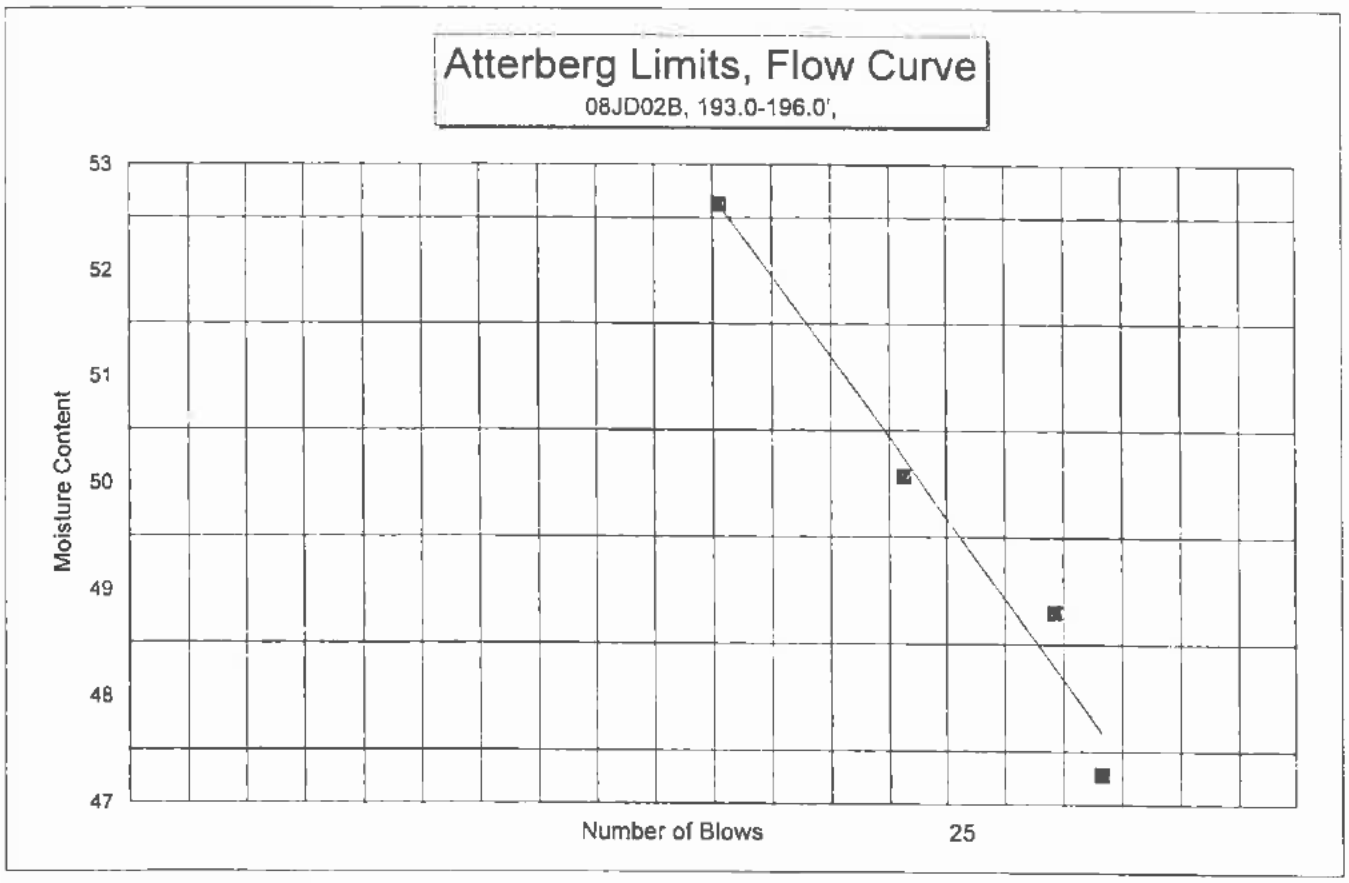
	1	2	3	4
Number of Blows	16	34	23	31
Wt Dish & Wet Soil	13.31	11.96	11.99	10.44
Wt Dish & Dry Soil	9.11	8.48	8.37	7.39
Wt of Moisture	4.20	3.48	3.62	3.05
Wt of Dish	1.13	1.12	1.14	1.14
Wt of Dry Soil	7.98	7.36	7.23	6.25
Moisture Content	52.63	47.28	50.07	48.80

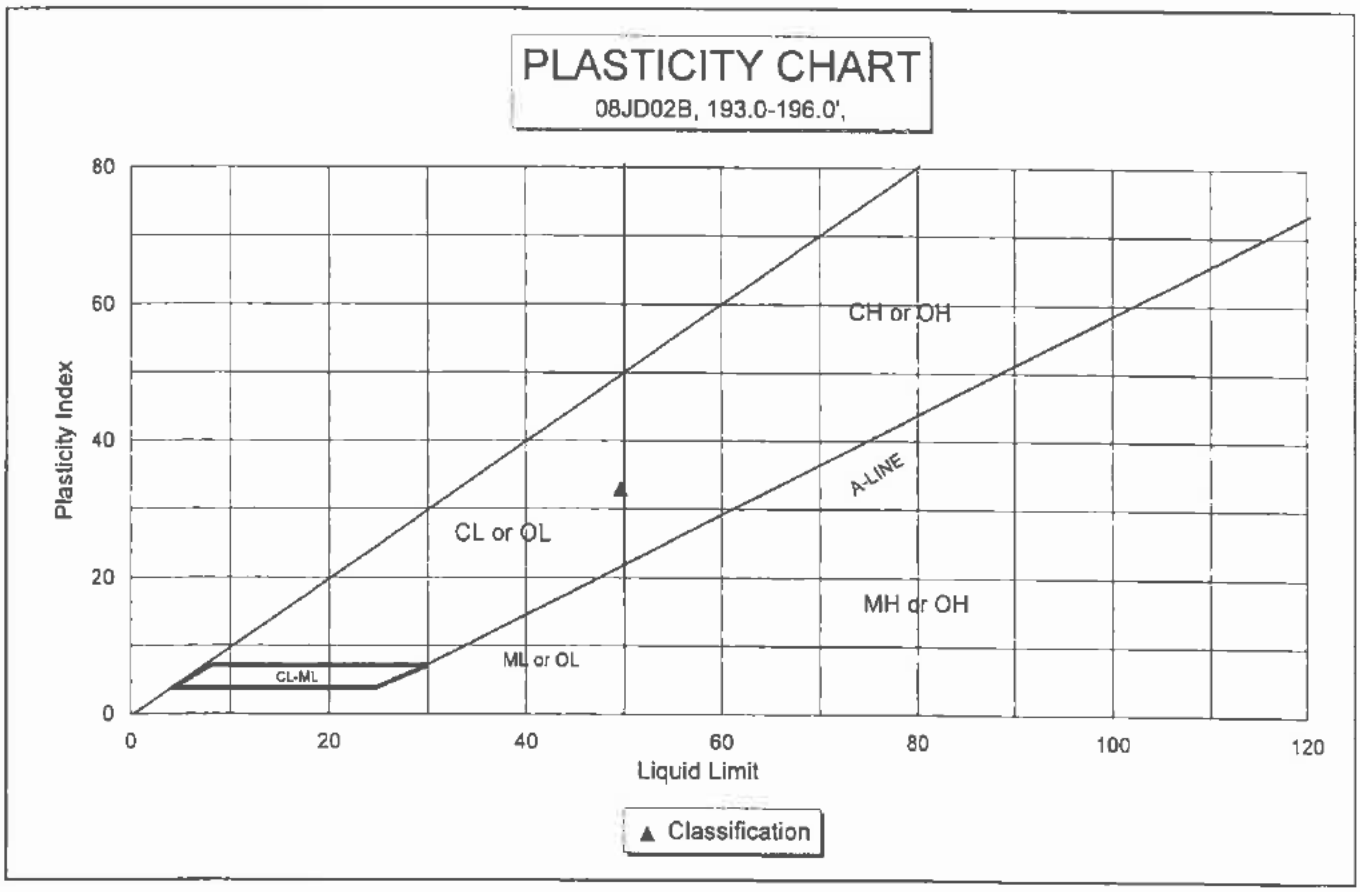
Liquid Limit	49.7
Plastic Limit	16.7
Plasticity Index	33.0

Atterberg Classification CL

Data entry by: MLM Date: 09/14/2009
Checked by: LB Date: 9-15-09
FileName: AJG0D02B

ADVANCED TERRA TESTING, INC. ATT


Atterberg Limits, Flow Curve
08JD02B, 193.0-196.0',
Moisture Content
53
52
51
50
49
48
47
Number of Blows
25


PLASTICITY CHART
08JD02B, 193.0-196.0',
Plasticity Index
80
60
40
20
0
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax Ltd.	JOB NO.	2692-16
BORING NO.	09JD11	DATE SAMPLED	--
DEPTH	11.0-11.5'	DATE TESTED	10/27/09 WAR
SAMPLE NO.	2.3		
SOIL DESCR.	--		
LOCATION	Usibelli Coal Mine, Jumbo Dome		

Plastic Limit
Determination

Wt Dish & Wet Soil
Wt Dish & Dry Soil
Wt of Moisture
Wt of Dish — NON-PLASTIC
Wt of Dry Soil
Moisture Content

Liquid Limit Device Number 0860
Determination

Number of Blows

Wt Dish & Wet Soil
Wt Dish & Dry Soil
Wt of Moisture
Wt of Dish — NON-PLASTIC
Wt of Dry Soil
Moisture Content

Liquid Limit	NP
Plastic Limit	NP
Plasticity Index	NP

Atterberg Classification NP

Data entry by: MLM Date: 10/27/2009
Checked by: TMR Date: 10/27/09
FileName: AJG01111

ADVANCED TERRA TESTING, INC. ATT

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax Ltd.	JOB NO.	2692-16
BORING NO.	09JD11	DATE SAMPLED	--
DEPTH	10.0-10.5'	DATE TESTED	10/27/09 WAR
SAMPLE NO.	2.1		
SOIL DESCR.	--		
LOCATION	Usibelli Coal Mine, Jumbo Dome		

Plastic Limit
Determination

Wt Dish & Wet Soil
Wt Dish & Dry Soil
Wt of Moisture
Wt of Dish — NON-PLASTIC
Wt of Dry Soil
Moisture Content

Liquid Limit Determination — Device Number 0860

Number of Blows

Wt Dish & Wet Soil
Wt Dish & Dry Soil
Wt of Moisture
Wt of Dish — NON-PLASTIC
Wt of Dry Soil
Moisture Content

Liquid Limit	NP
Plastic Limit	NP
Plasticity Index	NP

Atterberg Classification — NP

Data entry by: MLM Date: 10/27/2009
Checked by: TMR Date: 10/27/09
FileName: AJG01010

ADVANCED TERRA TESTING, INC. ATT

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax Ltd.	JOB NO.	2692-16
BORING NO.	09JD12	DATE SAMPLED	--
DEPTH	10.5-11.0'	DATE TESTED	10/27/09 WAR
SAMPLE NO.	2.2		
SOIL DESCR.	--		
LOCATION	Usibelli Coal Mine, Jumbo Dome		

Plastic Limit
Determination

Wt Dish & Wet Soil
Wt Dish & Dry Soil
Wt of Moisture
Wt of Dish — NON-PLASTIC
Wt of Dry Soil
Moisture Content

Liquid Limit — Device Number 0860
Determination

Number of Blows

Wt Dish & Wet Soil
Wt Dish & Dry Soil
Wt of Moisture
Wt of Dish — NON-PLASTIC
Wt of Dry Soil
Moisture Content

Liquid Limit	NP
Plastic Limit	NP
Plasticity Index	NP

Atterberg Classification NP

Data entry by: MLM Date: 10/27/2009
Checked by: TMR Date: 10/27/09
FileName: AJG01051

ADVANCED TERRA TESTING, INC. ATT

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax Ltd.	JOB NO.	2692-16
BORING NO.	09JD11	DATE SAMPLED	--
DEPTH	5.0-5.5'	DATE TESTED	10/27/09 WAR
SAMPLE NO.	1.1		
SOIL DESCR.	--		
LOCATION	Usibelli Coal Mine, Jumbo Dome		

Plastic Limit
Determination

Wt Dish & Wet Soil	
Wt Dish & Dry Soil	
Wt of Moisture	
Wt of Dish	NON-PLASTIC
Wt of Dry Soil	
Moisture Content	

Liquid Limit Device Number 0860
Determination

Number of Blows

Wt Dish & Wet Soil	
Wt Dish & Dry Soil	
Wt of Moisture	
Wt of Dish	NON-PLASTIC
Wt of Dry Soil	
Moisture Content	

Liquid Limit	NP
Plastic Limit	NP
Plasticity Index	NP

Atterberg Classification NP

Data entry by: MLM Date: 10/27/2009
Checked by: JMR Date: 10/27/09
FileName: AJG05055

ADVANCED TERRA TESTING, INC. ATT

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Ajax Ltd.	JOB NO.	2692-16
BORING NO.	09JD11	DATE SAMPLED	–
DEPTH	6.0-6.5'	DATE TESTED	10/27/09 WAR
SAMPLE NO.	1.3		
SOIL DESCR.	--		
LOCATION	Usibelli Coal Mine, Jumbo Dome		

Plastic Limit
Determination

Wt Dish & Wet Soil
Wt Dish & Dry Soil
Wt of Moisture
Wt of Dish — NON-PLASTIC
Wt of Dry Soil
Moisture Content

Liquid Limit — Device Number 0860
Determination

Number of Blows

Wt Dish & Wet Soil
Wt Dish & Dry Soil
Wt of Moisture
Wt of Dish — NON-PLASTIC
Wt of Dry Soil
Moisture Content

Liquid Limit	NP
Plastic Limit	NP
Plasticity Index	NP

Atterberg Classification NP

Data entry by: MLM Date: 10/27/2009
Checked by: IMR Date: 10/27/09
FileName: AJG06065

ADVANCED TERRA TESTING, INC. ATT

Atterberg Limit Worksheet (Single Point Method)

(for use with ST-3, Atterberg Limits of Soil, D4318)

Date: 10/8/2009
Technician: DN
Workorder: 2800-1
Sample #: 09-JD-09 Depth 68'
Project: Usibelli
Equipment Used:

Soil Description: Lean Clay (CL)

Natural Moisture Content	1	2
Container Number		
Tare Weight (g)		
Mass of Wet Soil + Tare (g)		
Mass of Dry Soil + Tare (g)		
Mass of Wet Soil (g)		
Mass of Dry Soil (g)		
Moisture Content %		
Average		

Was soil air-dried?
Percentage Retained on the No. 40 sieve

Liquid Limit Test	1	2
Container Number	1003	1004
Number of Blows to Close	25	25
Correction Factor (K)	1	1
Tare Weight (g)	0.69	0.71
Mass of Wet Soil + Tare (g)	9.35	13.69
Mass of Dry Soil + Tare (g)	6.06	8.74
Mass of Wet Soil (g)	8.7	13.0
Mass of Dry Soil (g)	5.4	8.0
Moisture Content % (w)	61.3%	61.6%
Test Liquid Limit (w*k)	61	62

Correction Factor (K)

Number of Drops	K
20	0.970
21	0.979
22	0.985
23	0.990
24	0.995
25	1.000
26	1.005
27	1.009
28	1.014
29	1.018
30	1.022

Plastic Limit Test	1	2
Container Number		
Tare Weight (g)	33.6	30.12
Mass of Wet Soil + Tare (g)	35.63	32.42
Mass of Dry Soil + Tare (g)	35.23	31.95
Mass of Wet Soil (g)	2.0	2.3
Mass of Dry Soil (g)	1.6	1.8
Moisture Content %	24.5%	25.7%

Calculation

Liquid Limit	61
Plastic Limit	25
Plasticity Index	36

Reviewed by

Shannon Wilson, Inc.
2055 Hill Road
Fairbanks, Alaska 99709

Atterberg Limit Worksheet (Single Point Method)

(for use with ST-3, Atterberg Limits of Soil, D4318)

Date: 10/8/2009
Technician: DN
Workorder: 2800-1
Sample #: 09-JD-05 Depth 165-166'
Project: **Usibelli**
Equipment Used:

Soil Description: Lean Clay (CL)

Natural Moisture Content	1	2
Container Number		
Tare Weight (g)		
Mass of Wet Soil + Tare (g)		
Mass of Dry Soil + Tare (g)		
Mass of Wet Soil (g)		
Mass of Dry Soil (g)		
Moisture Content %		
Average		

Was soil air-dried?
Percentage Retained on the No. 40 sieve

Liquid Limit Test	1	2
Container Number	1002	1001
Number of Blows to Close	25	25
Correction Factor (K)	1	1
Tare Weight (g)	0.7	0.69
Mass of Wet Soil + Tare (g)	13.68	11.73
Mass of Dry Soil + Tare (g)	9.06	7.82
Mass of Wet Soil (g)	13.0	11.0
Mass of Dry Soil (g)	8.4	7.1
Moisture Content % (w)	55.3%	54.8%
Test Liquid Limit (w*k)	55	55

Correction Factor (K)

Number of Drops	K
20	0.970
21	0.979
22	0.985
23	0.990
24	0.995
25	1.000
26	1.005
27	1.009
28	1.014
29	1.018
30	1.022

Plastic Limit Test	1	2
Container Number	6	7
Tare Weight (g)	29.94	34.58
Mass of Wet Soil + Tare (g)	34.79	37.97
Mass of Dry Soil + Tare (g)	33.83	37.34
Mass of Wet Soil (g)	4.9	3.4
Mass of Dry Soil (g)	3.9	2.8
Moisture Content %	24.7%	22.8%

Calculation

Liquid Limit	55
Plastic Limit	24
Plasticity Index	31

Reviewed by

Shannon Wilson, Inc
2055 Hill Road
Fairbanks, Alaska 99709

DIRECT SHEAR
ASTM D 3080

DIRECT SHEAR TEST DATA
ASTM D 3080

CLIENT Ajax Ltd.

JOB NO. 2692-14

BORING NO.	09JD05	SAMPLED	
DEPTH	222.0-223.0'	TEST STARTED	09/19/09 LB
SAMPLE NO.		TEST FINISHED	09/19/09 LB
POINT	A	CELL NUMBER	Geomatic
SOIL DESCR.		SATURATED TEST	Yes
LOCATION	UCM, Jumbo Dome	TEST TYPE	CD
NORMAL STRESS (psf)	21418		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture (g)	104.2	105.9
Wt. Wet Soil & Pan (g)	112.5	114.2
Wt. Dry Soil & Pan (g)	98.5	98.5
Wt. Lost Moisture (g)	14.0	15.7
Wt. of Pan Only (g)	8.3	8.3
Wt. of Dry Soil (g)	90.2	90.2
Moisture Content %	15.5	17.4
Wet Density (pcf)	134.5	142.0
Dry Density (pcf)	116.5	121.0

Init. Diameter (in)	1.938
Init. Area (sq in)	2.950
Init. Height (in)	1.000
Vol. Bef. Consol. (cu ft)	0.00171
Final Height (in)	0.963
Vol. After Consol. (cu ft)	0.00164

Test Set Up: Continuous Increasing Deflection Control
Shear Speed: 0.00510 in/min

Notes & Comments:

Data File Name: AJDSD05A

Normal Stress:	21418 psf	148.74 psi
Peak Stress:	17025 psf	118.23 psi
Ultimate Stress:	11841 psf	82.23 psi

Data entry by: MLM Date: 09/21/2009
Data checked by: LB Date: 9-23-09
FileName: AJDS2223

ADVANCED TERRA TESTING, INC. ATT

DIRECT SHEAR TEST DATA
ASTM D 3080

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	09JD05	SAMPLED	
DEPTH	222.0-223.0'	TEST STARTED	09/19/09 LB
SAMPLE NO.		TEST FINISHED	09/19/09 LB
POINT	B	CELL NUMBER	Geomatic
SOIL DESCR.		SATURATED TEST	Yes
LOCATION	UCM, Jumbo Dome	TEST TYPE	CD
NORMAL STRESS (psf)	18016		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture (g)	101.1	101.7
Wt. Wet Soil & Pan (g)	109.3	109.9
Wt. Dry Soil & Pan (g)	96.2	96.2
Wt. Lost Moisture (g)	13.1	13.7
Wt. of Pan Only (g)	8.3	8.3
Wt. of Dry Soil (g)	88.0	88.0
Moisture Content %	14.9	15.6
Wet Density (pcf)	130.5	138.1
Dry Density (pcf)	113.6	119.5

Init. Diameter (in)	1.938
Init. Area (sq in)	2.950
Init. Height (in)	1.000
Vol. Bef. Consol. (cu ft)	0.00171
Final Height (in)	0.951
Vol. After Consol. (cu ft)	0.00162

Test Set Up: Continuous Increasing Deflection Control
Shear Speed: 0.00510 in/min

Notes & Comments:

Data File Name: AJDSD05B

Normal Stress:	18016 psf	125.11 psi
Peak Stress:	11767 psf	81.72 psi
Ultimate Stress:	8970 psf	62.29 psi

Data entry by: MLM Date: 09/21/2009
Data checked by: LB Date: 9-23-09
FileName: AJDS2223

ADVANCED TERRA TESTING, INC. ATT

DIRECT SHEAR TEST DATA
ASTM D 3080

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	09JD05	SAMPLED	
DEPTH	222.0-223.0'	TEST STARTED	09/19/09 LB
SAMPLE NO.		TEST FINISHED	09/19/09 LB
POINT	C	CELL NUMBER	Geomatic
SOIL DESCR.		SATURATED TEST	Yes
LOCATION	UCM, Jumbo Dome	TEST TYPE	CD
NORMAL STRESS (psf)	12023		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture (g)	102.5	105.4
Wt. Wet Soil & Pan (g)	110.9	113.8
Wt. Dry Soil & Pan (g)	97.9	97.9
Wt. Lost Moisture (g)	13.0	16.0
Wt. of Pan Only (g)	8.4	8.4
Wt. of Dry Soil (g)	89.5	89.5
Moisture Content %	14.6	17.8
Wet Density (pcf)	132.3	139.6
Dry Density (pcf)	115.5	118.5

Init. Diameter (in)	1.938
Init. Area (sq in)	2.950
Init. Height (in)	1.000
Vol. Bef. Consol. (cu ft)	0.00171
Final Height (in)	0.975
Vol. After Consol. (cu ft)	0.00166

Test Set Up: Continuous Increasing Deflection Control
Shear Speed: 0.00510 in/min

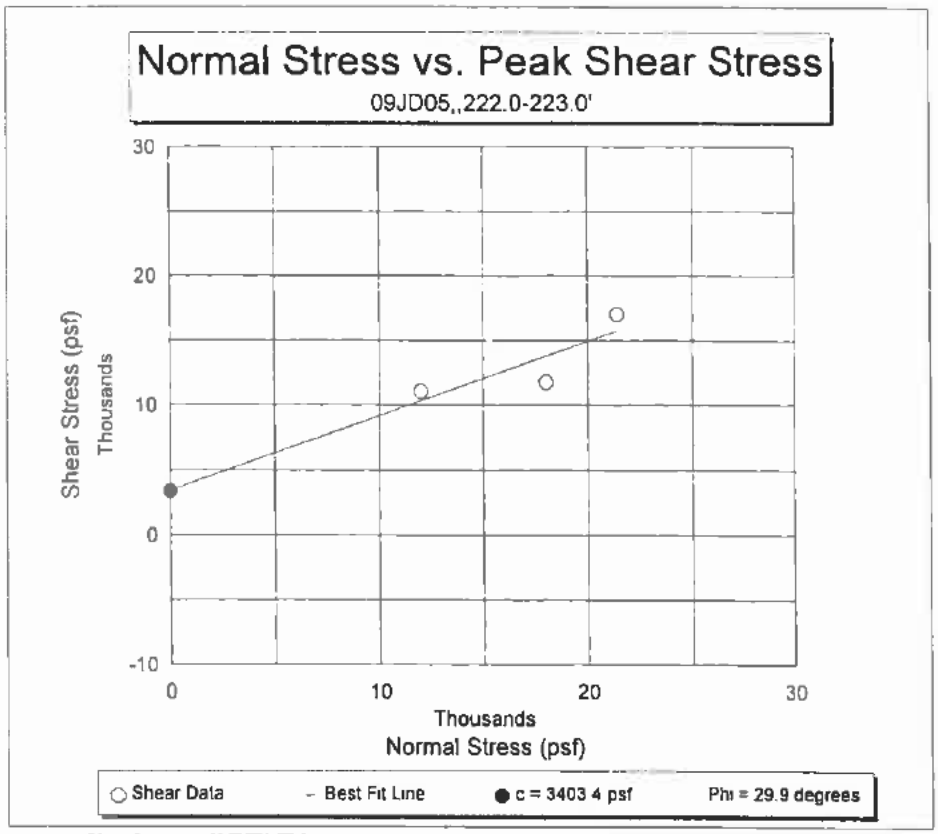
Notes & Comments:

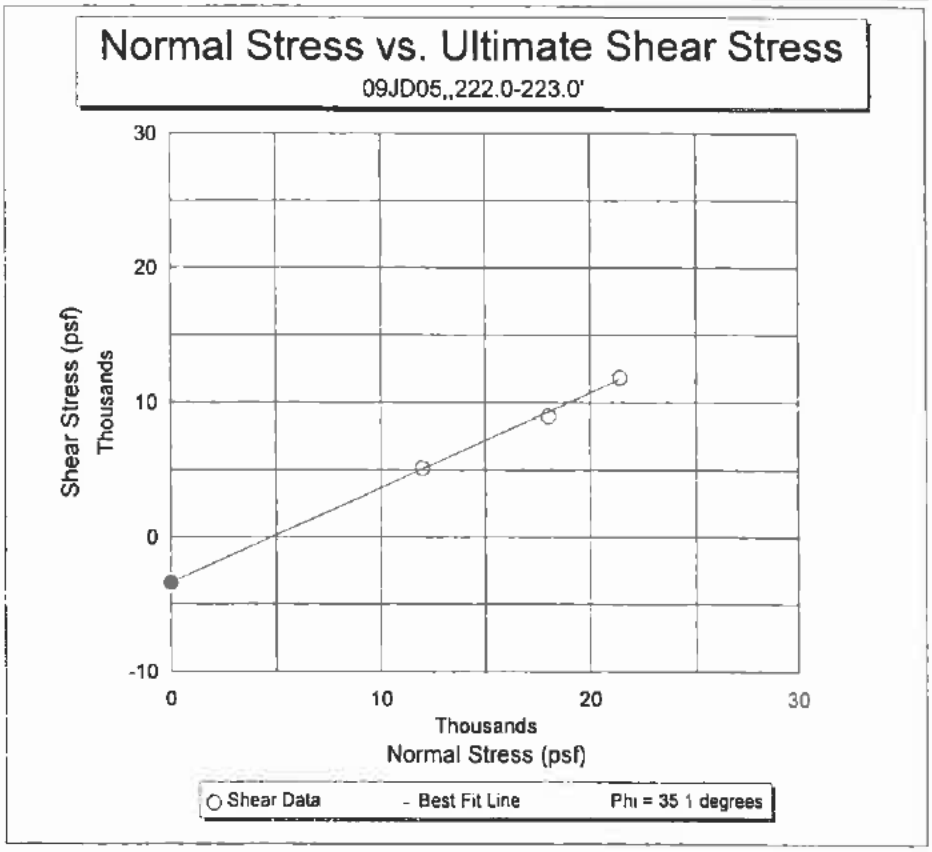
Data File Name: AJDSD05C

Normal Stress:	12023 psf	83.49 psi
Peak Stress:	11058 psf	76.79 psi
Ultimate Stress:	5147 psf	35.74 psi

Data entry by: MLM Date: 09/21/2009
Data checked by: LB Date: 9-23-09
FileName: AJDS2223

ADVANCED TERRA TESTING, INC. ATT



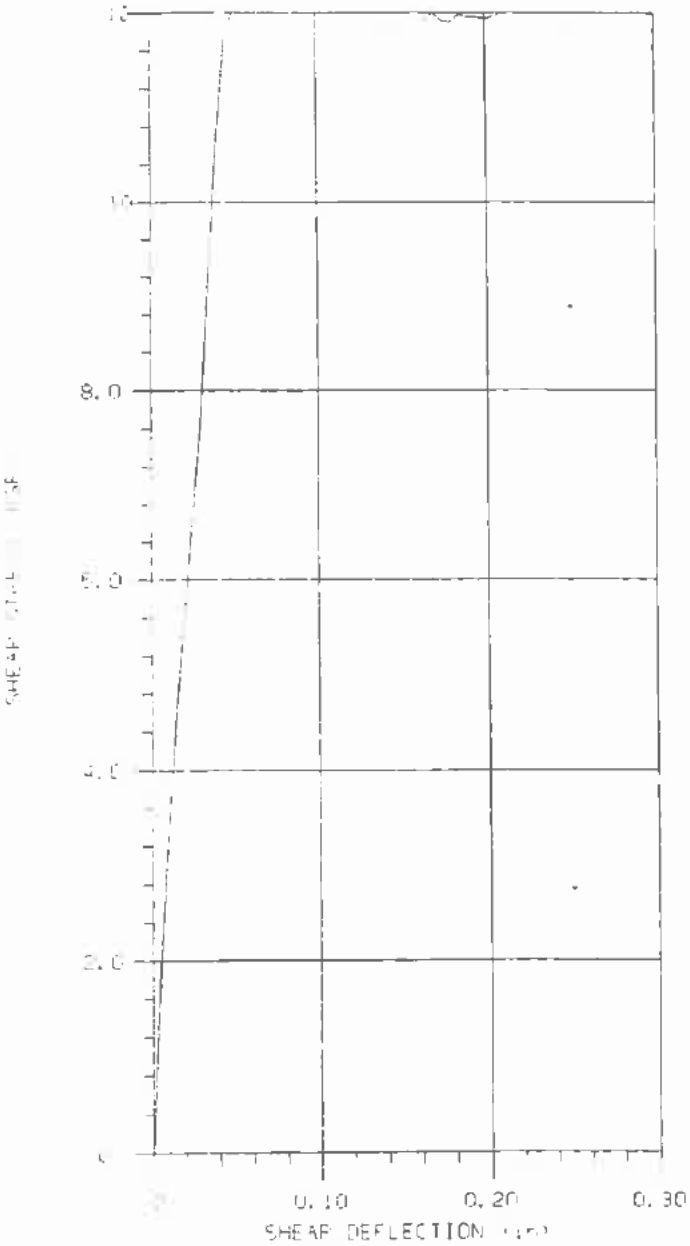


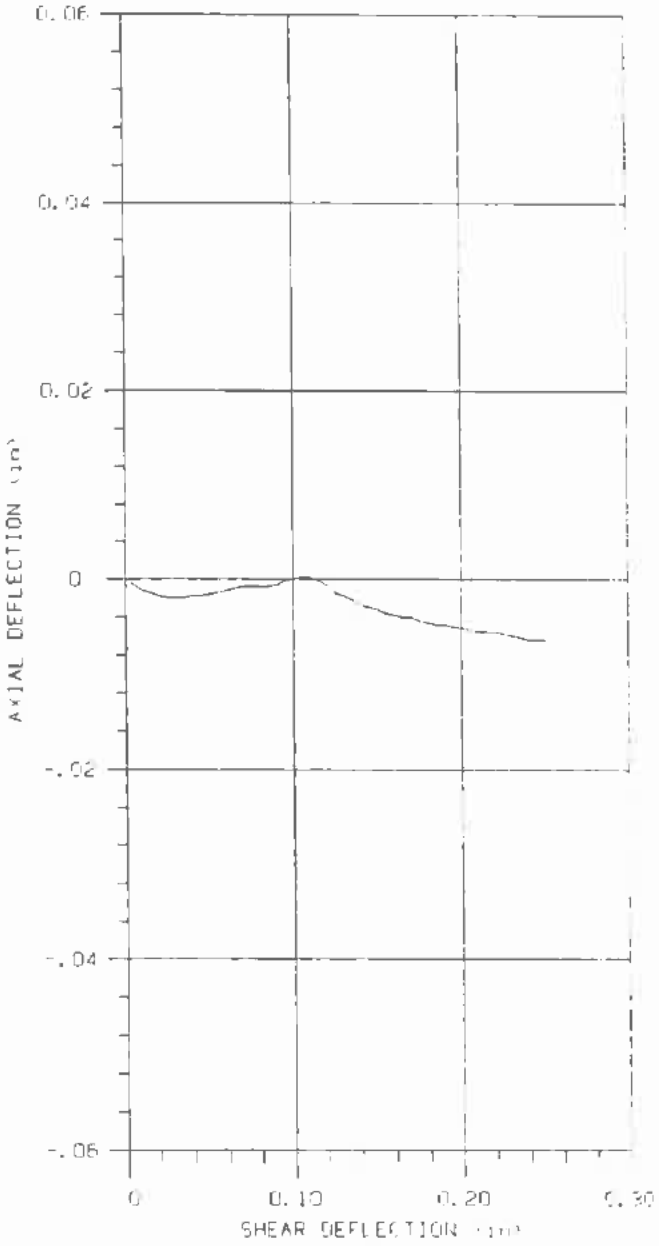
Data suggested negative cohesion intercept on Ultimate Shear Stress Graph. No cohesion value is reported.

Direct Shear Test

Client..... Ajax
Location..... UCM Jumbo Dome

Soil Type.....	Pt A	Job Number.....	2692-14
Depth.....	222-3 (ft)	Sample Number...	
Confining Pressure..	21418 (psf)	Boring.....	09J005
Shear Rate.....	0.0051 (in/min)	File Name.....	ajdsd05a.DAT
Date Tested.....	09-19-2009	Tested By.....	LB





Pass Number and Line Type....	1 ———	2 - - - - - -	3 — - —	4 — - - -
Maximum Shear Stress.....	17025	.0000	.0000	.0000
Shear Deflection @ Max Stress.	.0927	.0000	.0000	.0000

GEOMATIC Direct Shear Data

File Name.....ajdsd05a.DAT
Client.....Ajax
Job Number....2692-14
Location.....UCM Jumbo Dome
Date.....09-19-2009
Technician....LB
Sample Diameter (in).....1.938
Confining Pressure (psf)..21418
Number of Passes.....1
Shear Distance (in).....0.25
Shear Rate (in/min).....0.0051
Soil Type.....Pt A
Boring Number.....09JD05
Sample Number.....
Depth (ft).....222-3

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.005	2070	-.0007
0.010	3375	-.0012
0.015	4587	-.0015
0.020	5650	-.0017
0.025	6657	-.0020
0.030	7664	-.0020
0.035	9175	-.0020
0.040	10685	-.0019
0.045	11785	-.0017
0.050	12662	-.0016
0.055	13333	-.0015
0.060	14042	-.0012
0.065	14489	-.0009
0.071	14042	-.0008
0.075	13650	-.0008
0.080	13687	-.0008
0.085	15198	-.0008
0.090	16410	-.0006
0.095	16914	-.0002
0.100	16410	0.0000
0.105	16168	0.0001
0.110	15981	0.0001
0.115	14825	-.0001
0.120	13799	-.0007
0.125	13053	-.0013
0.130	12513	-.0017
0.135	12140	-.0022
0.140	11916	-.0027
0.145	11785	-.0030
0.150	11823	-.0032
0.155	11897	-.0036
0.160	11953	-.0038
0.165	11916	-.0039
0.170	11991	-.0041
0.175	11916	-.0044

Continued next page.

Pass 1 Continued

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.180	11897	-.0046
0.185	11972	-.0047
0.190	11953	-.0048
0.195	11953	-.0050
0.200	11935	-.0052
0.205	11953	-.0054
0.210	11991	-.0055
0.215	12046	-.0055
0.220	12084	-.0057
0.225	12158	-.0058
0.230	12196	-.0060
0.235	12214	-.0062
0.240	12121	-.0063
0.245	11897	-.0063
0.250	11841	-.0064

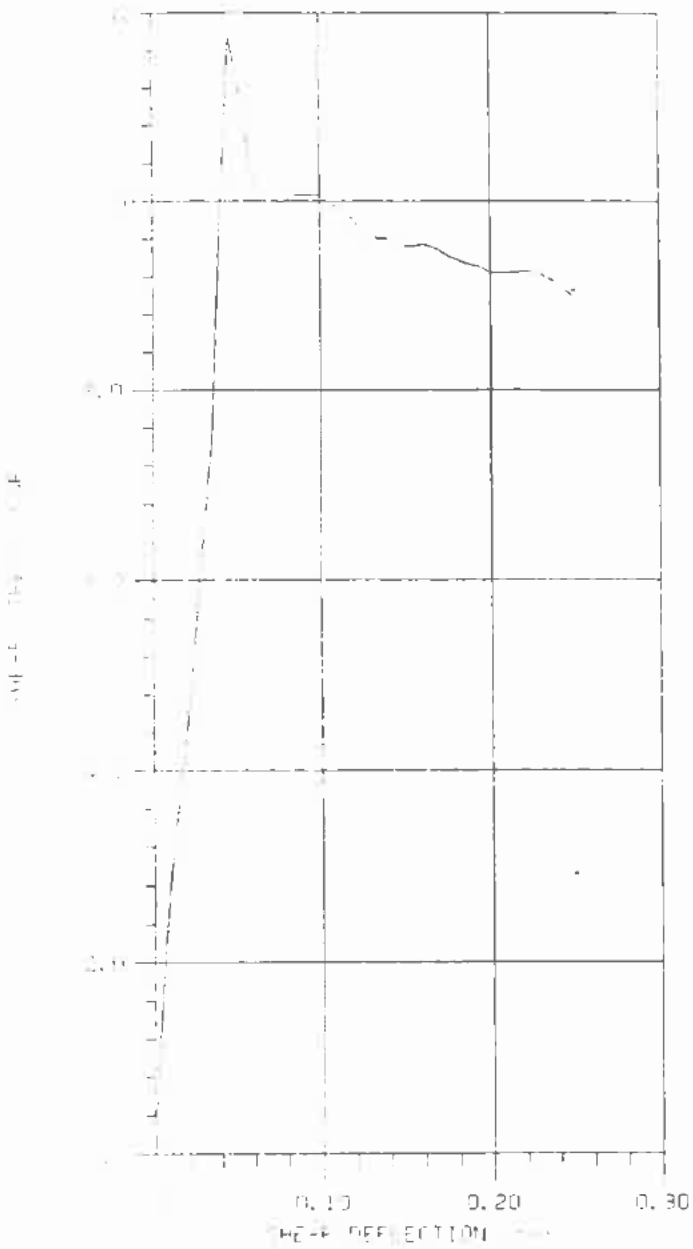
Pass 1 completed with max load = 17025 psf at deflection of .0927 in

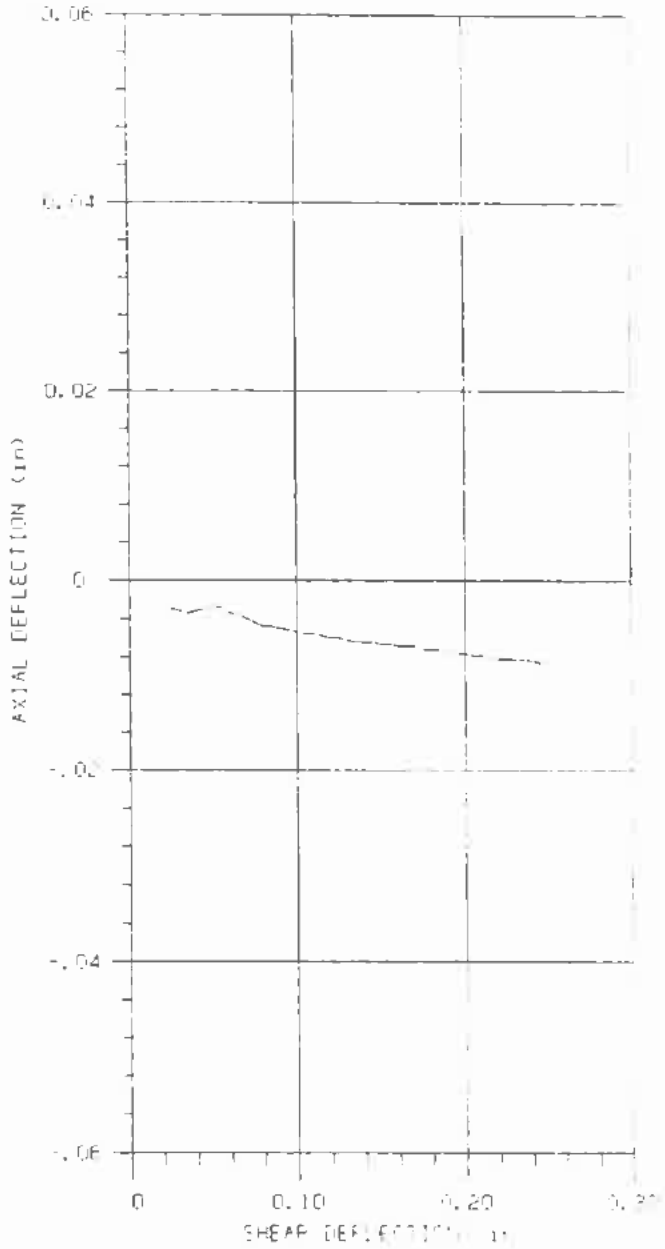
[illegible] Test

Client..... Ajax
Location..... UCM Jumbo Dome

Soil Type..... Pt B
Depth ..... 222-3 (ft)
Confining Pressure.. 18016 (psf)
Shear Rate..... 0.0051 (in/min)
Date Tested..... 05-19-2009

Job Number..... [illegible]
Sample Number...
Boring..... [illegible]
File Name..... [illegible]
Tested By..... LB





Cross Number and Line Type....	1	2	3	4
Max Shear Stress.....	1176.7	.0000	[illegible]	[illegible]
Shear Deflection @ Max Stress.	.0439	.0000	.0000	[illegible]

GEOMATIC Direct Shear Data

File Name.....ajdsd05b.DAT
Client.....Ajax
Job Number....2692-14
Location.....UCM Jumbo Dome
Date.....09-19-2009
Technician....LB
Sample Diameter (in).....1.938
Confining Pressure (psf)..18016
Number of Passes.....1
Shear Distance (in).....0.25
Shear Rate (in/min).....0.0051
Soil Type.....Pt B
Boring Number.....09JD05
Sample Number.....
Depth (ft).....222-3

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.005	1716	-.0006
0.010	2872	-.0012
0.015	3674	-.0019
0.020	4569	-.0025
0.025	5520	-.0030
0.030	6508	-.0033
0.035	7478	-.0034
0.040	9921	-.0033
0.046	11748	-.0030
0.050	11357	-.0029
0.055	10778	-.0029
0.060	10238	-.0034
0.065	10070	-.0037
0.070	9939	-.0041
0.075	9977	-.0043
0.080	9995	-.0047
0.085	10070	-.0049
0.090	10051	-.0050
0.095	10070	-.0052
0.100	10051	-.0054
0.105	9977	-.0056
0.110	9939	-.0057
0.115	9902	-.0058
0.120	9771	-.0059
0.125	9678	-.0060
0.130	9622	-.0062
0.135	9604	-.0063
0.140	9604	-.0064
0.145	9566	-.0065
0.150	9510	-.0066
0.155	9510	-.0066
0.160	9548	-.0067
0.165	9529	-.0068
0.170	9473	-.0069
0.175	9417	-.0071

Continued next page.

Pass 1 Continued

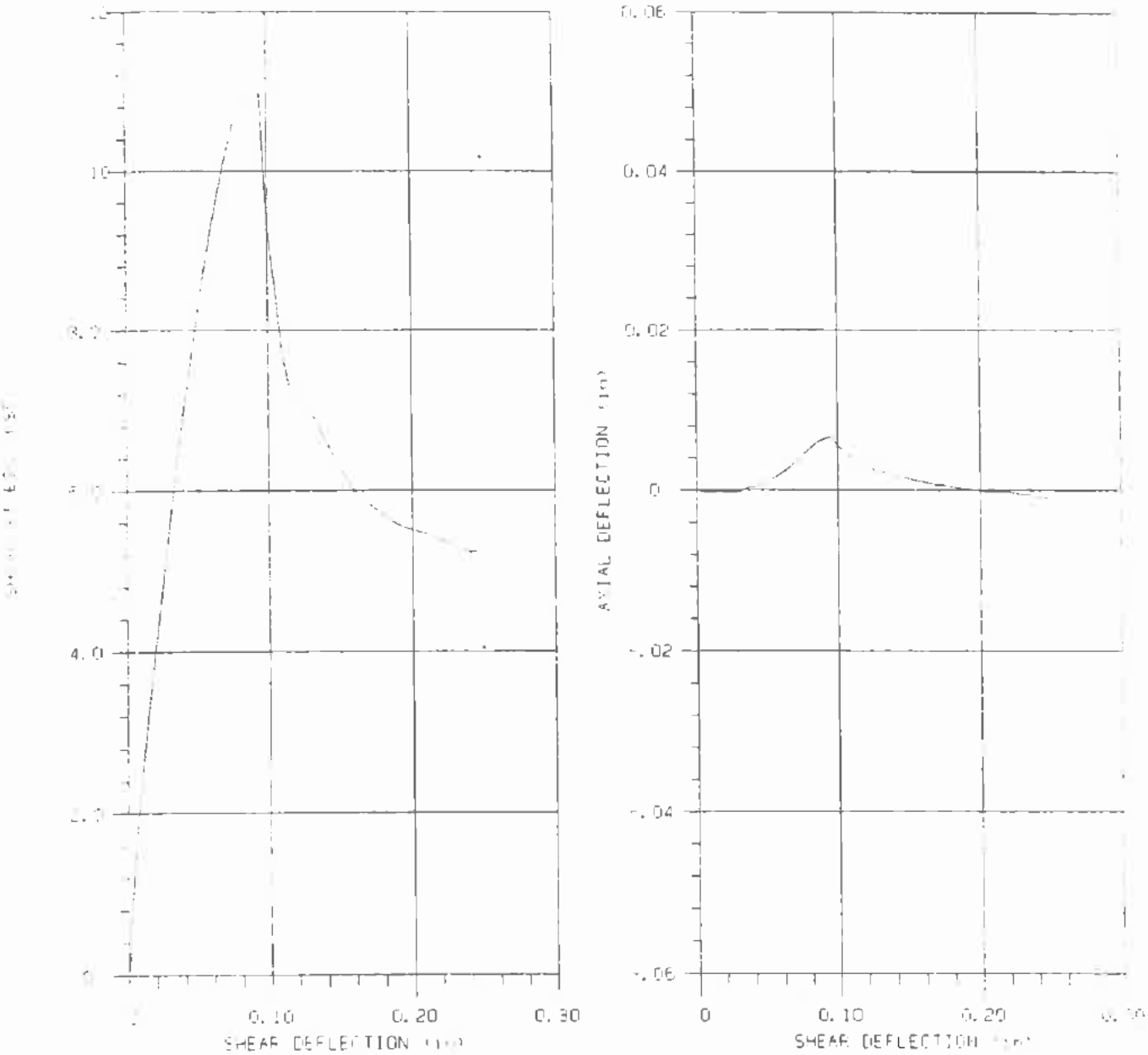
SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.180	9380	-.0073
0.185	9343	-.0073
0.190	9324	-.0074
0.195	9305	-.0075
0.200	9249	-.0076
0.205	9249	-.0077
0.210	9231	-.0079
0.215	9249	-.0080
0.220	9268	-.0081
0.225	9268	-.0081
0.230	9212	-.0082
0.235	9175	-.0083
0.240	9137	-.0084
0.245	9044	-.0086
0.250	8970	-.0088

Pass 1 completed with max load = 11767 psf at deflection of .0439 in

Direct Shear Test

Client..... [illegible]
Location..... [illegible] Jumbo Dome

Soil Type.....	Pt C	Job Number.....	2592-14
Depth.....	222-5 (ft)	Sample Number...	
Normal Pressure..	12029 (psf)	Boring.....	091005
Shear Rate.....	0.0051 in/min	File Name.....	a[illegible]se05[illegible].DAT
Date Tested.....	09-19-2009	Tested By.....	LE



Plot Number and Line Type....	1 ———	2 - - - - - -	3 ———	4 ———
Maximum Shear Stress.....	11058	.0000	.0000	.0000
Shear Deflection @ Max Stress.	.0902	.0000	.0000	.0000

GEOMATIC Direct Shear Data

File Name.....ajdsd05c.DAT
Client.....Ajax
Job Number....2692-14
Location.....UCM Jumbo Dome
Date.....09-19-2009
Technician....LB
Sample Diameter (in).....1.938
Confining Pressure (psf)..12023
Number of Passes.....1
Shear Distance (in).....0.25
Shear Rate (in/min).....0.0051
Soil Type.....Pt C
Boring Number.....09JD05
Sample Number.....
Depth (ft).....222-3

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.005	1492	-.0001
0.010	2406	-.0002
0.015	3263	-.0002
0.020	4084	-.0002
0.025	4792	-.0001
0.030	5538	-.0001
0.035	6284	0.0001
0.040	6993	0.0004
0.045	7627	0.0007
0.050	8242	0.0012
0.055	8802	0.0016
0.060	9324	0.0023
0.065	9790	0.0029
0.070	10182	0.0037
0.075	10536	0.0045
0.080	10778	0.0053
0.085	10928	0.0059
0.090	11039	0.0064
0.095	10984	0.0066
0.100	9268	0.0055
0.105	8578	0.0048
0.110	7720	0.0040
0.115	7291	0.0032
0.120	7179	0.0030
0.125	7123	0.0026
0.130	6974	0.0024
0.135	6825	0.0022
0.140	6620	0.0018
0.145	6471	0.0016
0.150	6284	0.0015
0.155	6135	0.0012
0.160	6005	0.0010
0.165	5911	0.0008
0.170	5837	0.0007
0.175	5762	0.0006

Continued next page.

Pass 1 Continued

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.180	5706	0.0004
0.185	5650	0.0002
0.190	5576	0.0001
0.195	5538	0.0000
0.200	5520	0.0000
0.205	5482	-.0001
0.210	5464	-.0001
0.215	5427	-.0002
0.220	5389	-.0003
0.225	5352	-.0004
0.230	5315	-.0006
0.235	5277	-.0007
0.240	5240	-.0008
0.245	5240	-.0009
0.250	5147	-.0010

Pass 1 completed with max load = 11058 psf at deflection of .0902 in

DIRECT SHEAR TEST DATA
ASTM D 3080

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	09JD03	SAMPLED	
DEPTH	168.5-169.0'	TEST STARTED	09/20/09 LB
SAMPLE NO.		TEST FINISHED	09/21/09 KR
POINT	A	CELL NUMBER	Geomatic
SOIL DESCR.		SATURATED TEST	Yes
LOCATION	UCM, Jumbo Dome	TEST TYPE	CD
NORMAL STRESS (psf)	21418		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture (g)	102.1	103.8
Wt. Wet Soil & Pan (g)	110.5	112.1
Wt. Dry Soil & Pan (g)	96.3	96.3
Wt. Lost Moisture (g)	14.2	15.8
Wt. of Pan Only (g)	8.3	8.3
Wt. of Dry Soil (g)	88.0	88.0
Moisture Content %	16.1	18.0
Wet Density (pcf)	131.9	141.0
Dry Density (pcf)	113.6	119.5

Init. Diameter (in)	1.938
Init. Area (sq in)	2.950
Init. Height (in)	1.000
Vol. Bef. Consol. (cu ft)	0.00171
Final Height (in)	0.951
Vol. After Consol. (cu ft)	0.00162

Test Set Up: Continuous Increasing Deflection Control
Shear Speed: 0.00440 in/min

Notes & Comments:

Data File Name: AJDSD03A

Normal Stress:	21418 psf	148.74 psi
Peak Stress:	15851 psf	110.08 psi
Ultimate Stress:	10182 psf	70.71 psi

Data entry by: MLM Date: 09/23/2009
Data checked by: LB Date: 9-23-09
FileName: AJDS0903

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DIRECT SHEAR TEST DATA
ASTM D 3080

CLIENT Ajax Ltd.

JOB NO. 2692-14

BORING NO.	09JD03	SAMPLED	
DEPTH	168.5-169.0'	TEST STARTED	09/20/09 LB
SAMPLE NO.		TEST FINISHED	09/21/09 KR
POINT	B	CELL NUMBER	Geomatic
SOIL DESCR.		SATURATED TEST	Yes
LOCATION	UCM, Jumbo Dome	TEST TYPE	CD
NORMAL STRESS (psf)	18016		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture (g)	103.0	104.5
Wt. Wet Soil & Pan (g)	109.6	111.2
Wt. Dry Soil & Pan (g)	95.0	95.0
Wt. Lost Moisture (g)	14.6	16.1
Wt. of Pan Only (g)	6.7	6.7
Wt. of Dry Soil (g)	88.4	88.4
Moisture Content %	16.5	18.3
Wet Density (pcf)	133.0	141.3
Dry Density (pcf)	114.1	119.5

Init. Diameter (in)	1.938
Init. Area (sq in)	2.950
Init. Height (in)	1.000
Vol. Bef. Consol. (cu ft)	0.00171
Final Height (in)	0.955
Vol. After Consol. (cu ft)	0.00163

Test Set Up: Continuous Increasing Deflection Control
Shear Speed: 0.00440 in/min

Notes & Comments:

Data File Name: AJDSD03B

Normal Stress:	18016 psf	125.11 psi
Peak Stress:	12699 psf	88.19 psi
Ultimate Stress:	9287 psf	64.49 psi

Data entry by: MLM Date: 09/23/2009
Data checked by: LB Date: 9-23-09
FileName: AJDS0903

ADVANCED TERRA TESTING, INC. ATT

DIRECT SHEAR TEST DATA
ASTM D 3080

CLIENT Ajax Ltd. JOB NO. 2692-14

BORING NO.	09JD03	SAMPLED	
DEPTH	168.5-169.0'	TEST STARTED	09/20/09 LB
SAMPLE NO.		TEST FINISHED	09/20/09 LB
POINT	C	CELL NUMBER	Geomatic
SOIL DESCR.		SATURATED TEST	Yes
LOCATION	UCM, Jumbo Dome	TEST TYPE	CD
NORMAL STRESS (psf)	9008		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture (g)	101.5	104.7
Wt. Wet Soil & Pan (g)	109.8	113.0
Wt. Dry Soil & Pan (g)	96.3	96.3
Wt. Lost Moisture (g)	13.5	16.7
Wt. of Pan Only (g)	8.3	8.3
Wt. of Dry Soil (g)	88.0	88.0
Moisture Content %	15.3	19.0
Wet Density (pcf)	131.1	140.5
Dry Density (pcf)	113.7	118.1

Init. Diameter (in)	1.938
Init. Area (sq in)	2.950
Init. Height (in)	1.000
Vol. Bef. Consol. (cu ft)	0.00171
Final Height (in)	0.963
Vol. After Consol. (cu ft)	0.00164

Test Set Up: Continuous Increasing Deflection Control
Shear Speed: 0.00440 in/min

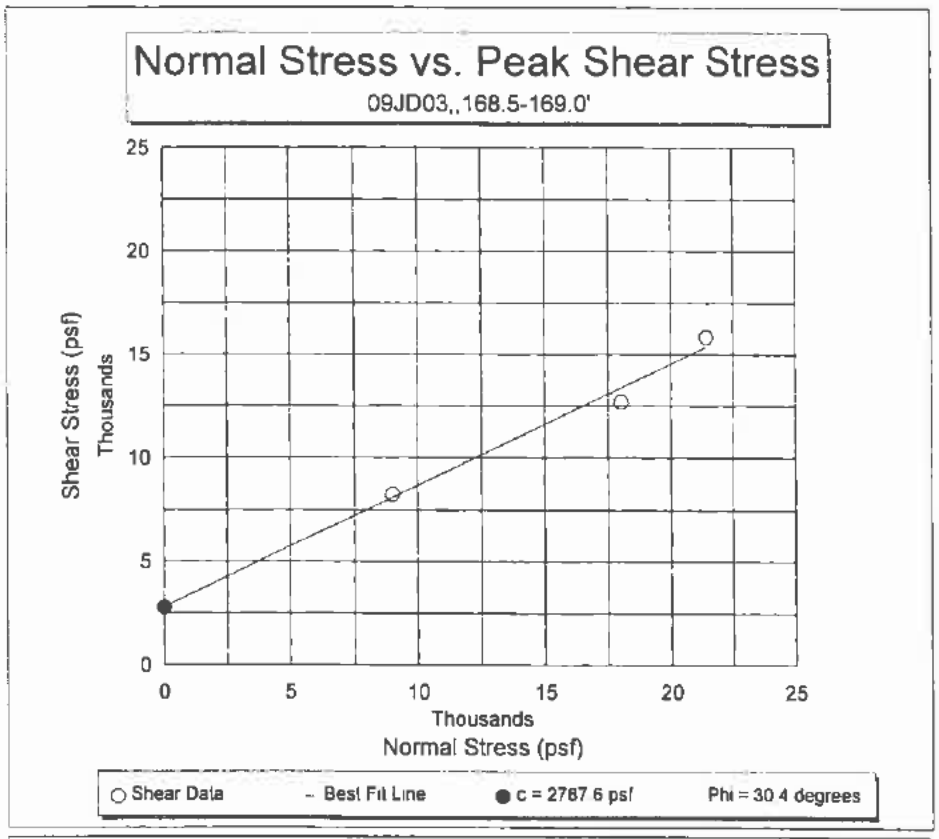
Notes & Comments:

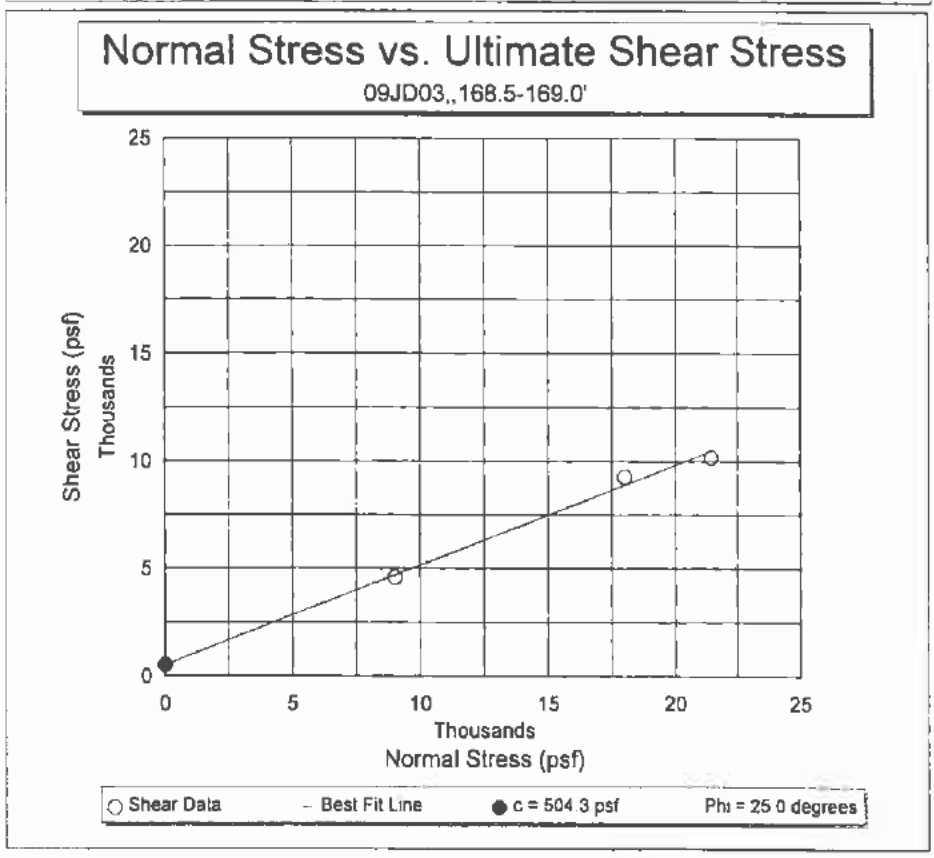
Data File Name: AJDSD03C

Normal Stress:	9008 psf	62.56 psi
Peak Stress:	8261 psf	57.37 psi
Ultimate Stress:	4587 psf	31.85 psi

Data entry by: MLM Date: 09/23/2009
Data checked by: LB Date: 9-23-09
FileName: AJDS0903

ADVANCED TERRA TESTING, INC. ATT


Normal Stress vs. Peak Shear Stress
09JD03,,168.5-169.0'
Shear Stress (psf)
Thousands
0
5
10
15
20
25
Thousands
Normal Stress (psf)
Shear Data
Best Fit Line
c = 2767 6 psf
Phi = 30 4 degrees

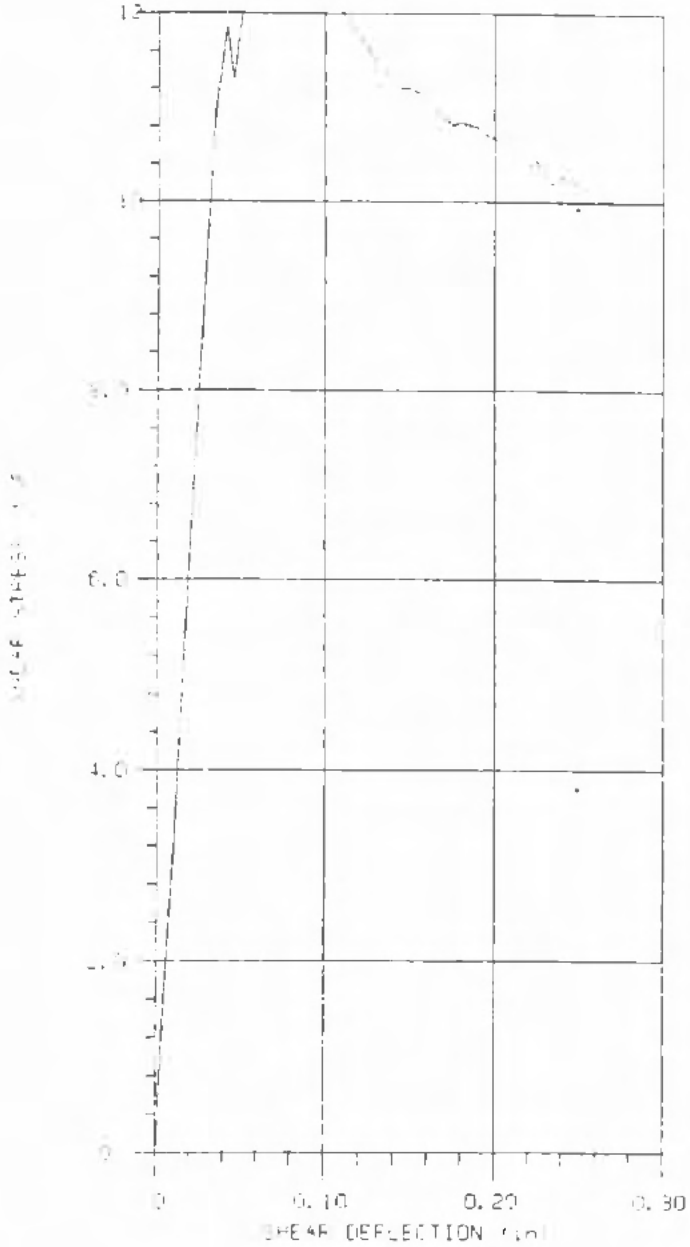

Normal Stress vs. Ultimate Shear Stress
09JD03,,168.5-169.0'
Shear Stress (psf)
Thousands
0
5
10
15
20
25
Thousands
Normal Stress (psf)
Shear Data
Best Fit Line
c = 504 3 psf
Phi = 25 0 degrees

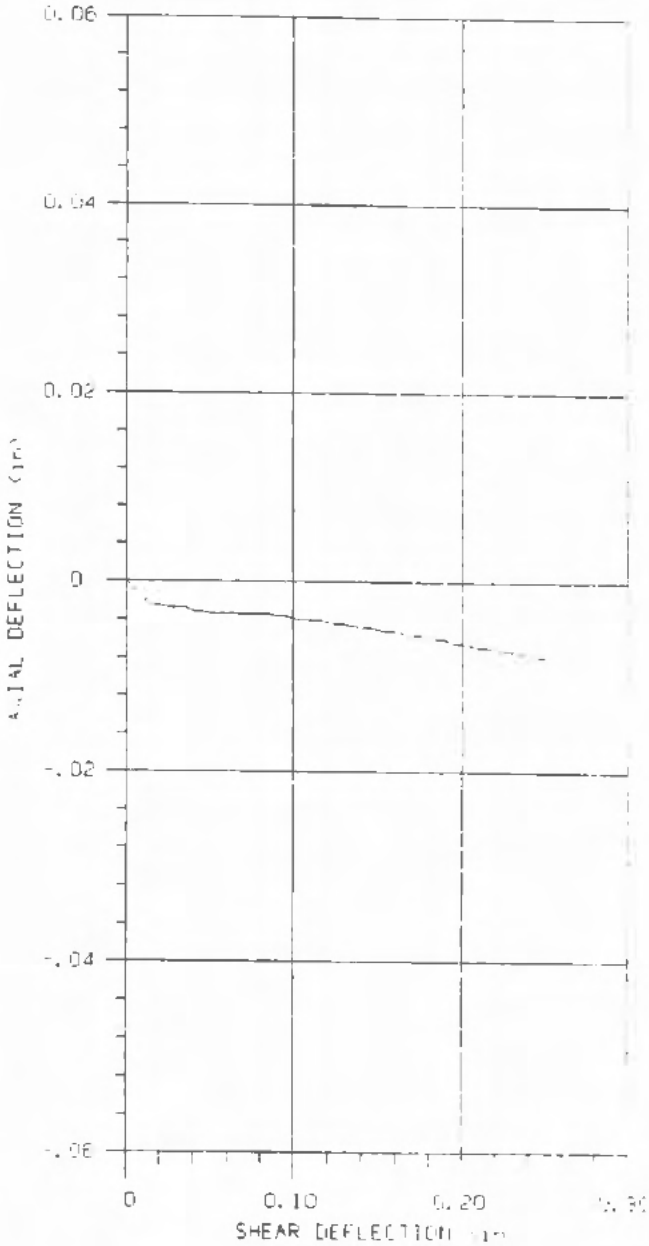
Direct Shear Test

Client..... Ajax
Location..... UCM Jumbo Dome

Soil Type..... Pt A
Depth..... 168-9 (ft)
Confining Pressure.. 21418 (psf)
Shear Rate..... 0.0044 (in/min)
Date Tested..... 09-21-2009

Job Number..... 2692-14
Sample Number...
Boring..... 091009
File Name..... ajasa03a.DAT
Tested By..... KP





Pass Number and Line Type....	1 ———	2 - - - - - -	3 — — —	4 ———
Maximum Shear Stress.....	15851	.0000	.0000	.0000
Shear Deflection @ Max Stress.	.0764	.0000	.0000	.0000

GEOMATIC Direct Shear Data

File Name.....ajdsd03a.DAT
Client.....Ajax
Job Number....2692-14
Location.....UCM Jumbo Dome
Date.....09-21-2009
Technician....KR
Sample Diameter (in).....1.938
Confining Pressure (psf)..21418
Number of Passes.....1
Shear Distance (in).....0.25
Shear Rate (in/min).....0.0044
Soil Type.....Pt A
Boring Number.....09JD03
Sample Number.....
Depth (ft).....168-9

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.005	1734	-.0010
0.010	3151	-.0018
0.015	4811	-.0025
0.020	6452	-.0026
0.025	8112	-.0027
0.030	9660	-.0028
0.035	11039	-.0029
0.041	11860	-.0032
0.045	11301	-.0033
0.050	12457	-.0034
0.055	13613	-.0034
0.060	14266	-.0034
0.065	14620	-.0034
0.070	14713	-.0034
0.075	15496	-.0034
0.080	14545	-.0034
0.085	13109	-.0034
0.090	12755	-.0035
0.095	12531	-.0036
0.100	12457	-.0038
0.105	12177	-.0039
0.110	12009	-.0040
0.115	11897	-.0041
0.120	11767	-.0042
0.125	11655	-.0043
0.130	11487	-.0044
0.135	11394	-.0046
0.140	11301	-.0047
0.145	11207	-.0049
0.150	11207	-.0050
0.155	11151	-.0051
0.160	11095	-.0052
0.165	10984	-.0054
0.170	10890	-.0056
0.175	10816	-.0057

Continued next page.

Pass 1 Continued

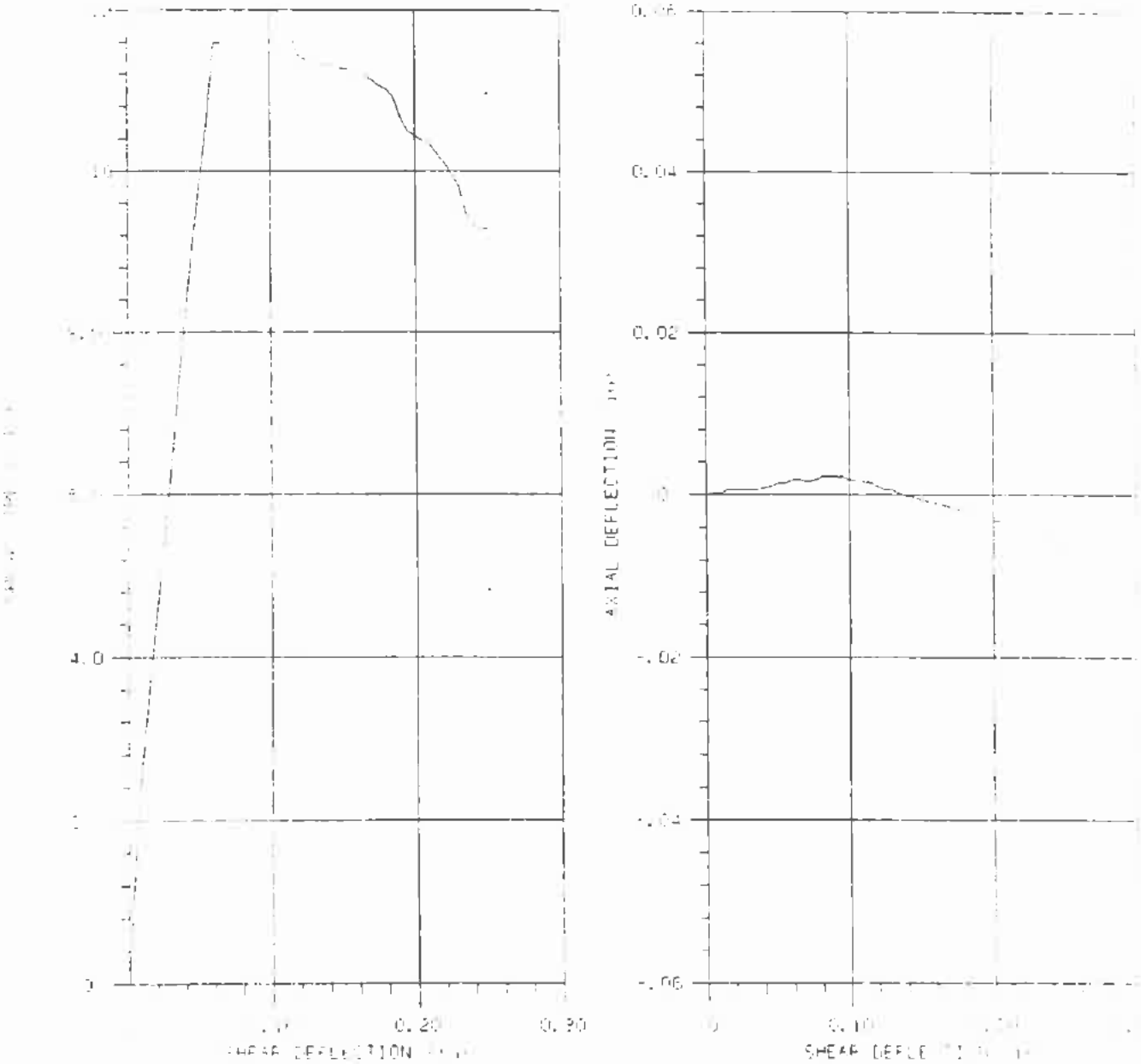
SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.180	10834	-.0058
0.185	10816	-.0059
0.190	10797	-.0061
0.195	10722	-.0063
0.200	10685	-.0065
0.205	10648	-.0066
0.210	10573	-.0067
0.215	10499	-.0068
0.220	10387	-.0070
0.225	10443	-.0072
0.230	10256	-.0073
0.235	10182	-.0074
0.240	10256	-.0075
0.245	10219	-.0077
0.250	10182	-.0079

Pass 1 completed with max load = 15851 psf at deflection of .0764 in

Direct Shear Test

[illegible] Jumbo Dome

[illegible] Type.....	Ft B	Job Number.....	2692-14
Depth.....	168-9 ft	Sample Number...	
Confining Pressure..	18016 (psf)	Boring.....	09-009
Shear Rate.....	0.0044 (in/min)	File Name.....	[illegible]
Date Tested.....	09-21-2009	Tested By.....	[illegible]



Pass Number and Line Type....	1 ———	2 - - - - -	3 — — —	4 ———
Maximum Shear Stress.....	12699	.0000	.0000	.0000
Shear Deflection @ Max Stress.	.0777	.0000	.0000	.0000

GEOMATIC Direct Shear Data

File Name.....ajdsd03b.DAT
Client.....Ajax
Job Number....2692-14
Location.....UCM Jumbo Dome
Date.....09-21-2009
Technician....KR
Sample Diameter (in).....1.938
Confining Pressure (psf)..18016
Number of Passes.....1
Shear Distance (in).....0.25
Shear Rate (in/min).....0.0044
Soil Type.....Pt B
Boring Number.....09JD03
Sample Number.....
Depth (ft).....168-9

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.005	1548	0.0002
0.010	2704	0.0003
0.015	3711	0.0005
0.020	4606	0.0006
0.025	5464	0.0007
0.030	6284	0.0006
0.035	7235	0.0006
0.040	8205	0.0008
0.045	9100	0.0009
0.050	9883	0.0013
0.055	10629	0.0015
0.060	11580	0.0017
0.065	11580	0.0017
0.070	11674	0.0016
0.076	12606	0.0017
0.080	12513	0.0021
0.085	12457	0.0022
0.090	12326	0.0022
0.095	12233	0.0022
0.100	12214	0.0019
0.105	12102	0.0018
0.110	11879	0.0016
0.115	11655	0.0013
0.120	11412	0.0010
0.125	11375	0.0007
0.130	11412	0.0005
0.135	11375	0.0001
0.140	11319	-.0001
0.145	11301	-.0003
0.150	11263	-.0006
0.155	11263	-.0008
0.160	11207	-.0010
0.165	11189	-.0012
0.170	11133	-.0015
0.175	11058	-.0017

Continued next page.

Pass 1 Continued

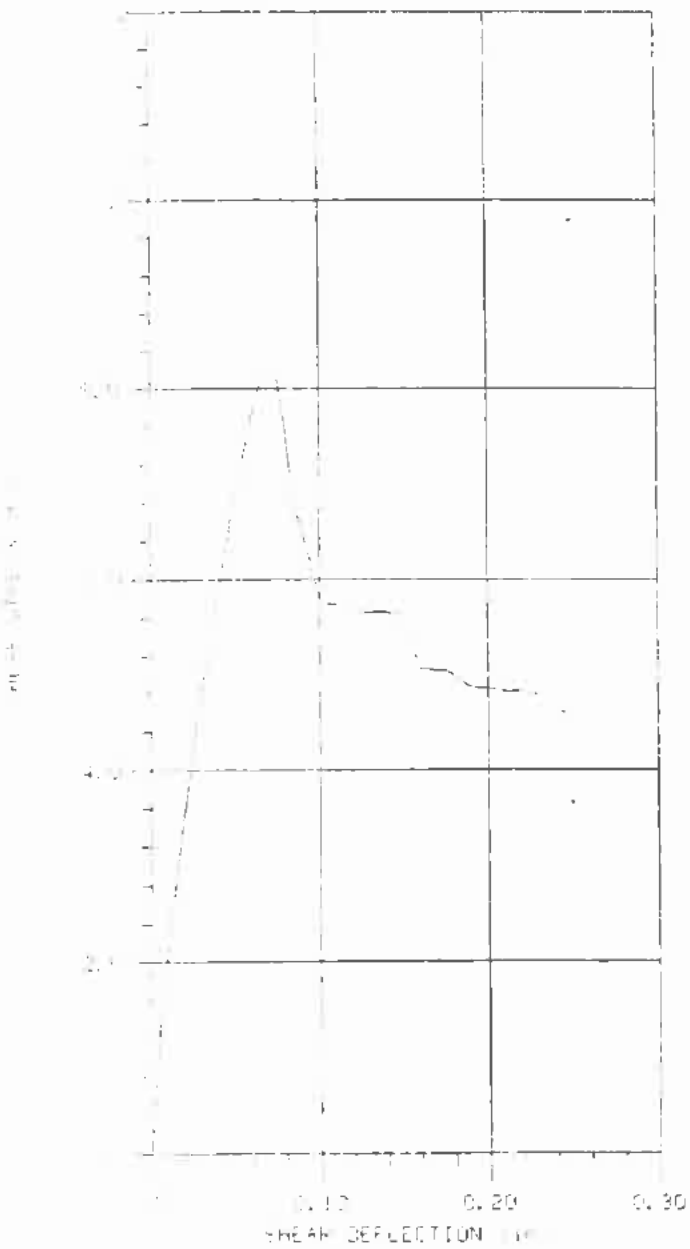
SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.180	11021	-.0018
0.185	10928	-.0022
0.190	10685	-.0025
0.195	10499	-.0028
0.200	10443	-.0031
0.205	10387	-.0033
0.210	10331	-.0037
0.215	10219	-.0040
0.220	10107	-.0042
0.225	9958	-.0046
0.230	9827	-.0049
0.235	9473	-.0054
0.240	9343	-.0057
0.245	9287	-.0061
0.250	9287	-.0064

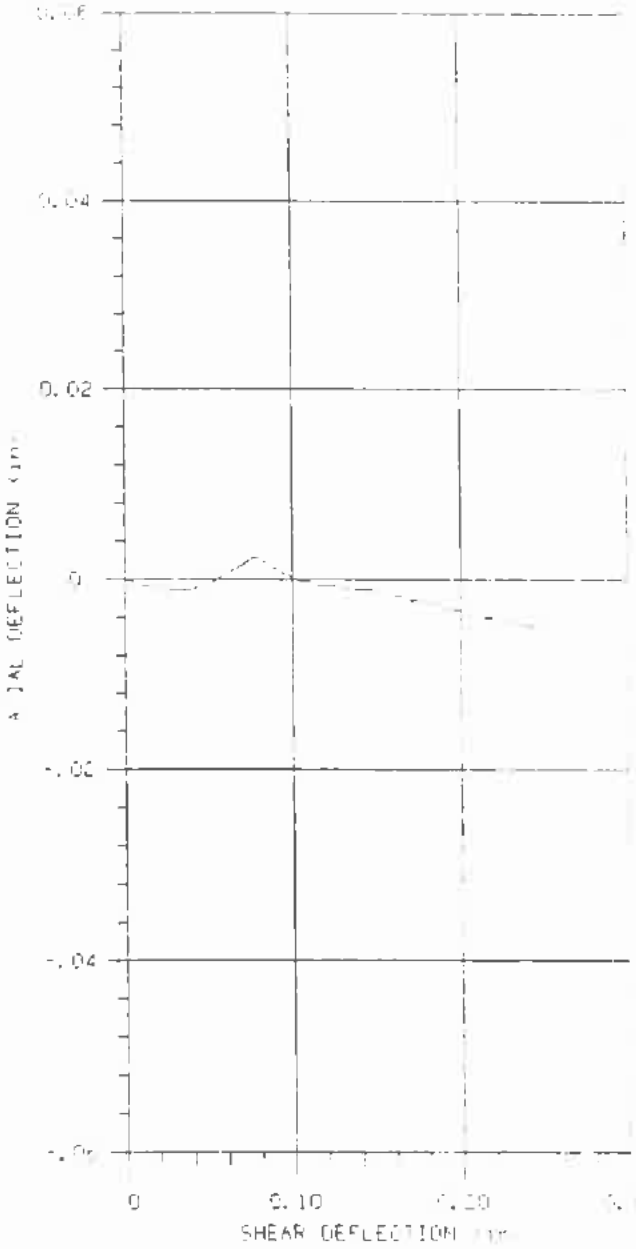
Pass 1 completed with max load = 12699 psf at deflection of .0777 in

Direct Shear Test

Project..... [illegible]
Location..... OCM Jumbo Dome

Soil Type.....	Pt. C	Job Number.....	[illegible]
Depth.....	168-[illegible] [illegible]	Sample Number...	
Normal Pressure..	9000 [illegible]	Boring.....	[illegible]
[illegible].....	0.0014 [illegible]	File Name.....	[illegible]
Date Tested.....	09-20-2009	Tested By.....	[illegible]





Peak Horizontal Shear Line Type....	1	2	3	4
Maximum Shear Stress.....	8261	.0000	.0000	[illegible]
Shear Deflection @ Max Stress.	.0706	.0000	.0000	[illegible]

GEOMATIC Direct Shear Data

File Name.....ajdsd03c.DAT
Client.....Ajax
Job Number....2692-14
Location.....UCM Jumbo Dome
Date.....09-20-2009
Technician....LB
Sample Diameter (in).....1.938
Confining Pressure (psf)..9008
Number of Passes.....1
Shear Distance (in).....0.25
Shear Rate (in/min).....0.0044
Soil Type.....Pt C
Boring Number.....09JD03
Sample Number.....
Depth (ft).....168-9

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.005	1361	-.0002
0.010	2144	-.0006
0.015	2872	-.0007
0.020	3580	-.0008
0.025	4233	-.0009
0.030	4830	-.0009
0.035	5389	-.0009
0.040	5911	-.0009
0.045	6396	-.0007
0.050	6881	-.0004
0.055	7310	0.0000
0.060	7702	0.0005
0.065	8037	0.0010
0.070	8242	0.0016
0.075	8130	0.0021
0.080	7608	0.0022
0.085	6788	0.0016
0.090	6508	0.0010
0.095	6172	0.0007
0.100	5799	0.0001
0.105	5744	-.0001
0.110	5744	-.0003
0.115	5706	-.0005
0.120	5688	-.0007
0.125	5669	-.0007
0.130	5669	-.0008
0.135	5669	-.0009
0.140	5669	-.0009
0.145	5650	-.0010
0.150	5613	-.0011
0.155	5296	-.0013
0.160	5054	-.0017
0.165	5054	-.0019
0.170	5035	-.0022
0.175	5035	-.0023

Continued next page.

Pass 1 Continued

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.180	4998	-.0024
0.185	4923	-.0026
0.190	4886	-.0030
0.195	4867	-.0032
0.200	4867	-.0033
0.205	4848	-.0036
0.210	4830	-.0038
0.215	4830	-.0040
0.220	4811	-.0041
0.225	4792	-.0042
0.230	4774	-.0045
0.235	4718	-.0046
0.240	4643	-.0047
0.245	4606	-.0048
0.250	4587	-.0050

Pass 1 completed with max load = 8261 psf at deflection of .0706 in

DIRECT SHEAR TEST DATA
ASTM D 3080

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	09JD09	SAMPLED	
DEPTH	132.5-134.5'	TEST STARTED	09/22/09 LB
SAMPLE NO.		TEST FINISHED	09/22/09 LB
POINT	A	CELL NUMBER	Geomatic
SOIL DESCR.		SATURATED TEST	Yes
LOCATION	UCM, Jumbo Dome	TEST TYPE	CD
NORMAL STRESS (psf)	21418		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture (g)	102.9	104.5
Wt. Wet Soil & Pan (g)	111.1	112.7
Wt. Dry Soil & Pan (g)	97.4	97.4
Wt. Lost Moisture (g)	13.7	15.2
Wt. of Pan Only (g)	8.2	8.2
Wt. of Dry Soil (g)	89.2	89.2
Moisture Content %	15.3	17.1
Wet Density (pcf)	132.9	144.8
Dry Density (pcf)	115.2	123.7

Init. Diameter (in)	1.938
Init. Area (sq in)	2.950
Init. Height (in)	1.000
Vol. Bef. Consol. (cu ft)	0.00171
Final Height (in)	0.932
Vol. After Consol. (cu ft)	0.00159

Test Set Up: Continuous Increasing Deflection Control
Shear Speed: 0.00380 in/min

Notes & Comments:

Data File Name: AJDSD09A

Normal Stress:	21418 psf	148.74 psi
Peak Stress:	15384 psf	106.83 psi
Ultimate Stress:	7478 psf	51.93 psi

Data entry by: MLM Date: 09/24/2009
Data checked by: LB Date: 9-25-2009
FileName: AJDS0909

ADVANCED TERRA TESTING, INC. ATT

DIRECT SHEAR TEST DATA
ASTM D 3080

CLIENT Ajax Ltd.

JOB NO. 2692-14

BORING NO.	09JD09	SAMPLED	
DEPTH	132.5-134.5'	TEST STARTED	09/22/09 LB
SAMPLE NO.		TEST FINISHED	09/22/09 LB
POINT	B	CELL NUMBER	Geomatic
SOIL DESCR.		SATURATED TEST	Yes
LOCATION	UCM, Jumbo Dome	TEST TYPE	CD
NORMAL STRESS (psf)	13995		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture (g)	101.8	102.9
Wt. Wet Soil & Pan (g)	110.0	111.1
Wt. Dry Soil & Pan (g)	94.3	94.3
Wt. Lost Moisture (g)	15.7	16.8
Wt. of Pan Only (g)	8.2	8.2
Wt. of Dry Soil (g)	86.1	86.1
Moisture Content %	18.2	19.5
Wet Density (pcf)	131.4	138.9
Dry Density (pcf)	111.2	116.2

Init. Diameter (in)	1.938
Init. Area (sq in)	2.950
Init. Height (in)	1.000
Vol. Bef. Consol. (cu ft)	0.00171
Final Height (in)	0.957
Vol. After Consol. (cu ft)	0.00163

Test Set Up: Continuous Increasing Deflection Control
Shear Speed: 0.00380 in/min

Notes & Comments:

Data File Name: AJDSD09B

Normal Stress:	13995 psf	97.19 psi
Peak Stress:	6322 psf	43.90 psi
Ultimate Stress:	5967 psf	41.44 psi

Data entry by: MLM Date: 09/24/2009
Data checked by: LB Date: 9-25-2009
FileName: AJDS0909

ADVANCED TERRA TESTING, INC. ATT

DIRECT SHEAR TEST DATA
ASTM D 3080

CLIENT	Ajax Ltd.	JOB NO.	2692-14
BORING NO.	09JD09	SAMPLED	
DEPTH	132.5-134.5'	TEST STARTED	09/22/09 LB
SAMPLE NO.		TEST FINISHED	09/22/09 LB
POINT	C	CELL NUMBER	Geomatic
SOIL DESCR.		SATURATED TEST	Yes
LOCATION	UCM, Jumbo Dome	TEST TYPE	CD
NORMAL STRESS (psf)	6998		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture (g)	104.7	107.4
Wt. Wet Soil & Pan (g)	112.9	115.7
Wt. Dry Soil & Pan (g)	99.0	99.0
Wt. Lost Moisture (g)	14.0	16.7
Wt. of Pan Only (g)	8.3	8.3
Wt. of Dry Soil (g)	90.7	90.7
Moisture Content %	15.4	18.4
Wet Density (pcf)	135.2	141.7
Dry Density (pcf)	117.1	119.6

Init. Diameter (in)	1.938
Init. Area (sq in)	2.950
Init. Height (in)	1.000
Vol. Bef. Consol. (cu ft)	0.00171
Final Height (in)	0.979
Vol. After Consol. (cu ft)	0.00167

Test Set Up: Continuous Increasing Deflection Control
Shear Speed: 0.00380 in/min

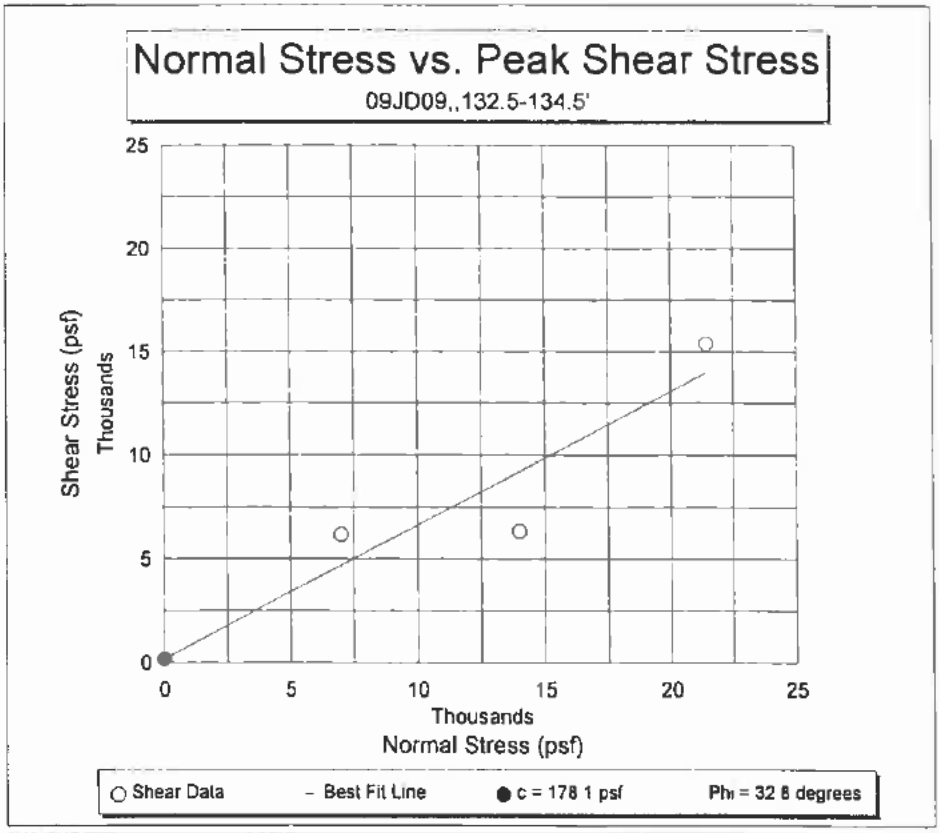
Notes & Comments:

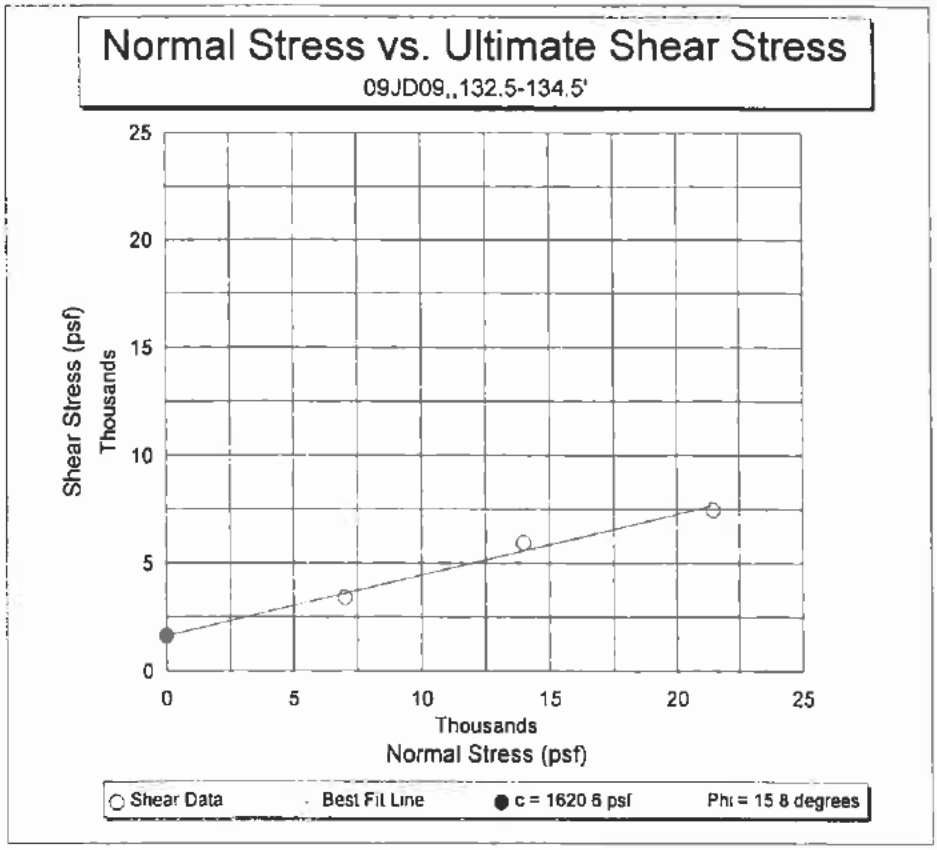
Data File Name: AJDSD09C

Normal Stress:	6998 psf	48.60 psi
Peak Stress:	6172 psf	42.86 psi
Ultimate Stress:	3394 psf	23.57 psi

Data entry by: MLM Date: 09/24/2009
Data checked by: LB Date: 9-25-2009
FileName: AJDS0909

ADVANCED TERRA TESTING, INC. ATT


Normal Stress vs. Peak Shear Stress
09JD09,,132.5-134.5'
Shear Stress (psf)
Thousands
0
5
10
15
20
25
Thousands
Normal Stress (psf)
Shear Data
Best Fit Line
c = 178 1 psf
Phi = 32 8 degrees

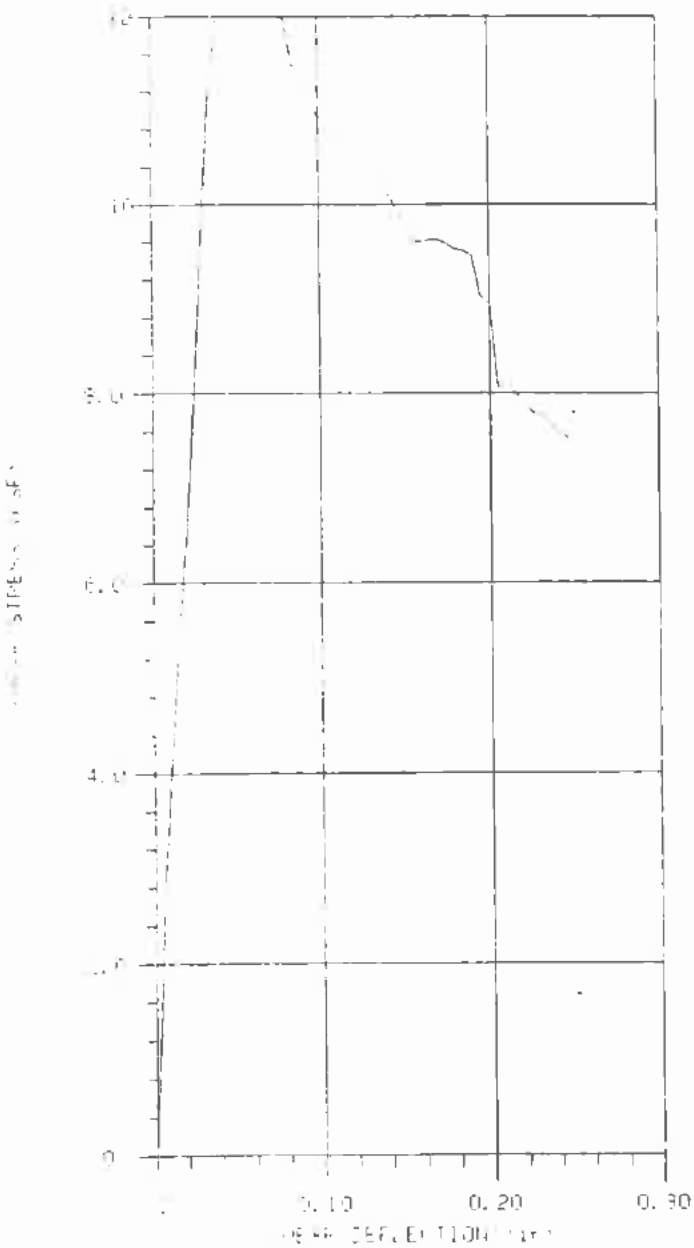

Normal Stress vs. Ultimate Shear Stress
09JD09,,132.5-134.5'
Shear Stress (psf)
Thousands
0
5
10
15
20
25
Thousands
Normal Stress (psf)
Shear Data
Best Fit Line
c = 1620 6 psf
Phi = 15 8 degrees

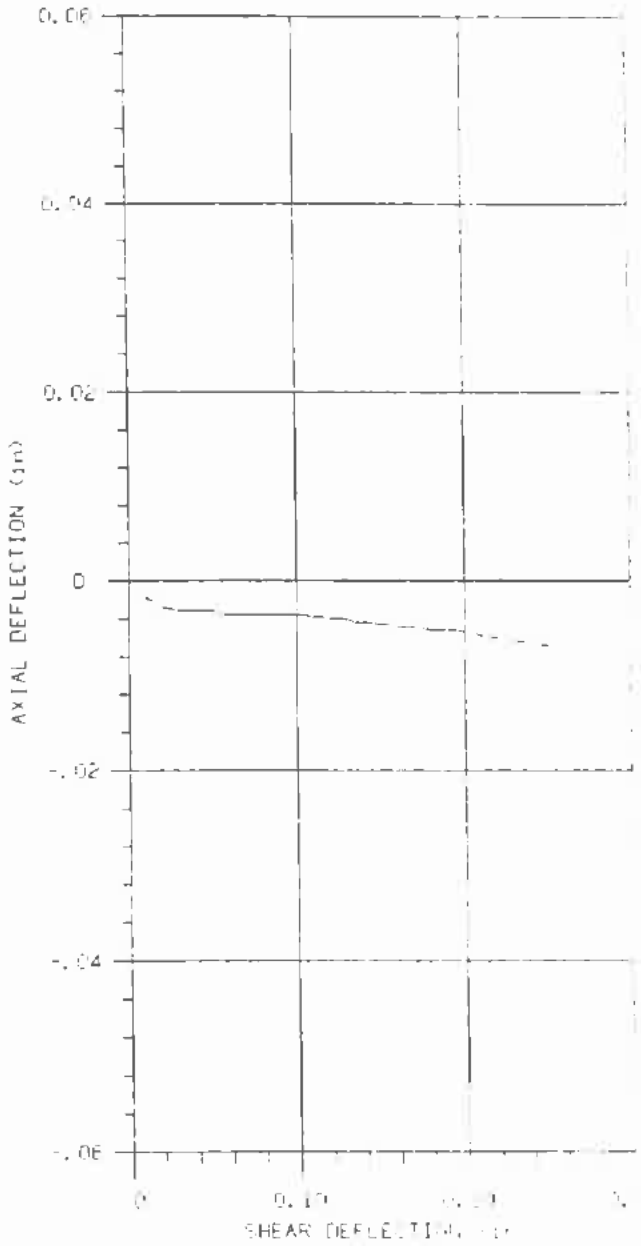
Direct Shear Test

Project..... [illegible]
Location..... UCM Jumbo Dome

Test Type..... Pt A
Depth..... 132-4 (ft)
Confining Pressure.. 21418 (psf)
Shear Rate..... 0.0038 (in/min)
Date Tested..... 09-22-2009

Job Number..... [illegible]
Sample Number...
Boring..... 09J009
File Name..... [illegible]
Tested By..... [illegible]





Pass Number and Line Type....	1 ———	2 - - - - - -	3 — — —	4 — · — · —
Maximum Shear Stress.....	15384	.0000	.0000	[illegible]
Shear Deflection @ Max Stress.	.0624	.0000	.0000	[illegible]

GEOMATIC Direct Shear Data

File Name.....ajdsd09a.DAT
Client.....Ajax
Job Number....2692-14
Location.....UCM Jumbo Dome
Date.....09-22-2009
Technician....LB
Sample Diameter (in).....1.938
Confining Pressure (psf)..21418
Number of Passes.....1
Shear Distance (in).....0.25
Shear Rate (in/min).....0.0038
Soil Type.....Pt A
Boring Number.....09JD09
Sample Number.....
Depth (ft).....132-4

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.005	2480	-.0011
0.010	3916	-.0017
0.015	5277	-.0023
0.020	6545	-.0028
0.025	8074	-.0030
0.030	9771	-.0031
0.035	11282	-.0031
0.040	12494	-.0032
0.045	13370	-.0032
0.050	14116	-.0033
0.055	14639	-.0035
0.060	14620	-.0035
0.065	14694	-.0035
0.070	12979	-.0035
0.075	12382	-.0035
0.080	11972	-.0035
0.085	11431	-.0036
0.090	11357	-.0036
0.095	11095	-.0037
0.100	10946	-.0037
0.105	10853	-.0037
0.110	10760	-.0038
0.115	10629	-.0038
0.120	10517	-.0039
0.125	10405	-.0040
0.130	10331	-.0041
0.135	10294	-.0043
0.140	10144	-.0044
0.145	9977	-.0045
0.150	9827	-.0046
0.155	9604	-.0046
0.160	9604	-.0047
0.165	9622	-.0048
0.170	9622	-.0049
0.175	9585	-.0050

Continued next page.

Pass 1 Continued

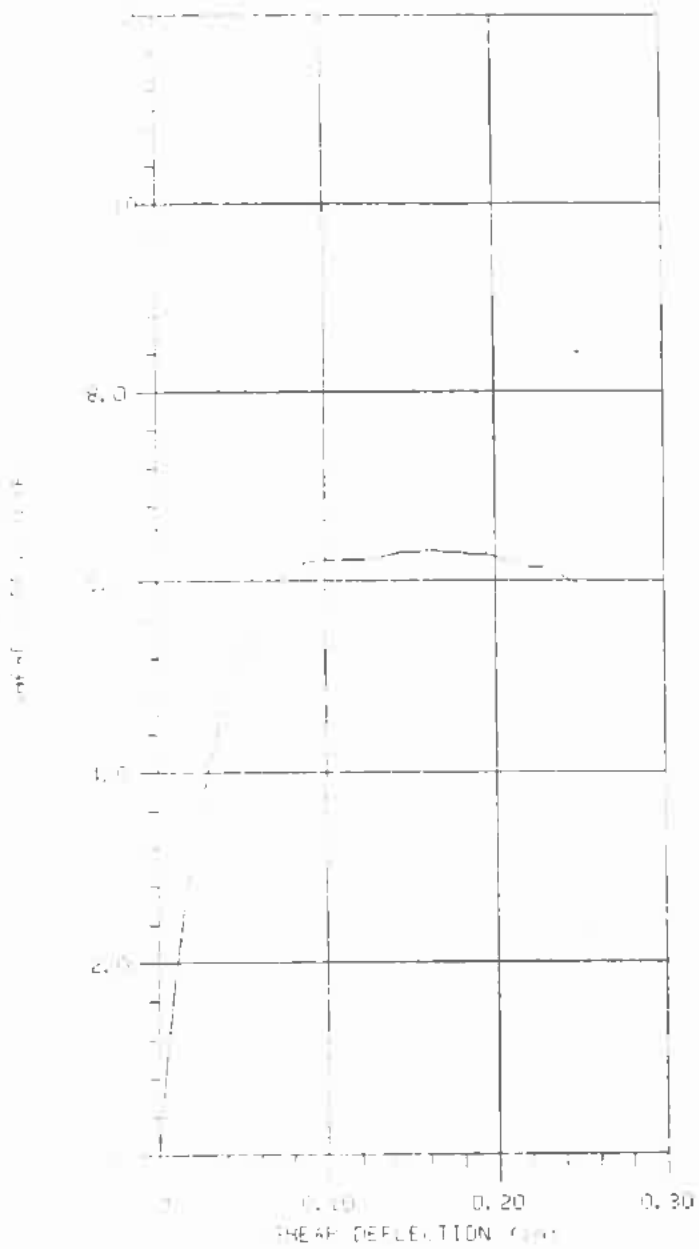
SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.180	9529	-.0051
0.185	9492	-.0051
0.190	9454	-.0052
0.195	9026	-.0053
0.200	8932	-.0054
0.205	8056	-.0056
0.210	8130	-.0058
0.215	8000	-.0060
0.220	7925	-.0061
0.225	7795	-.0062
0.230	7776	-.0063
0.235	7702	-.0064
0.240	7608	-.0066
0.245	7534	-.0068
0.250	7478	-.0069

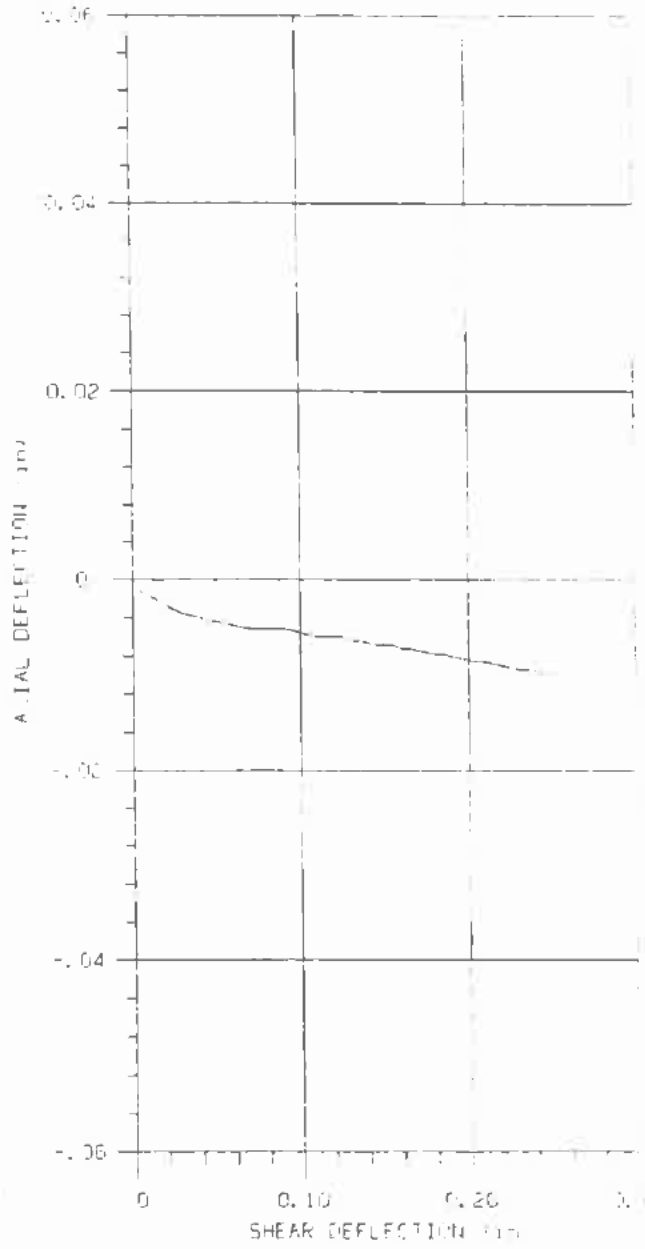
Pass 1 completed with max load = 15384 psf at deflection of .0624 in

Direct Shear Test

Project..... [illegible]
Location..... DCM Jumbo Dome

Soil Type.....	Pt B	Job Number.....	2692-14
Depth.....	132-4 (ft)	Sample Number...	
Confining Pressure..	13995 (psf)	Boring.....	091009
Shear Rate.....	0.0038 (in/min)	File Name.....	a_pas0092.DAT
Date Tested.....	09-23-2009	Tested By.....	LE





Press Number and Line Type....	1 ———	2 - - - - - -	3 — — —	4 — —
Max. Shear Stress.....	8320	.0000	.0000	.0000
Axial Deflection @ Max. Stress.	.1589	.0000	[illegible]	[illegible]

GEOMATIC Direct Shear Data

File Name.....ajdsd09b.DAT
Client.....Ajax
Job Number....2692-14
Location.....UCM Jumbo Dome
Date.....09-22-2009
Technician....LB
Sample Diameter (in).....1.938
Confining Pressure (psf)..13995
Number of Passes.....1
Shear Distance (in).....0.25
Shear Rate (in/min).....0.0038
Soil Type.....Pt B
Boring Number.....09JD09
Sample Number.....
Depth (ft).....132-4

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.005	1044	-.0012
0.010	1827	-.0019
0.015	2517	-.0023
0.020	3096	-.0029
0.025	3580	-.0032
0.030	4009	-.0036
0.035	4382	-.0038
0.040	4681	-.0041
0.045	4960	-.0043
0.050	5184	-.0045
0.055	5371	-.0046
0.060	5613	-.0048
0.065	5781	-.0050
0.070	5911	-.0051
0.075	6023	-.0052
0.080	6116	-.0052
0.085	6172	-.0053
0.090	6191	-.0053
0.095	6191	-.0054
0.100	6210	-.0056
0.105	6210	-.0058
0.110	6228	-.0059
0.115	6228	-.0060
0.120	6210	-.0061
0.125	6228	-.0061
0.130	6247	-.0063
0.135	6266	-.0064
0.140	6284	-.0066
0.145	6303	-.0068
0.150	6303	-.0069
0.155	6303	-.0069
0.160	6322	-.0071
0.165	6322	-.0073
0.170	6303	-.0074
0.175	6303	-.0076

Continued next page.

Pass 1 Continued

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.180	6303	-.0077
0.185	6284	-.0078
0.190	6284	-.0080
0.195	6284	-.0082
0.200	6266	-.0084
0.205	6228	-.0085
0.210	6191	-.0086
0.215	6172	-.0088
0.220	6135	-.0090
0.225	6135	-.0092
0.230	6135	-.0093
0.235	6079	-.0094
0.240	6042	-.0096
0.245	6005	-.0098
0.250	5967	-.0100

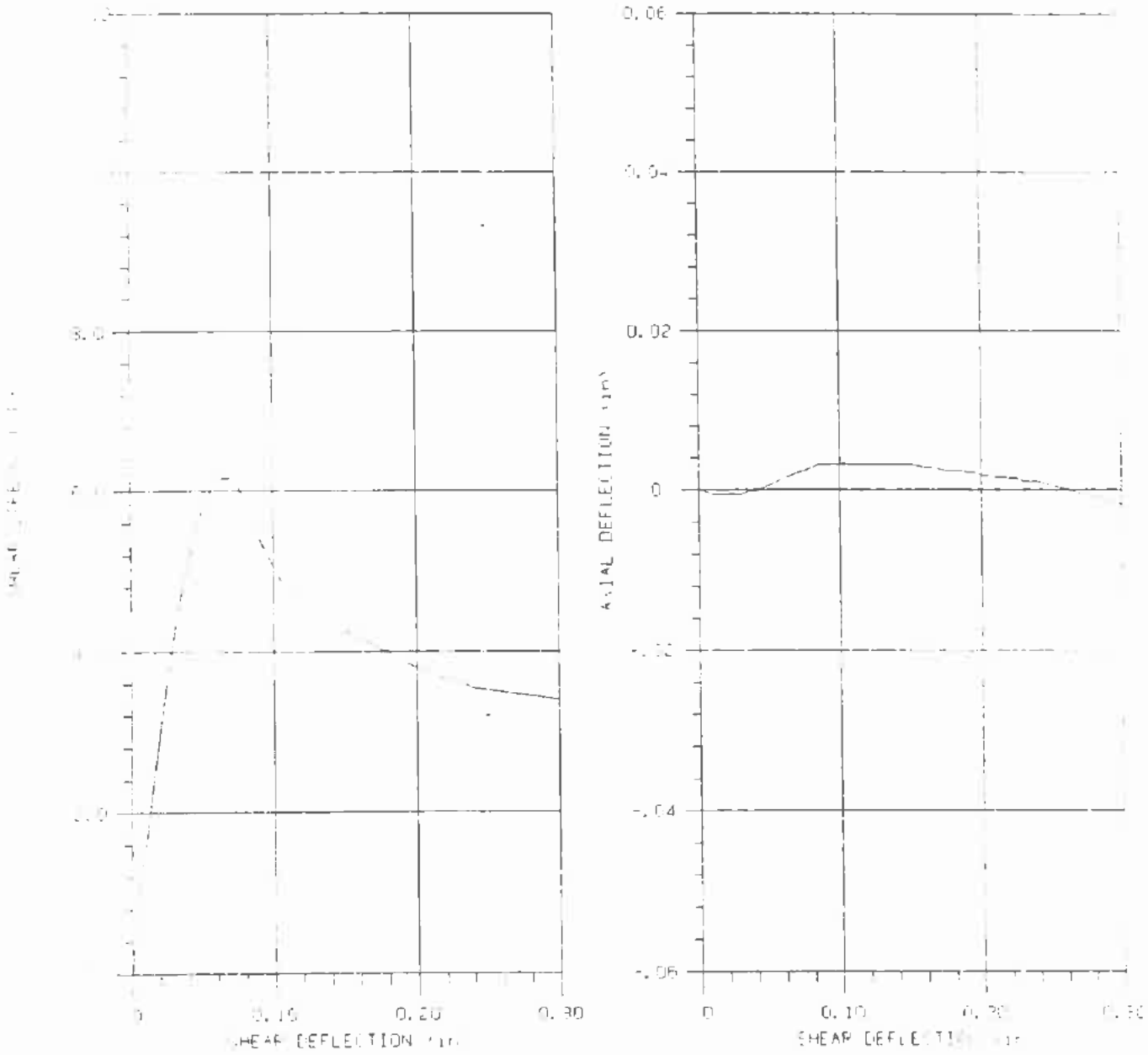
Pass 1 completed with max load = 6322 psf at deflection of .1589 in

Direct Shear Test

Client..... Ajax
Location..... UCM Jumbo Dome

Soil Type..... Pt C
Depth..... 132-4 [illegible]
Applied Pressure.. 6998 psf
[illegible]..... 0.0028 in/min
Date Tested..... 09-22-2009

Job Number..... [illegible]
Sample Number...
Boring..... [illegible]
File Name..... [illegible]
Tested By..... LF



Test Number and Line Type....	1 ———	2 - - - - -	3 — — —	4 — · — · —
Max Shear Stress.....	6172	.0000	[illegible]	[illegible]
Shear Deflection @ Max Stress.	.0656	.0000	.0000	[illegible]

GEOMATIC Direct Shear Data

File Name.....ajdsd09c.DAT
Client.....Ajax
Job Number....2692-14
Location.....UCM Jumbo Dome
Date.....09-22-2009
Technician....LB
Sample Diameter (in).....1.938
Confining Pressure (psf)..6998
Number of Passes.....1
Shear Distance (in).....0.25
Shear Rate (in/min).....0.0038
Soil Type.....Pt C
Boring Number.....09JD09
Sample Number.....
Depth (ft).....132-4

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.005	1156	-.0002
0.010	1566	-.0005
0.015	2294	-.0006
0.020	2984	-.0006
0.025	3636	-.0006
0.030	4196	-.0005
0.035	4681	-.0003
0.040	5128	-.0001
0.045	5482	0.0001
0.050	5762	0.0006
0.055	5967	0.0009
0.060	6116	0.0014
0.065	6154	0.0017
0.070	6154	0.0022
0.075	6061	0.0025
0.080	5893	0.0029
0.085	5632	0.0031
0.090	5427	0.0032
0.095	5240	0.0033
0.100	5054	0.0033
0.105	4904	0.0033
0.110	4792	0.0033
0.115	4699	0.0033
0.120	4625	0.0033
0.125	4550	0.0033
0.130	4475	0.0033
0.135	4420	0.0033
0.140	4364	0.0032
0.145	4308	0.0032
0.150	4252	0.0031
0.155	4214	0.0030
0.160	4177	0.0028
0.165	4121	0.0027
0.170	4084	0.0026
0.175	4028	0.0025

Continued next page.

Pass 1 Continued

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.180	3991	0.0024
0.185	3935	0.0024
0.190	3879	0.0022
0.195	3841	0.0021
0.200	3804	0.0018
0.205	3767	0.0017
0.210	3730	0.0016
0.215	3692	0.0016
0.220	3655	0.0015
0.225	3636	0.0013
0.230	3599	0.0011
0.235	3580	0.0009
0.240	3543	0.0009
0.336	3394	-.0017

Pass 1 completed with max load = 6172 psf at deflection of .0656 in

DIRECT SHEAR TEST DATA
ASTM D 3080

CLIENT Ajax Ltd.

JOB NO. 2692-16

BORING NO.	09JD12	SAMPLED	--
DEPTH	40.0-50.5'	TEST STARTED	10/20/09 LB
SAMPLE NO.	8.1, 9.1 & 10.1	TEST FINISHED	10/20/09 LB
POINT	A	CELL NUMBER	Geomatic
SOIL DESCR.	--	SATURATED TEST	Yes
LOCATION	Usibelli Coal Mine, Jumbo Dome	TEST TYPE	CD
NORMAL STRESS (psf)	12000		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture (g)	168.7	170.1
Wt. Wet Soil & Pan (g)	177.0	178.5
Wt. Dry Soil & Pan (g)	159.1	159.1
Wt. Lost Moisture (g)	18.0	19.4
Wt. of Pan Only (g)	8.3	8.3
Wt. of Dry Soil (g)	150.8	150.8
Moisture Content %	11.9	12.9
Wet Density (pcf)	140.9	151.6
Dry Density (pcf)	125.9	134.3

Init. Diameter (in)	2.410
Init. Area (sq in)	4.562
Init. Height (in)	1.000
Vol. Bef. Consol. (cu ft)	0.00264
Final Height (in)	0.937
Vol. After Consol. (cu ft)	0.00247

Test Set Up: Continuous Increasing Deflection Control
Shear Speed: 0.00590 in/min

Notes & Comments:

Data File Name: AJDS505A

Normal Stress:	12000 psf	83.33 psi
Peak Stress:	7296 psf	50.67 psi
Ultimate Stress:	7259 psf	50.41 psi

Data entry by: MLM Date: 10/22/2009
Data checked by: LB Date: 10/22/09
FileName: AJDSJD12

ADVANCED TERRA TESTING, INC. ATT

DIRECT SHEAR TEST DATA
ASTM D 3080

CLIENT	Ajax Ltd.	JOB NO.	2692-16
BORING NO.	09JD12	SAMPLED	--
DEPTH	40.0-50.5'	TEST STARTED	10/20/09 LB
SAMPLE NO.	8.1, 9.1 & 10.1	TEST FINISHED	10/20/09 LB
POINT	B	CELL NUMBER	Geomatic
SOIL DESCR.	--	SATURATED TEST	Yes
LOCATION	Usibelli Coal Mine, Jumbo Dome	TEST TYPE	CD
NORMAL STRESS (psf)	6000		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture (g)	168.7	171.0
Wt. Wet Soil & Pan (g)	176.9	179.3
Wt. Dry Soil & Pan (g)	158.9	158.9
Wt. Lost Moisture (g)	18.0	20.3
Wt. of Pan Only (g)	8.2	8.2
Wt. of Dry Soil (g)	150.7	150.7
Moisture Content %	11.9	13.5
Wet Density (pcf)	140.8	148.2
Dry Density (pcf)	125.8	130.6

Init. Diameter (in)	2.410
Init. Area (sq in)	4.562
Init. Height (in)	1.000
Vol. Bef. Consol. (cu ft)	0.00264
Final Height (in)	0.964
Vol. After Consol. (cu ft)	0.00254

Test Set Up: Continuous Increasing Deflection Control
Shear Speed: 0.00590 in/min

Notes & Comments:

Data File Name: AJDS505B

Normal Stress:	6000 psf	41.67 psi
Peak Stress:	3847 psf	26.72 psi
Ultimate Stress:	3823 psf	26.55 psi

Data entry by: MLM Date: 10/22/2009
Data checked by: LB Date: 10/23/09
FileName: AJDSJD12

ADVANCED TERRA TESTING, INC. ATT

DIRECT SHEAR TEST DATA
ASTM D 3080

CLIENT Ajax Ltd.

JOB NO. 2692-16

BORING NO.	09JD12	SAMPLED	--
DEPTH	40.0-50.5'	TEST STARTED	10/20/09 LB
SAMPLE NO.	8.1, 9.1 & 10.1	TEST FINISHED	10/20/09 LB
POINT	C	CELL NUMBER	Geomatic
SOIL DESCR.	--	SATURATED TEST	Yes
LOCATION	Usibelli Coal Mine, Jumbo Dome	TEST TYPE	CD
NORMAL STRESS (psf)	3000		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture (g)	168.7	171.8
Wt. Wet Soil & Pan (g)	175.4	178.5
Wt. Dry Soil & Pan (g)	157.4	157.4
Wt. Lost Moisture (g)	18.0	21.1
Wt. of Pan Only (g)	6.8	6.8
Wt. of Dry Soil (g)	150.7	150.7
Moisture Content %	11.9	14.0
Wet Density (pcf)	140.9	148.0
Dry Density (pcf)	125.8	129.8

Init. Diameter (in)	2.410
Init. Area (sq in)	4.562
Init. Height (in)	1.000
Vol. Bef. Consol. (cu ft)	0.00264
Final Height (in)	0.969
Vol. After Consol. (cu ft)	0.00256

Test Set Up: Continuous Increasing Deflection Control
Shear Speed: 0.00590 in/min

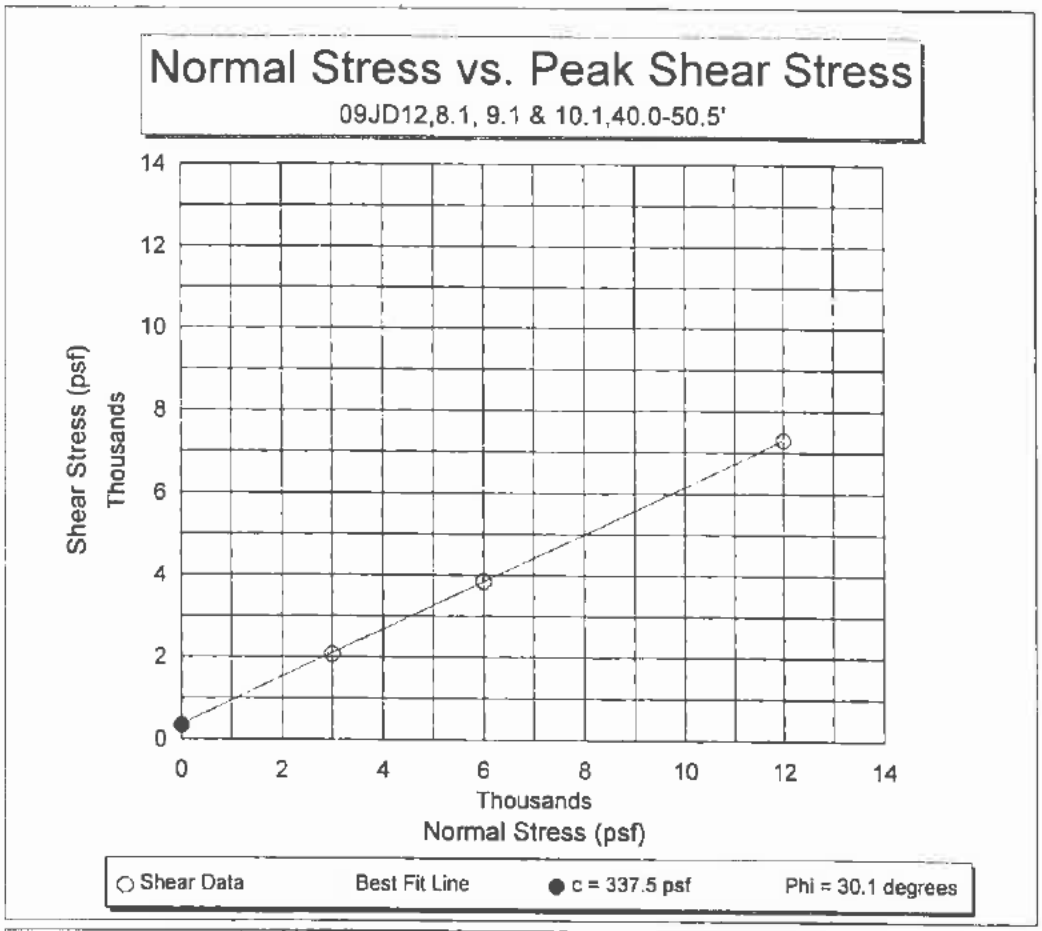
Notes & Comments:

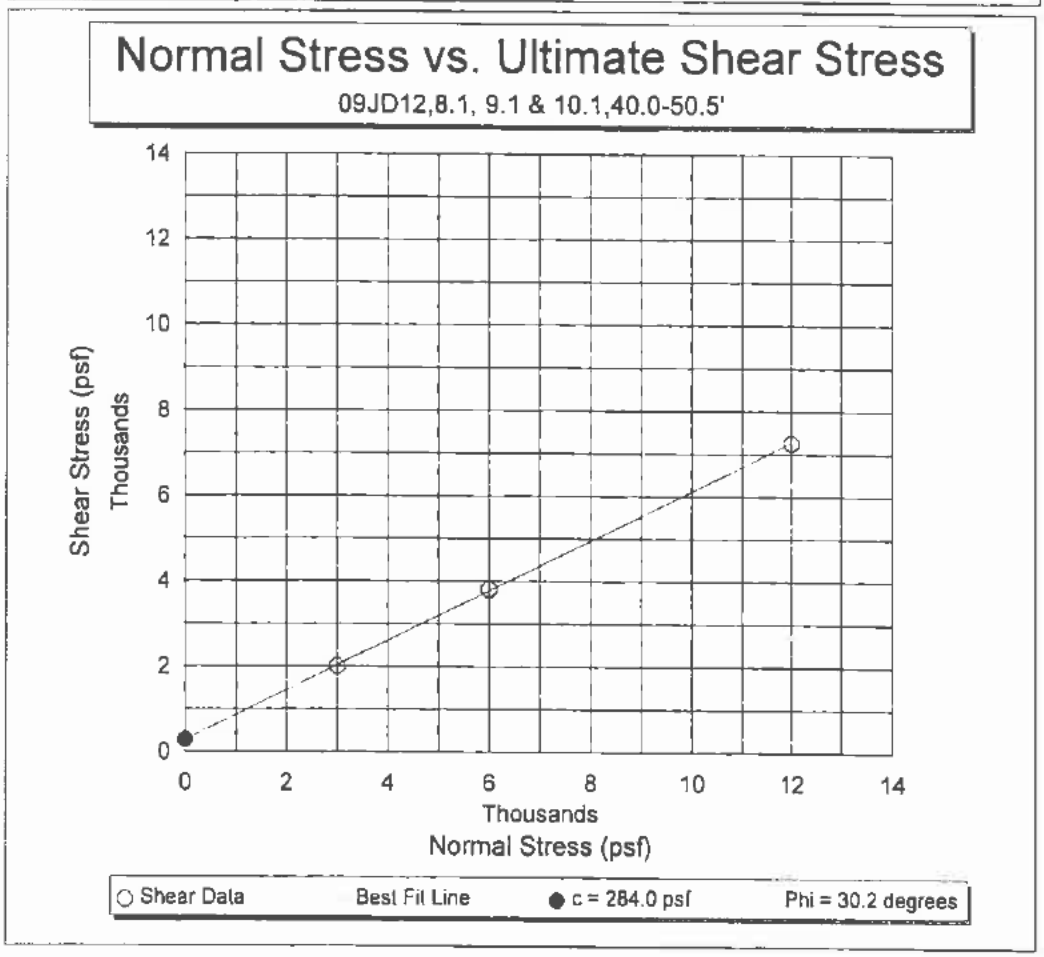
Data File Name: AJDS505C

Normal Stress:	3000 psf	20.83 psi
Peak Stress:	2062 psf	14.32 psi
Ultimate Stress:	2002 psf	13.90 psi

Data entry by: MLM Date: 10/22/2009
Data checked by: LB Date: 10/22/09
FileName: AJDSJD12

ADVANCED TERRA TESTING, INC. ATT

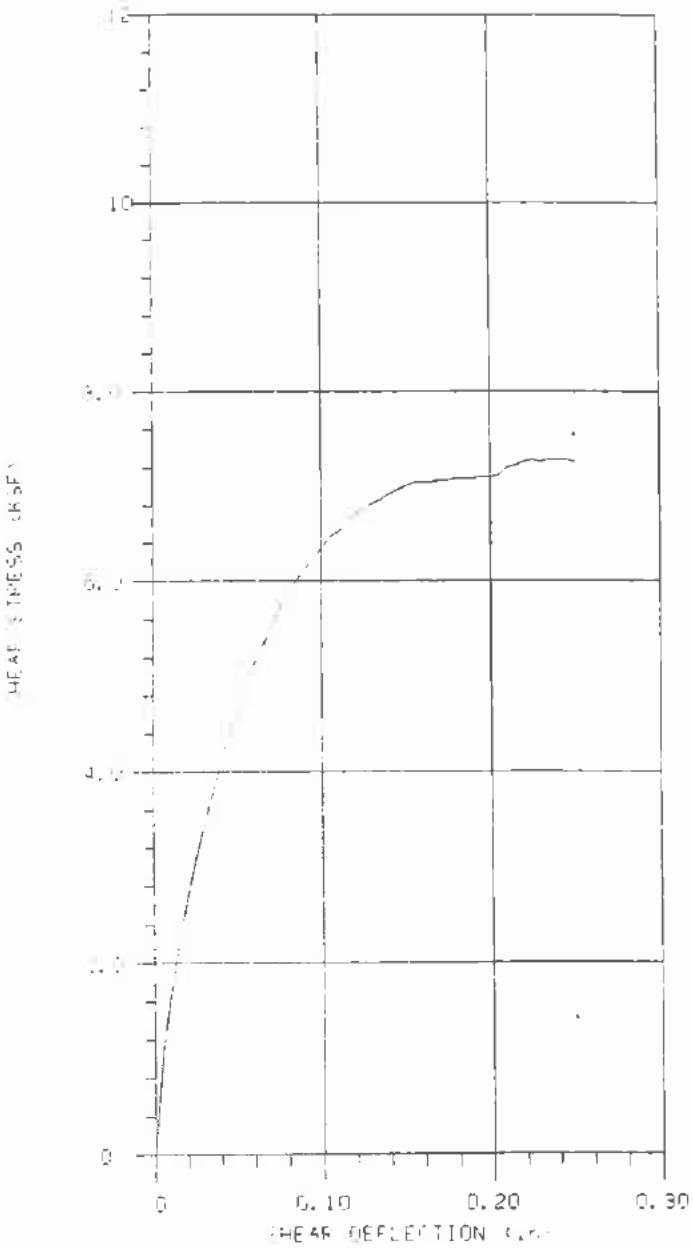

Normal Stress vs. Peak Shear Stress
09JD12,8.1, 9.1 & 10.1,40.0-50.5'
Shear Stress (psf)
Thousands
0
2
4
6
8
10
12
14
Thousands
Normal Stress (psf)
Shear Data
Best Fit Line
c = 337.5 psf
Phi = 30.1 degrees

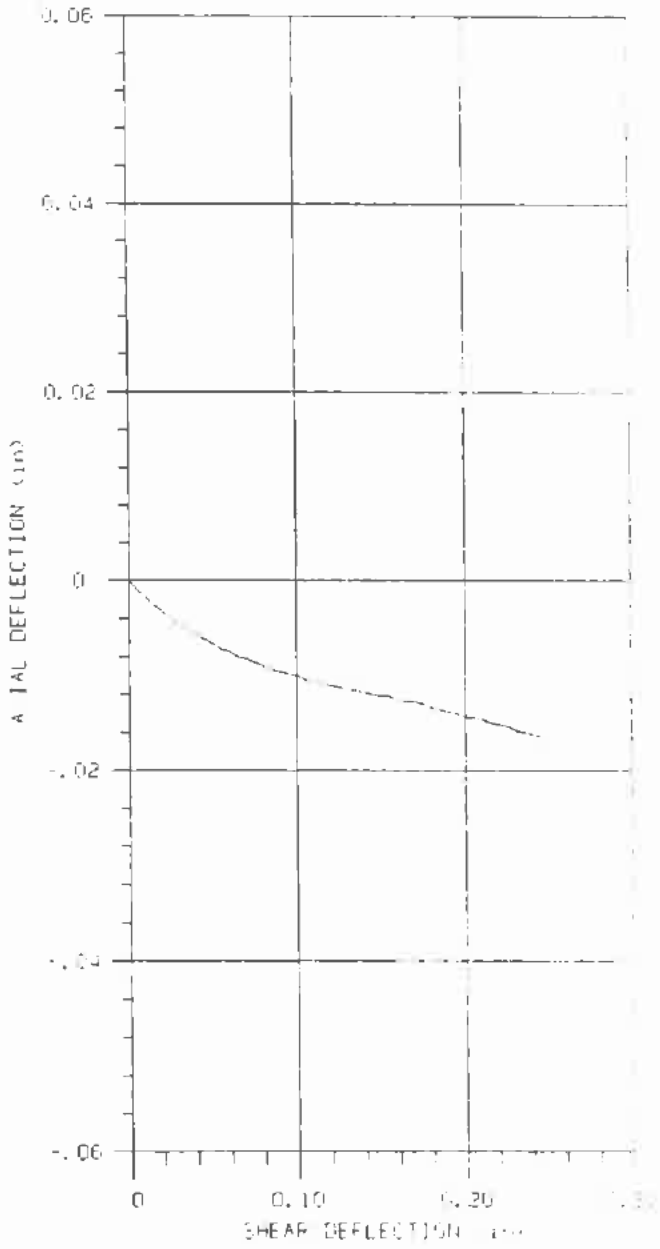

Normal Stress vs. Ultimate Shear Stress
09JD12,8.1, 9.1 & 10.1,40.0-50.5'
Shear Stress (psf)
Thousands
0
2
4
6
8
10
12
14
Thousands
Normal Stress (psf)
Shear Data
Best Fit Line
c = 284.0 psf
Phi = 30.2 degrees

Direct Shear Test

Client..... Aja Ltd
Location..... Vistelli Coal Mine Jumbo

Test Type.....	Ft A	Job Number.....	[illegible]
Depth.....	40-50 (ft)	Sample Number...	[illegible]
Confining Pressure..	12000 (psf)	Boring.....	09JD12
Shear Rate.....	0.0059 (in/min)	File Name.....	ajas505a.DAT
Date Tested.....	10-20-2009	Tested By.....	LB





Case Number and Line Type....	1 ———	2 - - - - - -	3 — — —	4 —·—·—
Maximum Shear Stress.....	7296	.0000	.0000	.0000
Shear Deflection @ Max. Stress.	.2279	.0000	.0000	.0000

GEOMATIC Direct Shear Data

File Name.....ajds505a.DAT
Client.....Ajax Ltd
Job Number....2692-16
Location.....Usibelli Coal Mine Jumbo
Date.....10-20-2009
Technician....LB
Sample Diameter (in).....2.410
Confining Pressure (psf)..12000
Number of Passes.....1
Shear Distance (in).....0.25
Shear Rate (in/min).....0.0059
Soil Type.....Pt A
Boring Number.....09JD12
Sample Number.....8.1 9.1 10.1
Depth (ft).....40-50

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.005	1073	-.0009
0.010	1676	-.0017
0.015	2183	-.0025
0.020	2677	-.0033
0.025	3075	-.0040
0.030	3413	-.0046
0.035	3738	-.0050
0.040	4076	-.0057
0.045	4377	-.0062
0.050	4618	-.0066
0.055	4860	-.0071
0.060	5113	-.0074
0.065	5318	-.0080
0.070	5499	-.0083
0.075	5692	-.0087
0.080	5848	-.0089
0.085	5993	-.0094
0.090	6114	-.0096
0.095	6234	-.0098
0.100	6343	-.0100
0.105	6451	-.0103
0.110	6524	-.0105
0.115	6620	-.0108
0.120	6705	-.0110
0.125	6765	-.0112
0.130	6813	-.0114
0.135	6861	-.0116
0.140	6922	-.0118
0.145	6958	-.0120
0.150	7006	-.0121
0.155	7042	-.0123
0.160	7042	-.0126
0.165	7042	-.0128
0.170	7066	-.0129
0.175	7066	-.0131

Continued next page.

Pass 1 Continued

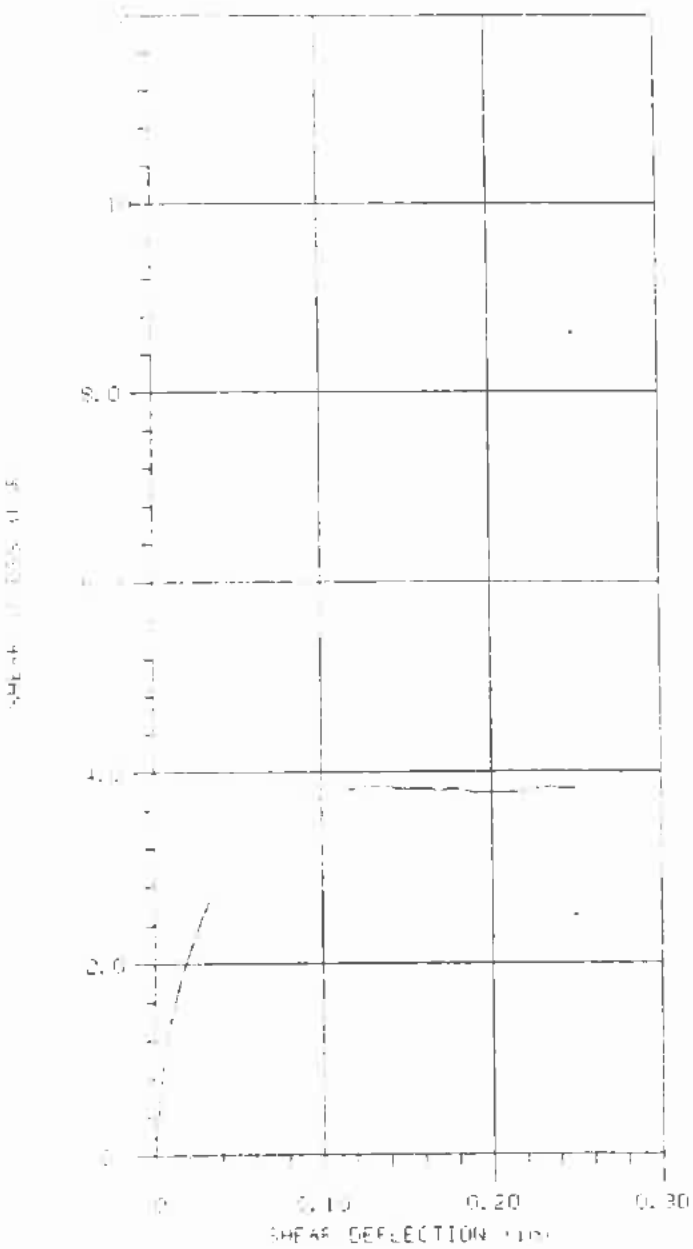
SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.180	7078	-.0134
0.185	7078	-.0136
0.190	7078	-.0138
0.195	7103	-.0141
0.200	7103	-.0144
0.205	7127	-.0145
0.210	7199	-.0147
0.215	7223	-.0150
0.220	7259	-.0152
0.225	7271	-.0154
0.230	7259	-.0158
0.235	7283	-.0160
0.240	7271	-.0162
0.245	7283	-.0164
0.250	7259	-.0167

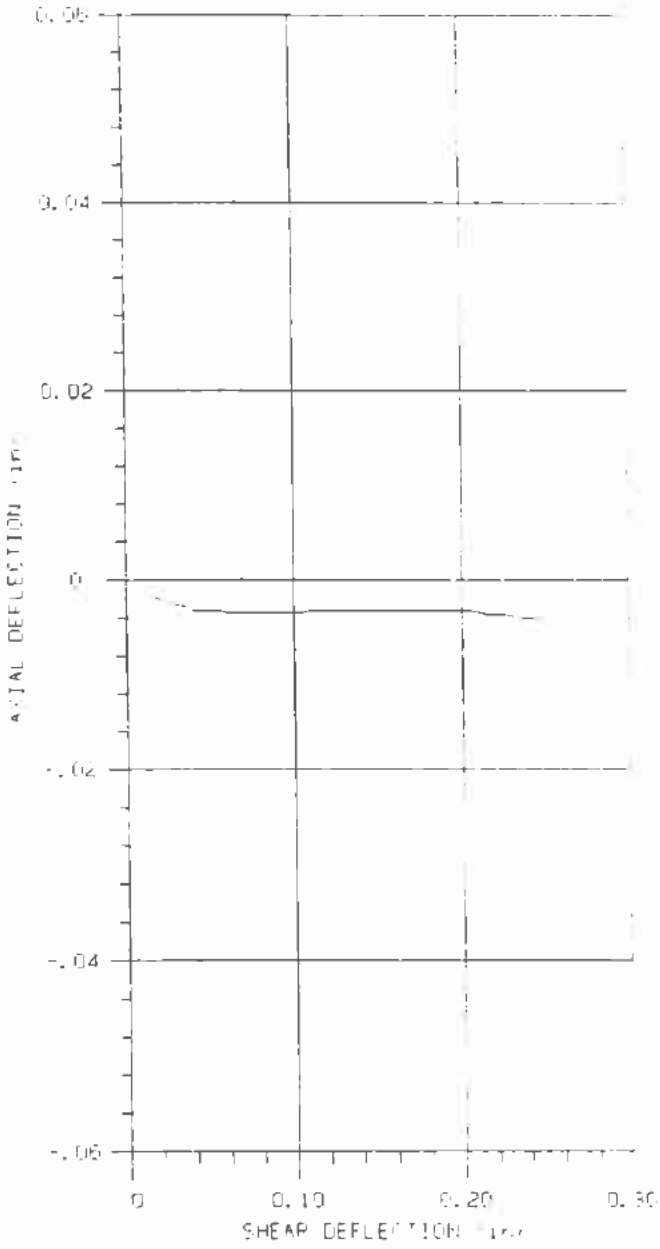
Pass 1 completed with max load = 7296 psf at deflection of .2279 in

Direct Shear Test

Client..... [illegible] Ltd
Location..... Usibelli Coal Mine Jumbo

Soil Type.....	Pt B	Job Number.....	2691-16
Depth.....	40-50 (ft)	Sample Number...	[illegible]
Overburden Pressure..	6000 (psf)	Boring.....	[illegible]
Shear Rate.....	0.0059 (in/min)	File Name.....	[illegible]
Date Tested.....	10-20-2009	Tested By.....	LB





Pass Number and Line Type....	1 ———	2 - - - - - -	3 — — —	4 — — —
Max. Shear Stress.....	3817	.0000	.0000	.0000
Shear Deflection @ Max Stress.	.1249	.0000	.0000	.0000

GEOMATIC Direct Shear Data

File Name.....ajds505b.DAT
Client.....Ajax Ltd
Job Number....2692-16
Location.....Usibelli Coal Mine Jumbo
Date.....10-20-2009
Technician....LB
Sample Diameter (in).....2.410
Confining Pressure (psf)..6000
Number of Passes.....1
Shear Distance (in).....0.25
Shear Rate (in/min).....0.0059
Soil Type.....Pt B
Boring Number.....09JD12
Sample Number.....8.1 9.1 10.1
Depth (ft).....40-50

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.005	1001	-.0006
0.010	1447	-.0011
0.015	1797	-.0017
0.020	2074	-.0020
0.025	2315	-.0024
0.030	2532	-.0026
0.035	2713	-.0028
0.040	2858	-.0031
0.045	3003	-.0032
0.050	3123	-.0033
0.055	3232	-.0033
0.060	3316	-.0034
0.065	3413	-.0034
0.070	3473	-.0034
0.075	3545	-.0034
0.080	3606	-.0034
0.085	3654	-.0034
0.090	3690	-.0034
0.095	3714	-.0034
0.100	3726	-.0034
0.105	3762	-.0034
0.110	3798	-.0033
0.115	3823	-.0033
0.120	3823	-.0032
0.125	3835	-.0032
0.130	3835	-.0032
0.135	3835	-.0032
0.140	3835	-.0031
0.145	3823	-.0031
0.150	3823	-.0031
0.155	3823	-.0031
0.160	3823	-.0031
0.165	3811	-.0031
0.170	3798	-.0031
0.175	3811	-.0031

Continued next page.

Pass 1 Continued

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.180	3811	-.0031
0.185	3798	-.0031
0.190	3786	-.0031
0.195	3774	-.0031
0.200	3774	-.0032
0.205	3774	-.0033
0.210	3774	-.0034
0.215	3786	-.0035
0.220	3798	-.0036
0.225	3811	-.0037
0.230	3823	-.0038
0.235	3835	-.0039
0.240	3811	-.0040
0.245	3811	-.0041
0.250	3823	-.0042

Pass 1 completed with max load = 3847 psf at deflection of .1249 in

GEOMATIC Direct Shear Data

File Name.....ajds505c.DAT
Client.....Ajax Ltd
Job Number....2692-16
Location.....Usibelli Coal Mine Jumbo
Date.....10-20-2009
Technician....LB
Sample Diameter (in).....2.410
Confining Pressure (psf)..3000
Number of Passes.....1
Shear Distance (in).....0.25
Shear Rate (in/min).....0.0059
Soil Type.....Pt C
Boring Number.....09JD12
Sample Number.....8.1 9.1 10.1
Depth (ft).....40-50

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.005	567	-.0007
0.010	868	-.0010
0.015	1121	-.0013
0.020	1302	-.0014
0.025	1459	-.0014
0.030	1580	-.0014
0.035	1688	-.0012
0.040	1773	-.0009
0.045	1833	-.0007
0.050	1881	-.0004
0.055	1929	0.0000
0.060	1966	0.0004
0.065	1990	0.0008
0.070	2014	0.0011
0.075	2026	0.0016
0.080	2038	0.0019
0.085	2050	0.0024
0.090	2050	0.0026
0.095	2050	0.0031
0.100	2050	0.0033
0.105	2050	0.0035
0.110	2038	0.0039
0.115	2038	0.0040
0.120	2038	0.0042
0.125	2050	0.0044
0.130	2050	0.0047
0.135	2050	0.0048
0.140	2050	0.0049
0.145	2038	0.0050
0.150	2038	0.0051
0.155	2038	0.0052
0.160	2038	0.0053
0.165	2038	0.0054
0.170	2050	0.0055
0.175	2062	0.0056

Continued next page.

Pass 1 Continued

SHEAR DEFLECTION (in)	SHEAR STRESS (lb/sqFT)	AXIAL DEFLECTION (in)
0.180	2050	0.0056
0.185	2050	0.0057
0.190	2038	0.0057
0.195	2038	0.0057
0.200	2026	0.0057
0.205	2038	0.0057
0.210	2038	0.0057
0.215	2026	0.0057
0.220	2014	0.0056
0.225	2014	0.0056
0.230	2014	0.0056
0.235	2002	0.0054
0.240	2002	0.0052
0.245	1990	0.0050
0.250	2002	0.0049

Pass 1 completed with max load = 2062 psf at deflection of .0908 in

APPENDIX C
SLIDE COMPUTER PRINTOUTS

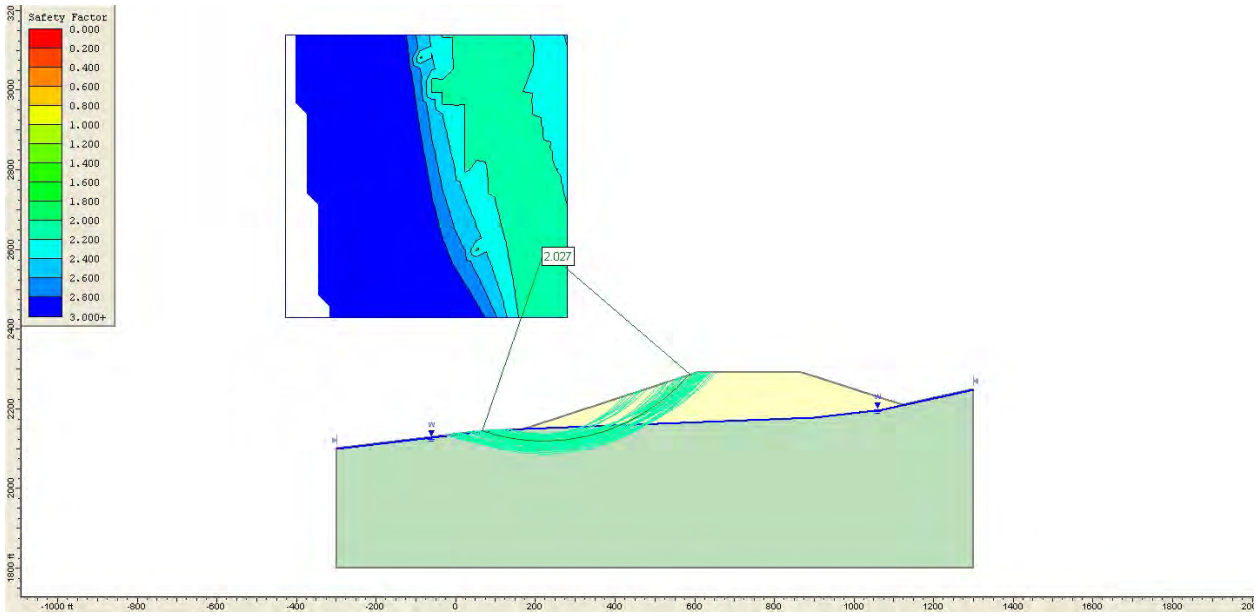


Figure C1 – Deep-seated Out-of-pit Spoil Stability for Compacted, Dry Conditions

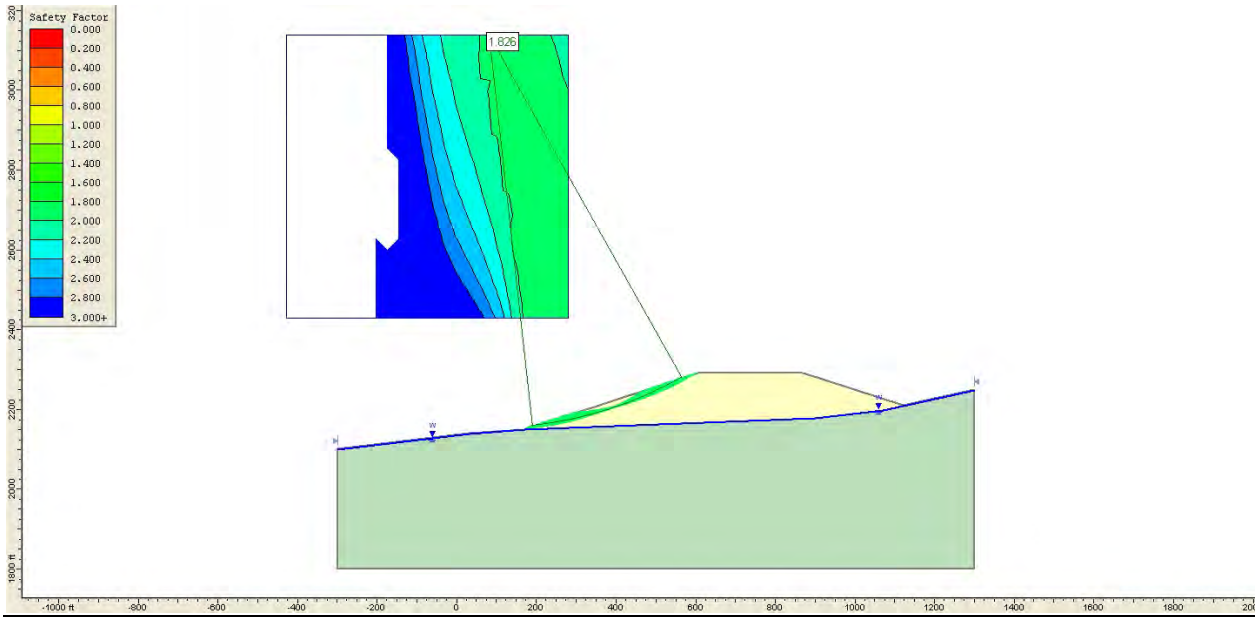


Figure C2 – Shallow, Total Slope Out-of-pit Spoil Stability for Uncompacted, Dry Conditions

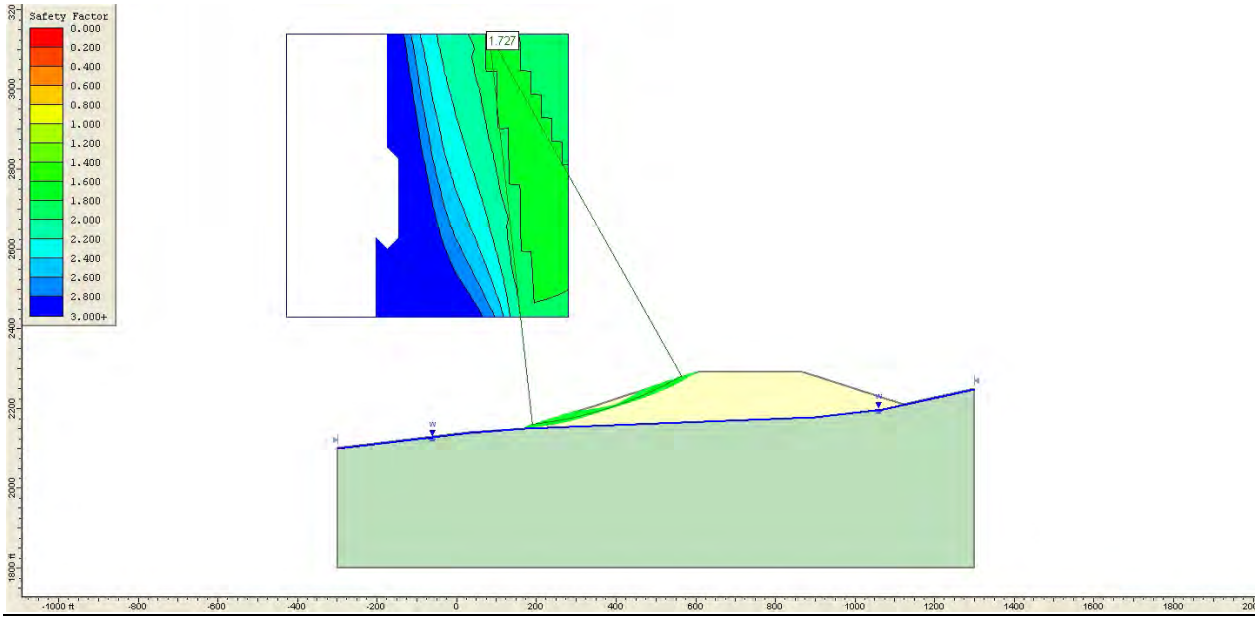


Figure C3 – Shallow, Total Slope Out-of-pit Spoil Stability for Compacted, Wet Conditions

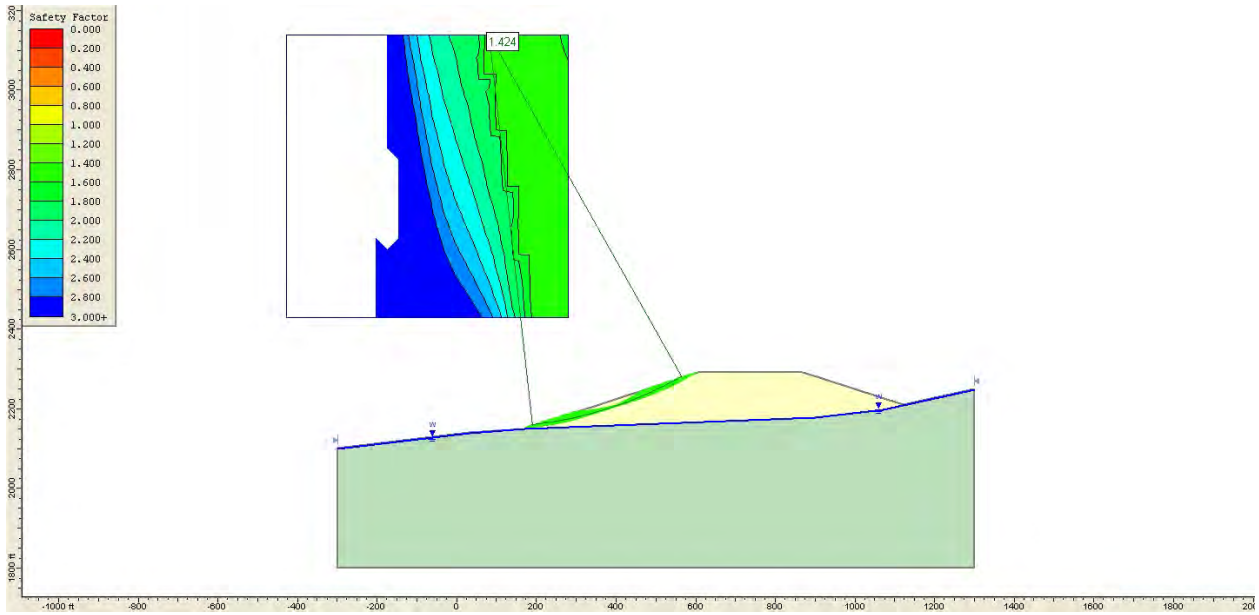


Figure C4 – Shallow, Total Slope Out-of-pit Spoil Stability for Uncompacted, Wet Conditions

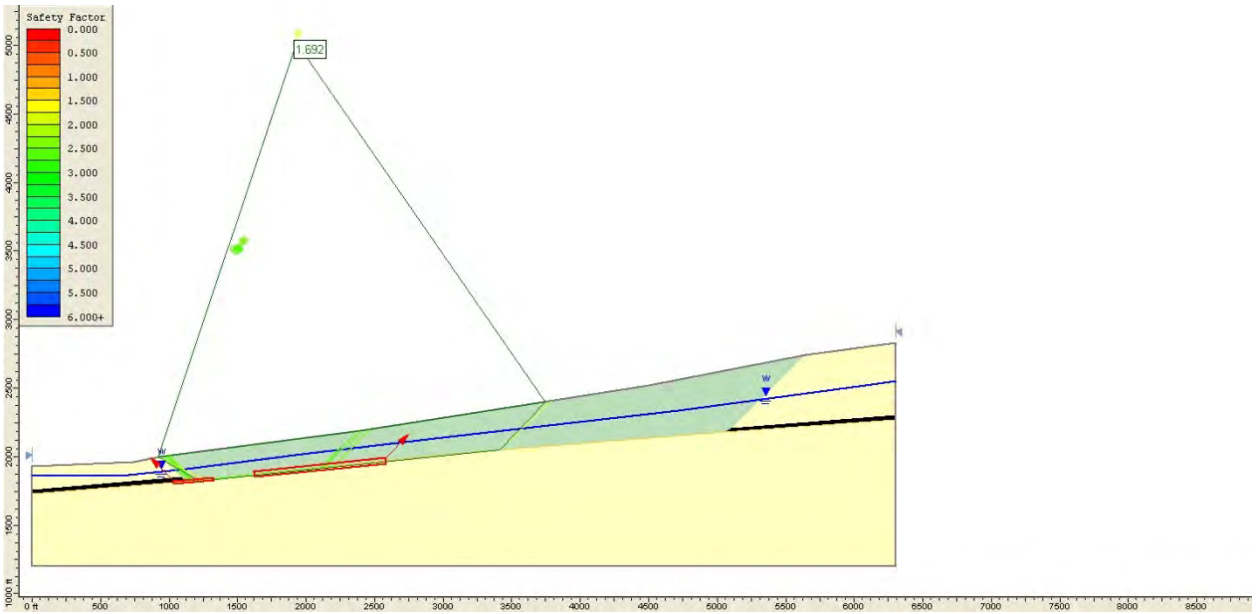


Figure C5 – Overall Post Mining Topography (Backfill) Stability for Highest Likely Phreatic Surface

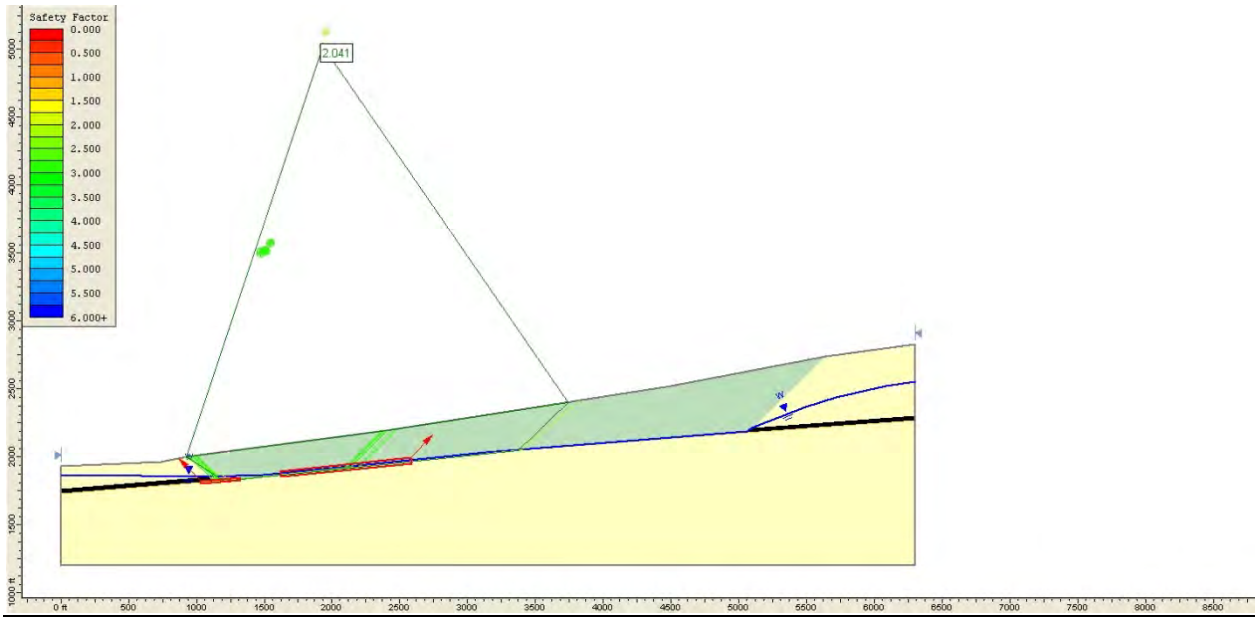


Figure C6 – Overall Post Mining Topography (Backfill) Stability for Lowest Likely Phreatic Surface

SECTION 6.0

COAL REMOVAL AND STORAGE

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6.2 Coal Conservation Measures D6-1

6.3 Coal Handling And Storage D6-1

6.0 COAL REMOVAL AND STORAGE

6.1 REMOVAL PROCESS

Over the life of the Jumbo Dome Mine operations, approximately 83.3 million short tons of in-situ coal will be exposed at a maximum annual rate of approximately 3.0 million short tons. Both dragline and/or shovel-truck stripping operations will remove the overburden and interburden materials to a level just above the top of each coal seam. Dozers will then be used to clean the top of the coal seam. Once the coal seam(s) has been cleaned, it will be drilled and blasted as described in Section D4.0 (Blasting Plan) to fragment the coal for loading. Depending upon operating conditions and equipment availability, a front end loader, shovel, or backhoe may be used to load the coal into haulage trucks. When soft floor conditions are a factor, the backhoe will be used since it can travel on top of the coal.

6.2 COAL CONSERVATION MEASURES

Coal, the marketable product, will be handled so that a minimum amount is wasted. Dragline operators will be instructed to dig only until small portions of the coal begin to show in the pit floor. Truck and shovel stripping will be performed to a depth of one or two feet above the coal so that equipment traction can be maintained. Dozers will perform the final coal cleaning and push the final volume of overburden to within reach of the dragline or shovel. Based on past experience, this process normally allows coal losses on the hanging wall to be less than one foot. Once the hanging wall of coal is exposed, a final clean up around the edges will be performed by a front end loader, as needed. The coal will be blasted lightly so as not to lose any as fly coal outside of the coal pit.

6.3 COAL HANDLING AND STORAGE

Coal from the Jumbo Dome Mine will be hauled by truck to UCM's existing coal handling facilities. The existing coal handling facilities are addressed under UCM's Poker Flats mine permit (No. 01-83-796) and are not considered a component of this permit application. No coal stockpiling, crushing, or screening will be conducted on the Jumbo Dome Mine permit area.

SECTION 7.0

ROADS AND COAL TRANSPORT SYSTEMS

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LIST OF PLATES

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7.0 ROADS AND COAL TRANSPORT SYSTEMS

7.1 ROADS

The main access/coal road leading to, and overlapping with, the southern boundary of the Jumbo Dome (JD) mine permit area was previously permitted under surface coal mining permit number S-0605 (see Plate D2-1). Within the JD permit area, there will be a number of different types of roads and each road type will serve a specific function. The types of roads that will be utilized are as follows:

- Long-Term Haul Roads.
- Short-Term Haul Roads.
- Light Traffic Roads.
- Remote Access Trails.

The specific function of each road type is discussed below.

Long-Term Haul Roads

Long-term haul roads are roads which will undergo heavy duty usage throughout the life of the mine or longer. They are designed for 80 feet of driving surface and grades are limited to ten percent maximum. Long-term haul roads are designed to meet all required MSHA regulations as they pertain to UCM operations. Cut slopes are determined by the type of material in the cut. Competent materials such as undisturbed sandstone, may be cut at grades as steep as 0.5H to 1V. The fill sections of roads are designed to have shoulder slopes ranging from 1.3H to 1V or flatter depending on fill depth. The running surface is covered with a veneer of fine gravel to provide a good traveling surface. All fill slopes are revegetated to reduce erosion and siltation from surface waters. Cut slopes are normally too steep to be revegetated. Properly sized culverts are placed at main drainage points and equipped with thaw pipes, when necessary.

Short-Term Haul Roads

Short-term haul roads include pit haul roads and multiple-lane heavy equipment access roads which have an anticipated life of a few months to a few years. Design considerations are less stringent for these roads. Widths vary from 30 to 80 feet and grades up to 15 percent may be used for short distances. Cut and fill slopes are at the steepest that can be maintained with the available material. Culverts and bridges are installed only as necessary to preserve the road during its anticipated life span. Short term haul roads are normally contained within the active pit area.

Light Traffic Roads

Light traffic roads are designed to provide temporary access for light trucks, maintenance vehicles, and intermittent heavy equipment. These roads are normally no more than 40 feet wide and constructed by field personnel and designed in the field to expedite access to the desired area. These roads are often very steep and are not expected to remain in use by heavy equipment for extended periods of time. Light traffic roads are used for pit access and access to facilities within the permit area including the potential land application site.

Remote Access Trails

Remote access trails are used for access to areas undisturbed by mining for purposes of exploration, data acquisition, and maintenance. Design consideration for these trails is to create as little surface disturbance as possible. Trails are often no more than corridors where the large trees have been removed. Widths are minimal and grades are the maximum consistent with terrain and the equipment which will be using them. Usually, drainage control will be limited to surface features, such as reseeding and water-barring, that will require little or no maintenance. These trails may remain in use throughout the life of the permit, but normally, traffic will be light and intermittent or of a seasonal nature. Remote access trails are contained within the permit area.

7.1.1 JD Long-Term Haul Roads

The approximate location of long-term haul roads within the 5-year permit term area for the JD mine are shown on the General Facilities Arrangement map (Plate D2-1), Section D2.0. Typical long-term haul road cross-sections and culvert design criteria are shown on Plate D7-1.
The major culvert locations for the long-term haul roads are shown on Plate D2-1.

The main long-term haul road for JD mine overlaps the existing JD haul road corridor that was permitted under permit number S-0605 within the southern portion of the JD mine permit, and continues in a north-northeasterly direction. Construction of the road will involve both fill and cut sections as it progresses up to the proposed mine area. Fill areas will be founded on native slopes of varying angles. The fill section sub-base will be properly prepared for long term road stability with the fill material buttressing the undisturbed south facing slopes (see Plate D7-1, Road Design, Typical Cross Sections). The actual centerline of the road may vary from that shown on Plate D2-1 (General Facilities Arrangement) to accommodate the optimum profile. Where applicable, topsoil will be salvaged into windrows along the toe of the fill area and replaced on the finished fill slopes and then revegetated.

During the construction of the main haul road, the drainage and sediment control plan will consist of frequent on-site observations and any offsite sediment will be controlled with hay bales or sediment fences as needed in accordance with the multi-sector general permit for storm water.

7.2 ROAD MAINTENANCE

Road maintenance work will be periodically performed to optimize equipment longevity and also maintain safety and environmental standards. During summer months, water will be spread on roads to minimize dust generated by mine traffic. The water for the watering operations will come from Popovitch Creek which have existing water use permits issued by DNR or from supernatant from the settling ponds. Graders will be used year-round to smooth and maintain road surfaces. On the main roads, a crown will be graded into the center to promote drainage

during rain events. During the winter months, snow will be cleared with graders and occasional help from a front-end loader. Gravel may also be spread on roads after snow clearing to promote safety.

On an as-needed basis, brushing will be done to clear road edges of vegetation that impairs visibility. The typical clearing width will be 30 feet from road edges and will involve cutting and shearing trees and brush. Greater clearing widths may sometimes be needed on the inside of corners and at intersections. An effort will be made to avoid clearing operations during the migratory bird-nesting season.

7.3 EXISTING ROADS AND COAL TRANSPORT SYSTEMS

The following existing systems will be used for access and transportation of coal from the JD mine.

Jumbo Dome Haul Road

This haul road connects the JD mine with the Hoseanna Creek haul road. It was permitted under surface coal mining permit number S-0605.

Hoseanna Creek Haul Road

The Hoseanna Creek haul road connects the Jumbo Dome haul road with the UCM coal tipple. It was permitted under surface coal mining permit numbers 01-83-796 and 02-83-796

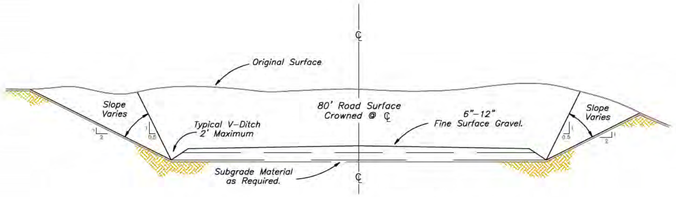
UCM Coal Tipple and Train Loadout

Coal from the JD mine will be crushed at the coal tipple and then conveyed across the Nenana River to a train loadout site. The UCM coal tipple facility and train loadout site were permitted under surface coal mining permit number 01-83-796. A relatively small portion of coal from the JD mine may also be trucked to Golden Valley Electric Association's Healy power plant.

PLATE D7-1

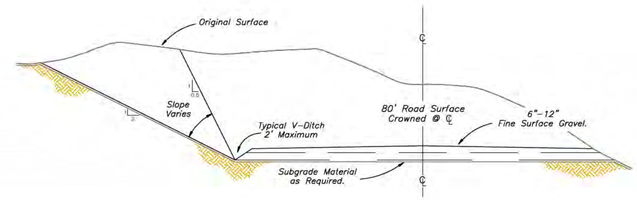
ROAD DESIGN TYPICAL CROSS SECTIONS

TYPICAL HAUL ROAD CROSS SECTIONS



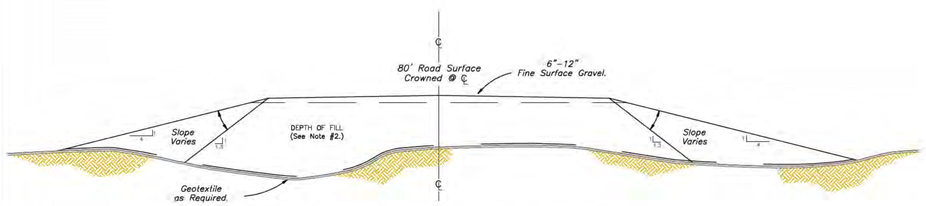
TYPICAL HAUL ROAD CUT

NOT TO SCALE



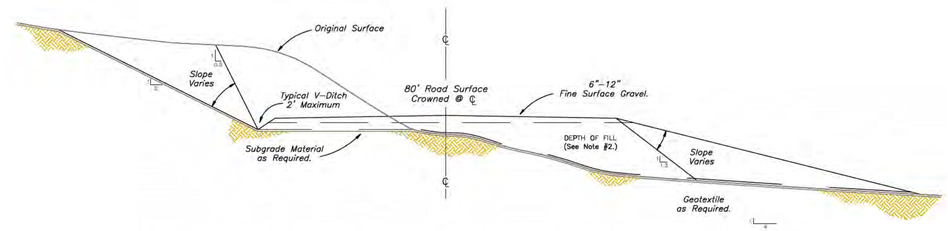
TYPICAL HAUL ROAD, HILLSIDE CUT

NOT TO SCALE
(See Note #1.)



TYPICAL HAUL ROAD FILL

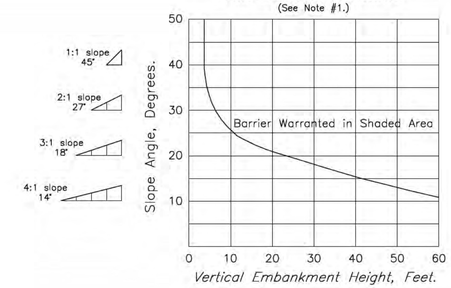
NOT TO SCALE
(See Note #1.)



TYPICAL HAUL ROAD, HILLSIDE CUT & FILL

NOT TO SCALE

ROAD EDGE BARRIER CRITERIA
FOR ELEVATED ROADWAYS
(See Note #1.)

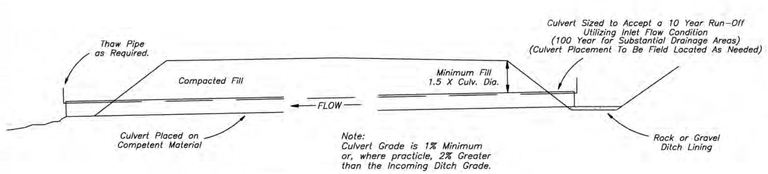


Barriers are warranted when Slope Angle and Slope Height exceed those listed on chart.

Slope Angle (°)	Gradient	Slope Height	Approx. Slope Length
45.0	1:1	4 ft	6 ft
33.7	1.5:1	4 ft	7 ft
26.6	2:1	10 ft	22 ft
21.8	2.5:1	19 ft	51 ft
18.4	3:1	31 ft	98 ft
16.0	3.5:1	39 ft	142 ft
14.0	4:1	47 ft	194 ft
12.5	4.5:1	55 ft	253 ft
11.3	5:1	66 ft	336 ft
10.2	5.5:1	83 ft	468 ft
9.4	6:1	100 ft	608 ft

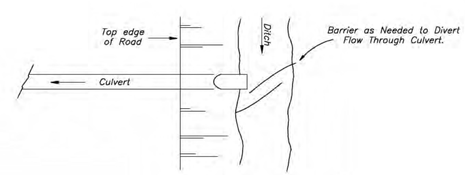
(From MSHA Program Information Bulletin No. P93-8, 4/01/93)

CULVERT DESIGN CRITERIA



TYPICAL CROSS SECTION

NOT TO SCALE



TYPICAL PLAN VIEW

NOT TO SCALE

NOTES:

1. ELEVATED ROADWAYS HAVE AT LEAST ONE EMBANKMENT NOT PROTECTED BY A NATURAL TOPOGRAPHIC BARRIER, WHERE A DROP IN GRADE OR HEIGHT CAN ENDANGER AN UNCONTROLLED OR SLIDING VEHICLE. THE GRAPH ABOVE IS INTENDED FOR USE ON PERMANENT OUT OF PIT HAUL ROADS. THE TERM, "BARRIER", MAY BE A CURB, FENCE, BERM, ROAD EDGE MARKER AND/OR A REDUCED SPEED LIMIT. EXACT ROAD EDGE CONFIGURATION IS DETERMINED BY A SITE SPECIFIC EVALUATION.
2. THE DEPTH OF ROAD FILL IS DEPENDENT ON SOIL CONDITIONS OF THE ORIGINAL GROUND AND FINAL HAUL ROAD GRADE DESIGN.

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
0	09/09	RLM	ORIGINAL SUBMITTAL

DESIGN BY: T. VENECHUK
DRAWN BY: R. MARTIN
CHECK BY: F. WALLIS
DWG FILE: 7-2.DWG
XREF DWG FILE: N/A

USIBELLI COAL MINE INC. UCM

ROAD DESIGN
TYPICAL CROSS-SECTIONS

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. D7-1
SHEET No. 1 OF 1
REV. 0

SECTION 8.0

EXISTING STRUCTURES AND MINE FACILITIES

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8.0 MINE FACILITIES

8.1 EXPLOSIVES STORAGE

The explosives storage structures will be located on the south end of the permit property as shown on Plate D2-1, General Facilities Arrangement. The explosive storage structures will be constructed in accordance with all federal, state, and local laws.

8.2 POWERLINE CORRIDOR

Routing for a powerline from the existing distribution system to the Jumbo Dome permit area will follow the Jumbo Dome mine road corridor. This powerline will be addressed in the surface mining permit that was acquired for the road corridor (Permit No. S-0605). Powerline routing for the electrical service through the permit area is shown in Plate D2-1, General Facilities Arrangement. The main supply lines for the power distribution system will be owned by Golden Valley Electric Association.

Design of the power line will follow the standards used at the Two Bull Ridge mine. Construction will be performed in such a manner as to minimize ground disturbance. For any disturbed area within the corridor, topsoil will be salvaged as outlined in Section D3.0. There will be no additional wetland disturbance required for the construction of the power line. When there is no future need for the power line it will be removed.

An electrical substation will be constructed at the north end of the power line corridor. In the vicinity of the sub-station, a ready line to plug in vehicles in the winter and a skid mounted warm up shack will also be constructed.

8.3 SIGNS AND MARKERS

UCM will place signs that are easily seen and constructed of durable material. Permit signs and markers will be posted wherever mining activities occur in close proximity to the permit boundary, to avoid confusion regarding the exact permit area limits. Stream buffer zones will be marked on Marguerite Creek.

Identification signs are currently posted on the Nenana River Road, Gold Run Pass south access road, Poker Flats south access road, and the West Side Tipple Road. The existing signs will be modified to include Jumbo Dome Mine.

8.4 ACCESS CONTROL FEATURES

The primary entrance from public roads to UCM operations is controlled by a gate constructed to deny access to anyone not authorized to enter the mine area. Employees of UCM gain access by using an electronic key to open the gate. Non-employees are required to call the main mine office using a phone provided at the main entry gate to gain access. All gates have the mine permit numbers, MSHA identification numbers, and blast warning signals posted on a sign. Secondary access gates do not have phone contact with the mine office or electronic key entry.

There are no public roads which provide access to the permit area. The only access is via roads permitted under the Poker Flats surface mining permit (#01-83-796).

8.5 EXISTING STRUCTURES

The primary existing structures in the Jumbo Dome Mine permit area are those associated with exploration activities both pre- and post ASMCRA. These include trails used to access drill sites and monitoring wells. All monitoring wells and recent trails were permitted under an exploration permit. A large portion of the existing trails will be consumed by the mining operation. Trails which will see continued use for data collection outside the mine limits, but

within the permit area have been constructed to the standards for trails in, Section D7.0. UCM has obtained the required fish habitat permits for crossings of Marguerite Creek. Monitoring wells will be abandoned in accordance with provisions of the exploration permit which authorized their installation. There is an existing trail system pre-dating exploration efforts located directly adjacent to Marguerite Creek.

SECTION 9.0

DRAINAGE AND SEDIMENT CONTROL PLAN

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9.0 DRAINAGE AND SEDIMENT CONTROL PLAN

9.1 GENERAL

The proposed surface water control system for protecting the hydrologic system outside of the disturbed area consists of temporary diversion ditches, disturbed area runoff collection ditches, and sediment ponds designed as zero discharge (during a 100 year, 6 hour event per 11 AAC 90.336) structures.

Designs were completed for the drainage structures that are required to control and contain runoff from the disturbance areas created in the first 5-year term. These structures are:

- Channels JD-2, JD-3, OOPS 1, OOPS2, CWD-1, CWD 2, CWD-4 and temporary CWD 3
- Culverts HR1 and HR-2
- Ponds JD-1, JD-2, JD-3 First Term, and Shop Pond

Conceptual designs are presented for Ponds JD-3 and JD-4 and Channels JD-3, JD-4, and CWD 4 to give the State an idea of what UCM is currently planning for drainage control beyond the first term.

The designs for culvert MCHR are presented in a related permit for the Jumbo Dome Road Corridor project.

The locations of both the designed and future drainage structures are shown on Plate D9-1. Specific details for each facility and associated components are discussed in the following sections.

Water control facilities will be in place prior to mining. They will remain in place until no longer required for operations and/or successful vegetation re-establishment of affected tributary areas. The proposed sediment ponds and channels will be reclaimed according to the methodologies discussed in Section 10, Reclamation Plan.

9.2 DESIGN HYDROLOGY

The general design criteria for the ponds is to contain the entire volume from a 100-year, 6-hour storm. Each pond will have an emergency spillway designed to safely pass a 25-year, 24-hour

storm assuming the pond is full when the event happens. The water control facilities have been designed to handle peak flow rates caused by summer rainfall events. Runoff peak flow rates and volumes for the proposed ponds, ditches, and culverts were designed utilizing SEDCAD4. SEDCAD4 is a computer program designed to calculate runoff volume and peak flow with a numerical modeling technique based on user inputs of a design storm event, (i.e., precipitation frequency data, selection of rainfall distribution, and convolution increment). The methodology, assumptions, and inputs used in determining peak flows, pond designs, channel designs, and culvert designs are discussed in Appendix D9-1.

The drainage and sediment control structures were designed with the assumption that all runoff will be directed to the structures. This is a conservative assumption due to the fact that a significant amount of the runoff from the disturbed areas will be intercepted by the open pits. In addition, the entire drainage basin within the proposed mining limits was considered disturbed.

9.3 GROUNDWATER CONTROL

Groundwater seepage into the active pit and other deep excavations is expected. This inflow will probably be randomly derived from the coal seams, the overlying gravels and muskeg, and to a lesser extent the sandstone overburden/interburden. The seepage will be collected in sumps located at the low point(s) within the pits. To the extent practical, UCM will utilize temporary sumps within the pit area to help contain some of the flows. The remaining flows will be pumped as necessary to exiting channels that will route the water to one of the proposed ponds. Groundwater elevations were accounted for in the design of ponds JD-2 and JD-3 First Term.

In an attempt to reduce the amount of groundwater in the pits, groundwater inflows at the upper end of the box cut and the pit end walls may be diverted through the use of a clean groundwater diversion system. This diversion will utilize gravel drains at the face of the 3 and 4 coal seams at the upper end of the box cut and in each pit end wall. As the drains are being constructed, it will be immediately covered with backfill material to isolate it from any potential surface runoff from disturbed areas. The drain system will be diverted periodically across the length of the pits under the backfilled spoils to infiltrate the groundwater flows. No water from the active mining pit will be diverted into this clean groundwater diversion system. Figure D9-2 and Plate D10-1 depict

the location and design of the clean groundwater diversion system. If this diversion system cannot be implemented effectively, UCM will not use it.

UCM may implement ahead of mining dewatering wells to reduce the amount of water in the pit. The natural condition of the groundwater does not meet Water Quality Based Effluent Limits for iron and manganese, therefore UCM will route the pumped water either to the land application site or to the sediment ponds.

9.4 SURFACE WATER CONTROL – DITCHES

A system of collection and diversion channels will be employed to collect runoff from the disturbed area and convey it to containment ponds. Where advantageous, runoff from undisturbed areas will be diverted away from the disturbed area to minimize the amount of water within areas of disturbance. The locations of these channels and ponds are identified on Plate D9-1. The flows and design parameters are shown in Figure D9-1.

Channels OOPS-1 and OOPS-2 are designed to collect runoff from the out-of-pit spoil pile area and divert it to Pond JD-1. Channel JD-2 is designed to collect runoff from the disturbed mining areas and divert the runoff to Pond JD-2. Conceptual Channels JD-3 and JD-4 are designed to collect runoff from the disturbed mining areas in future terms and divert the runoff to Ponds JD-3 and JD-4, respectively. The Facility Pad area will be graded to drain to the Shop Pond.

Channel CWD-1 will be located above the mine site and will divert clean water runoff around the mining area to the natural drainage between Pond JD-1 and the Mine Area, which drains to Marguerite Creek. Channel CWD-2 is designed to divert runoff around the out-of-pit spoil pile and also will discharge to the natural drainage between Pond JD-1 and the Mine Area, which drains to Marguerite Creek. Channel CWD-3 is designed to temporarily divert water away from Pond JD-2 and discharge to Marguerite Creek. This channel will only be utilized until the mining activities reach the watershed above the channel, at which time it will be removed and mine runoff will drain to Pond JD-2. Channel CWD-4 is designed to divert runoff around the land application site. This channel will only be installed if the land application effort is triggered. See Section 9.7. The channels and associated watersheds are shown on Plate D9-1. All clean water diversion ditch (CWD) discharges will be permitted under an Alaska Pollution Discharge

Elimination System (APDES) Multi Sector General Permit for Sector H, Coal Mines and Coal Mine Related Facilities.

The proposed channels are temporary and, according to the Alaska Surface Coal Mining Program Regulations, must be designed to safely pass the peak discharge from a 2-year, 24-hour storm event. However, due to the length of time the channels will be utilized, they have been designed to safely convey the peak discharge from a 10-year, 24-hour storm event.

The channels' peak flows were modeled using the SEDCAD4 program. The methodology, assumptions, and input parameters used in the design of the channels are discussed in Appendix D9-1. Each channel was designed for a range of slopes over the length of the channel. The results of the channel designs are shown in Figure D9-1.

When practical, channel gradient and geometry were selected to minimize contribution of additional sediment load to the receiving ponds or waters due to channel degradation. Where peak flow velocities are greater than 6 fps, riprap will be used to prevent channel degradation. The riprap will be sized as shown in Figure D9-1. The designed gradation is for a D_{max} of 1.5 x D_{50}, and the D_{10} will be 0.2 x D_{50}. The channels with peak flows less than 6 fps will be lined with a 3-inch-minus coarse gravel. Where diversion ditches discharge into natural surroundings, energy dissipation measures such as energy pools or riprap pads will be employed to further inhibit erosion. Routine maintenance will be employed to repair the channels and preserve the overall integrity of the entire channel system.

As mentioned above, the proposed channels are temporary. They will remain in place until no longer necessary for operational requirements and ultimately will be reclaimed.

9.5 SURFACE WATER CONTROL - CONTAINMENT PONDS

Ponds JD-1, JD-2, JD-3, and JD-4 operate to contain runoff from the affected area which may drain toward Marguerite Creek at any time during mining and/or reclamation. Drainage basin systems are shown on Plate D9-1. Final certified designs for each pond that will be built during the first five year term (JD-1, JD-2, JD-3 First Term, and Shop Pond are shown on Plates D9-2, D9-3, D9-4 and D9-7 respectively; the remaining conceptual ponds (JD-3 and JD-4) are shown

on Plates D9-5 and D9-6. Upon completion of the pond construction, an engineering report will be submitted to DMWM; it will verify that the design intent of the ponds as presented here and in the plates has been met in the construction and final as-built configuration of the ponds.

The ponds are designed to effectively contain the total runoff produced from the 100-year, 6-hour storm event. They will have an emergency spillway designed to safely pass the peak discharge from the 25-year, 24-hour storm event while maintaining one foot of freeboard. The methodology, assumptions, and input parameters utilized in the design of the ponds are discussed in Appendix D9-1.

The ponds are designed with an assumed operational water elevation. As long as the water levels in the ponds are maintained at or below this level, both ponds will effectively contain the peak discharge from the 100-year, 6-hour storm event without discharging through the emergency spillway. The operational water levels for the ponds are indicated on Plates D9-2, D9-3, D9-5, and D9-6. The operational level will be maintained by using a variety of methods, including dust control, infiltration, evaporation, sublimation, and irrigation of reclaimed areas. The ponds will have visual indicators of pond levels to ensure proper operation of the ponds.

At the beginning of the first term of mining, UCM will construct the first phase of Pond JD-3. The first phase is called JD-3 First Term and is shown on Drawing JD-4. The JD-3 First Term pond is not designed to collect any stormwater runoff. Its main purpose is to provide an outlet for Pond JD-2 in case it is difficult to maintain the operational water level using the methods outlined above.

As shown on Plate D9-3, the ground water level for JD-2 is well below the planned operational level, which will provide approximately 250 ac-ft of active storage in pond JD-2 to work with. If the capacity of JD-3 First Term is included, there will be approximately 350 ac-ft of active storage available.

The annual management of the ponds at different stages in the mining operations is discussed in Section 9.7.

Except for the Shop Pond, the ponds have incorporated emergency spillways. The spillways will be trapezoidal channels with 20-foot-bottom widths and 3H:1V side slopes. The outslopes of the

spillways will be armored. Refer to Plates D9-2, D9-3, D9-5, and D9-6 for spillway locations and designs. The spillways are designed to safely pass the peak discharge from the 25-year, 24-hour event while maintaining a minimum of 1 foot of freeboard. Because the ponds are designed to contain the 100-year, 6-hour event, the spillways were designed assuming the ponds are full to the invert when the event accrues.

The general operational policy for the ponds will be to operate them with zero discharge (during a 100-year, 6 hour event). This will be done utilizing their large capacity and a number of operational uses explained in Section 9.7

Ponds JD-1, JD-2, JD-3, and JD-4 will be completely incised. Interior slopes of the incised ponds will be no greater than 1H:1V slope to maximize the capacity of each containment pond. Prior to construction of the ponds, the topsoil will be removed and stockpiled.

Estimated annual sediment yields were determined for the ponds using SEDCAD4. The methodology and assumptions used in determining the annual sediment yield are discussed in Appendix D9-1. The annual sediment yield for Ponds JD-1 and JD-3 are 0.9 ac-ft and 5.61 ac-ft, respectively. The sediment storage capacity for ponds JD-1 and JD-2 are 15 ac-ft and over 400 ac-ft, respectively.

Containment ponds will be inspected routinely for signs of imminent failure and structural weakening. Results of these inspections will be logged, and conditions which constitute a hazard to degrading the stability of the impoundments will be addressed.

The sediment levels in the ponds will be monitored so that the design sediment capacity is not exceeded. As needed, the ponds will be cleaned out and the removed sediment will be placed in the active mining area. For both construction and maintenance, ponds will be accessed from the planned access roads.

The sediment ponds will continue to be maintained and functional during the post-reclamation, pre-bond release period. Upon receipt of approval from the regulatory agency to eliminate the ponds, all ponds will be removed by draining any remaining water, backfilling, and recontouring the area as appropriate. The area may be left as a depression to enhance wetland restoration.

9.6 CULVERTS

The culverts were designed for the main haul road and access roads in the permit boundary area. The general locations of the culverts are shown on Plate D9-1. Final locations will be shown on the as-built drawings. In addition, several smaller culverts will be installed, where practical, along the proposed haul road. However, the main culverts were designed assuming no additional culverts and that all drainage is diverted to them. Any culverts that were considered to be temporary and sized to safely pass the discharge from the 10-year, 24-hour event will be removed at the end of mining.

The design for culvert MCHR was presented in a related permit for the Jumbo Dome Road Corridor (ASMCRA S-0605) project but the design has been included in Appendix D9-2. The other culverts were designed using the SEDCAD4 computer program. The methodology, assumptions, and input parameters utilized in the design of the culverts are discussed in Appendix D9-1. Culvert HR-1 is designed to convey the 100-year, 6-hour storm since the long-term haul road was proposed as a permanent structure. Culvert HR-2 is considered temporary and designed to convey the 10-year, 24-hour storm event. The results are summarized below:

Culvert	Flow (cfs)	Headwater (ft)	Required Size (in)	Proposed Size (in)
HR-1	13.1	2.2	24	36
HR-2	51.1	4.0	42	42

9.7 SITE-WIDE WATER MANAGEMENT PLAN

The Jumbo Dome water management plan is designed to control and maintain an operation water level for each pond that maintains a zero discharge during the 100-year, 6-hour storm event.

The water management plan will be implemented in stages based on the mining operations in the Jumbo Dome area. To contain the runoff from the disturbed areas, the ponds must be utilized at different stages of mining operations. During the first five-year term, Ponds JD-1, JD-2, JD-3 First Term, and the Shop Pond will be constructed. Pond JD-1 will store runoff from the out-of-pit spoil

pile. To keep Pond JD-1 at its designated operating level, water can be pumped to Pond JD-2, which has considerably more storage. The Shop Pond will be constructed to collect runoff from the facilities area. To keep the Shop Pond at its designated operating level, water can be pumped to Ponds JD-1 or JD-2. Pond JD-2 will collect runoff from the disturbed mining area, pumped groundwater from the open pits or a head of mining dewatering wells, and any other springs and seeps in the mine area. To assist in maintaining the operational level in JD-2, UCM plans to construct JD-3 First Term as a relief pond in case water levels in JD-2 approach the operational level. The surface water runoff will be diverted around JD-3 First Term. Pond JD-3 will be operated to maintain a 60 ac-ft capacity every November in order to maintain the worse case annual water deficit shown in the water balance. If the capacity cannot be maintained, the land application system will be designed and constructed. A Land Application Permit from the Alaska Department of Environmental Conservation will permit the pumping of supernatant from JD-3 or groundwater from the ahead of mine wells for disposal if it is needed. The operational level in Ponds JD-2 and JD-3 will be maintained in a number of ways, including:

- Maintain water in pit
- Pond infiltration
- Dust abatement
- Irrigation of reclaimed ground
- Enhanced Evaporation
- Enhanced sublimation by snowmaking
- Land application, if required

An anticipated 0.24 ac-ft per day of water will be maintained in the pit. An estimated 0.21 ac-ft per day of water will infiltrate in the sedimentation ponds, based on modeling results. All water use estimates are conservative and include a safety factor to account for equipment breakdowns and inclement weather.

Dust abatement is an operational consumptive water use required by MSHA and ADEC. Dust abatement on the 5.6-mile haul road to the Jumbo Dome Mine will be a continuous effort during all shifts from mid-April to mid-October. A conservative estimate of 0.663 ac-ft per day is the anticipated water use for dust abatement.

Irrigation is an operational consumptive water use to enhance vegetation growth for erosion control. Irrigation water use will increase during the life of the mine as more acres are reclaimed. A

conservative estimate for irrigation water use is 0.16 ac-ft/acre/day. In the first two years of the first mine term, the irrigation will be restricted to the topsoil pile. In later years of the first mine term, irrigation efforts will include the out-of-pit spoil pile and the box cut reclamation area. As mining continues, additional reclaimed areas requiring irrigation will demand increased water.

Evaporation may be enhanced by the use of evaporation units. These units are proposed to be installed in one or all of the sedimentation ponds. This method of evaporation would be operational between May and September. The water use rate is dependent upon the number of units deployed. A conservative estimate for evaporation is 0.024 ac-ft per day. Evaporation rates are based on data from the Denali National Park weather station pan evaporation rates. Denali National Park is located approximately 20 miles from the site and has a similar climate to the Jumbo Dome project site.

Snow sublimation may be enhanced by incorporating snowmaking of the pond supernatant. Studies of snow sublimation in the arctic and sub-arctic of Alaska have shown that sublimation rates can range from 10 to 50 percent of the winter precipitation. UCM used a conservative number of 15 percent sublimation rate in the water balance calculations based on the use of one snowmaking machine. Actual rates may be considerably higher. Sublimation is a function of air temperature, humidity, and wind speed variations associated with changing weather patterns and space-dependent variations related to local surface roughness, vegetation, proximity to open water/ocean, and other environmental factors.

If the methods discussed above fail to maintain the operational levels, UCM will finalize the design of the a land application system. At this point in time, the land application system is considered optional, but will be permitted. The proposed land application area is shown on Drawing D2-1. UCM has evaluated the feasibility of the area and is preparing a Land Application Permit in case this method is required. The land application system will be operated in accordance with the Alaska Department of Environmental Conservation Land Application Permit.

Approximately 20 acres are proposed for the land application site. The proposed site is located within the coal mining limits and, therefore, will not create additional disturbance beyond the mine life. The land application if required would be used primarily during the early years of mining. A conservative estimate of 0.48 ac-ft per day is used in the water balance. Field studies were conducted to determine the actual infiltration rate in the land application site to determine the required pond sizes.

As mining progress to the north, and backfill areas are reclaimed and vegetation is reestablished, stormwater runoff from these areas will be allowed to run directly back into Marguerite Creek. As this occurs, the pond uses will change.

After the out-of-pit spoil pile is reclaimed and vegetation is established, Pond JD-1 will be converted to a BMP and eventually reclaimed.

Pond JD-2 will remain open for the duration of the mining operations. Once mining progresses past Pond JD-2 and the area is reclaimed, the runoff will be diverted around Pond JD-2; it will only receive precipitation that falls directly on the pond area and water that is being pumped from the open pit, Pond JD-3, and JD-4.

Both Ponds JD-3 and JD-4 will remain open for the duration of the mining operations. After mining and reclamation are complete, all three ponds will be reclaimed.

A conceptual water balance has been created to estimate water management in the Jumbo Dome area during different stages of the mining operations. The critical stages include:

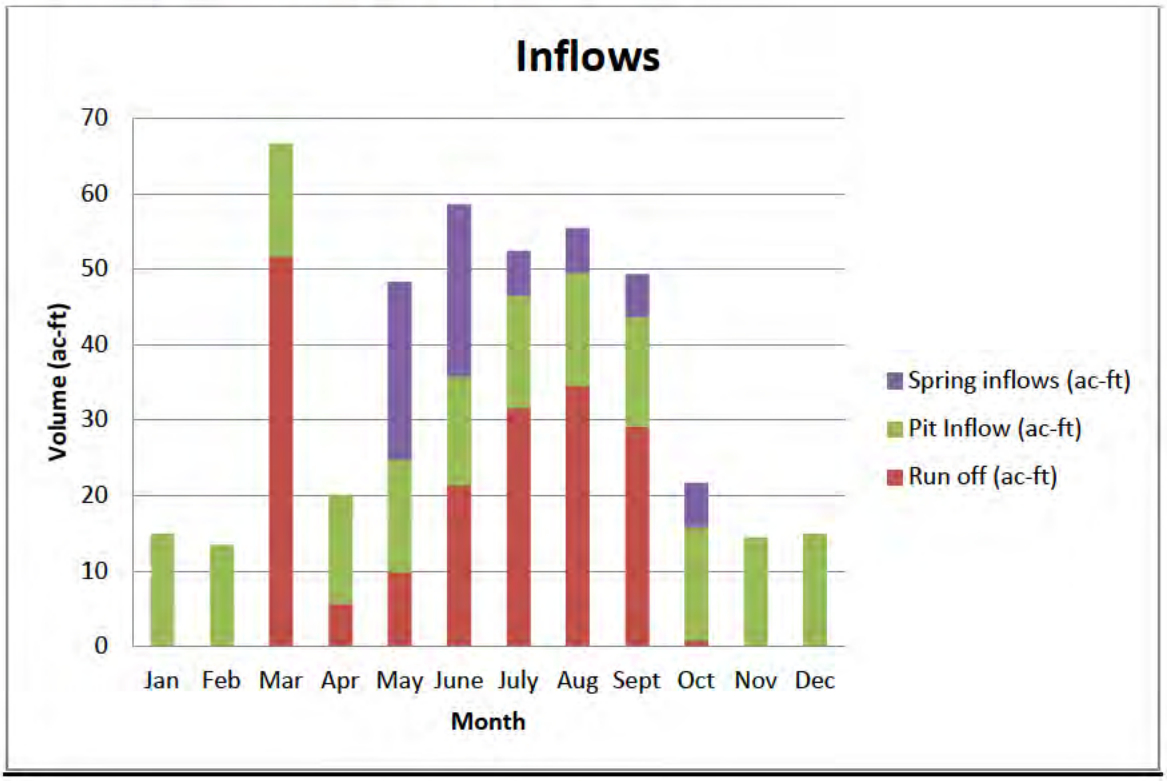
- First Term (Ponds JD-1, JD-2, and JD-3 First Term)
- Pond JD-1 closed, a third of the area reporting to JD-2 reclaimed and released, and JD-3 constructed
- Areas that reported to JD-2 reclaimed and released, a third of the area reporting to JD-3 reclaimed and released, and JD-4 constructed

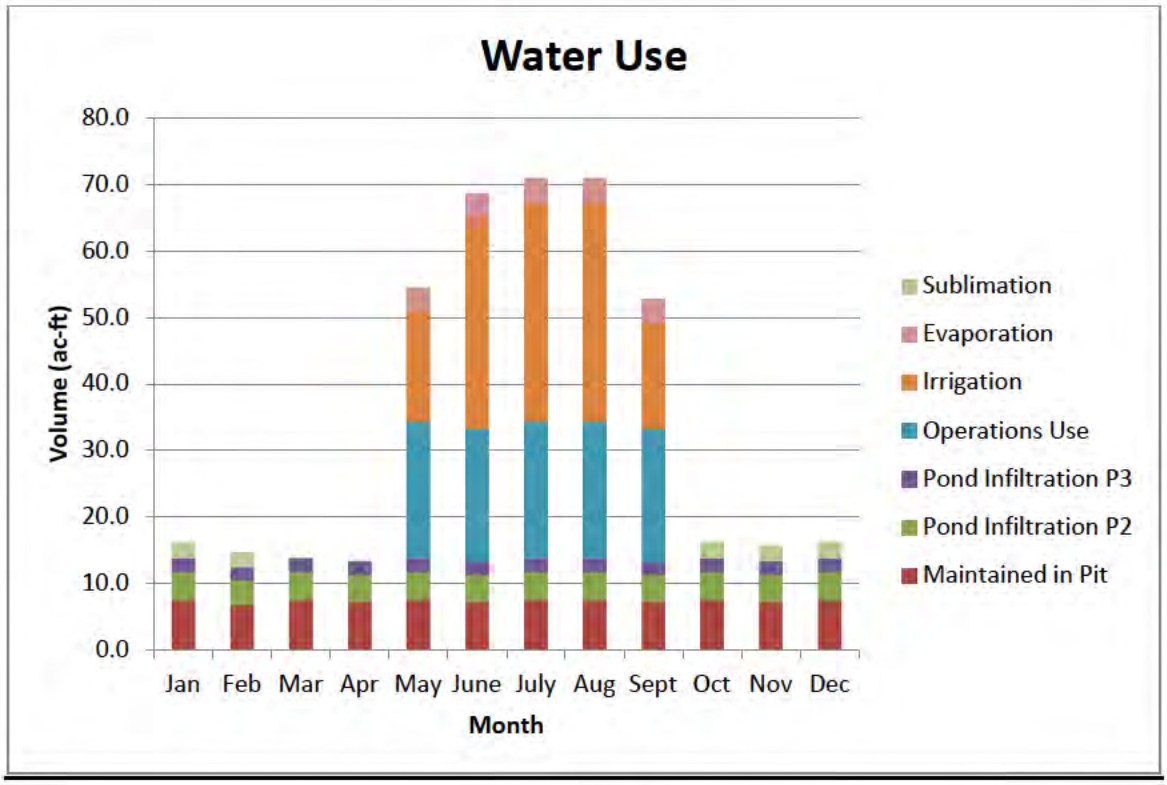
Below are three figures representing the conceptual annual water balance for each phase. The first shows the total inflow by source, the second one shows the total amount used by method, and the third one shows the total amount of water in compared to water out and the cumulative total.

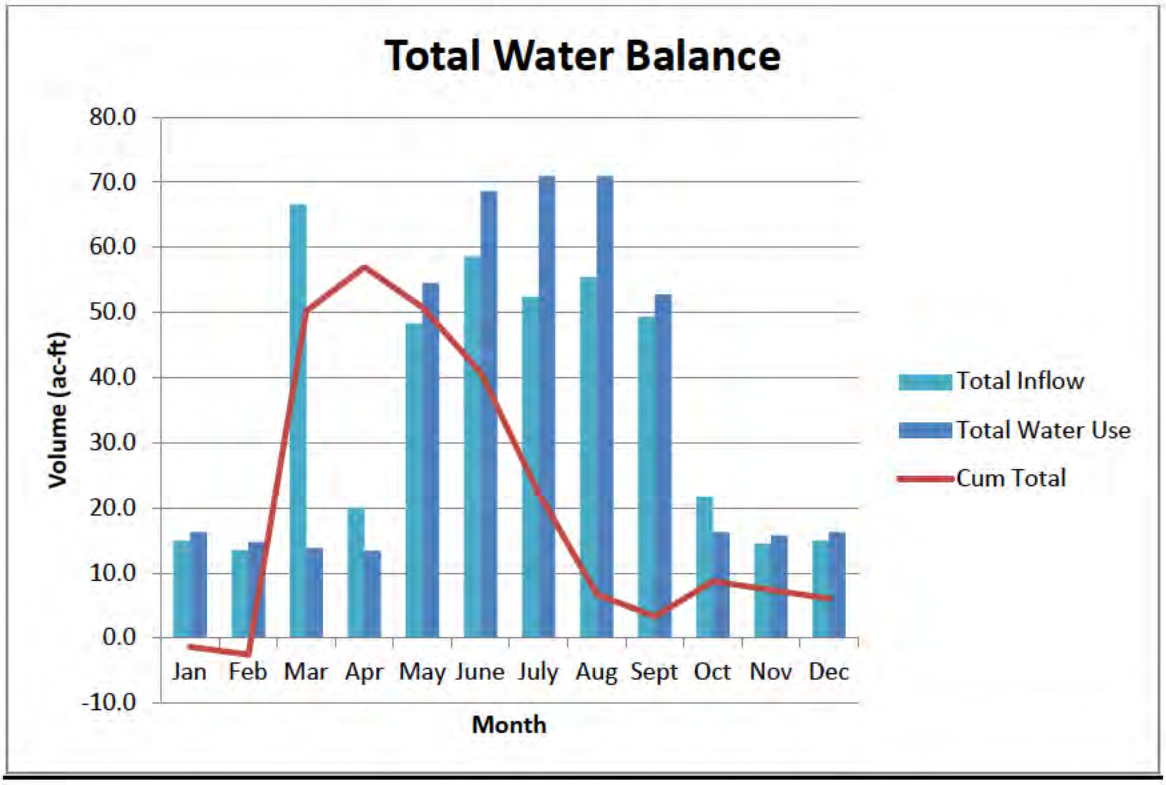
The water balances illustrated below do not include the land application disposal option. Land application will be used to supplement irrigation during the early years of mining if it is necessary to maintain the operational water levels in the ponds.

If UCM is unable to maintain the operational level in the ponds, using the water management strategies mentioned above, UCM may pursue obtaining an ADEC surface water discharge permit.

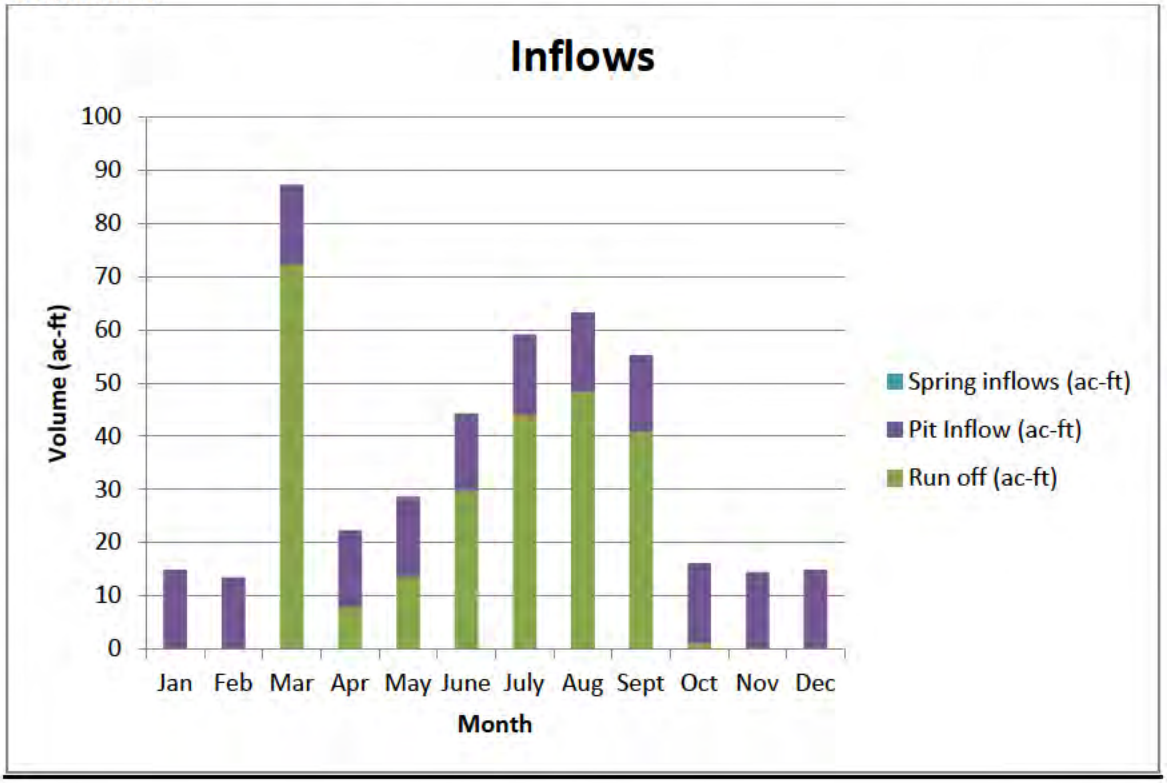
First Term (Ponds JD-1, JD-2, and JD-3 First Term)

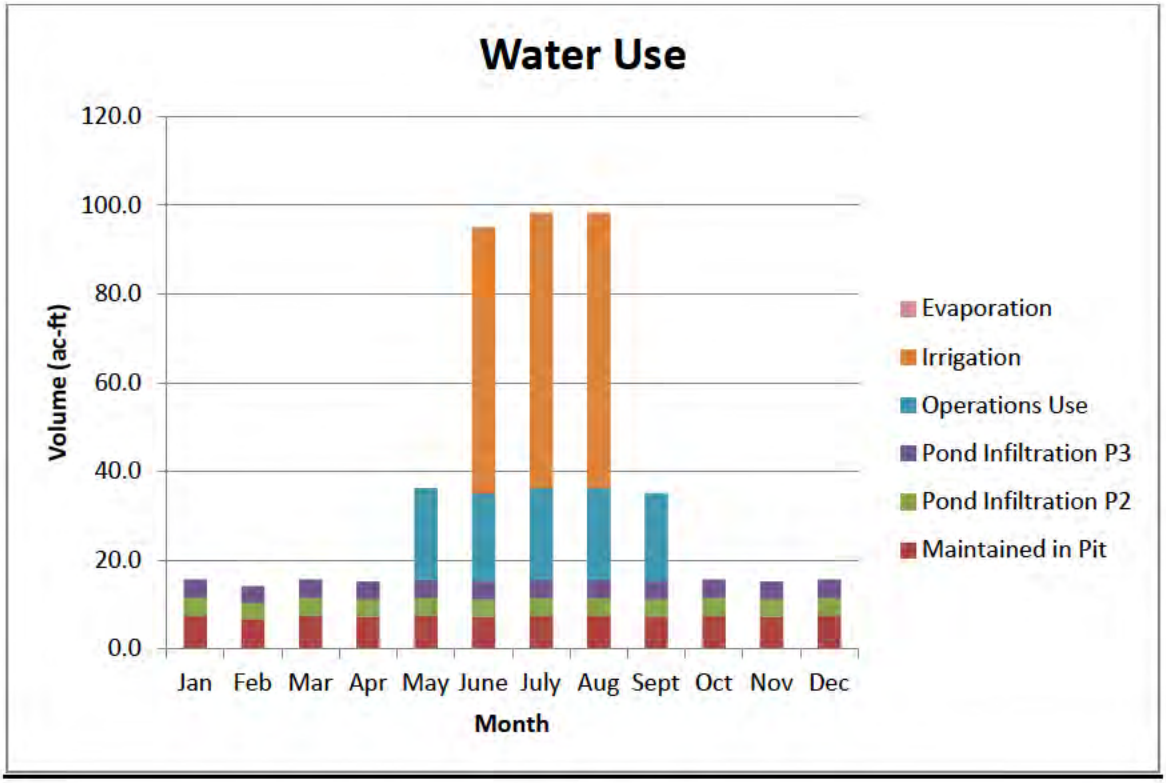


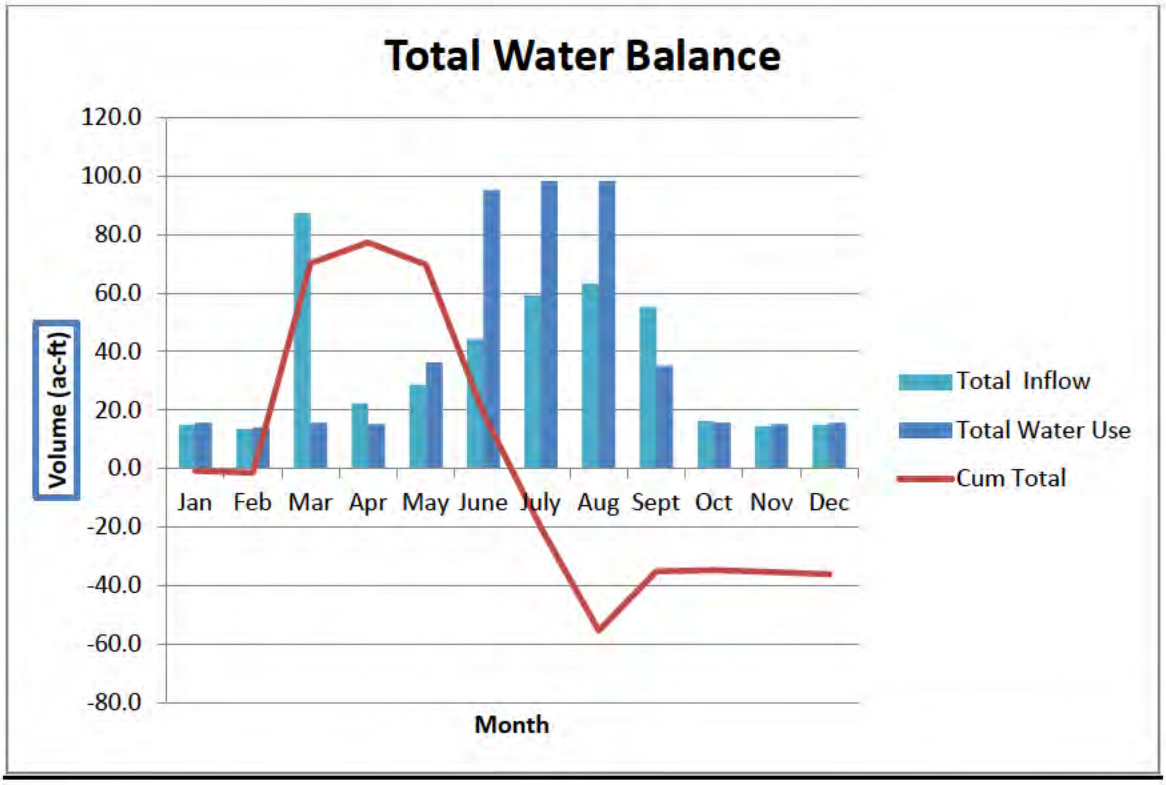



Total Water Balance
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
Volume (ac-ft)
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Month
Total Inflow
Total Water Use
Cum Total

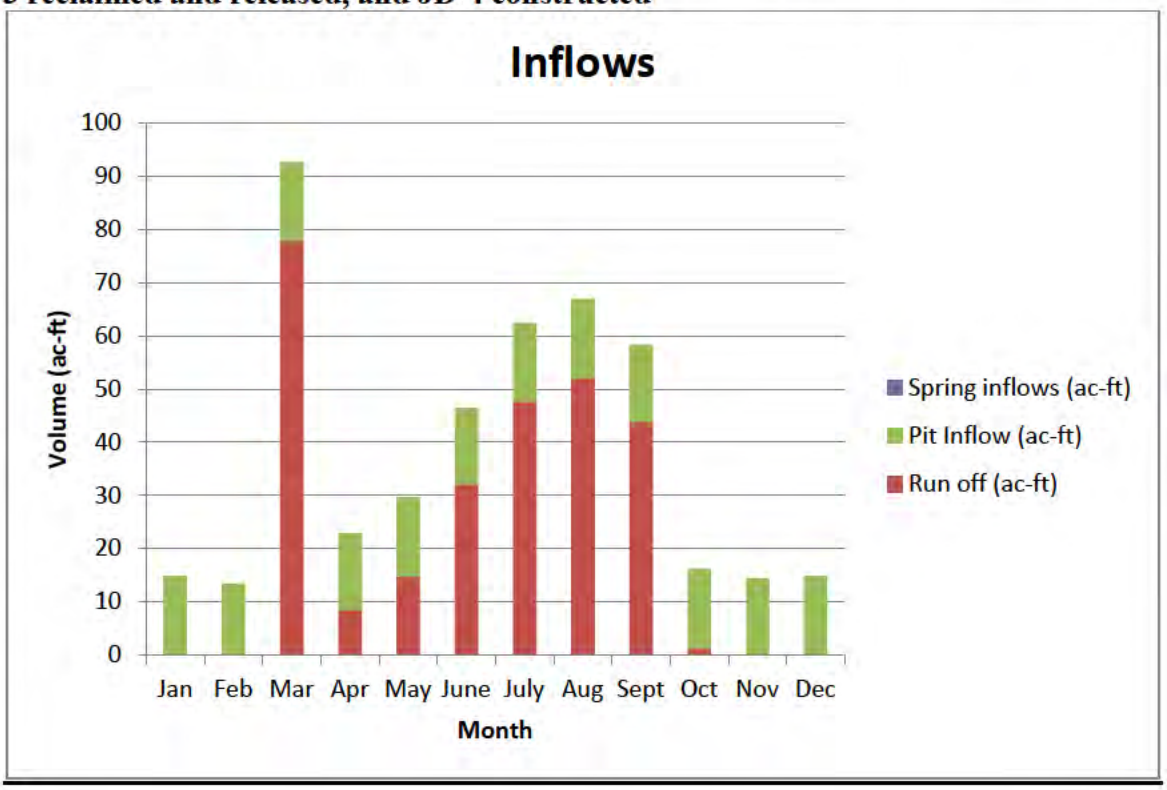
Pond JD-1 closed, a third of the area reporting to JD-2 reclaimed and released, and JD-3 constructed

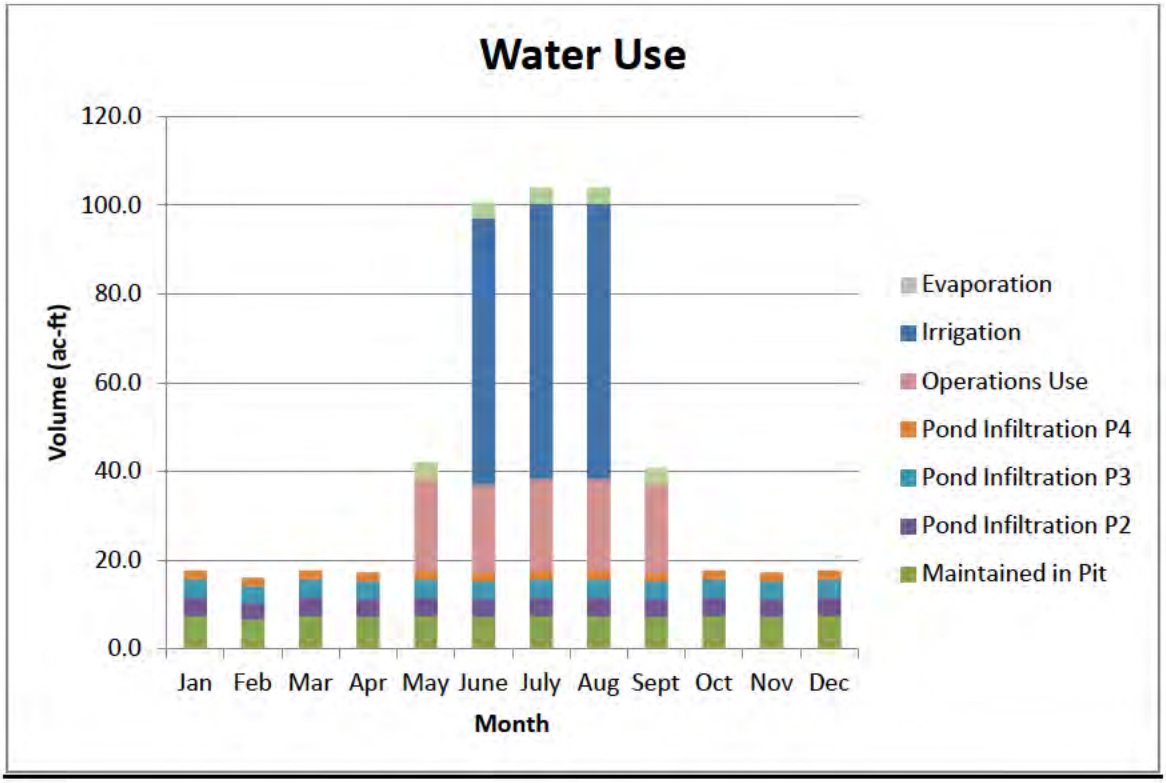


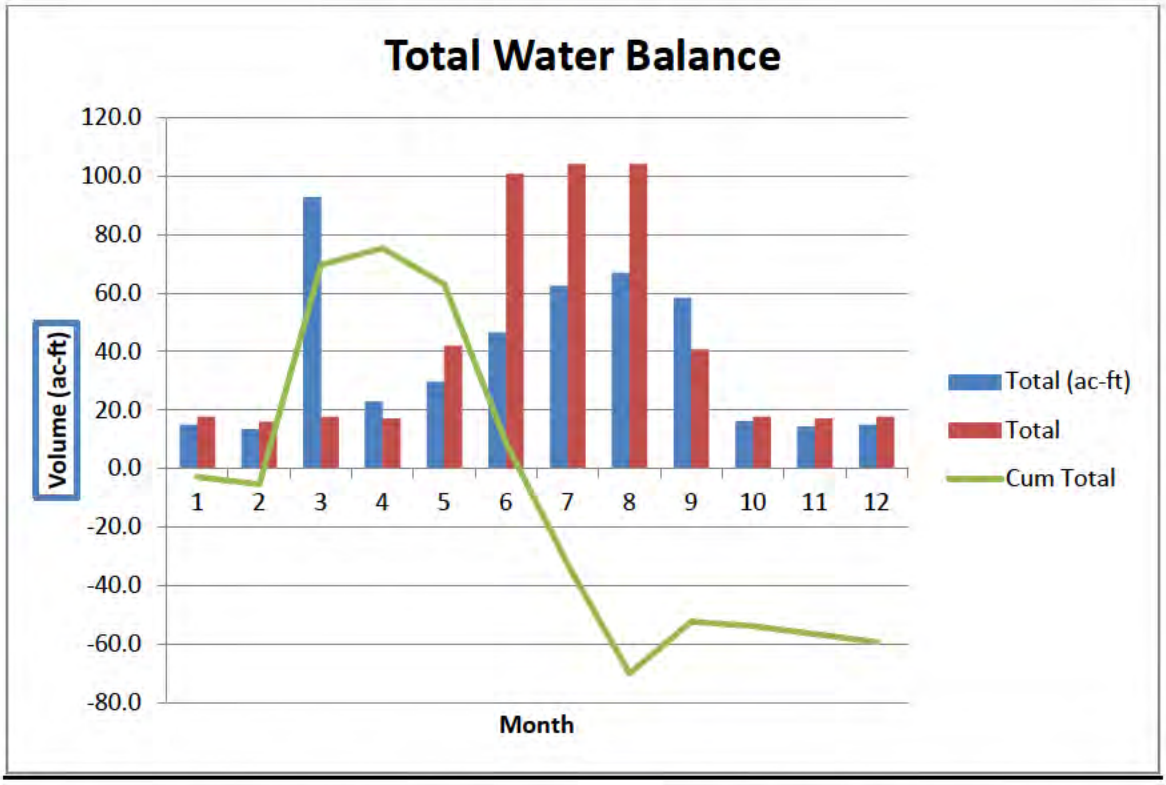



Total Water Balance
120.0
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
-80.0
Volume (ac-ft)
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Month
Total Inflow
Total Water Use
Cum Total

All areas that reported to JD-2 reclaimed and released, a third of the area reporting to JD-3 reclaimed and released, and JD-4 constructed



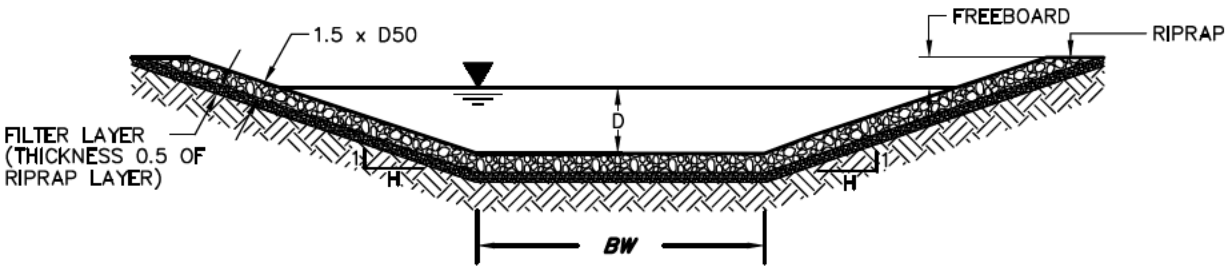




As shown on the charts above, in the first five years UCM should be able to maintain the operational levels. In case it is difficult to maintain the operational levels in the first term, UCM will develop the land application process after all necessary permits are in place. After the first five year term, a lot more reclaimed land will become available for irrigation and a lot more water can be applied. This increase in water use for irrigation will make maintaining the operational levels in the ponds more manageable. Even though UCM is planning to operate the ponds as zero discharge (during a 100-year, 6 hour event) structures, we will still pursue a discharge permit with the State as an added factor of safety.

FIGURE D9-1

JUMBO DOME MINE CHANNEL DESIGN SUMMARY



TYPICAL RIPRAP LINED CHANNEL

Channel	Flow Q (cfs)	Slope (%)	Bottom Width (BW) (ft)	SIDESLOPE H:1V (ft)	Depth of Flow (D) (ft)	Velocity (fps)	Freeboard (ft)	Total Depth (ft)	Rip Rap (in)
OOPS-1	16.8	3.4	5	3	0.54	4.69	1.0	1.54	3
OOPS-2	12.9	3.6	5	3	0.46	4.38	1.0	1.46	3
JD-2	103.9	2.5	10	3	1.21	6.33	1.0	2.21	6
JD-3	134.7	1.0	10	3	1.45	6.5	1.0	2.45	6
JD-4	31.0	2.0	10	3	0.6	4.38	1.0	1.6	3
CWD-1	5.9	3.1	20	3	0.14	2.14	1.0	1.14	3
CWD-1-2	13.1	14.0	20	3	0.16	3.99	1.0	1.16	3
CWD-2	1.0	3.3	5	3	0.11	1.79	1.0	1.11	3
CWD-3	1.6	2.0	5	3	0.16	1.91	1.0	1.16	3
CWD-4	114.6	3.1	20	3	0.85	5.98	1.0	1.85	6

REV. No.	DESCRIPTION OF REVISION	BY	DATE
	ISSUED FOR PERMIT	BC	5/11

MWH

DESIGNED: B.COLEMAN
DRAWN: B. COLEMAN
CHECKED: T.LEIDICH
DATE: 5/11

PROJECT:

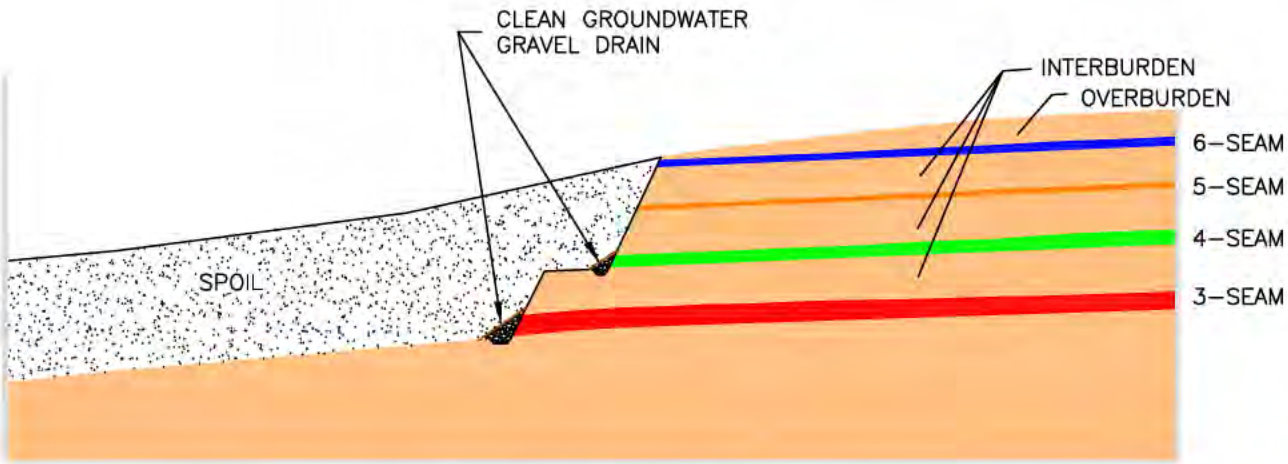
DRAWING: JUMBO DOME MINE CHANNEL SUMMARY

REVISION: 0
PROJECT NUMBER: 1009161
FIGURE No.: D9-1

AutoCAD FILE: channel summary.dwg PROJECT NUMBER: 1009161

FIGURE D9-2

TYPICAL CROSS SECTION, CLEAN GROUNDWATER DIVERSION



PIT END WALL

		DESIGNED:	MWH	PROJECT: JUMBO DOME MINE	REVISION: A
		DRAWN:	JMB	FIGURE:	PROJECT NUMBER: 1005742
		CHECKED:	TEL	TYPICAL CROSS SECTION CLEAN WATER DIVERSION	FIGURE: D9-2
		DATE:	11/09		

AutoCAD FILE: _____ PROJECT NUMBER: 1005742

APPENDIX D9-1
DRAINAGE AND SEDIMENT CONTROL PLAN
METHODOLOGY AND ASSUMPTIONS

DRAINAGE AND SEDIMENT CONTROL METHODOLOGIES AND ASSUMPTIONS

SEDCAD4 HYDROLOGIC COMPUTER MODEL

Calculations for all ponds channels and culverts were performed utilizing the SEDCAD4 Computer Model developed by Civil Software Design.

SEDCAD4 is a hydrologic, hydraulic and sediment calculation model designed for use on computer systems. The SEDCAD4 hydrologic model calculates runoff volume, and peak flow via a numerical modeling technique based on user inputs of a design storm event, (i.e., precipitation frequency data, selection of rainfall distribution, and convolution increment). Hydrographs are developed on a subwatershed basis with the input of area, time of concentration, SCS Curve Number, and the selection of a hydrograph shape. Routing of hydrographs is accomplished by the Muskingum Method.

Inputs to the hydrology component of the SEDCAD4 Computer Model include:

Precipitation Distribution
Storm Duration
Return Period/Precipitation
Hydrograph Response Shape
Drainage Basin Area
Time of Concentration
Muskingum Routing Parameters
Curve Number

Input values used in this model, are shown on the SEDCAD4 printouts and are explained in the following text of this exhibit.

Precipitation Distribution

A precipitation distribution is input to model the run-off hydrograph. SEDCAD4 allows the user to choose between the SCS Type I and Type II Storms. The SCS Type I Storm was used for the Jumbo Dome Mine area.

Storm Duration

Storm durations of 6 hours and 24 hours were used to model the watersheds for the Jumbo Dome Mine area.

Return Period/Precipitation

A precipitation amount is required for the appropriate return period. The following precipitation amounts were used for Jumbo Dome Mine Area:

10-year, 24-hour event	2.0 inches
25-year, 24-hour event	2.5 inches

100-year, 24-hour event	3.0 inches
100-year, 6-hour event	2.0 inches

The precipitation amounts were obtained from the TP-47, "Probable Maximum Precipitation and Rainfall - Frequency Data for Alaska" (U.S. Department of Commerce, 1963).

Hydrograph Response Shape

A unit hydrograph is chosen for each drainage area or sub-area model to predict the run-off response. The hydrograph responses available in the SEDCAD4 model are slow, medium, and fast. A slow response corresponds to a forested area or an area with a number of obstructions. A fast response corresponds to an unvegetated or poorly protected area. Fast and medium hydrograph responses were chosen for disturbed and undisturbed areas, respectively. The internal convolution increment is 0.05 hours and values are saved at the user specified interval of 0.1 hours or greater. A convolution increment of 0.1 was specified for the Jumbo Dome Mine area.

Drainage Basin Area

The drainage areas were determined by direct measurement from a 1" = 500', 10' contour maps. The watershed areas are shown on Plate D9-1. Watershed areas were determined for all components of the drainage and sediment control plan.

Time of Concentration, T_c

The time of concentration was calculated using the SCS upland method (a utility of SEDCAD4). All hydraulic lengths, drainage heights and slopes were measured directly from a 1" = 500', 10' contour map. The calculated values for each structure are shown on the SEDCAD4 printouts.

Muskingum Routing Parameters, K, X

The Muskingum Routing Parameters were also calculated using the SCS upland method. All hydraulic lengths, drainage heights and slopes were measured directly from a 1" = 500', 10' contour map provided by UCM. The values calculated between each junction and/or subwatershed are shown on the SEDCAD4 printouts.

Curve Number, CN

Curve numbers (CN) were approximated based on hydrologic soil type, which was determined from the soil descriptions in the base line soils report, as well as type and amount of ground cover. Curve numbers were obtained from Technical Release No. 55 (USDA-SCS, 1986). Based on hydrologic soil type and vegetative cover the following curve numbers were determined:

Disturbed

Soil Type:	B
Ground Cover Type:	Newly Regraded
Ground Cover:	Bare
Curve Number:	86

Undisturbed

Soil Type:	B
Ground Cover Type:	Wooded or Forest
Ground Cover:	Poor
Curve Number:	66

SEDCAD4 SEDIMENTATION AND POND DESIGN COMPUTER MODEL

The calculations to determine the storm sediment yield and pond efficiency were performed by the use of the SEDCAD4 Computer Model developed by Civil Software Design.

The sedimentation program was applied to develop a sedimentation graph using the Revised Universal Soil Loss Equation (RUSLE) and the following input parameters:

$$Y=95 \times (V \times Q_p)^{0.56} \times K \times LS \times CP$$

Where: Y = Sediment yield (tons)
V = Run off volume (acre-feet)
Q_p = Peak discharge (cfs)
K = Soil erodibility factor
LS = Representative length-slope factor
CP = Control practice factor

The length-slope factor for the RUSLE subroutine is as follows:

$$LS = (\lambda/72.6)^m \times (slope\ factor)$$

Where: λ = Representative slope length (ft)
m = 0.6 for slope > 10%
m = 0.5 for 4% < slope # 10%
m = 0.4 for slope = 4%
m = 0.3 for slope < 4%

The slope factor is a piecewise linear relationship with the slope breakpoint at 8% as shown on Figure 5.5, Slope Factor for the RUSLE, contained in the SEDCAD4 Users Manual.

The sediment graph is then routed to a structure using an exponential decay procedure incorporating deposition of a particle size distribution.

Inputs for the sedimentology portion of the SEDCAD4 routine are:

Particle size distribution
Run off volume
Peak discharge
Soil erodibility factor

Representative slope length
Average slope
Control practice factor
Sediment specific weight
Specific Gravity and Bulk Submerged
Specific Gravity
Pond and Spillway dimensions

Particle Size Distribution
Particle size distribution was determined from soil texture of topsoil samples collected from site and outlined in the baseline soil section.

Run off Volume, V
The run off volume is calculated by the SEDCAD4 computer model during the hydrologic modeling routine.

Peak Discharge, Q_p
The peak discharge is calculated by the SEDCAD4 computer model during the hydrologic modeling routine.

Soil Erodability Factor, K
The K factor for the site was determined based on soil descriptions outlined in the baseline soil section. According to the soil descriptions for the site, the majority of soils in the area are described as Sandy Loam. A typical K factor for a Sandy Loam texture is 0.24 (Barfield Warner).

Representative Slope Length, 8
The slope length is representative of the typical slope length found on the subwatershed. It is the distance from the point of origin of overland flow to the point where the slope decreases such that significant deposition occurs or the flow enters a defined channel. Slope lengths were measured from a 1" = 100', 20' contour map. The calculated values for each structure are shown on the SEDCAD4 printouts.

Average Slope
The average slope is entered as a percent and is the representative slope for overland flow for each subwatershed. The average slope was measured directly from a 1" = 500', 10' contour map. The calculated values for each structure are shown on the SEDCAD4 printouts.

Control Practice Factor, CP
The control practice factor is defined as the ratio of sediment loss from an area with a given cover and conservation practice to that of a field in continuous fallow. The following values were utilized:

Area Condition CP

Area	Condition	CP
Disturbed	Rough, irregular,	0.6
Undisturbed	40%-70% effective canopy, 75%-85% litter	.004

Annual sediment yield, V_{annual}

Sediment yields calculated by SEDCAD4 for single storm events can be converted to annual yields using the annual R value. The annual R factor was determined using the following equation:

$$R_{annual} = 16.55\ x\ \left(P_{2,6}\right)^{2.2}$$

For a SCS Type I Storm:

Where: $P_{2,6}$ = 2 year, 6 hour precipitation in inches

= 0.75 inches

Specific Gravity and Bulk Submerged Specific Gravity

Specific gravity	2.65
Bulk Specific Gravity	1.35

Pond and Spillway Dimensions

All pond and spillway dimensions are shown on Plates D9-2 and D9-3.

Channel and Riprap Sizing

Riprap sizing and dimensions for the channels with a slope less than 10% were done based on the safety factor method presented by the Federal Highway Administration's Design of Riprap Revetment. Channel and riprap sizing for channels with a slope greater than 10% were based on Robinson's Design of Rock Chutes from the American Society of Agricultural and Biological Engineers. A safety factor of 1.2 was used with this method to account for any unknowns that may be encountered during construction. All inputs and results are shown in Table D9-2, Jumbo Dome Channel Design Summary.

Culvert Design

The culverts were determined using SEDCAD. The SEDCAD model provides you with the ability to size a culvert based length, type, slope, headwater and design. All culvert inputs are shown on the SEDCAD computer printouts.

REFERENCES

Barfield, B.J., Warner, R.C., Haan, C.T., 1981, Applied Hydrology and Sedimentology for Disturbed Areas.

Robinson, K.M., Rice, C.E., Kadavy, K.C., 1998, Design of Rock Chutes. American Society of Agricultural Engineers.

U.S. Department of Transportation, Federal Highway Administration, March 1989, Design of Riprap Revetment. Publication No. FHWA A-IP-89-016.

Usibelli Coal Company, 1996, Two Bull Ridge Permit Application.

Warner, R.C., Schwab, P.J, 1992, SEDCAD + Version 4.

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Pond JD-1

Design of containment pond JD-1 for a 100-year 6-hour Type I SCS storm.

Jumbo Dome mine area at the Usibelli Coal Mine

Bandon Coleman

MWH
1801 California St
Ste 2900
Denver, CO 80202

Phone: (303) 291-2261
Email: Brandon.A.Coleman@mwhglobal.com

General Information

Storm Information:

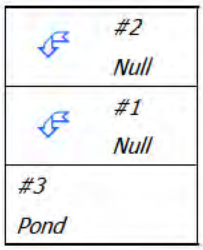
Storm Type:	NRCS Type I
Design Storm:	100 yr - 6 hr
Rainfall Depth:	2.000 inches

Particle Size Distribution:

Size (mm)	USIBELLI - Poker Flats
4.7500	100.000%
0.0750	89.000%
0.0020	8.000%
0.0010	0.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#3	0.000	0.000	JD OOPS-1
Null	#2	==>	#3	0.000	0.000	JD OOPS-2
Pond	#3	==>	End	0.000	0.000	Pond JD-1



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#2		19.000	19.000	25.24	1.33	1,013.1	728,957	326.13	197.84
#1		33.300	33.300	32.34	2.27	1,593.4	649,690	262.05	168.57
#3	In	4.500	56.800	56.30	4.31	2,606.6	586,335	246.54	157.96
	Out			0.00	0.00	2,606.6	0	0.00	0.00

Particle Size Distribution(s) at Each Structure

Structure #2 (JD OOPS-2):

Size (mm)	In/Out
4.7500	100.000%
0.0750	89.000%
0.0020	8.000%
0.0010	0.000%

Structure #1 (JD OOPS-1):

Size (mm)	In/Out
4.7500	100.000%
0.0750	100.000%
0.0020	9.535%
0.0010	0.000%

Structure #3:

Size (mm)	In	Out
4.7500	100.000%	100.000%
0.0750	95.725%	100.000%
0.0020	8.939%	100.000%
0.0010	0.000%	0.000%

Structure Detail:

Structure #2 (Null)

JD OOPS-2

Structure #1 (Null)

JD OOPS-1

Structure #3 (Pond)

Pond JD-1

Pond Inputs:

Initial Pool Elev:	2,134.00 ft
Initial Pool:	14.99 ac-ft
*Sediment Storage:	0.90 ac-ft
Dead Space:	0.00 %

**Sediment capacity based on Average Annual R of 8.8 for 1 year(s)*

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
2,137.00	20.00	3.00:1	3.00:1	20.00

Pond Results:

Peak Elevation:	2,136.72 ft
H'graph Detention Time:	0.00 hrs
Pond Model:	CSTRS
Dewater Time:	0.00 days
Trap Efficiency:	0.00 %

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
2,122.21	1.035	0.000	0.000		Top of Sed. Storage
2,122.50	1.046	0.302	0.000		
2,123.00	1.065	0.829	0.000		
2,123.50	1.084	1.366	0.000		
2,124.00	1.103	1.913	0.000		
2,124.50	1.122	2.469	0.000		
2,125.00	1.142	3.036	0.000		

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
2,125.50	1.162	3.612	0.000		
2,126.00	1.182	4.198	0.000		
2,126.50	1.202	4.794	0.000		
2,127.00	1.223	5.400	0.000		
2,127.50	1.243	6.016	0.000		
2,128.00	1.264	6.643	0.000		
2,128.50	1.285	7.280	0.000		
2,129.00	1.305	7.928	0.000		
2,129.50	1.326	8.586	0.000		
2,130.00	1.347	9.254	0.000		
2,130.50	1.368	9.933	0.000		
2,131.00	1.390	10.622	0.000		
2,131.50	1.411	11.322	0.000		
2,132.00	1.433	12.033	0.000		
2,132.50	1.455	12.755	0.000		
2,133.00	1.477	13.488	0.000		
2,133.50	1.499	14.232	0.000		
2,134.00	1.521	14.987	0.000		
2,134.50	1.544	15.753	0.000		
2,135.00	1.566	16.530	0.000		
2,135.50	1.589	17.319	0.000		
2,136.00	1.612	18.119	0.000		
2,136.50	1.635	18.931	0.000		
2,136.72	1.645	19.291	0.000	0.00	Peak Stage
2,137.00	1.658	19.754	0.000		Spillway #1
2,137.50	1.681	20.589	3.643		
2,138.00	1.704	21.435	49.679		
2,138.50	1.728	22.293	103.690		
2,139.00	1.751	23.163	176.689		
2,139.50	1.775	24.044	266.492		
2,140.00	1.799	24.938	373.219		

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
2,122.21	0.000	0.000
2,122.50	0.000	0.000
2,123.00	0.000	0.000
2,123.50	0.000	0.000
2,124.00	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
2,124.50	0.000	0.000
2,125.00	0.000	0.000
2,125.50	0.000	0.000
2,126.00	0.000	0.000
2,126.50	0.000	0.000
2,127.00	0.000	0.000
2,127.50	0.000	0.000
2,128.00	0.000	0.000
2,128.50	0.000	0.000
2,129.00	0.000	0.000
2,129.50	0.000	0.000
2,130.00	0.000	0.000
2,130.50	0.000	0.000
2,131.00	0.000	0.000
2,131.50	0.000	0.000
2,132.00	0.000	0.000
2,132.50	0.000	0.000
2,133.00	0.000	0.000
2,133.50	0.000	0.000
2,134.00	0.000	0.000
2,134.50	0.000	0.000
2,135.00	0.000	0.000
2,135.50	0.000	0.000
2,136.00	0.000	0.000
2,136.50	0.000	0.000
2,137.00	0.000	0.000
2,137.50	3.643	3.643
2,138.00	49.679	49.679
2,138.50	103.690	103.690
2,139.00	176.689	176.689
2,139.50	266.492	266.492
2,140.00	373.219	373.219

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	19.000	0.094	0.000	0.000	86.000	F	25.24	1.334
	Σ	**19.000**						**25.24**	**1.334**
#1	1	33.300	0.166	0.000	0.000	86.000	F	32.34	2.270
	Σ	**33.300**						**32.34**	**2.270**
#3	1	4.500	0.000	0.000	0.000	99.000	F	11.71	0.703
	Σ	**56.800**						**56.30**	**4.307**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#2	1	0.240	300.00	30.00	0.6000	1.0000	1	1,013.1	728,957	326.13	197.84
	Σ							**1,013.1**	**728,957**	**326.13**	**197.84**
#1	1	0.240	300.00	30.00	0.6000	1.0000	1	1,593.4	649,690	262.05	168.57
	Σ							**1,593.4**	**649,690**	**262.05**	**168.57**
#3	1	0.000	1.00	0.01	0.0001	1.0000	1	0.0	0	0.00	0.00
	Σ							**2,606.6**	**586,335**	**246.54**	**157.96**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	33.73	140.00	415.00	5.800	0.019
		8. Large gullies, diversions, and low flowing streams	3.41	100.00	2,932.03	5.540	0.147
#1	**1**	**Time of Concentration:**					**0.166**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	29.09	80.00	275.00	5.390	0.014
		8. Large gullies, diversions, and low flowing streams	3.63	60.00	1,654.03	5.710	0.080
#2	**1**	**Time of Concentration:**					**0.094**

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Pond JD-1 Emergency Spillway Design

Design of containment pond JD-1 emergency spillway for a 25-year 24-hour Type I SCS storm.

Jumbo Dome mine area at the Usibelli Coal Mine

Bandon Coleman

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General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	25 yr - 24 hr
Rainfall Depth:	2.500 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#3	0.000	0.000	JD OOPS-1
Null	#2	==>	#3	0.000	0.000	JD OOPS-2
Pond	#3	==>	End	0.000	0.000	Pond JD-1

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#2		19.000	19.000	19.56	1.97
#1		33.300	33.300	25.68	3.32
#3	In	4.500	56.800	43.82	6.18
	Out			25.26	0.00

Structure Detail:

Structure #2 (Null)

JD OOPS-2

Structure #1 (Null)

JD OOPS-1

Structure #3 (Pond)

Pond JD-1

Pond Inputs:

Initial Pool Elev:	2,137.00 ft
Initial Pool:	20.66 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
2,137.00	20.00	3.00:1	3.00:1	20.00

Pond Results:

Peak Elevation:	2,137.73 ft
Dewater Time:	1.28 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
2,120.00	0.000	0.000	0.000	
2,120.50	0.064	0.011	0.000	
2,121.00	0.257	0.086	0.000	
2,121.50	0.578	0.289	0.000	
2,122.00	1.027	0.685	0.000	
2,122.50	1.046	1.203	0.000	
2,123.00	1.065	1.730	0.000	
2,123.50	1.084	2.268	0.000	
2,124.00	1.103	2.814	0.000	
2,124.50	1.122	3.371	0.000	
2,125.00	1.142	3.937	0.000	
2,125.50	1.162	4.513	0.000	
2,126.00	1.182	5.099	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
2,126.50	1.202	5.695	0.000		
2,127.00	1.223	6.301	0.000		
2,127.50	1.243	6.917	0.000		
2,128.00	1.264	7.544	0.000		
2,128.50	1.285	8.181	0.000		
2,129.00	1.305	8.829	0.000		
2,129.50	1.326	9.487	0.000		
2,130.00	1.347	10.155	0.000		
2,130.50	1.368	10.834	0.000		
2,131.00	1.390	11.523	0.000		
2,131.50	1.411	12.223	0.000		
2,132.00	1.433	12.934	0.000		
2,132.50	1.455	13.656	0.000		
2,133.00	1.477	14.389	0.000		
2,133.50	1.499	15.133	0.000		
2,134.00	1.521	15.888	0.000		
2,134.50	1.544	16.654	0.000		
2,135.00	1.566	17.432	0.000		
2,135.50	1.589	18.220	0.000		
2,136.00	1.612	19.021	0.000		
2,136.50	1.635	19.832	0.000		
2,137.00	1.658	20.655	0.000		Spillway #1
2,137.50	1.681	21.490	3.643	26.50	
2,137.73	1.692	21.887	25.260	4.20	Peak Stage
2,138.00	1.704	22.336	49.679		
2,138.50	1.728	23.194	103.690		
2,139.00	1.751	24.064	176.689		
2,139.50	1.775	24.945	266.492		
2,140.00	1.799	25.839	373.219		

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
2,120.00	0.000	0.000
2,120.50	0.000	0.000
2,121.00	0.000	0.000
2,121.50	0.000	0.000
2,122.00	0.000	0.000
2,122.50	0.000	0.000
2,123.00	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
2,123.50	0.000	0.000
2,124.00	0.000	0.000
2,124.50	0.000	0.000
2,125.00	0.000	0.000
2,125.50	0.000	0.000
2,126.00	0.000	0.000
2,126.50	0.000	0.000
2,127.00	0.000	0.000
2,127.50	0.000	0.000
2,128.00	0.000	0.000
2,128.50	0.000	0.000
2,129.00	0.000	0.000
2,129.50	0.000	0.000
2,130.00	0.000	0.000
2,130.50	0.000	0.000
2,131.00	0.000	0.000
2,131.50	0.000	0.000
2,132.00	0.000	0.000
2,132.50	0.000	0.000
2,133.00	0.000	0.000
2,133.50	0.000	0.000
2,134.00	0.000	0.000
2,134.50	0.000	0.000
2,135.00	0.000	0.000
2,135.50	0.000	0.000
2,136.00	0.000	0.000
2,136.50	0.000	0.000
2,137.00	0.000	0.000
2,137.50	3.643	3.643
2,138.00	49.679	49.679
2,138.50	103.690	103.690
2,139.00	176.689	176.689
2,139.50	266.492	266.492
2,140.00	373.219	373.219

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	19.000	0.094	0.000	0.000	86.000	F	19.56	1.967
	Σ	**19.000**						**19.56**	**1.967**
#1	1	33.300	0.166	0.000	0.000	86.000	F	25.68	3.325
	Σ	**33.300**						**25.68**	**3.325**
#3	1	4.500	0.000	0.000	0.000	99.000	F	8.45	0.893
	Σ	**56.800**						**43.82**	**6.185**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	33.73	140.00	415.00	5.800	0.019
		8. Large gullies, diversions, and low flowing streams	3.41	100.00	2,932.03	5.540	0.147
#1	**1**	**Time of Concentration:**					**0.166**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	29.09	80.00	275.00	5.390	0.014
		8. Large gullies, diversions, and low flowing streams	3.63	60.00	1,654.03	5.710	0.080
#2	**1**	**Time of Concentration:**					**0.094**

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Pond JD-2

Design of containment pond JD-2 for a 100-year 6-hour Type 1 SCS storm.

Jumbo Dome mine area at the Usibelli Coal mine

Bandon Coleman

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General Information

Storm Information:

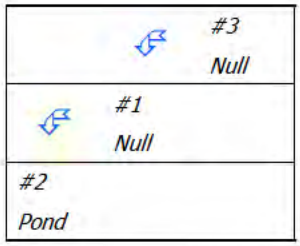
Storm Type:	NRCS Type I
Design Storm:	100 yr - 6 hr
Rainfall Depth:	2.000 inches

Particle Size Distribution:

Size (mm)	USIBELLI - Poker Flats
4.7500	100.000%
0.0750	89.000%
0.0020	8.000%
0.0010	0.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.000	0.000	JD-2-2
Pond	#2	==>	End	0.000	0.000	Pond JD-2
Null	#3	==>	#1	0.000	0.000	JD-2-1



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#3		46.500	46.500	61.78	3.26	2,760.6	785,614	351.48	215.35
#1		266.400	312.900	198.82	21.05	16,217.6	629,356	253.58	183.02
#2	In	12.200	325.100	205.62	22.96	16,217.6	612,578	246.82	171.77
	Out			0.00	0.00	16,217.6	0	0.00	0.00

Particle Size Distribution(s) at Each Structure

Structure #3 (JD-2-1):

Size (mm)	In/Out
4.7500	100.000%
0.0750	89.000%
0.0020	8.000%
0.0010	0.000%

Structure #1 (JD-2-2):

Size (mm)	In/Out
4.7500	100.000%
0.0750	98.128%
0.0020	10.981%
0.0010	0.000%

Structure #2:

Size (mm)	In	Out
4.7500	100.000%	0.000%
0.0750	98.128%	0.000%
0.0020	10.981%	0.000%
0.0010	0.000%	0.000%

Structure Detail:

Structure #3 (Null)

JD-2-1

Structure #1 (Null)

JD-2-2

Structure #2 (Pond)

Pond JD-2

Pond Inputs:

Initial Pool Elev:	2,083.00 ft
Initial Pool:	481.36 ac-ft
*Sediment Storage:	5.61 ac-ft
Dead Space:	20.00 %

**Sediment capacity based on Average Annual R of 8.8 for 1 year(s)*

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
2,087.00	20.00	3.00:1	3.00:1	20.00

Pond Results:

Peak Elevation:	2,085.68 ft
H'graph Detention Time:	0.00 hrs
Pond Model:	CSTRS
Dewater Time:	0.00 days
Trap Efficiency:	0.00 %

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
2,009.26	2.161	0.000	0.000		Top of Sed. Storage
2,009.50	2.311	0.545	0.000		
2,010.00	2.640	1.782	0.000		
2,010.50	2.845	3.153	0.000		
2,011.00	3.057	4.628	0.000		
2,011.50	3.276	6.211	0.000		
2,012.00	3.504	7.906	0.000		
2,012.50	3.738	9.716	0.000		

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
2,013.00	3.981	11.645	0.000	
2,013.50	4.231	13.698	0.000	
2,014.00	4.489	15.878	0.000	
2,014.50	4.754	18.188	0.000	
2,015.00	5.027	20.633	0.000	
2,015.50	5.063	23.156	0.000	
2,016.00	5.099	25.696	0.000	
2,016.50	5.135	28.255	0.000	
2,017.00	5.171	30.831	0.000	
2,017.50	5.208	33.426	0.000	
2,018.00	5.244	36.039	0.000	
2,018.50	5.281	38.671	0.000	
2,019.00	5.318	41.321	0.000	
2,019.50	5.355	43.989	0.000	
2,020.00	5.392	46.676	0.000	
2,020.50	5.414	49.377	0.000	
2,021.00	5.437	52.090	0.000	
2,021.50	5.460	54.814	0.000	
2,022.00	5.482	57.550	0.000	
2,022.50	5.505	60.296	0.000	
2,023.00	5.528	63.055	0.000	
2,023.50	5.550	65.824	0.000	
2,024.00	5.573	68.605	0.000	
2,024.50	5.596	71.397	0.000	
2,025.00	5.619	74.201	0.000	
2,025.50	5.642	77.016	0.000	
2,026.00	5.664	79.843	0.000	
2,026.50	5.687	82.681	0.000	
2,027.00	5.710	85.530	0.000	
2,027.50	5.733	88.391	0.000	
2,028.00	5.756	91.263	0.000	
2,028.50	5.779	94.147	0.000	
2,029.00	5.802	97.042	0.000	
2,029.50	5.825	99.948	0.000	
2,030.00	5.848	102.867	0.000	
2,030.50	5.871	105.796	0.000	
2,031.00	5.894	108.738	0.000	
2,031.50	5.917	111.691	0.000	
2,032.00	5.941	114.655	0.000	
2,032.50	5.964	117.631	0.000	
2,033.00	5.987	120.619	0.000	
2,033.50	6.011	123.619	0.000	
2,034.00	6.034	126.630	0.000	
2,034.50	6.057	129.653	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
2,035.00	6.081	132.687	0.000	
2,035.50	6.104	135.734	0.000	
2,036.00	6.128	138.792	0.000	
2,036.50	6.152	141.862	0.000	
2,037.00	6.175	144.943	0.000	
2,037.50	6.199	148.037	0.000	
2,038.00	6.223	151.142	0.000	
2,038.50	6.246	154.260	0.000	
2,039.00	6.270	157.389	0.000	
2,039.50	6.294	160.530	0.000	
2,040.00	6.318	163.683	0.000	
2,040.50	6.342	166.848	0.000	
2,041.00	6.366	170.025	0.000	
2,041.50	6.390	173.214	0.000	
2,042.00	6.413	176.414	0.000	
2,042.50	6.437	179.627	0.000	
2,043.00	6.461	182.852	0.000	
2,043.50	6.486	186.088	0.000	
2,044.00	6.510	189.337	0.000	
2,044.50	6.534	192.598	0.000	
2,045.00	6.558	195.871	0.000	
2,045.50	6.582	199.156	0.000	
2,046.00	6.606	202.453	0.000	
2,046.50	6.631	205.763	0.000	
2,047.00	6.655	209.084	0.000	
2,047.50	6.679	212.418	0.000	
2,048.00	6.704	215.763	0.000	
2,048.50	6.728	219.122	0.000	
2,049.00	6.753	222.492	0.000	
2,049.50	6.777	225.874	0.000	
2,050.00	6.802	229.269	0.000	
2,050.50	6.827	232.676	0.000	
2,051.00	6.851	236.096	0.000	
2,051.50	6.876	239.528	0.000	
2,052.00	6.901	242.972	0.000	
2,052.50	6.925	246.428	0.000	
2,053.00	6.950	249.897	0.000	
2,053.50	6.975	253.379	0.000	
2,054.00	7.000	256.872	0.000	
2,054.50	7.025	260.379	0.000	
2,055.00	7.050	263.897	0.000	
2,055.50	7.075	267.429	0.000	
2,056.00	7.100	270.972	0.000	
2,056.50	7.125	274.528	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
2,057.00	7.150	278.097	0.000	
2,057.50	7.175	281.678	0.000	
2,058.00	7.200	285.272	0.000	
2,058.50	7.225	288.878	0.000	
2,059.00	7.250	292.497	0.000	
2,059.50	7.276	296.129	0.000	
2,060.00	7.301	299.773	0.000	
2,060.50	7.326	303.430	0.000	
2,061.00	7.352	307.099	0.000	
2,061.50	7.377	310.782	0.000	
2,062.00	7.402	314.476	0.000	
2,062.50	7.428	318.184	0.000	
2,063.00	7.453	321.904	0.000	
2,063.50	7.479	325.638	0.000	
2,064.00	7.505	329.383	0.000	
2,064.50	7.530	333.142	0.000	
2,065.00	7.556	336.914	0.000	
2,065.50	7.582	340.698	0.000	
2,066.00	7.607	344.495	0.000	
2,066.50	7.633	348.305	0.000	
2,067.00	7.659	352.128	0.000	
2,067.50	7.684	355.964	0.000	
2,068.00	7.710	359.813	0.000	
2,068.50	7.736	363.674	0.000	
2,069.00	7.762	367.549	0.000	
2,069.50	7.788	371.436	0.000	
2,070.00	7.814	375.337	0.000	
2,070.50	7.840	379.250	0.000	
2,071.00	7.866	383.177	0.000	
2,071.50	7.892	387.117	0.000	
2,072.00	7.918	391.069	0.000	
2,072.50	7.944	395.035	0.000	
2,073.00	7.971	399.014	0.000	
2,073.50	7.997	403.006	0.000	
2,074.00	8.023	407.011	0.000	
2,074.50	8.050	411.029	0.000	
2,075.00	8.076	415.060	0.000	
2,075.50	8.102	419.105	0.000	
2,076.00	8.129	423.163	0.000	
2,076.50	8.155	427.233	0.000	
2,077.00	8.181	431.318	0.000	
2,077.50	8.208	435.415	0.000	
2,078.00	8.234	439.526	0.000	
2,078.50	8.261	443.649	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
2,079.00	8.288	447.787	0.000		
2,079.50	8.314	451.937	0.000		
2,080.00	8.341	456.101	0.000		
2,080.50	8.368	460.278	0.000		
2,081.00	8.394	464.469	0.000		
2,081.50	8.421	468.673	0.000		
2,082.00	8.448	472.890	0.000		
2,082.50	8.475	477.121	0.000		
2,083.00	8.502	481.365	0.000		
2,083.50	8.529	485.623	0.000		
2,084.00	8.556	489.894	0.000		
2,084.50	8.583	494.178	0.000		
2,085.00	8.610	498.477	0.000		
2,085.50	8.637	502.788	0.000		
2,085.68	8.647	504.309	0.000	0.00	Peak Stage
2,086.00	8.664	507.114	0.000		
2,086.50	8.691	511.452	0.000		
2,087.00	8.718	515.805	0.000		Spillway #1
2,087.50	8.745	520.171	3.643		
2,088.00	8.773	524.550	49.679		
2,088.50	8.800	528.943	103.690		
2,089.00	8.827	533.350	176.689		
2,089.50	8.855	537.771	266.492		
2,090.00	8.882	542.205	373.219		

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
2,009.26	0.000	0.000
2,009.50	0.000	0.000
2,010.00	0.000	0.000
2,010.50	0.000	0.000
2,011.00	0.000	0.000
2,011.50	0.000	0.000
2,012.00	0.000	0.000
2,012.50	0.000	0.000
2,013.00	0.000	0.000
2,013.50	0.000	0.000
2,014.00	0.000	0.000
2,014.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
2,015.00	0.000	0.000
2,015.50	0.000	0.000
2,016.00	0.000	0.000
2,016.50	0.000	0.000
2,017.00	0.000	0.000
2,017.50	0.000	0.000
2,018.00	0.000	0.000
2,018.50	0.000	0.000
2,019.00	0.000	0.000
2,019.50	0.000	0.000
2,020.00	0.000	0.000
2,020.50	0.000	0.000
2,021.00	0.000	0.000
2,021.50	0.000	0.000
2,022.00	0.000	0.000
2,022.50	0.000	0.000
2,023.00	0.000	0.000
2,023.50	0.000	0.000
2,024.00	0.000	0.000
2,024.50	0.000	0.000
2,025.00	0.000	0.000
2,025.50	0.000	0.000
2,026.00	0.000	0.000
2,026.50	0.000	0.000
2,027.00	0.000	0.000
2,027.50	0.000	0.000
2,028.00	0.000	0.000
2,028.50	0.000	0.000
2,029.00	0.000	0.000
2,029.50	0.000	0.000
2,030.00	0.000	0.000
2,030.50	0.000	0.000
2,031.00	0.000	0.000
2,031.50	0.000	0.000
2,032.00	0.000	0.000
2,032.50	0.000	0.000
2,033.00	0.000	0.000
2,033.50	0.000	0.000
2,034.00	0.000	0.000
2,034.50	0.000	0.000
2,035.00	0.000	0.000
2,035.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
2,036.00	0.000	0.000
2,036.50	0.000	0.000
2,037.00	0.000	0.000
2,037.50	0.000	0.000
2,038.00	0.000	0.000
2,038.50	0.000	0.000
2,039.00	0.000	0.000
2,039.50	0.000	0.000
2,040.00	0.000	0.000
2,040.50	0.000	0.000
2,041.00	0.000	0.000
2,041.50	0.000	0.000
2,042.00	0.000	0.000
2,042.50	0.000	0.000
2,043.00	0.000	0.000
2,043.50	0.000	0.000
2,044.00	0.000	0.000
2,044.50	0.000	0.000
2,045.00	0.000	0.000
2,045.50	0.000	0.000
2,046.00	0.000	0.000
2,046.50	0.000	0.000
2,047.00	0.000	0.000
2,047.50	0.000	0.000
2,048.00	0.000	0.000
2,048.50	0.000	0.000
2,049.00	0.000	0.000
2,049.50	0.000	0.000
2,050.00	0.000	0.000
2,050.50	0.000	0.000
2,051.00	0.000	0.000
2,051.50	0.000	0.000
2,052.00	0.000	0.000
2,052.50	0.000	0.000
2,053.00	0.000	0.000
2,053.50	0.000	0.000
2,054.00	0.000	0.000
2,054.50	0.000	0.000
2,055.00	0.000	0.000
2,055.50	0.000	0.000
2,056.00	0.000	0.000
2,056.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
2,057.00	0.000	0.000
2,057.50	0.000	0.000
2,058.00	0.000	0.000
2,058.50	0.000	0.000
2,059.00	0.000	0.000
2,059.50	0.000	0.000
2,060.00	0.000	0.000
2,060.50	0.000	0.000
2,061.00	0.000	0.000
2,061.50	0.000	0.000
2,062.00	0.000	0.000
2,062.50	0.000	0.000
2,063.00	0.000	0.000
2,063.50	0.000	0.000
2,064.00	0.000	0.000
2,064.50	0.000	0.000
2,065.00	0.000	0.000
2,065.50	0.000	0.000
2,066.00	0.000	0.000
2,066.50	0.000	0.000
2,067.00	0.000	0.000
2,067.50	0.000	0.000
2,068.00	0.000	0.000
2,068.50	0.000	0.000
2,069.00	0.000	0.000
2,069.50	0.000	0.000
2,070.00	0.000	0.000
2,070.50	0.000	0.000
2,071.00	0.000	0.000
2,071.50	0.000	0.000
2,072.00	0.000	0.000
2,072.50	0.000	0.000
2,073.00	0.000	0.000
2,073.50	0.000	0.000
2,074.00	0.000	0.000
2,074.50	0.000	0.000
2,075.00	0.000	0.000
2,075.50	0.000	0.000
2,076.00	0.000	0.000
2,076.50	0.000	0.000
2,077.00	0.000	0.000
2,077.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
2,078.00	0.000	0.000
2,078.50	0.000	0.000
2,079.00	0.000	0.000
2,079.50	0.000	0.000
2,080.00	0.000	0.000
2,080.50	0.000	0.000
2,081.00	0.000	0.000
2,081.50	0.000	0.000
2,082.00	0.000	0.000
2,082.50	0.000	0.000
2,083.00	0.000	0.000
2,083.50	0.000	0.000
2,084.00	0.000	0.000
2,084.50	0.000	0.000
2,085.00	0.000	0.000
2,085.50	0.000	0.000
2,086.00	0.000	0.000
2,086.50	0.000	0.000
2,087.00	0.000	0.000
2,087.50	3.643	3.643
2,088.00	49.679	49.679
2,088.50	103.690	103.690
2,089.00	176.689	176.689
2,089.50	266.492	266.492
2,090.00	373.219	373.219

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#3	1	46.500	0.108	0.000	0.000	86.000	F	61.78	3.264
	Σ	**46.500**						**61.78**	**3.264**
#1	1	266.400	0.416	0.000	0.000	86.000	F	182.50	17.786
	Σ	**312.900**						**198.82**	**21.050**
#2	1	12.200	0.000	0.000	0.000	99.000	F	31.76	1.906
	Σ	**325.100**						**205.62**	**22.957**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#3	1	0.240	300.00	30.00	0.6000	1.0000	1	2,760.6	785,614	351.48	215.35
	Σ							**2,760.6**	**785,614**	**351.48**	**215.35**
#1	1	0.240	300.00	30.00	0.6000	1.0000	1	13,457.0	639,267	251.74	176.05
	Σ							**16,217.6**	**629,356**	**253.58**	**183.02**
#2	1	0.000	1.00	0.01	0.0001	1.0000	1	0.0	0	0.00	0.00
	Σ							**16,217.6**	**612,578**	**246.82**	**171.77**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	16.67	50.00	300.00	4.080	0.020
		7. Paved area and small upland gullies	11.11	270.00	2,430.00	6.700	0.100
		8. Large gullies, diversions, and low flowing streams	2.48	125.00	5,045.00	4.720	0.296
#1	**1**	**Time of Concentration:**					**0.416**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	15.00	45.00	300.00	3.870	0.021
		7. Paved area and small upland gullies	10.80	225.00	2,084.00	6.610	0.087
#3	**1**	**Time of Concentration:**					**0.108**

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Pond JD-2 Emergency Spillway

Design of containment pond JD-2 emergency spillway for a 25-year 24-hour Type 1 SCS storm.

Jumbo Dome mine area at the Usibelli Coal mine

Bandon Coleman

MWH
1801 California St
Ste 2900
Denver, CO 80202

Phone: (303) 291-2261
Email: Brandon.A.Coleman@mwhglobal.com

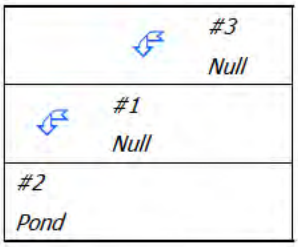
General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	25 yr - 24 hr
Rainfall Depth:	2.500 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.000	0.000	JD-2-2
Pond	#2	==>	End	0.000	0.000	Pond JD-2
Null	#3	==>	#1	0.000	0.000	JD-2-1



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#3		46.500	46.500	47.88	4.81
#1		266.400	312.900	159.08	30.86
#2	In	12.200	325.100	163.97	33.29
	Out			58.31	32.48

Structure Detail:

Structure #3 (Null)

JD-2-1

Structure #1 (Null)

JD-2-2

Structure #2 (Pond)

Pond JD-2

Pond Inputs:

Initial Pool Elev:	2,087.00 ft
Initial Pool:	521.40 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
2,087.00	20.00	3.00:1	3.00:1	20.00

Pond Results:

Peak Elevation:	2,088.08 ft
Dewater Time:	1.21 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
2,000.00	0.052	0.000	0.000	
2,000.50	0.069	0.030	0.000	
2,001.00	0.089	0.070	0.000	
2,001.50	0.111	0.119	0.000	
2,002.00	0.135	0.181	0.000	
2,002.50	0.162	0.255	0.000	
2,003.00	0.191	0.343	0.000	
2,003.50	0.223	0.446	0.000	
2,004.00	0.257	0.566	0.000	
2,004.50	0.293	0.703	0.000	
2,005.00	0.332	0.859	0.000	
2,005.50	0.465	1.058	0.000	
2,006.00	0.618	1.328	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
2,006.50	0.794	1.680	0.000	
2,007.00	0.992	2.125	0.000	
2,007.50	1.211	2.675	0.000	
2,008.00	1.454	3.341	0.000	
2,008.50	1.717	4.133	0.000	
2,009.00	2.003	5.062	0.000	
2,009.50	2.311	6.140	0.000	
2,010.00	2.640	7.376	0.000	
2,010.50	2.845	8.747	0.000	
2,011.00	3.057	10.222	0.000	
2,011.50	3.276	11.805	0.000	
2,012.00	3.504	13.500	0.000	
2,012.50	3.738	15.310	0.000	
2,013.00	3.981	17.240	0.000	
2,013.50	4.231	19.292	0.000	
2,014.00	4.489	21.472	0.000	
2,014.50	4.754	23.783	0.000	
2,015.00	5.027	26.228	0.000	
2,015.50	5.063	28.750	0.000	
2,016.00	5.099	31.291	0.000	
2,016.50	5.135	33.849	0.000	
2,017.00	5.171	36.426	0.000	
2,017.50	5.208	39.021	0.000	
2,018.00	5.244	41.634	0.000	
2,018.50	5.281	44.265	0.000	
2,019.00	5.318	46.915	0.000	
2,019.50	5.355	49.583	0.000	
2,020.00	5.392	52.270	0.000	
2,020.50	5.414	54.971	0.000	
2,021.00	5.437	57.684	0.000	
2,021.50	5.460	60.408	0.000	
2,022.00	5.482	63.144	0.000	
2,022.50	5.505	65.891	0.000	
2,023.00	5.528	68.649	0.000	
2,023.50	5.550	71.418	0.000	
2,024.00	5.573	74.199	0.000	
2,024.50	5.596	76.992	0.000	
2,025.00	5.619	79.795	0.000	
2,025.50	5.642	82.611	0.000	
2,026.00	5.664	85.437	0.000	
2,026.50	5.687	88.275	0.000	
2,027.00	5.710	91.124	0.000	
2,027.50	5.733	93.985	0.000	
2,028.00	5.756	96.857	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
2,028.50	5.779	99.741	0.000	
2,029.00	5.802	102.636	0.000	
2,029.50	5.825	105.543	0.000	
2,030.00	5.848	108.461	0.000	
2,030.50	5.871	111.391	0.000	
2,031.00	5.894	114.332	0.000	
2,031.50	5.917	117.285	0.000	
2,032.00	5.941	120.250	0.000	
2,032.50	5.964	123.226	0.000	
2,033.00	5.987	126.213	0.000	
2,033.50	6.011	129.213	0.000	
2,034.00	6.034	132.224	0.000	
2,034.50	6.057	135.247	0.000	
2,035.00	6.081	138.282	0.000	
2,035.50	6.104	141.328	0.000	
2,036.00	6.128	144.386	0.000	
2,036.50	6.152	147.456	0.000	
2,037.00	6.175	150.538	0.000	
2,037.50	6.199	153.631	0.000	
2,038.00	6.223	156.737	0.000	
2,038.50	6.246	159.854	0.000	
2,039.00	6.270	162.983	0.000	
2,039.50	6.294	166.124	0.000	
2,040.00	6.318	169.277	0.000	
2,040.50	6.342	172.442	0.000	
2,041.00	6.366	175.619	0.000	
2,041.50	6.390	178.808	0.000	
2,042.00	6.413	182.009	0.000	
2,042.50	6.437	185.221	0.000	
2,043.00	6.461	188.446	0.000	
2,043.50	6.486	191.683	0.000	
2,044.00	6.510	194.932	0.000	
2,044.50	6.534	198.192	0.000	
2,045.00	6.558	201.465	0.000	
2,045.50	6.582	204.750	0.000	
2,046.00	6.606	208.048	0.000	
2,046.50	6.631	211.357	0.000	
2,047.00	6.655	214.678	0.000	
2,047.50	6.679	218.012	0.000	
2,048.00	6.704	221.358	0.000	
2,048.50	6.728	224.716	0.000	
2,049.00	6.753	228.086	0.000	
2,049.50	6.777	231.469	0.000	
2,050.00	6.802	234.863	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
2,050.50	6.827	238.271	0.000	
2,051.00	6.851	241.690	0.000	
2,051.50	6.876	245.122	0.000	
2,052.00	6.901	248.566	0.000	
2,052.50	6.925	252.023	0.000	
2,053.00	6.950	255.492	0.000	
2,053.50	6.975	258.973	0.000	
2,054.00	7.000	262.467	0.000	
2,054.50	7.025	265.973	0.000	
2,055.00	7.050	269.492	0.000	
2,055.50	7.075	273.023	0.000	
2,056.00	7.100	276.567	0.000	
2,056.50	7.125	280.123	0.000	
2,057.00	7.150	283.691	0.000	
2,057.50	7.175	287.273	0.000	
2,058.00	7.200	290.866	0.000	
2,058.50	7.225	294.473	0.000	
2,059.00	7.250	298.092	0.000	
2,059.50	7.276	301.723	0.000	
2,060.00	7.301	305.367	0.000	
2,060.50	7.326	309.024	0.000	
2,061.00	7.352	312.694	0.000	
2,061.50	7.377	316.376	0.000	
2,062.00	7.402	320.071	0.000	
2,062.50	7.428	323.778	0.000	
2,063.00	7.453	327.499	0.000	
2,063.50	7.479	331.232	0.000	
2,064.00	7.505	334.978	0.000	
2,064.50	7.530	338.736	0.000	
2,065.00	7.556	342.508	0.000	
2,065.50	7.582	346.292	0.000	
2,066.00	7.607	350.090	0.000	
2,066.50	7.633	353.900	0.000	
2,067.00	7.659	357.723	0.000	
2,067.50	7.684	361.558	0.000	
2,068.00	7.710	365.407	0.000	
2,068.50	7.736	369.269	0.000	
2,069.00	7.762	373.143	0.000	
2,069.50	7.788	377.031	0.000	
2,070.00	7.814	380.931	0.000	
2,070.50	7.840	384.845	0.000	
2,071.00	7.866	388.771	0.000	
2,071.50	7.892	392.711	0.000	
2,072.00	7.918	396.663	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
2,072.50	7.944	400.629	0.000		
2,073.00	7.971	404.608	0.000		
2,073.50	7.997	408.600	0.000		
2,074.00	8.023	412.605	0.000		
2,074.50	8.050	416.623	0.000		
2,075.00	8.076	420.654	0.000		
2,075.50	8.102	424.699	0.000		
2,076.00	8.129	428.757	0.000		
2,076.50	8.155	432.828	0.000		
2,077.00	8.181	436.912	0.000		
2,077.50	8.208	441.009	0.000		
2,078.00	8.234	445.120	0.000		
2,078.50	8.261	449.244	0.000		
2,079.00	8.288	453.381	0.000		
2,079.50	8.314	457.531	0.000		
2,080.00	8.341	461.695	0.000		
2,080.50	8.368	465.872	0.000		
2,081.00	8.394	470.063	0.000		
2,081.50	8.421	474.267	0.000		
2,082.00	8.448	478.484	0.000		
2,082.50	8.475	482.715	0.000		
2,083.00	8.502	486.959	0.000		
2,083.50	8.529	491.217	0.000		
2,084.00	8.556	495.488	0.000		
2,084.50	8.583	499.773	0.000		
2,085.00	8.610	504.071	0.000		
2,085.50	8.637	508.383	0.000		
2,086.00	8.664	512.708	0.000		
2,086.50	8.691	517.047	0.000		
2,087.00	8.718	521.399	0.000		Spillway #1
2,087.50	8.745	525.765	3.643	14.50*	
2,088.00	8.773	530.145	49.679	13.90	
2,088.08	8.777	530.846	58.309	0.70	Peak Stage
2,088.50	8.800	534.538	103.690		
2,089.00	8.827	538.945	176.689		
2,089.50	8.855	543.365	266.492		
2,090.00	8.882	547.799	373.219		

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
2,000.00	0.000	0.000
2,000.50	0.000	0.000
2,001.00	0.000	0.000
2,001.50	0.000	0.000
2,002.00	0.000	0.000
2,002.50	0.000	0.000
2,003.00	0.000	0.000
2,003.50	0.000	0.000
2,004.00	0.000	0.000
2,004.50	0.000	0.000
2,005.00	0.000	0.000
2,005.50	0.000	0.000
2,006.00	0.000	0.000
2,006.50	0.000	0.000
2,007.00	0.000	0.000
2,007.50	0.000	0.000
2,008.00	0.000	0.000
2,008.50	0.000	0.000
2,009.00	0.000	0.000
2,009.50	0.000	0.000
2,010.00	0.000	0.000
2,010.50	0.000	0.000
2,011.00	0.000	0.000
2,011.50	0.000	0.000
2,012.00	0.000	0.000
2,012.50	0.000	0.000
2,013.00	0.000	0.000
2,013.50	0.000	0.000
2,014.00	0.000	0.000
2,014.50	0.000	0.000
2,015.00	0.000	0.000
2,015.50	0.000	0.000
2,016.00	0.000	0.000
2,016.50	0.000	0.000
2,017.00	0.000	0.000
2,017.50	0.000	0.000
2,018.00	0.000	0.000
2,018.50	0.000	0.000
2,019.00	0.000	0.000
2,019.50	0.000	0.000
2,020.00	0.000	0.000
2,020.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
2,021.00	0.000	0.000
2,021.50	0.000	0.000
2,022.00	0.000	0.000
2,022.50	0.000	0.000
2,023.00	0.000	0.000
2,023.50	0.000	0.000
2,024.00	0.000	0.000
2,024.50	0.000	0.000
2,025.00	0.000	0.000
2,025.50	0.000	0.000
2,026.00	0.000	0.000
2,026.50	0.000	0.000
2,027.00	0.000	0.000
2,027.50	0.000	0.000
2,028.00	0.000	0.000
2,028.50	0.000	0.000
2,029.00	0.000	0.000
2,029.50	0.000	0.000
2,030.00	0.000	0.000
2,030.50	0.000	0.000
2,031.00	0.000	0.000
2,031.50	0.000	0.000
2,032.00	0.000	0.000
2,032.50	0.000	0.000
2,033.00	0.000	0.000
2,033.50	0.000	0.000
2,034.00	0.000	0.000
2,034.50	0.000	0.000
2,035.00	0.000	0.000
2,035.50	0.000	0.000
2,036.00	0.000	0.000
2,036.50	0.000	0.000
2,037.00	0.000	0.000
2,037.50	0.000	0.000
2,038.00	0.000	0.000
2,038.50	0.000	0.000
2,039.00	0.000	0.000
2,039.50	0.000	0.000
2,040.00	0.000	0.000
2,040.50	0.000	0.000
2,041.00	0.000	0.000
2,041.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
2,042.00	0.000	0.000
2,042.50	0.000	0.000
2,043.00	0.000	0.000
2,043.50	0.000	0.000
2,044.00	0.000	0.000
2,044.50	0.000	0.000
2,045.00	0.000	0.000
2,045.50	0.000	0.000
2,046.00	0.000	0.000
2,046.50	0.000	0.000
2,047.00	0.000	0.000
2,047.50	0.000	0.000
2,048.00	0.000	0.000
2,048.50	0.000	0.000
2,049.00	0.000	0.000
2,049.50	0.000	0.000
2,050.00	0.000	0.000
2,050.50	0.000	0.000
2,051.00	0.000	0.000
2,051.50	0.000	0.000
2,052.00	0.000	0.000
2,052.50	0.000	0.000
2,053.00	0.000	0.000
2,053.50	0.000	0.000
2,054.00	0.000	0.000
2,054.50	0.000	0.000
2,055.00	0.000	0.000
2,055.50	0.000	0.000
2,056.00	0.000	0.000
2,056.50	0.000	0.000
2,057.00	0.000	0.000
2,057.50	0.000	0.000
2,058.00	0.000	0.000
2,058.50	0.000	0.000
2,059.00	0.000	0.000
2,059.50	0.000	0.000
2,060.00	0.000	0.000
2,060.50	0.000	0.000
2,061.00	0.000	0.000
2,061.50	0.000	0.000
2,062.00	0.000	0.000
2,062.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
2,063.00	0.000	0.000
2,063.50	0.000	0.000
2,064.00	0.000	0.000
2,064.50	0.000	0.000
2,065.00	0.000	0.000
2,065.50	0.000	0.000
2,066.00	0.000	0.000
2,066.50	0.000	0.000
2,067.00	0.000	0.000
2,067.50	0.000	0.000
2,068.00	0.000	0.000
2,068.50	0.000	0.000
2,069.00	0.000	0.000
2,069.50	0.000	0.000
2,070.00	0.000	0.000
2,070.50	0.000	0.000
2,071.00	0.000	0.000
2,071.50	0.000	0.000
2,072.00	0.000	0.000
2,072.50	0.000	0.000
2,073.00	0.000	0.000
2,073.50	0.000	0.000
2,074.00	0.000	0.000
2,074.50	0.000	0.000
2,075.00	0.000	0.000
2,075.50	0.000	0.000
2,076.00	0.000	0.000
2,076.50	0.000	0.000
2,077.00	0.000	0.000
2,077.50	0.000	0.000
2,078.00	0.000	0.000
2,078.50	0.000	0.000
2,079.00	0.000	0.000
2,079.50	0.000	0.000
2,080.00	0.000	0.000
2,080.50	0.000	0.000
2,081.00	0.000	0.000
2,081.50	0.000	0.000
2,082.00	0.000	0.000
2,082.50	0.000	0.000
2,083.00	0.000	0.000
2,083.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
2,084.00	0.000	0.000
2,084.50	0.000	0.000
2,085.00	0.000	0.000
2,085.50	0.000	0.000
2,086.00	0.000	0.000
2,086.50	0.000	0.000
2,087.00	0.000	0.000
2,087.50	3.643	3.643
2,088.00	49.679	49.679
2,088.50	103.690	103.690
2,089.00	176.689	176.689
2,089.50	266.492	266.492
2,090.00	373.219	373.219

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#3	1	46.500	0.108	0.000	0.000	86.000	F	47.88	4.814
	Σ	**46.500**						**47.88**	**4.814**
#1	1	266.400	0.416	0.000	0.000	86.000	F	147.33	26.050
	Σ	**312.900**						**159.08**	**30.864**
#2	1	12.200	0.000	0.000	0.000	99.000	F	22.90	2.421
	Σ	**325.100**						**163.97**	**33.285**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	16.67	50.00	300.00	4.080	0.020
		7. Paved area and small upland gullies	11.11	270.00	2,430.00	6.700	0.100
		8. Large gullies, diversions, and low flowing streams	2.48	125.00	5,045.00	4.720	0.296
#1	**1**	**Time of Concentration:**					**0.416**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	15.00	45.00	300.00	3.870	0.021
		7. Paved area and small upland gullies	10.80	225.00	2,084.00	6.610	0.087
#3	**1**	**Time of Concentration:**					**0.108**

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Pond JD-3

Design of containment pond JD-3 for a 100-year 6-hour Type 1 SCS storm.

Jumbo Dome mine area for the Usibelli Coal Mine

Bandon Coleman

MWH
1801 California St
Ste 2900
Denver, CO 80202

Phone: (303) 291-2261
Email: Brandon.A.Coleman@mwhglobal.com

General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	100 yr - 6 hr
Rainfall Depth:	2.000 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.000	0.000	JD Channel 3
Pond	#2	==>	End	0.000	0.000	JD Pond 3

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1		304.300	304.300	258.87	20.50
#2	In	9.900	314.200	264.73	22.05
	Out			0.00	0.00

Structure Detail:

Structure #1 (Null)

JD Channel 3

Structure #2 (Pond)

JD Pond 3

Pond Inputs:

Initial Pool Elev:	1,993.00 ft
Initial Pool:	506.84 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
1,997.00	20.00	3.00:1	3.00:1	20.00

Pond Results:

Peak Elevation:	1,996.05 ft
Dewater Time:	0.00 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1,865.00	0.000	0.000	0.000	
1,865.50	0.002	0.000	0.000	
1,866.00	0.007	0.002	0.000	
1,866.50	0.016	0.008	0.000	
1,867.00	0.028	0.019	0.000	
1,867.50	0.044	0.037	0.000	
1,868.00	0.064	0.064	0.000	
1,868.50	0.087	0.102	0.000	
1,869.00	0.113	0.151	0.000	
1,869.50	0.144	0.216	0.000	
1,870.00	0.177	0.296	0.000	
1,870.50	0.230	0.397	0.000	
1,871.00	0.289	0.526	0.000	
1,871.50	0.355	0.687	0.000	
1,872.00	0.427	0.882	0.000	
1,872.50	0.506	1.115	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1,873.00	0.593	1.390	0.000	
1,873.50	0.686	1.709	0.000	
1,874.00	0.785	2.076	0.000	
1,874.50	0.892	2.496	0.000	
1,875.00	1.005	2.970	0.000	
1,875.50	1.074	3.489	0.000	
1,876.00	1.144	4.043	0.000	
1,876.50	1.217	4.634	0.000	
1,877.00	1.292	5.261	0.000	
1,877.50	1.370	5.926	0.000	
1,878.00	1.450	6.631	0.000	
1,878.50	1.532	7.376	0.000	
1,879.00	1.616	8.163	0.000	
1,879.50	1.702	8.993	0.000	
1,880.00	1.791	9.866	0.000	
1,880.50	1.828	10.771	0.000	
1,881.00	1.865	11.694	0.000	
1,881.50	1.903	12.636	0.000	
1,882.00	1.941	13.597	0.000	
1,882.50	1.979	14.577	0.000	
1,883.00	2.018	15.576	0.000	
1,883.50	2.057	16.595	0.000	
1,884.00	2.097	17.634	0.000	
1,884.50	2.137	18.692	0.000	
1,885.00	2.177	19.770	0.000	
1,885.50	2.195	20.863	0.000	
1,886.00	2.214	21.966	0.000	
1,886.50	2.232	23.077	0.000	
1,887.00	2.251	24.198	0.000	
1,887.50	2.270	25.328	0.000	
1,888.00	2.288	26.468	0.000	
1,888.50	2.307	27.616	0.000	
1,889.00	2.326	28.775	0.000	
1,889.50	2.345	29.942	0.000	
1,890.00	2.364	31.120	0.000	
1,890.50	2.383	32.306	0.000	
1,891.00	2.402	33.503	0.000	
1,891.50	2.421	34.708	0.000	
1,892.00	2.440	35.924	0.000	
1,892.50	2.460	37.149	0.000	
1,893.00	2.479	38.383	0.000	
1,893.50	2.498	39.628	0.000	
1,894.00	2.518	40.882	0.000	
1,894.50	2.537	42.145	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1,895.00	2.557	43.419	0.000	
1,895.50	2.576	44.702	0.000	
1,896.00	2.596	45.995	0.000	
1,896.50	2.616	47.298	0.000	
1,897.00	2.635	48.611	0.000	
1,897.50	2.655	49.934	0.000	
1,898.00	2.675	51.266	0.000	
1,898.50	2.695	52.609	0.000	
1,899.00	2.715	53.961	0.000	
1,899.50	2.735	55.323	0.000	
1,900.00	2.755	56.696	0.000	
1,900.50	2.775	58.078	0.000	
1,901.00	2.795	59.471	0.000	
1,901.50	2.815	60.873	0.000	
1,902.00	2.835	62.286	0.000	
1,902.50	2.855	63.708	0.000	
1,903.00	2.875	65.141	0.000	
1,903.50	2.896	66.584	0.000	
1,904.00	2.916	68.036	0.000	
1,904.50	2.936	69.500	0.000	
1,905.00	2.957	70.973	0.000	
1,905.50	2.977	72.457	0.000	
1,906.00	2.998	73.950	0.000	
1,906.50	3.018	75.454	0.000	
1,907.00	3.039	76.968	0.000	
1,907.50	3.059	78.493	0.000	
1,908.00	3.080	80.027	0.000	
1,908.50	3.100	81.573	0.000	
1,909.00	3.121	83.128	0.000	
1,909.50	3.142	84.694	0.000	
1,910.00	3.163	86.270	0.000	
1,910.50	3.184	87.857	0.000	
1,911.00	3.204	89.454	0.000	
1,911.50	3.225	91.061	0.000	
1,912.00	3.246	92.679	0.000	
1,912.50	3.267	94.307	0.000	
1,913.00	3.288	95.946	0.000	
1,913.50	3.309	97.596	0.000	
1,914.00	3.330	99.256	0.000	
1,914.50	3.352	100.926	0.000	
1,915.00	3.373	102.607	0.000	
1,915.50	3.394	104.299	0.000	
1,916.00	3.415	106.001	0.000	
1,916.50	3.437	107.714	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1,917.00	3.458	109.438	0.000	
1,917.50	3.479	111.172	0.000	
1,918.00	3.501	112.917	0.000	
1,918.50	3.522	114.673	0.000	
1,919.00	3.544	116.439	0.000	
1,919.50	3.565	118.216	0.000	
1,920.00	3.587	120.005	0.000	
1,920.50	3.609	121.803	0.000	
1,921.00	3.630	123.613	0.000	
1,921.50	3.652	125.433	0.000	
1,922.00	3.673	127.265	0.000	
1,922.50	3.695	129.107	0.000	
1,923.00	3.717	130.960	0.000	
1,923.50	3.739	132.824	0.000	
1,924.00	3.761	134.699	0.000	
1,924.50	3.783	136.585	0.000	
1,925.00	3.805	138.482	0.000	
1,925.50	3.827	140.390	0.000	
1,926.00	3.849	142.309	0.000	
1,926.50	3.871	144.239	0.000	
1,927.00	3.893	146.180	0.000	
1,927.50	3.915	148.132	0.000	
1,928.00	3.937	150.095	0.000	
1,928.50	3.960	152.069	0.000	
1,929.00	3.982	154.055	0.000	
1,929.50	4.005	156.051	0.000	
1,930.00	4.027	158.059	0.000	
1,930.50	4.049	160.078	0.000	
1,931.00	4.072	162.109	0.000	
1,931.50	4.094	164.150	0.000	
1,932.00	4.117	166.203	0.000	
1,932.50	4.139	168.267	0.000	
1,933.00	4.162	170.342	0.000	
1,933.50	4.185	172.429	0.000	
1,934.00	4.207	174.527	0.000	
1,934.50	4.230	176.636	0.000	
1,935.00	4.253	178.757	0.000	
1,935.50	4.276	180.889	0.000	
1,936.00	4.299	183.032	0.000	
1,936.50	4.321	185.187	0.000	
1,937.00	4.344	187.354	0.000	
1,937.50	4.367	189.532	0.000	
1,938.00	4.390	191.721	0.000	
1,938.50	4.413	193.922	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1,939.00	4.437	196.134	0.000	
1,939.50	4.460	198.358	0.000	
1,940.00	4.483	200.594	0.000	
1,940.50	4.506	202.841	0.000	
1,941.00	4.529	205.100	0.000	
1,941.50	4.552	207.371	0.000	
1,942.00	4.575	209.652	0.000	
1,942.50	4.599	211.946	0.000	
1,943.00	4.622	214.251	0.000	
1,943.50	4.645	216.568	0.000	
1,944.00	4.669	218.897	0.000	
1,944.50	4.692	221.237	0.000	
1,945.00	4.716	223.589	0.000	
1,945.50	4.740	225.953	0.000	
1,946.00	4.763	228.329	0.000	
1,946.50	4.787	230.716	0.000	
1,947.00	4.811	233.116	0.000	
1,947.50	4.834	235.527	0.000	
1,948.00	4.858	237.950	0.000	
1,948.50	4.882	240.385	0.000	
1,949.00	4.906	242.832	0.000	
1,949.50	4.930	245.291	0.000	
1,950.00	4.954	247.762	0.000	
1,950.50	4.978	250.245	0.000	
1,951.00	5.002	252.740	0.000	
1,951.50	5.026	255.246	0.000	
1,952.00	5.050	257.765	0.000	
1,952.50	5.074	260.296	0.000	
1,953.00	5.098	262.839	0.000	
1,953.50	5.122	265.394	0.000	
1,954.00	5.146	267.961	0.000	
1,954.50	5.171	270.540	0.000	
1,955.00	5.195	273.132	0.000	
1,955.50	5.219	275.735	0.000	
1,956.00	5.244	278.351	0.000	
1,956.50	5.268	280.979	0.000	
1,957.00	5.292	283.619	0.000	
1,957.50	5.317	286.271	0.000	
1,958.00	5.341	288.936	0.000	
1,958.50	5.366	291.613	0.000	
1,959.00	5.391	294.302	0.000	
1,959.50	5.415	297.003	0.000	
1,960.00	5.440	299.717	0.000	
1,960.50	5.463	302.443	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1,961.00	5.485	305.180	0.000	
1,961.50	5.508	307.928	0.000	
1,962.00	5.531	310.688	0.000	
1,962.50	5.553	313.459	0.000	
1,963.00	5.576	316.241	0.000	
1,963.50	5.599	319.035	0.000	
1,964.00	5.622	321.840	0.000	
1,964.50	5.645	324.657	0.000	
1,965.00	5.668	327.485	0.000	
1,965.50	5.695	330.326	0.000	
1,966.00	5.722	333.180	0.000	
1,966.50	5.749	336.048	0.000	
1,967.00	5.776	338.929	0.000	
1,967.50	5.803	341.824	0.000	
1,968.00	5.830	344.732	0.000	
1,968.50	5.858	347.654	0.000	
1,969.00	5.885	350.590	0.000	
1,969.50	5.913	353.539	0.000	
1,970.00	5.940	356.502	0.000	
1,970.50	5.965	359.479	0.000	
1,971.00	5.991	362.468	0.000	
1,971.50	6.016	365.469	0.000	
1,972.00	6.041	368.484	0.000	
1,972.50	6.067	371.511	0.000	
1,973.00	6.092	374.550	0.000	
1,973.50	6.118	377.603	0.000	
1,974.00	6.144	380.668	0.000	
1,974.50	6.169	383.747	0.000	
1,975.00	6.195	386.838	0.000	
1,975.50	6.221	389.942	0.000	
1,976.00	6.247	393.058	0.000	
1,976.50	6.272	396.188	0.000	
1,977.00	6.298	399.331	0.000	
1,977.50	6.324	402.487	0.000	
1,978.00	6.350	405.655	0.000	
1,978.50	6.376	408.837	0.000	
1,979.00	6.403	412.032	0.000	
1,979.50	6.429	415.240	0.000	
1,980.00	6.455	418.460	0.000	
1,980.50	6.481	421.694	0.000	
1,981.00	6.507	424.942	0.000	
1,981.50	6.533	428.202	0.000	
1,982.00	6.560	431.475	0.000	
1,982.50	6.586	434.761	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
1,983.00	6.612	438.061	0.000		
1,983.50	6.639	441.373	0.000		
1,984.00	6.665	444.699	0.000		
1,984.50	6.691	448.038	0.000		
1,985.00	6.718	451.391	0.000		
1,985.50	6.744	454.756	0.000		
1,986.00	6.771	458.135	0.000		
1,986.50	6.797	461.527	0.000		
1,987.00	6.824	464.932	0.000		
1,987.50	6.850	468.351	0.000		
1,988.00	6.877	471.783	0.000		
1,988.50	6.904	475.228	0.000		
1,989.00	6.930	478.686	0.000		
1,989.50	6.957	482.158	0.000		
1,990.00	6.984	485.644	0.000		
1,990.50	7.011	489.142	0.000		
1,991.00	7.038	492.654	0.000		
1,991.50	7.065	496.180	0.000		
1,992.00	7.092	499.719	0.000		
1,992.50	7.119	503.272	0.000		
1,993.00	7.146	506.838	0.000		
1,993.50	7.173	510.418	0.000		
1,994.00	7.200	514.011	0.000		
1,994.50	7.228	517.618	0.000		
1,995.00	7.255	521.239	0.000		
1,995.50	7.282	524.873	0.000		
1,996.00	7.309	528.521	0.000		
1,996.05	7.312	528.874	0.000	0.00	Peak Stage
1,996.50	7.337	532.183	0.000		
1,997.00	7.364	535.858	0.000		Spillway #1
1,997.50	7.391	539.547	3.643		
1,998.00	7.419	543.249	49.679		
1,998.50	7.446	546.965	103.690		
1,999.00	7.474	550.695	176.689		
1,999.50	7.501	554.439	266.492		
2,000.00	7.529	558.197	373.219		

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,865.00	0.000	0.000
1,865.50	0.000	0.000
1,866.00	0.000	0.000
1,866.50	0.000	0.000
1,867.00	0.000	0.000
1,867.50	0.000	0.000
1,868.00	0.000	0.000
1,868.50	0.000	0.000
1,869.00	0.000	0.000
1,869.50	0.000	0.000
1,870.00	0.000	0.000
1,870.50	0.000	0.000
1,871.00	0.000	0.000
1,871.50	0.000	0.000
1,872.00	0.000	0.000
1,872.50	0.000	0.000
1,873.00	0.000	0.000
1,873.50	0.000	0.000
1,874.00	0.000	0.000
1,874.50	0.000	0.000
1,875.00	0.000	0.000
1,875.50	0.000	0.000
1,876.00	0.000	0.000
1,876.50	0.000	0.000
1,877.00	0.000	0.000
1,877.50	0.000	0.000
1,878.00	0.000	0.000
1,878.50	0.000	0.000
1,879.00	0.000	0.000
1,879.50	0.000	0.000
1,880.00	0.000	0.000
1,880.50	0.000	0.000
1,881.00	0.000	0.000
1,881.50	0.000	0.000
1,882.00	0.000	0.000
1,882.50	0.000	0.000
1,883.00	0.000	0.000
1,883.50	0.000	0.000
1,884.00	0.000	0.000
1,884.50	0.000	0.000
1,885.00	0.000	0.000
1,885.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,886.00	0.000	0.000
1,886.50	0.000	0.000
1,887.00	0.000	0.000
1,887.50	0.000	0.000
1,888.00	0.000	0.000
1,888.50	0.000	0.000
1,889.00	0.000	0.000
1,889.50	0.000	0.000
1,890.00	0.000	0.000
1,890.50	0.000	0.000
1,891.00	0.000	0.000
1,891.50	0.000	0.000
1,892.00	0.000	0.000
1,892.50	0.000	0.000
1,893.00	0.000	0.000
1,893.50	0.000	0.000
1,894.00	0.000	0.000
1,894.50	0.000	0.000
1,895.00	0.000	0.000
1,895.50	0.000	0.000
1,896.00	0.000	0.000
1,896.50	0.000	0.000
1,897.00	0.000	0.000
1,897.50	0.000	0.000
1,898.00	0.000	0.000
1,898.50	0.000	0.000
1,899.00	0.000	0.000
1,899.50	0.000	0.000
1,900.00	0.000	0.000
1,900.50	0.000	0.000
1,901.00	0.000	0.000
1,901.50	0.000	0.000
1,902.00	0.000	0.000
1,902.50	0.000	0.000
1,903.00	0.000	0.000
1,903.50	0.000	0.000
1,904.00	0.000	0.000
1,904.50	0.000	0.000
1,905.00	0.000	0.000
1,905.50	0.000	0.000
1,906.00	0.000	0.000
1,906.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,907.00	0.000	0.000
1,907.50	0.000	0.000
1,908.00	0.000	0.000
1,908.50	0.000	0.000
1,909.00	0.000	0.000
1,909.50	0.000	0.000
1,910.00	0.000	0.000
1,910.50	0.000	0.000
1,911.00	0.000	0.000
1,911.50	0.000	0.000
1,912.00	0.000	0.000
1,912.50	0.000	0.000
1,913.00	0.000	0.000
1,913.50	0.000	0.000
1,914.00	0.000	0.000
1,914.50	0.000	0.000
1,915.00	0.000	0.000
1,915.50	0.000	0.000
1,916.00	0.000	0.000
1,916.50	0.000	0.000
1,917.00	0.000	0.000
1,917.50	0.000	0.000
1,918.00	0.000	0.000
1,918.50	0.000	0.000
1,919.00	0.000	0.000
1,919.50	0.000	0.000
1,920.00	0.000	0.000
1,920.50	0.000	0.000
1,921.00	0.000	0.000
1,921.50	0.000	0.000
1,922.00	0.000	0.000
1,922.50	0.000	0.000
1,923.00	0.000	0.000
1,923.50	0.000	0.000
1,924.00	0.000	0.000
1,924.50	0.000	0.000
1,925.00	0.000	0.000
1,925.50	0.000	0.000
1,926.00	0.000	0.000
1,926.50	0.000	0.000
1,927.00	0.000	0.000
1,927.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,928.00	0.000	0.000
1,928.50	0.000	0.000
1,929.00	0.000	0.000
1,929.50	0.000	0.000
1,930.00	0.000	0.000
1,930.50	0.000	0.000
1,931.00	0.000	0.000
1,931.50	0.000	0.000
1,932.00	0.000	0.000
1,932.50	0.000	0.000
1,933.00	0.000	0.000
1,933.50	0.000	0.000
1,934.00	0.000	0.000
1,934.50	0.000	0.000
1,935.00	0.000	0.000
1,935.50	0.000	0.000
1,936.00	0.000	0.000
1,936.50	0.000	0.000
1,937.00	0.000	0.000
1,937.50	0.000	0.000
1,938.00	0.000	0.000
1,938.50	0.000	0.000
1,939.00	0.000	0.000
1,939.50	0.000	0.000
1,940.00	0.000	0.000
1,940.50	0.000	0.000
1,941.00	0.000	0.000
1,941.50	0.000	0.000
1,942.00	0.000	0.000
1,942.50	0.000	0.000
1,943.00	0.000	0.000
1,943.50	0.000	0.000
1,944.00	0.000	0.000
1,944.50	0.000	0.000
1,945.00	0.000	0.000
1,945.50	0.000	0.000
1,946.00	0.000	0.000
1,946.50	0.000	0.000
1,947.00	0.000	0.000
1,947.50	0.000	0.000
1,948.00	0.000	0.000
1,948.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,949.00	0.000	0.000
1,949.50	0.000	0.000
1,950.00	0.000	0.000
1,950.50	0.000	0.000
1,951.00	0.000	0.000
1,951.50	0.000	0.000
1,952.00	0.000	0.000
1,952.50	0.000	0.000
1,953.00	0.000	0.000
1,953.50	0.000	0.000
1,954.00	0.000	0.000
1,954.50	0.000	0.000
1,955.00	0.000	0.000
1,955.50	0.000	0.000
1,956.00	0.000	0.000
1,956.50	0.000	0.000
1,957.00	0.000	0.000
1,957.50	0.000	0.000
1,958.00	0.000	0.000
1,958.50	0.000	0.000
1,959.00	0.000	0.000
1,959.50	0.000	0.000
1,960.00	0.000	0.000
1,960.50	0.000	0.000
1,961.00	0.000	0.000
1,961.50	0.000	0.000
1,962.00	0.000	0.000
1,962.50	0.000	0.000
1,963.00	0.000	0.000
1,963.50	0.000	0.000
1,964.00	0.000	0.000
1,964.50	0.000	0.000
1,965.00	0.000	0.000
1,965.50	0.000	0.000
1,966.00	0.000	0.000
1,966.50	0.000	0.000
1,967.00	0.000	0.000
1,967.50	0.000	0.000
1,968.00	0.000	0.000
1,968.50	0.000	0.000
1,969.00	0.000	0.000
1,969.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,970.00	0.000	0.000
1,970.50	0.000	0.000
1,971.00	0.000	0.000
1,971.50	0.000	0.000
1,972.00	0.000	0.000
1,972.50	0.000	0.000
1,973.00	0.000	0.000
1,973.50	0.000	0.000
1,974.00	0.000	0.000
1,974.50	0.000	0.000
1,975.00	0.000	0.000
1,975.50	0.000	0.000
1,976.00	0.000	0.000
1,976.50	0.000	0.000
1,977.00	0.000	0.000
1,977.50	0.000	0.000
1,978.00	0.000	0.000
1,978.50	0.000	0.000
1,979.00	0.000	0.000
1,979.50	0.000	0.000
1,980.00	0.000	0.000
1,980.50	0.000	0.000
1,981.00	0.000	0.000
1,981.50	0.000	0.000
1,982.00	0.000	0.000
1,982.50	0.000	0.000
1,983.00	0.000	0.000
1,983.50	0.000	0.000
1,984.00	0.000	0.000
1,984.50	0.000	0.000
1,985.00	0.000	0.000
1,985.50	0.000	0.000
1,986.00	0.000	0.000
1,986.50	0.000	0.000
1,987.00	0.000	0.000
1,987.50	0.000	0.000
1,988.00	0.000	0.000
1,988.50	0.000	0.000
1,989.00	0.000	0.000
1,989.50	0.000	0.000
1,990.00	0.000	0.000
1,990.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,991.00	0.000	0.000
1,991.50	0.000	0.000
1,992.00	0.000	0.000
1,992.50	0.000	0.000
1,993.00	0.000	0.000
1,993.50	0.000	0.000
1,994.00	0.000	0.000
1,994.50	0.000	0.000
1,995.00	0.000	0.000
1,995.50	0.000	0.000
1,996.00	0.000	0.000
1,996.50	0.000	0.000
1,997.00	0.000	0.000
1,997.50	3.643	3.643
1,998.00	49.679	49.679
1,998.50	103.690	103.690
1,999.00	176.689	176.689
1,999.50	266.492	266.492
2,000.00	373.219	373.219

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	304.300	0.252	0.000	0.000	86.000	F	258.87	20.501
	Σ	**304.300**						**258.87**	**20.501**
#2	1	9.900	0.000	0.000	0.000	99.000	F	25.77	1.547
	Σ	**314.200**						**264.73**	**22.048**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	20.00	60.00	300.00	4.470	0.018
		7. Paved area and small upland gullies	10.34	565.00	5,465.00	6.470	0.234
#1	**1**	**Time of Concentration:**					**0.252**

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Pond JD-3 Emergency Spillway

Design of containment pond JD-3 emergency spillway for a 25-year 24-hour Type 1 SCS storm.

Jumbo Dome mine area for the Usibelli Coal Mine

Bandon Coleman

MWH
1801 California St
Ste 2900
Denver, CO 80202

Phone: (303) 291-2261
Email: Brandon.A.Coleman@mwhglobal.com

General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	25 yr - 24 hr
Rainfall Depth:	2.500 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.000	0.000	JD Channel 3
Pond	#2	==>	End	0.000	0.000	JD Pond 3

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1		304.300	304.300	206.68	30.03
#2	In	9.900	314.200	210.90	31.99
	Out			67.04	31.51

Structure Detail:

Structure #1 (Null)

JD Channel 3

Structure #2 (Pond)

JD Pond 3

Pond Inputs:

Initial Pool Elev:	1,997.00 ft
Initial Pool:	535.86 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
1,997.00	20.00	3.00:1	3.00:1	20.00

Pond Results:

Peak Elevation:	1,998.16 ft
Dewater Time:	1.12 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1,865.00	0.000	0.000	0.000	
1,865.50	0.002	0.000	0.000	
1,866.00	0.007	0.002	0.000	
1,866.50	0.016	0.008	0.000	
1,867.00	0.028	0.019	0.000	
1,867.50	0.044	0.037	0.000	
1,868.00	0.064	0.064	0.000	
1,868.50	0.087	0.102	0.000	
1,869.00	0.113	0.151	0.000	
1,869.50	0.144	0.216	0.000	
1,870.00	0.177	0.296	0.000	
1,870.50	0.230	0.397	0.000	
1,871.00	0.289	0.526	0.000	
1,871.50	0.355	0.687	0.000	
1,872.00	0.427	0.882	0.000	
1,872.50	0.506	1.115	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1,873.00	0.593	1.390	0.000	
1,873.50	0.686	1.709	0.000	
1,874.00	0.785	2.076	0.000	
1,874.50	0.892	2.496	0.000	
1,875.00	1.005	2.970	0.000	
1,875.50	1.074	3.489	0.000	
1,876.00	1.144	4.043	0.000	
1,876.50	1.217	4.634	0.000	
1,877.00	1.292	5.261	0.000	
1,877.50	1.370	5.926	0.000	
1,878.00	1.450	6.631	0.000	
1,878.50	1.532	7.376	0.000	
1,879.00	1.616	8.163	0.000	
1,879.50	1.702	8.993	0.000	
1,880.00	1.791	9.866	0.000	
1,880.50	1.828	10.771	0.000	
1,881.00	1.865	11.694	0.000	
1,881.50	1.903	12.636	0.000	
1,882.00	1.941	13.597	0.000	
1,882.50	1.979	14.577	0.000	
1,883.00	2.018	15.576	0.000	
1,883.50	2.057	16.595	0.000	
1,884.00	2.097	17.634	0.000	
1,884.50	2.137	18.692	0.000	
1,885.00	2.177	19.770	0.000	
1,885.50	2.195	20.863	0.000	
1,886.00	2.214	21.966	0.000	
1,886.50	2.232	23.077	0.000	
1,887.00	2.251	24.198	0.000	
1,887.50	2.270	25.328	0.000	
1,888.00	2.288	26.468	0.000	
1,888.50	2.307	27.616	0.000	
1,889.00	2.326	28.775	0.000	
1,889.50	2.345	29.942	0.000	
1,890.00	2.364	31.120	0.000	
1,890.50	2.383	32.306	0.000	
1,891.00	2.402	33.503	0.000	
1,891.50	2.421	34.708	0.000	
1,892.00	2.440	35.924	0.000	
1,892.50	2.460	37.149	0.000	
1,893.00	2.479	38.383	0.000	
1,893.50	2.498	39.628	0.000	
1,894.00	2.518	40.882	0.000	
1,894.50	2.537	42.145	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1,895.00	2.557	43.419	0.000	
1,895.50	2.576	44.702	0.000	
1,896.00	2.596	45.995	0.000	
1,896.50	2.616	47.298	0.000	
1,897.00	2.635	48.611	0.000	
1,897.50	2.655	49.934	0.000	
1,898.00	2.675	51.266	0.000	
1,898.50	2.695	52.609	0.000	
1,899.00	2.715	53.961	0.000	
1,899.50	2.735	55.323	0.000	
1,900.00	2.755	56.696	0.000	
1,900.50	2.775	58.078	0.000	
1,901.00	2.795	59.471	0.000	
1,901.50	2.815	60.873	0.000	
1,902.00	2.835	62.286	0.000	
1,902.50	2.855	63.708	0.000	
1,903.00	2.875	65.141	0.000	
1,903.50	2.896	66.584	0.000	
1,904.00	2.916	68.036	0.000	
1,904.50	2.936	69.500	0.000	
1,905.00	2.957	70.973	0.000	
1,905.50	2.977	72.457	0.000	
1,906.00	2.998	73.950	0.000	
1,906.50	3.018	75.454	0.000	
1,907.00	3.039	76.968	0.000	
1,907.50	3.059	78.493	0.000	
1,908.00	3.080	80.027	0.000	
1,908.50	3.100	81.573	0.000	
1,909.00	3.121	83.128	0.000	
1,909.50	3.142	84.694	0.000	
1,910.00	3.163	86.270	0.000	
1,910.50	3.184	87.857	0.000	
1,911.00	3.204	89.454	0.000	
1,911.50	3.225	91.061	0.000	
1,912.00	3.246	92.679	0.000	
1,912.50	3.267	94.307	0.000	
1,913.00	3.288	95.946	0.000	
1,913.50	3.309	97.596	0.000	
1,914.00	3.330	99.256	0.000	
1,914.50	3.352	100.926	0.000	
1,915.00	3.373	102.607	0.000	
1,915.50	3.394	104.299	0.000	
1,916.00	3.415	106.001	0.000	
1,916.50	3.437	107.714	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1,917.00	3.458	109.438	0.000	
1,917.50	3.479	111.172	0.000	
1,918.00	3.501	112.917	0.000	
1,918.50	3.522	114.673	0.000	
1,919.00	3.544	116.439	0.000	
1,919.50	3.565	118.216	0.000	
1,920.00	3.587	120.005	0.000	
1,920.50	3.609	121.803	0.000	
1,921.00	3.630	123.613	0.000	
1,921.50	3.652	125.433	0.000	
1,922.00	3.673	127.265	0.000	
1,922.50	3.695	129.107	0.000	
1,923.00	3.717	130.960	0.000	
1,923.50	3.739	132.824	0.000	
1,924.00	3.761	134.699	0.000	
1,924.50	3.783	136.585	0.000	
1,925.00	3.805	138.482	0.000	
1,925.50	3.827	140.390	0.000	
1,926.00	3.849	142.309	0.000	
1,926.50	3.871	144.239	0.000	
1,927.00	3.893	146.180	0.000	
1,927.50	3.915	148.132	0.000	
1,928.00	3.937	150.095	0.000	
1,928.50	3.960	152.069	0.000	
1,929.00	3.982	154.055	0.000	
1,929.50	4.005	156.051	0.000	
1,930.00	4.027	158.059	0.000	
1,930.50	4.049	160.078	0.000	
1,931.00	4.072	162.109	0.000	
1,931.50	4.094	164.150	0.000	
1,932.00	4.117	166.203	0.000	
1,932.50	4.139	168.267	0.000	
1,933.00	4.162	170.342	0.000	
1,933.50	4.185	172.429	0.000	
1,934.00	4.207	174.527	0.000	
1,934.50	4.230	176.636	0.000	
1,935.00	4.253	178.757	0.000	
1,935.50	4.276	180.889	0.000	
1,936.00	4.299	183.032	0.000	
1,936.50	4.321	185.187	0.000	
1,937.00	4.344	187.354	0.000	
1,937.50	4.367	189.532	0.000	
1,938.00	4.390	191.721	0.000	
1,938.50	4.413	193.922	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1,939.00	4.437	196.134	0.000	
1,939.50	4.460	198.358	0.000	
1,940.00	4.483	200.594	0.000	
1,940.50	4.506	202.841	0.000	
1,941.00	4.529	205.100	0.000	
1,941.50	4.552	207.371	0.000	
1,942.00	4.575	209.652	0.000	
1,942.50	4.599	211.946	0.000	
1,943.00	4.622	214.251	0.000	
1,943.50	4.645	216.568	0.000	
1,944.00	4.669	218.897	0.000	
1,944.50	4.692	221.237	0.000	
1,945.00	4.716	223.589	0.000	
1,945.50	4.740	225.953	0.000	
1,946.00	4.763	228.329	0.000	
1,946.50	4.787	230.716	0.000	
1,947.00	4.811	233.116	0.000	
1,947.50	4.834	235.527	0.000	
1,948.00	4.858	237.950	0.000	
1,948.50	4.882	240.385	0.000	
1,949.00	4.906	242.832	0.000	
1,949.50	4.930	245.291	0.000	
1,950.00	4.954	247.762	0.000	
1,950.50	4.978	250.245	0.000	
1,951.00	5.002	252.740	0.000	
1,951.50	5.026	255.246	0.000	
1,952.00	5.050	257.765	0.000	
1,952.50	5.074	260.296	0.000	
1,953.00	5.098	262.839	0.000	
1,953.50	5.122	265.394	0.000	
1,954.00	5.146	267.961	0.000	
1,954.50	5.171	270.540	0.000	
1,955.00	5.195	273.132	0.000	
1,955.50	5.219	275.735	0.000	
1,956.00	5.244	278.351	0.000	
1,956.50	5.268	280.979	0.000	
1,957.00	5.292	283.619	0.000	
1,957.50	5.317	286.271	0.000	
1,958.00	5.341	288.936	0.000	
1,958.50	5.366	291.613	0.000	
1,959.00	5.391	294.302	0.000	
1,959.50	5.415	297.003	0.000	
1,960.00	5.440	299.717	0.000	
1,960.50	5.463	302.443	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1,961.00	5.485	305.180	0.000	
1,961.50	5.508	307.928	0.000	
1,962.00	5.531	310.688	0.000	
1,962.50	5.553	313.459	0.000	
1,963.00	5.576	316.241	0.000	
1,963.50	5.599	319.035	0.000	
1,964.00	5.622	321.840	0.000	
1,964.50	5.645	324.657	0.000	
1,965.00	5.668	327.485	0.000	
1,965.50	5.695	330.326	0.000	
1,966.00	5.722	333.180	0.000	
1,966.50	5.749	336.048	0.000	
1,967.00	5.776	338.929	0.000	
1,967.50	5.803	341.824	0.000	
1,968.00	5.830	344.732	0.000	
1,968.50	5.858	347.654	0.000	
1,969.00	5.885	350.590	0.000	
1,969.50	5.913	353.539	0.000	
1,970.00	5.940	356.502	0.000	
1,970.50	5.965	359.479	0.000	
1,971.00	5.991	362.468	0.000	
1,971.50	6.016	365.469	0.000	
1,972.00	6.041	368.484	0.000	
1,972.50	6.067	371.511	0.000	
1,973.00	6.092	374.550	0.000	
1,973.50	6.118	377.603	0.000	
1,974.00	6.144	380.668	0.000	
1,974.50	6.169	383.747	0.000	
1,975.00	6.195	386.838	0.000	
1,975.50	6.221	389.942	0.000	
1,976.00	6.247	393.058	0.000	
1,976.50	6.272	396.188	0.000	
1,977.00	6.298	399.331	0.000	
1,977.50	6.324	402.487	0.000	
1,978.00	6.350	405.655	0.000	
1,978.50	6.376	408.837	0.000	
1,979.00	6.403	412.032	0.000	
1,979.50	6.429	415.240	0.000	
1,980.00	6.455	418.460	0.000	
1,980.50	6.481	421.694	0.000	
1,981.00	6.507	424.942	0.000	
1,981.50	6.533	428.202	0.000	
1,982.00	6.560	431.475	0.000	
1,982.50	6.586	434.761	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
1,983.00	6.612	438.061	0.000		
1,983.50	6.639	441.373	0.000		
1,984.00	6.665	444.699	0.000		
1,984.50	6.691	448.038	0.000		
1,985.00	6.718	451.391	0.000		
1,985.50	6.744	454.756	0.000		
1,986.00	6.771	458.135	0.000		
1,986.50	6.797	461.527	0.000		
1,987.00	6.824	464.932	0.000		
1,987.50	6.850	468.351	0.000		
1,988.00	6.877	471.783	0.000		
1,988.50	6.904	475.228	0.000		
1,989.00	6.930	478.686	0.000		
1,989.50	6.957	482.158	0.000		
1,990.00	6.984	485.644	0.000		
1,990.50	7.011	489.142	0.000		
1,991.00	7.038	492.654	0.000		
1,991.50	7.065	496.180	0.000		
1,992.00	7.092	499.719	0.000		
1,992.50	7.119	503.272	0.000		
1,993.00	7.146	506.838	0.000		
1,993.50	7.173	510.418	0.000		
1,994.00	7.200	514.011	0.000		
1,994.50	7.228	517.618	0.000		
1,995.00	7.255	521.239	0.000		
1,995.50	7.282	524.873	0.000		
1,996.00	7.309	528.521	0.000		
1,996.50	7.337	532.183	0.000		
1,997.00	7.364	535.858	0.000		Spillway #1
1,997.50	7.391	539.547	3.643	12.25*	
1,998.00	7.419	543.249	49.679	13.70	
1,998.16	7.428	544.444	67.042	0.85	Peak Stage
1,998.50	7.446	546.965	103.690		
1,999.00	7.474	550.695	176.689		
1,999.50	7.501	554.439	266.492		
2,000.00	7.529	558.197	373.219		

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,865.00	0.000	0.000
1,865.50	0.000	0.000
1,866.00	0.000	0.000
1,866.50	0.000	0.000
1,867.00	0.000	0.000
1,867.50	0.000	0.000
1,868.00	0.000	0.000
1,868.50	0.000	0.000
1,869.00	0.000	0.000
1,869.50	0.000	0.000
1,870.00	0.000	0.000
1,870.50	0.000	0.000
1,871.00	0.000	0.000
1,871.50	0.000	0.000
1,872.00	0.000	0.000
1,872.50	0.000	0.000
1,873.00	0.000	0.000
1,873.50	0.000	0.000
1,874.00	0.000	0.000
1,874.50	0.000	0.000
1,875.00	0.000	0.000
1,875.50	0.000	0.000
1,876.00	0.000	0.000
1,876.50	0.000	0.000
1,877.00	0.000	0.000
1,877.50	0.000	0.000
1,878.00	0.000	0.000
1,878.50	0.000	0.000
1,879.00	0.000	0.000
1,879.50	0.000	0.000
1,880.00	0.000	0.000
1,880.50	0.000	0.000
1,881.00	0.000	0.000
1,881.50	0.000	0.000
1,882.00	0.000	0.000
1,882.50	0.000	0.000
1,883.00	0.000	0.000
1,883.50	0.000	0.000
1,884.00	0.000	0.000
1,884.50	0.000	0.000
1,885.00	0.000	0.000
1,885.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,886.00	0.000	0.000
1,886.50	0.000	0.000
1,887.00	0.000	0.000
1,887.50	0.000	0.000
1,888.00	0.000	0.000
1,888.50	0.000	0.000
1,889.00	0.000	0.000
1,889.50	0.000	0.000
1,890.00	0.000	0.000
1,890.50	0.000	0.000
1,891.00	0.000	0.000
1,891.50	0.000	0.000
1,892.00	0.000	0.000
1,892.50	0.000	0.000
1,893.00	0.000	0.000
1,893.50	0.000	0.000
1,894.00	0.000	0.000
1,894.50	0.000	0.000
1,895.00	0.000	0.000
1,895.50	0.000	0.000
1,896.00	0.000	0.000
1,896.50	0.000	0.000
1,897.00	0.000	0.000
1,897.50	0.000	0.000
1,898.00	0.000	0.000
1,898.50	0.000	0.000
1,899.00	0.000	0.000
1,899.50	0.000	0.000
1,900.00	0.000	0.000
1,900.50	0.000	0.000
1,901.00	0.000	0.000
1,901.50	0.000	0.000
1,902.00	0.000	0.000
1,902.50	0.000	0.000
1,903.00	0.000	0.000
1,903.50	0.000	0.000
1,904.00	0.000	0.000
1,904.50	0.000	0.000
1,905.00	0.000	0.000
1,905.50	0.000	0.000
1,906.00	0.000	0.000
1,906.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,907.00	0.000	0.000
1,907.50	0.000	0.000
1,908.00	0.000	0.000
1,908.50	0.000	0.000
1,909.00	0.000	0.000
1,909.50	0.000	0.000
1,910.00	0.000	0.000
1,910.50	0.000	0.000
1,911.00	0.000	0.000
1,911.50	0.000	0.000
1,912.00	0.000	0.000
1,912.50	0.000	0.000
1,913.00	0.000	0.000
1,913.50	0.000	0.000
1,914.00	0.000	0.000
1,914.50	0.000	0.000
1,915.00	0.000	0.000
1,915.50	0.000	0.000
1,916.00	0.000	0.000
1,916.50	0.000	0.000
1,917.00	0.000	0.000
1,917.50	0.000	0.000
1,918.00	0.000	0.000
1,918.50	0.000	0.000
1,919.00	0.000	0.000
1,919.50	0.000	0.000
1,920.00	0.000	0.000
1,920.50	0.000	0.000
1,921.00	0.000	0.000
1,921.50	0.000	0.000
1,922.00	0.000	0.000
1,922.50	0.000	0.000
1,923.00	0.000	0.000
1,923.50	0.000	0.000
1,924.00	0.000	0.000
1,924.50	0.000	0.000
1,925.00	0.000	0.000
1,925.50	0.000	0.000
1,926.00	0.000	0.000
1,926.50	0.000	0.000
1,927.00	0.000	0.000
1,927.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,928.00	0.000	0.000
1,928.50	0.000	0.000
1,929.00	0.000	0.000
1,929.50	0.000	0.000
1,930.00	0.000	0.000
1,930.50	0.000	0.000
1,931.00	0.000	0.000
1,931.50	0.000	0.000
1,932.00	0.000	0.000
1,932.50	0.000	0.000
1,933.00	0.000	0.000
1,933.50	0.000	0.000
1,934.00	0.000	0.000
1,934.50	0.000	0.000
1,935.00	0.000	0.000
1,935.50	0.000	0.000
1,936.00	0.000	0.000
1,936.50	0.000	0.000
1,937.00	0.000	0.000
1,937.50	0.000	0.000
1,938.00	0.000	0.000
1,938.50	0.000	0.000
1,939.00	0.000	0.000
1,939.50	0.000	0.000
1,940.00	0.000	0.000
1,940.50	0.000	0.000
1,941.00	0.000	0.000
1,941.50	0.000	0.000
1,942.00	0.000	0.000
1,942.50	0.000	0.000
1,943.00	0.000	0.000
1,943.50	0.000	0.000
1,944.00	0.000	0.000
1,944.50	0.000	0.000
1,945.00	0.000	0.000
1,945.50	0.000	0.000
1,946.00	0.000	0.000
1,946.50	0.000	0.000
1,947.00	0.000	0.000
1,947.50	0.000	0.000
1,948.00	0.000	0.000
1,948.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,949.00	0.000	0.000
1,949.50	0.000	0.000
1,950.00	0.000	0.000
1,950.50	0.000	0.000
1,951.00	0.000	0.000
1,951.50	0.000	0.000
1,952.00	0.000	0.000
1,952.50	0.000	0.000
1,953.00	0.000	0.000
1,953.50	0.000	0.000
1,954.00	0.000	0.000
1,954.50	0.000	0.000
1,955.00	0.000	0.000
1,955.50	0.000	0.000
1,956.00	0.000	0.000
1,956.50	0.000	0.000
1,957.00	0.000	0.000
1,957.50	0.000	0.000
1,958.00	0.000	0.000
1,958.50	0.000	0.000
1,959.00	0.000	0.000
1,959.50	0.000	0.000
1,960.00	0.000	0.000
1,960.50	0.000	0.000
1,961.00	0.000	0.000
1,961.50	0.000	0.000
1,962.00	0.000	0.000
1,962.50	0.000	0.000
1,963.00	0.000	0.000
1,963.50	0.000	0.000
1,964.00	0.000	0.000
1,964.50	0.000	0.000
1,965.00	0.000	0.000
1,965.50	0.000	0.000
1,966.00	0.000	0.000
1,966.50	0.000	0.000
1,967.00	0.000	0.000
1,967.50	0.000	0.000
1,968.00	0.000	0.000
1,968.50	0.000	0.000
1,969.00	0.000	0.000
1,969.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,970.00	0.000	0.000
1,970.50	0.000	0.000
1,971.00	0.000	0.000
1,971.50	0.000	0.000
1,972.00	0.000	0.000
1,972.50	0.000	0.000
1,973.00	0.000	0.000
1,973.50	0.000	0.000
1,974.00	0.000	0.000
1,974.50	0.000	0.000
1,975.00	0.000	0.000
1,975.50	0.000	0.000
1,976.00	0.000	0.000
1,976.50	0.000	0.000
1,977.00	0.000	0.000
1,977.50	0.000	0.000
1,978.00	0.000	0.000
1,978.50	0.000	0.000
1,979.00	0.000	0.000
1,979.50	0.000	0.000
1,980.00	0.000	0.000
1,980.50	0.000	0.000
1,981.00	0.000	0.000
1,981.50	0.000	0.000
1,982.00	0.000	0.000
1,982.50	0.000	0.000
1,983.00	0.000	0.000
1,983.50	0.000	0.000
1,984.00	0.000	0.000
1,984.50	0.000	0.000
1,985.00	0.000	0.000
1,985.50	0.000	0.000
1,986.00	0.000	0.000
1,986.50	0.000	0.000
1,987.00	0.000	0.000
1,987.50	0.000	0.000
1,988.00	0.000	0.000
1,988.50	0.000	0.000
1,989.00	0.000	0.000
1,989.50	0.000	0.000
1,990.00	0.000	0.000
1,990.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,991.00	0.000	0.000
1,991.50	0.000	0.000
1,992.00	0.000	0.000
1,992.50	0.000	0.000
1,993.00	0.000	0.000
1,993.50	0.000	0.000
1,994.00	0.000	0.000
1,994.50	0.000	0.000
1,995.00	0.000	0.000
1,995.50	0.000	0.000
1,996.00	0.000	0.000
1,996.50	0.000	0.000
1,997.00	0.000	0.000
1,997.50	3.643	3.643
1,998.00	49.679	49.679
1,998.50	103.690	103.690
1,999.00	176.689	176.689
1,999.50	266.492	266.492
2,000.00	373.219	373.219

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	304.300	0.252	0.000	0.000	86.000	F	206.68	30.026
	Σ	**304.300**						**206.68**	**30.026**
#2	1	9.900	0.000	0.000	0.000	99.000	F	18.58	1.965
	Σ	**314.200**						**210.90**	**31.991**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	20.00	60.00	300.00	4.470	0.018
		7. Paved area and small upland gullies	10.34	565.00	5,465.00	6.470	0.234
#1	**1**	**Time of Concentration:**					**0.252**

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Pond JD-4

Design of containment pond JD-4 for a 100-yr 6-hour Type 1 SCS storm.

Jumbo Dome mine area for the Usibelli Coal mine

Bandon Coleman

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1801 California St
Ste 2900
Denver, CO 80202

Phone: (303) 291-2261
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General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	100 yr - 6 hr
Rainfall Depth:	2.000 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.000	0.000	JD Channel 4
Pond	#2	==>	End	0.000	0.000	JD Pond 4

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1		68.200	68.200	55.26	4.30
#2	In	297.600	365.800	265.02	23.75
	Out			0.00	0.00

Structure Detail:

Structure #1 (Null)

JD Channel 4

Structure #2 (Pond)

JD Pond 4

Pond Inputs:

Initial Pool Elev:	1,947.50 ft
Initial Pool:	65.60 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
1,957.00	65.00	3.00:1	3.00:1	20.00

Pond Results:

Peak Elevation:	1,956.70 ft
Dewater Time:	0.00 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1,890.00	0.030	0.000	0.000	
1,890.50	0.036	0.016	0.000	
1,891.00	0.043	0.036	0.000	
1,891.50	0.050	0.059	0.000	
1,892.00	0.057	0.086	0.000	
1,892.50	0.066	0.117	0.000	
1,893.00	0.074	0.152	0.000	
1,893.50	0.084	0.191	0.000	
1,894.00	0.094	0.236	0.000	
1,894.50	0.104	0.285	0.000	
1,895.00	0.115	0.340	0.000	
1,895.50	0.125	0.400	0.000	
1,896.00	0.136	0.465	0.000	
1,896.50	0.147	0.536	0.000	
1,897.00	0.158	0.612	0.000	
1,897.50	0.170	0.694	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1,898.00	0.182	0.782	0.000	
1,898.50	0.195	0.876	0.000	
1,899.00	0.208	0.977	0.000	
1,899.50	0.222	1.085	0.000	
1,900.00	0.236	1.199	0.000	
1,900.50	0.250	1.321	0.000	
1,901.00	0.264	1.449	0.000	
1,901.50	0.278	1.584	0.000	
1,902.00	0.293	1.727	0.000	
1,902.50	0.308	1.878	0.000	
1,903.00	0.324	2.036	0.000	
1,903.50	0.340	2.201	0.000	
1,904.00	0.356	2.375	0.000	
1,904.50	0.373	2.558	0.000	
1,905.00	0.390	2.748	0.000	
1,905.50	0.408	2.948	0.000	
1,906.00	0.426	3.156	0.000	
1,906.50	0.444	3.373	0.000	
1,907.00	0.463	3.600	0.000	
1,907.50	0.482	3.836	0.000	
1,908.00	0.501	4.082	0.000	
1,908.50	0.521	4.337	0.000	
1,909.00	0.541	4.603	0.000	
1,909.50	0.562	4.879	0.000	
1,910.00	0.583	5.165	0.000	
1,910.50	0.605	5.462	0.000	
1,911.00	0.627	5.769	0.000	
1,911.50	0.649	6.088	0.000	
1,912.00	0.672	6.419	0.000	
1,912.50	0.695	6.760	0.000	
1,913.00	0.719	7.114	0.000	
1,913.50	0.743	7.479	0.000	
1,914.00	0.767	7.857	0.000	
1,914.50	0.792	8.246	0.000	
1,915.00	0.817	8.648	0.000	
1,915.50	0.843	9.063	0.000	
1,916.00	0.869	9.491	0.000	
1,916.50	0.895	9.932	0.000	
1,917.00	0.922	10.387	0.000	
1,917.50	0.950	10.855	0.000	
1,918.00	0.977	11.336	0.000	
1,918.50	1.005	11.832	0.000	
1,919.00	1.034	12.342	0.000	
1,919.50	1.063	12.866	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1,920.00	1.092	13.404	0.000	
1,920.50	1.127	13.959	0.000	
1,921.00	1.163	14.532	0.000	
1,921.50	1.199	15.122	0.000	
1,922.00	1.236	15.731	0.000	
1,922.50	1.274	16.358	0.000	
1,923.00	1.312	17.005	0.000	
1,923.50	1.350	17.670	0.000	
1,924.00	1.389	18.355	0.000	
1,924.50	1.429	19.059	0.000	
1,925.00	1.469	19.784	0.000	
1,925.50	1.507	20.528	0.000	
1,926.00	1.545	21.290	0.000	
1,926.50	1.583	22.073	0.000	
1,927.00	1.623	22.874	0.000	
1,927.50	1.662	23.695	0.000	
1,928.00	1.702	24.536	0.000	
1,928.50	1.743	25.397	0.000	
1,929.00	1.784	26.279	0.000	
1,929.50	1.825	27.181	0.000	
1,930.00	1.867	28.104	0.000	
1,930.50	1.882	29.041	0.000	
1,931.00	1.898	29.986	0.000	
1,931.50	1.913	30.939	0.000	
1,932.00	1.928	31.899	0.000	
1,932.50	1.944	32.867	0.000	
1,933.00	1.959	33.843	0.000	
1,933.50	1.975	34.826	0.000	
1,934.00	1.991	35.818	0.000	
1,934.50	2.006	36.817	0.000	
1,935.00	2.022	37.824	0.000	
1,935.50	2.038	38.839	0.000	
1,936.00	2.053	39.862	0.000	
1,936.50	2.069	40.892	0.000	
1,937.00	2.085	41.931	0.000	
1,937.50	2.101	42.977	0.000	
1,938.00	2.117	44.031	0.000	
1,938.50	2.133	45.094	0.000	
1,939.00	2.149	46.164	0.000	
1,939.50	2.165	47.242	0.000	
1,940.00	2.181	48.329	0.000	
1,940.50	2.197	49.423	0.000	
1,941.00	2.213	50.526	0.000	
1,941.50	2.229	51.636	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
1,942.00	2.245	52.755	0.000		
1,942.50	2.261	53.881	0.000		
1,943.00	2.278	55.016	0.000		
1,943.50	2.294	56.159	0.000		
1,944.00	2.310	57.310	0.000		
1,944.50	2.327	58.469	0.000		
1,945.00	2.343	59.636	0.000		
1,945.50	2.359	60.812	0.000		
1,946.00	2.376	61.996	0.000		
1,946.50	2.392	63.188	0.000		
1,947.00	2.409	64.388	0.000		
1,947.50	2.425	65.597	0.000		
1,948.00	2.442	66.813	0.000		
1,948.50	2.459	68.038	0.000		
1,949.00	2.475	69.272	0.000		
1,949.50	2.492	70.514	0.000		
1,950.00	2.509	71.764	0.000		
1,950.50	2.526	73.023	0.000		
1,951.00	2.542	74.290	0.000		
1,951.50	2.559	75.565	0.000		
1,952.00	2.576	76.849	0.000		
1,952.50	2.593	78.141	0.000		
1,953.00	2.610	79.442	0.000		
1,953.50	2.627	80.751	0.000		
1,954.00	2.644	82.068	0.000		
1,954.50	2.661	83.395	0.000		
1,955.00	2.678	84.729	0.000		
1,955.50	2.695	86.073	0.000		
1,956.00	2.712	87.424	0.000		
1,956.50	2.729	88.785	0.000		
1,956.70	2.736	89.332	0.000	0.00	Peak Stage
1,957.00	2.747	90.154	0.000		Spillway #1
1,957.50	2.764	91.531	18.086		
1,958.00	2.781	92.918	36.172		
1,958.50	2.799	94.312	90.509		
1,959.00	2.816	95.716	147.342		
1,959.50	2.833	97.128	222.641		
1,960.00	2.851	98.550	312.409		

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,890.00	0.000	0.000
1,890.50	0.000	0.000
1,891.00	0.000	0.000
1,891.50	0.000	0.000
1,892.00	0.000	0.000
1,892.50	0.000	0.000
1,893.00	0.000	0.000
1,893.50	0.000	0.000
1,894.00	0.000	0.000
1,894.50	0.000	0.000
1,895.00	0.000	0.000
1,895.50	0.000	0.000
1,896.00	0.000	0.000
1,896.50	0.000	0.000
1,897.00	0.000	0.000
1,897.50	0.000	0.000
1,898.00	0.000	0.000
1,898.50	0.000	0.000
1,899.00	0.000	0.000
1,899.50	0.000	0.000
1,900.00	0.000	0.000
1,900.50	0.000	0.000
1,901.00	0.000	0.000
1,901.50	0.000	0.000
1,902.00	0.000	0.000
1,902.50	0.000	0.000
1,903.00	0.000	0.000
1,903.50	0.000	0.000
1,904.00	0.000	0.000
1,904.50	0.000	0.000
1,905.00	0.000	0.000
1,905.50	0.000	0.000
1,906.00	0.000	0.000
1,906.50	0.000	0.000
1,907.00	0.000	0.000
1,907.50	0.000	0.000
1,908.00	0.000	0.000
1,908.50	0.000	0.000
1,909.00	0.000	0.000
1,909.50	0.000	0.000
1,910.00	0.000	0.000
1,910.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,911.00	0.000	0.000
1,911.50	0.000	0.000
1,912.00	0.000	0.000
1,912.50	0.000	0.000
1,913.00	0.000	0.000
1,913.50	0.000	0.000
1,914.00	0.000	0.000
1,914.50	0.000	0.000
1,915.00	0.000	0.000
1,915.50	0.000	0.000
1,916.00	0.000	0.000
1,916.50	0.000	0.000
1,917.00	0.000	0.000
1,917.50	0.000	0.000
1,918.00	0.000	0.000
1,918.50	0.000	0.000
1,919.00	0.000	0.000
1,919.50	0.000	0.000
1,920.00	0.000	0.000
1,920.50	0.000	0.000
1,921.00	0.000	0.000
1,921.50	0.000	0.000
1,922.00	0.000	0.000
1,922.50	0.000	0.000
1,923.00	0.000	0.000
1,923.50	0.000	0.000
1,924.00	0.000	0.000
1,924.50	0.000	0.000
1,925.00	0.000	0.000
1,925.50	0.000	0.000
1,926.00	0.000	0.000
1,926.50	0.000	0.000
1,927.00	0.000	0.000
1,927.50	0.000	0.000
1,928.00	0.000	0.000
1,928.50	0.000	0.000
1,929.00	0.000	0.000
1,929.50	0.000	0.000
1,930.00	0.000	0.000
1,930.50	0.000	0.000
1,931.00	0.000	0.000
1,931.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,932.00	0.000	0.000
1,932.50	0.000	0.000
1,933.00	0.000	0.000
1,933.50	0.000	0.000
1,934.00	0.000	0.000
1,934.50	0.000	0.000
1,935.00	0.000	0.000
1,935.50	0.000	0.000
1,936.00	0.000	0.000
1,936.50	0.000	0.000
1,937.00	0.000	0.000
1,937.50	0.000	0.000
1,938.00	0.000	0.000
1,938.50	0.000	0.000
1,939.00	0.000	0.000
1,939.50	0.000	0.000
1,940.00	0.000	0.000
1,940.50	0.000	0.000
1,941.00	0.000	0.000
1,941.50	0.000	0.000
1,942.00	0.000	0.000
1,942.50	0.000	0.000
1,943.00	0.000	0.000
1,943.50	0.000	0.000
1,944.00	0.000	0.000
1,944.50	0.000	0.000
1,945.00	0.000	0.000
1,945.50	0.000	0.000
1,946.00	0.000	0.000
1,946.50	0.000	0.000
1,947.00	0.000	0.000
1,947.50	0.000	0.000
1,948.00	0.000	0.000
1,948.50	0.000	0.000
1,949.00	0.000	0.000
1,949.50	0.000	0.000
1,950.00	0.000	0.000
1,950.50	0.000	0.000
1,951.00	0.000	0.000
1,951.50	0.000	0.000
1,952.00	0.000	0.000
1,952.50	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,953.00	0.000	0.000
1,953.50	0.000	0.000
1,954.00	0.000	0.000
1,954.50	0.000	0.000
1,955.00	0.000	0.000
1,955.50	0.000	0.000
1,956.00	0.000	0.000
1,956.50	0.000	0.000
1,957.00	0.000	0.000
1,957.50	18.086	18.086
1,958.00	36.172	36.172
1,958.50	90.509	90.509
1,959.00	147.342	147.342
1,959.50	222.641	222.641
1,960.00	312.409	312.409

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	68.200	0.232	0.000	0.000	85.000	F	55.26	4.298
	Σ	**68.200**						**55.26**	**4.298**
#2	1	8.600	0.000	0.000	0.000	99.000	F	22.39	1.344
	2	289.000	0.321	0.000	0.000	85.000	F	206.04	18.106
	Σ	**365.800**						**265.02**	**23.748**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	13.33	40.00	300.00	3.650	0.022
		7. Paved area and small upland gullies	19.08	290.00	1,520.00	8.790	0.048
		8. Large gullies, diversions, and low flowing streams	2.01	50.00	2,490.16	4.250	0.162
#1	**1**	**Time of Concentration:**					**0.232**
#2	2	5. Nearly bare and untilled, and alluvial valley fans	25.00	75.00	300.00	5.000	0.016
		7. Paved area and small upland gullies	10.98	805.00	7,330.04	6.670	0.305
#2	**2**	**Time of Concentration:**					**0.321**

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Pond JD-4 Emergency Spillway

Design of containment pond JD-4 emergency spillway for 25-year 24-hour Type 1 SCS storm

Bandon Coleman

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General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	25 yr - 24 hr
Rainfall Depth:	2.500 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.000	0.000	JD Channel 4
Pond	#2	==>	End	0.000	0.000	JD Pond 4

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1		68.200	68.200	44.47	6.37
#2	In	297.600	365.800	212.91	34.91
	Out			140.55	34.92

Structure Detail:

Structure #1 (Null)

JD Channel 4

Structure #2 (Pond)

JD Pond 4

Pond Inputs:

Initial Pool Elev:	1,957.00 ft
Initial Pool:	90.16 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
1,957.00	65.00	3.00:1	3.00:1	20.00

Pond Results:

Peak Elevation:	1,958.76 ft
Dewater Time:	0.88 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
1,890.00	0.030	0.000	0.000	
1,892.00	0.058	0.086	0.000	
1,894.00	0.094	0.237	0.000	
1,895.00	0.115	0.341	0.000	
1,896.00	0.136	0.466	0.000	
1,898.00	0.183	0.784	0.000	
1,900.00	0.236	1.201	0.000	
1,902.00	0.293	1.730	0.000	
1,904.00	0.356	2.378	0.000	
1,905.00	0.390	2.751	0.000	
1,906.00	0.426	3.159	0.000	
1,908.00	0.501	4.085	0.000	
1,910.00	0.583	5.168	0.000	
1,912.00	0.672	6.423	0.000	
1,914.00	0.767	7.861	0.000	
1,915.00	0.817	8.653	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
1,916.00	0.869	9.496	0.000		
1,918.00	0.978	11.341	0.000		
1,920.00	1.092	13.410	0.000		
1,922.00	1.237	15.737	0.000		
1,924.00	1.389	18.361	0.000		
1,925.00	1.469	19.790	0.000		
1,926.00	1.545	21.297	0.000		
1,928.00	1.702	24.543	0.000		
1,930.00	1.867	28.111	0.000		
1,932.00	1.928	31.907	0.000		
1,934.00	1.991	35.825	0.000		
1,935.00	2.022	37.831	0.000		
1,936.00	2.053	39.869	0.000		
1,938.00	2.117	44.039	0.000		
1,940.00	2.181	48.337	0.000		
1,942.00	2.245	52.763	0.000		
1,944.00	2.310	57.318	0.000		
1,945.00	2.343	59.644	0.000		
1,946.00	2.376	62.004	0.000		
1,948.00	2.442	66.821	0.000		
1,950.00	2.509	71.772	0.000		
1,952.00	2.576	76.857	0.000		
1,954.00	2.644	82.077	0.000		
1,955.00	2.678	84.737	0.000		
1,956.00	2.712	87.433	0.000		
1,957.00	2.747	90.162	0.000		Spillway #1
1,958.00	2.781	92.926	36.172	19.35	
1,958.76	2.808	95.054	140.553	1.75	Peak Stage
1,960.00	2.851	98.558	312.409		

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,890.00	0.000	0.000
1,892.00	0.000	0.000
1,894.00	0.000	0.000
1,895.00	0.000	0.000
1,896.00	0.000	0.000
1,898.00	0.000	0.000
1,900.00	0.000	0.000

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
1,902.00	0.000	0.000
1,904.00	0.000	0.000
1,905.00	0.000	0.000
1,906.00	0.000	0.000
1,908.00	0.000	0.000
1,910.00	0.000	0.000
1,912.00	0.000	0.000
1,914.00	0.000	0.000
1,915.00	0.000	0.000
1,916.00	0.000	0.000
1,918.00	0.000	0.000
1,920.00	0.000	0.000
1,922.00	0.000	0.000
1,924.00	0.000	0.000
1,925.00	0.000	0.000
1,926.00	0.000	0.000
1,928.00	0.000	0.000
1,930.00	0.000	0.000
1,932.00	0.000	0.000
1,934.00	0.000	0.000
1,935.00	0.000	0.000
1,936.00	0.000	0.000
1,938.00	0.000	0.000
1,940.00	0.000	0.000
1,942.00	0.000	0.000
1,944.00	0.000	0.000
1,945.00	0.000	0.000
1,946.00	0.000	0.000
1,948.00	0.000	0.000
1,950.00	0.000	0.000
1,952.00	0.000	0.000
1,954.00	0.000	0.000
1,955.00	0.000	0.000
1,956.00	0.000	0.000
1,957.00	0.000	0.000
1,958.00	36.172	36.172
1,960.00	312.409	312.409

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	68.200	0.232	0.000	0.000	85.000	F	44.47	6.370
	Σ	**68.200**						**44.47**	**6.370**
#2	1	8.600	0.000	0.000	0.000	99.000	F	16.14	1.707
	2	289.000	0.321	0.000	0.000	85.000	F	166.95	26.835
	Σ	**365.800**						**212.91**	**34.912**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	13.33	40.00	300.00	3.650	0.022
		7. Paved area and small upland gullies	19.08	290.00	1,520.00	8.790	0.048
		8. Large gullies, diversions, and low flowing streams	2.01	50.00	2,490.16	4.250	0.162
#1	**1**	**Time of Concentration:**					**0.232**
#2	2	5. Nearly bare and untilled, and alluvial valley fans	25.00	75.00	300.00	5.000	0.016
		7. Paved area and small upland gullies	10.98	805.00	7,330.04	6.670	0.305
#2	**2**	**Time of Concentration:**					**0.321**

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Shop Pond 100-yr 6-hr Storm Event

Design of containment pond for the Shop Area for a 100-year 6-hour Type 1 SCS strom.

Emergency spillway was used to define freeboard to the top of the embankment. It will not be required in the final pond design.

Jumbo Dome mine area at the Usibelli Coal mine

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General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	100 yr - 6 hr
Rainfall Depth:	2.000 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	End	0.000	0.000	Facilites Pond

#1
Pond

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	In	7.600	7.600	6.44	0.51
	Out			0.00	0.00

Structure Detail:

Structure #1 (Pond)

Facilites Pond

Pond Inputs:

Initial Pool Elev:	2,256.00 ft
Initial Pool:	0.63 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
2,259.00	20.00	3.00:1	3.00:1	5.00

Pond Results:

Peak Elevation:	2,258.64 ft
Dewater Time:	0.00 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
2,250.00	0.000	0.000	0.000		
2,250.50	0.007	0.001	0.000		
2,251.00	0.027	0.009	0.000		
2,251.50	0.061	0.031	0.000		
2,252.00	0.109	0.073	0.000		
2,252.50	0.116	0.129	0.000		
2,253.00	0.124	0.189	0.000		
2,253.50	0.131	0.253	0.000		
2,254.00	0.139	0.320	0.000		
2,254.50	0.147	0.391	0.000		
2,255.00	0.155	0.467	0.000		
2,255.50	0.163	0.546	0.000		
2,256.00	0.171	0.630	0.000		
2,256.50	0.179	0.717	0.000		
2,257.00	0.188	0.809	0.000		
2,257.50	0.197	0.905	0.000		
2,258.00	0.206	1.006	0.000		
2,258.50	0.215	1.111	0.000		
2,258.64	0.218	1.141	0.000	0.00	Peak Stage

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
2,259.00	0.225	1.221	0.000		Spillway #1
2,259.50	0.234	1.336	0.952		
2,259.90	0.242	1.431	12.246		
2,260.00	0.244	1.455	15.371		

Detailed Discharge Table

Elevation (ft)	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
2,250.00	0.000	0.000
2,250.50	0.000	0.000
2,251.00	0.000	0.000
2,251.50	0.000	0.000
2,252.00	0.000	0.000
2,252.50	0.000	0.000
2,253.00	0.000	0.000
2,253.50	0.000	0.000
2,254.00	0.000	0.000
2,254.50	0.000	0.000
2,255.00	0.000	0.000
2,255.50	0.000	0.000
2,256.00	0.000	0.000
2,256.50	0.000	0.000
2,257.00	0.000	0.000
2,257.50	0.000	0.000
2,258.00	0.000	0.000
2,258.50	0.000	0.000
2,259.00	0.000	0.000
2,259.50	0.952	0.952
2,259.90	12.246	12.246
2,260.00	15.371	15.371

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	7.600	0.255	0.000	0.000	86.000	F	6.44	0.512
	Σ	**7.600**						**6.44**	**0.512**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	0.50	3.22	644.00	0.700	0.255
#1	**1**	**Time of Concentration:**					**0.255**

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Channels OOPS-1 and OOPS-2

Design of channels OOPS-1 and OOPS-2 for a 10-year 24-hour Type I SCS storm.

Jumbo Dome mine area at the Usibelli Coal Mine

Bandon Coleman

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Denver, CO 80202

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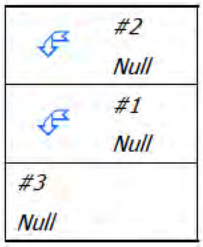
General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	10 yr - 24 hr
Rainfall Depth:	2.000 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#3	0.000	0.000	JD OOPS-1
Null	#2	==>	#3	0.000	0.000	JD OOPS-2
Null	#3	==>	End	0.000	0.000	Pond JD-1



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#2	19.000	19.000	12.86	1.34
#1	33.300	33.300	16.76	2.27
#3	4.500	56.800	29.56	4.32

Structure Detail:

Structure #2 (Null)

JD OOPS-2

Structure #1 (Null)

JD OOPS-1

Structure #3 (Null)

Pond JD-1

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	19.000	0.094	0.000	0.000	86.000	F	12.86	1.343
	Σ	**19.000**						**12.86**	**1.343**
#1	1	33.300	0.166	0.000	0.000	86.000	F	16.76	2.270
	Σ	**33.300**						**16.76**	**2.270**
#3	1	4.500	0.000	0.000	0.000	99.000	F	6.73	0.706
	Σ	**56.800**						**29.56**	**4.319**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	33.73	140.00	415.00	5.800	0.019
		8. Large gullies, diversions, and low flowing streams	3.41	100.00	2,932.03	5.540	0.147
#1	**1**	**Time of Concentration:**					**0.166**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	29.09	80.00	275.00	5.390	0.014
		8. Large gullies, diversions, and low flowing streams	3.63	60.00	1,654.03	5.710	0.080
#2	**1**	**Time of Concentration:**					**0.094**

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Clean Water Diversion 1 (CWD-1) and Clean Water Diversion 2 (CWD-2)

Peak flow estimates for Channel CWD-1 and CWD-2 for a 10-year 24-hour SCS Type 1 Storm event.

Jumbo Dome Mine Area for the Usibellie Coal Mine

Bandon Coleman

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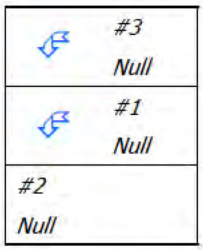
General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	10 yr - 24 hr
Rainfall Depth:	2.000 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.000	0.000	Channel 1 clean water diversion
Null	#2	==>	End	0.000	0.000	CWD-1-2
Null	#3	==>	#2	0.000	0.000	CWD-2



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#3	76.600	76.600	0.83	0.79
#1	567.900	567.900	5.89	5.80
#2	19.300	663.800	13.07	7.95

Structure Detail:

Structure #3 (Null)

CWD-2

Structure #1 (Null)

Channel 1 clean water diversion

Structure #2 (Null)

CWD-1-2

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#3	1	76.600	0.249	0.000	0.000	66.000	M	0.83	0.788
	Σ	**76.600**						**0.83**	**0.788**
#1	1	567.900	0.661	0.000	0.000	66.000	M	5.89	5.795
	Σ	**567.900**						**5.89**	**5.795**
#2	1	19.300	0.066	0.000	0.000	86.000	F	13.07	1.364
	Σ	**663.800**						**13.07**	**7.947**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	75.00	225.00	300.00	8.660	0.009
		7. Paved area and small upland gullies	25.94	1,250.00	4,819.01	10.250	0.130
		8. Large gullies, diversions, and low flowing streams	3.11	310.00	9,956.00	5.290	0.522
#1	**1**	**Time of Concentration:**					**0.661**
#2	1	5. Nearly bare and untilled, and alluvial valley fans	16.67	50.00	300.00	4.080	0.020
		7. Paved area and small upland gullies	17.66	250.00	1,416.00	8.450	0.046
#2	**1**	**Time of Concentration:**					**0.066**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	23.44	75.00	320.00	4.840	0.018
		7. Paved area and small upland gullies	24.00	560.00	2,333.00	9.860	0.065
		8. Large gullies, diversions, and low flowing streams	3.34	110.00	3,290.06	5.480	0.166
#3	**1**	**Time of Concentration:**					**0.249**

Culvert HR-1

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
150.00	3.00	0.0150	2.20	0.00	0.70

Culvert Results:

Minimum pipe diameter: 1 - 24 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 13.10 cfs

Maximum Headwater = 2.20 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (21 in)	**Discharge (cfs) (24 in)**	Discharge (cfs) (30 in)
0.22	0.38	**0.44**	0.55
0.44	1.08	**1.23**	1.53
0.66	1.97	**2.25**	2.81
0.88	3.03	**3.46**	4.32
1.10	4.23	**4.83**	6.04
1.32	5.56	**6.35**	7.94
1.54	7.00	**8.00**	10.00
1.76	8.56	**9.78**	12.22
1.98	10.21	**11.67**	14.58
2.20	11.60	**13.67**	17.08
2.42	12.89	**15.47**	19.71
2.64	14.06	**17.12**	22.46
2.86	15.14	**18.62**	25.32
3.08	16.14	**20.02**	27.63
3.30	17.09	**21.31**	29.91

Culvert HR-2

Culvert Inputs:

Length (ft)	Slope (%)	Manning's n	Max. Headwater (ft)	Tailwater (ft)	Entrance Loss Coef. (Ke)
150.00	3.00	0.0150	4.00	0.00	0.70

Culvert Results:

Minimum pipe diameter: 1 - 42 inch pipe(s) required

Detailed Performance Curves

Design Discharge = 51.10 cfs

Maximum Headwater = 4.00 ft

(BOLD indicates design pipe size)

Headwater (ft)	Discharge (cfs) (36 in)	**Discharge (cfs) (42 in)**	Discharge (cfs) (45 in)
0.40	1.59	**1.86**	1.99
0.80	4.50	**5.24**	5.62
1.20	8.26	**9.63**	10.32
1.60	12.71	**14.83**	15.89
2.00	17.77	**20.73**	22.21
2.40	23.36	**27.25**	29.19
2.80	29.43	**34.34**	36.79
3.20	35.96	**41.95**	44.95
3.60	42.27	**50.06**	53.63
4.00	47.70	**58.63**	62.82
4.40	52.64	**65.63**	72.47
4.80	57.14	**72.28**	79.63
5.20	61.31	**78.36**	86.89
5.60	65.22	**84.01**	93.58
6.00	68.92	**89.30**	99.82

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Channel JD-2

Peak flow estimates for channel JD-2 for a 10-year 24-hour Type 1 SCS storm.

Jumbo Dome mine area at the Usibelli Coal mine

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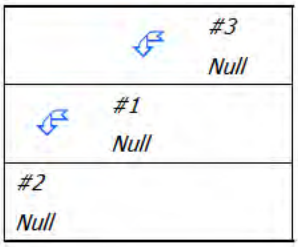
General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	10 yr - 24 hr
Rainfall Depth:	2.000 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.000	0.000	JD-2-2
Null	#2	==>	End	0.000	0.000	Pond JD-2
Null	#3	==>	#1	0.000	0.000	JD-2-1



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#3	46.500	46.500	31.48	3.29
#1	266.400	312.900	103.85	21.07
#2	12.200	325.100	107.75	22.99

Structure Detail:

Structure #3 (Null)

JD-2-1

Structure #1 (Null)

JD-2-2

Structure #2 (Null)

Pond JD-2

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#3	1	46.500	0.108	0.000	0.000	86.000	F	31.48	3.287
	Σ	**46.500**						**31.48**	**3.287**
#1	1	266.400	0.416	0.000	0.000	86.000	F	95.80	17.786
	Σ	**312.900**						**103.85**	**21.073**
#2	1	12.200	0.000	0.000	0.000	99.000	F	18.25	1.914
	Σ	**325.100**						**107.75**	**22.987**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	16.67	50.00	300.00	4.080	0.020
		7. Paved area and small upland gullies	11.11	270.00	2,430.00	6.700	0.100
		8. Large gullies, diversions, and low flowing streams	2.48	125.00	5,045.00	4.720	0.296
#1	**1**	**Time of Concentration:**					**0.416**
#3	1	5. Nearly bare and untilled, and alluvial valley fans	15.00	45.00	300.00	3.870	0.021
		7. Paved area and small upland gullies	10.80	225.00	2,084.00	6.610	0.087
#3	**1**	**Time of Concentration:**					**0.108**

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Channel JD-3

Peak flow estimates for Channel JD-3 for a 10-year 24-hour Type 1 SCS storm.

Jumbo Dome mine area for the Usibelli Coal Mine

Bandon Coleman

MWH
1801 California St
Ste 2900
Denver, CO 80202

Phone: (303) 291-2261
Email: Brandon.A.Coleman@mwhglobal.com

General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	10 yr - 24 hr
Rainfall Depth:	2.000 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.000	0.000	JD Channel 3
Null	#2	==>	End	0.000	0.000	JD Pond 3

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	304.300	304.300	134.72	20.50
#2	9.900	314.200	138.09	22.05

Structure Detail:

Structure #1 (Null)

JD Channel 3

Structure #2 (Null)

JD Pond 3

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	304.300	0.252	0.000	0.000	86.000	F	134.72	20.501
	Σ	**304.300**						**134.72**	**20.501**
#2	1	9.900	0.000	0.000	0.000	99.000	F	14.81	1.553
	Σ	**314.200**						**138.09**	**22.054**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	20.00	60.00	300.00	4.470	0.018
		7. Paved area and small upland gullies	10.34	565.00	5,465.00	6.470	0.234
#1	**1**	**Time of Concentration:**					**0.252**

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Channel JD-4

Peak flow estimates for Channel JD-4 for a 10-yr 24-hour Type 1 SCS storm.

Jumbo Dome mine area for the Usibelli Coal mine

Bandon Coleman

MWH
1801 California St
Ste 2900
Denver, CO 80202

Phone: (303) 291-2261
Email: Brandon.A.Coleman@mwhglobal.com

General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	10 yr - 24 hr
Rainfall Depth:	2.000 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#2	0.000	0.000	JD Channel 4
Null	#2	==>	End	0.000	0.000	JD Pond 4

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	68.200	68.200	31.03	4.59
#2	297.600	365.800	149.00	25.27

Structure Detail:

Structure #1 (Null)

JD Channel 4

Structure #2 (Null)

JD Pond 4

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	68.200	0.232	0.000	0.000	86.000	F	31.03	4.589
	Σ	**68.200**						**31.03**	**4.589**
#2	1	8.600	0.000	0.000	0.000	99.000	F	12.86	1.349
	2	289.000	0.321	0.000	0.000	86.000	F	116.39	19.333
	Σ	**365.800**						**149.00**	**25.271**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	13.33	40.00	300.00	3.650	0.022
		7. Paved area and small upland gullies	19.08	290.00	1,520.00	8.790	0.048
		8. Large gullies, diversions, and low flowing streams	2.01	50.00	2,490.16	4.250	0.162
#1	**1**	**Time of Concentration:**					**0.232**
#2	2	5. Nearly bare and untilled, and alluvial valley fans	25.00	75.00	300.00	5.000	0.016
		7. Paved area and small upland gullies	10.98	805.00	7,330.04	6.670	0.305
#2	**2**	**Time of Concentration:**					**0.321**

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Clean Water Diversion 3 (Temporary Drainage Ditch)

Peak flow estimates for Channl CWD-3 for a 10-year 24-hour SCS Type 1 Storm event.

Jumbo Dome Mine Area for the Usibelli Coal Mine

Bandon Coleman

MWH
1801 California St
Ste 2900
Denver, CO 80202

Phone: (303) 291-2261
Email: Brandon.A.Coleman@mwhglobal.com

General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	10 yr - 24 hr
Rainfall Depth:	2.000 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	JD-2 Temp Ditch

#1
Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	150.100	150.100	1.62	1.54

Structure Detail:

Structure #1 (Null)

JD-2 Temp Ditch

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	150.100	0.273	0.000	0.000	66.000	M	1.62	1.539
	Σ	**150.100**						**1.62**	**1.539**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	16.67	50.00	300.00	4.080	0.020
		7. Paved area and small upland gullies	12.70	250.00	1,968.00	7.170	0.076
		8. Large gullies, diversions, and low flowing streams	2.00	54.10	2,705.00	4.240	0.177
#1	**1**	**Time of Concentration:**					**0.273**

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Clean Water Diversion 4 (CWD-4)

Peak flow estimates for Channel CWD-4 for a 10-year 24-hour SCS Type 1 Storm event.

Jumbo Dome Mine Area at the Usibelli Coal Mine

Bandon Coleman

MWH
1801 California St
Ste 2900
Denver, CO 80202

Phone: (303) 291-2261
Email: Brandon.A.Coleman@mwhglobal.com

General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	10 yr - 24 hr
Rainfall Depth:	2.000 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	Channel 4 clean water diversion

#1
Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	293.600	293.600	114.57	19.64

Structure Detail:

Structure #1 (Null)

Channel 4 clean water diversion

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	293.600	0.346	0.000	0.000	86.000	F	114.57	19.645
	Σ	**293.600**						**114.57**	**19.645**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	5. Nearly bare and untilled, and alluvial valley fans	18.33	55.00	300.00	4.280	0.019
		7. Paved area and small upland gullies	23.81	2,045.00	8,590.01	9.820	0.242
		8. Large gullies, diversions, and low flowing streams	3.09	50.00	1,620.01	5.270	0.085
#1	**1**	**Time of Concentration:**					**0.346**

Table D9-2. Jumbo Dome Channel Design Summary

RIPRAP DESIGN - SAFETY FACTORS METHOD

DATE: May 26, 2011
PROJECT: Usibelli Jumbo Dome Channels
OBJECTIVE: Estimate riprap size in drainage channels
CALCULATIONS BY: Brandon Coleman, E.I.T.

INPUT PARAMETERS						RIPRAP SIZING - FHA METHODOLOGY (Stability Factor = 1.2)							CALCULATED CHANNEL PARAMETERS					
Channel ID	Channel Slope (ft/ft)	Bottom Width (ft)	Side Slope "z"H:1V (ft)	Design Flow (cfs)	Recommended Riprap (in)	Calculated D50 (in)	Specific Gravity of rock, SG	Correction Factor	Angle of Repose, ϕ (deg)	sin θ	sin ϕ	K1	Estimated Manning's n	Depth of Flow (ft)	Wetted Perimeter (ft)	Flow Area (sq ft)	Flow Velocity (ft/s)	Froude Number
Channel OOPS-1	0.0341	5	3	16.76	3	2.03	2.65	1.00	42.00	0.32	0.67	0.88	0.0334	0.540	8.42	3.57	4.69	1.25
Channel OOPS-2	0.0363	5	3	12.86	3	1.80	2.65	1.00	42.00	0.32	0.67	0.88	0.0337	0.460	7.91	2.93	4.38	1.26
Channel JD-2	0.0248	10	3	103.85	6	3.35	2.65	1.00	42.00	0.32	0.67	0.88	0.0353	1.205	17.62	16.41	6.33	1.14
Channel JD-3	0.02	10	3	134.72	6	3.32	2.65	1.00	42.00	0.32	0.67	0.88	0.0342	1.445	19.14	20.71	6.50	1.09
Channel JD-4	0.0201	10	3	31.03	3	1.58	2.65	1.00	42.00	0.32	0.67	0.88	0.0309	0.600	13.79	7.08	4.38	1.07
CWD-1	0.0311	20	3	5.89	3	0.39	2.65	1.00	42.00	0.32	0.67	0.88	0.0329	0.135	20.85	2.75	2.14	1.04
CWD-1-2	0.1392	20	3	13.07	3	2.30	2.65	1.00	42.00	0.32	0.67	0.88	0.0410	0.160	21.01	3.28	3.99	1.78
CWD-2	0.0334	5	3	1.00	3	0.26	2.65	1.00	42.00	0.32	0.67	0.88	0.0333	0.105	5.66	0.56	1.79	1.00
CWD-3	0.02	5	3	1.62	3	0.26	2.65	1.00	42.00	0.32	0.67	0.88	0.0309	0.155	5.98	0.85	1.91	0.89
CWD-4	0.0309	20	3	114.57	6	3.36	2.65	1.00	42.00	0.32	0.67	0.88	0.0364	0.850	25.38	19.17	5.98	1.21

RIPRAP DESIGN - ROBINSON METHOD

DATE: May 26, 2011
PROJECT: Jumbo Dome Emergency Spillway Design
OBJECTIVE: Riprap sizing for emergency spillways for Jumbo Dome ponds
CALCULATIONS BY: Brandon Coleman, E.I.T.

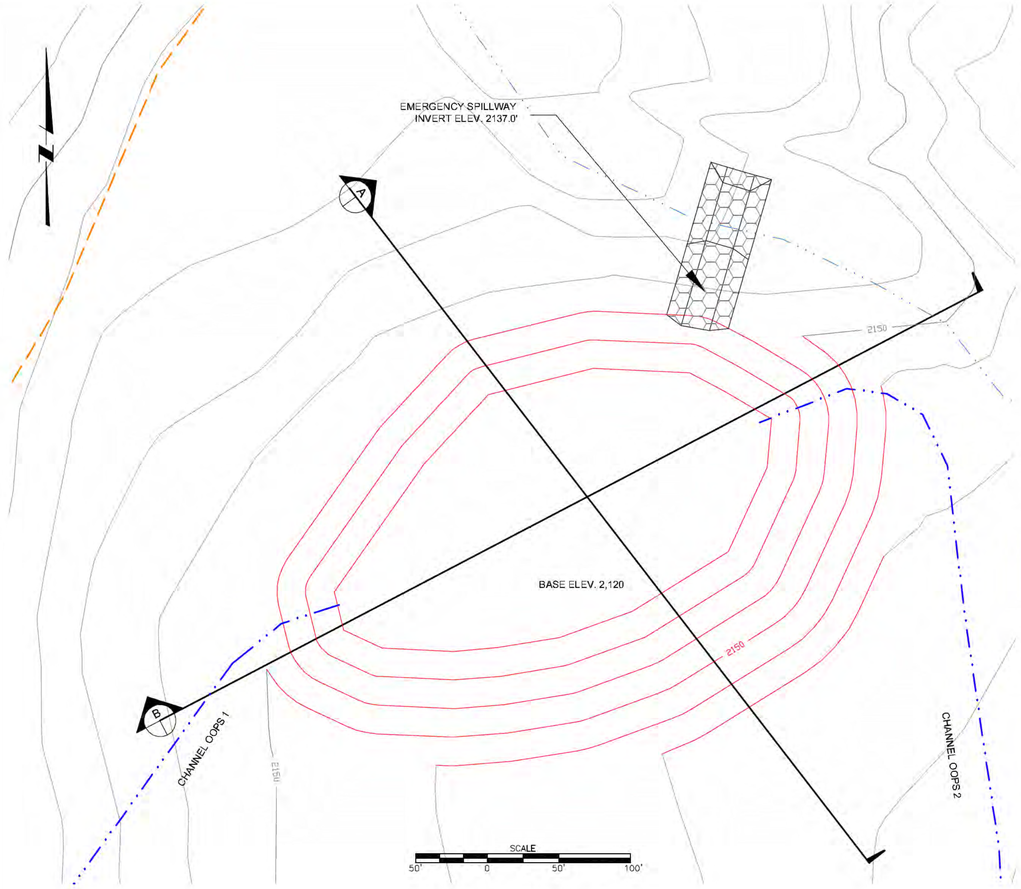
INPUT PARAMETERS							RIPRAP SIZING - ROBINSON METHODOLOGY							
Channel ID	Channel Slope (ft/ft)	Bottom Width (ft)	Side Slope "z"H:1V (ft)	Design Flow (cfs)	Recommended Riprap (D50) (in)	Factor Of Safety	Calculated D50 (in)	Unit Discharge (cfs/ft)	Estimated Manning's n	Porosity	Vm	qm	qs	Depth of Flow
Pond JD-1 Emergency Spillway	0.290	20	3	25.3	6	1.2	5.15	1.26	0.05	0.46	0.50	0.50	0.77	0.16
Pond JD-2 Emergency Spillway	0.100	20	3	58.3	6	1.2	5.78	2.92	0.04	0.46	0.29	0.29	2.62	0.43
Pond JD-3 Emergency Spillway	0.200	20	3	67.0	9	1.2	7.70	3.35	0.05	0.46	0.51	0.76	2.59	0.38
Pond JD-4 Emergency Spillway	0.200	20	3	140.6	12	1.2	11.39	7.03	0.05	0.46	0.58	1.17	5.86	0.64

1.2 Factor of Safety for unknowns in methodology

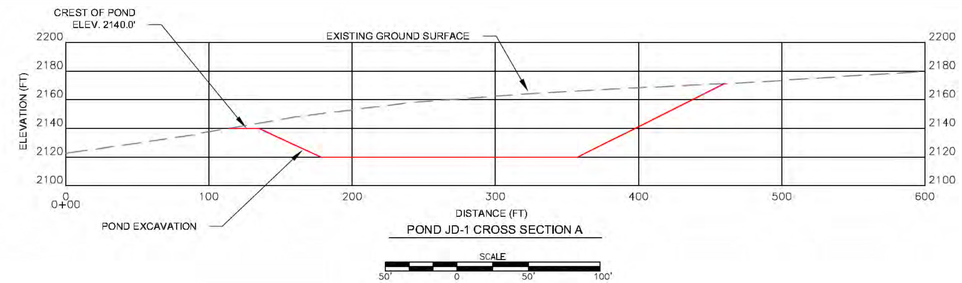
Assumptions:
1. Rock is crushed and angular in shape
2. The coefficent of uniformity of the rock is 1.25-1.73
3. The specific gravity of the stone ranges must from 2.54 to 2.82 or the safety factor must be adjusted to account for the specific gravity of the stone

PLATE D9-1

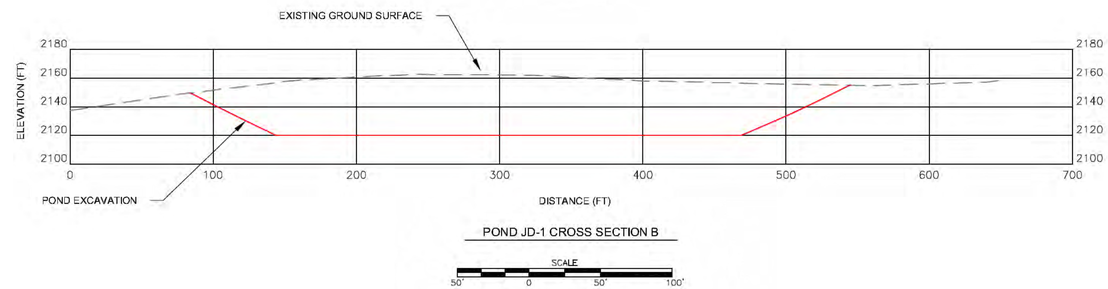
DRANINAGE AND SEDIMENT CONTROL PLAN



PLAN VIEW POND JD-1

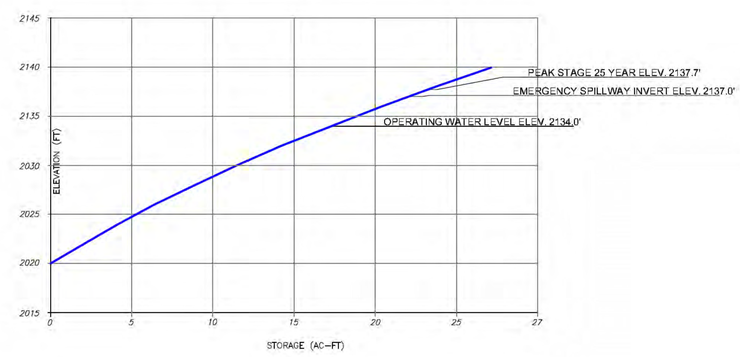


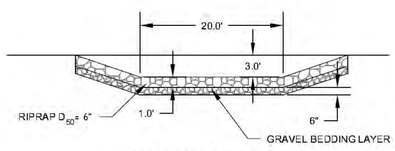
POND JD-1 CROSS SECTION A



POND JD-1 CROSS SECTION B

POND JD-1
STAGE/ELEVATION CURVE





EMERGENCY SPILLWAY

LEGEND

- PROPOSED POND JD-1 CONTOUR AND ELEVATION, FT
- APPROXIMATE EXISTING CONTOUR AND ELEVATION, FT
- EXISTING STREAM/DRAINAGE
- PROPOSED INITIAL FIVE YEAR DISTURBANCE AREA
- PROPOSED DRAINAGE CHANNEL

Channel	Flow Q (cfs)	Slope (%)	Bottom Width (ft)	Depth of Flow (D) (ft)	Freeboard (ft)	Total Depth (ft)	Rip Rap D50 (in)
SPILLWAY OUTSLOPE	25.3	29	20	0.2	2.8	3.0	6

PROFESSIONAL ENGINEER'S STATEMENT

I, Thomas E. Leidich, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

10/25/11
DATE

STATE OF ALASKA 49TH THOMAS E. LEIDICH EM 12365 REGISTERED PROFESSIONAL ENGINEER

NOTES:

- HORIZONTAL DATUM IS ALASKA STATE PLANE CO-OR. ZONE-4, NAD 27.
- VERTICAL DATUM IS MEAN SEA LEVEL
- AERIAL PHOTOGRAPHY BY AERO-METRIC, INC., ANCHORAGE DIVISION.
- AERIAL TOPOGRAPHY BY STERO MODELING METHOD FLIGHT DATE JUNE 23, 2000.
- AERIAL MAPPING BY LIDAR METHOD FLIGHT DATE MAY 30, 2005.

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
1	09/11	TEL	UPDATED SUBMITTAL
0	1/10	TEL	ORIGINAL SUBMITTAL

DESIGN BY: MHH
DRAWN BY: JMB
CHECK BY: TEL
DWG FILE:
XREF DWG FILE:

USIBELLI COAL MINE INC.

SEDIMENT POND JD-1 DESIGN

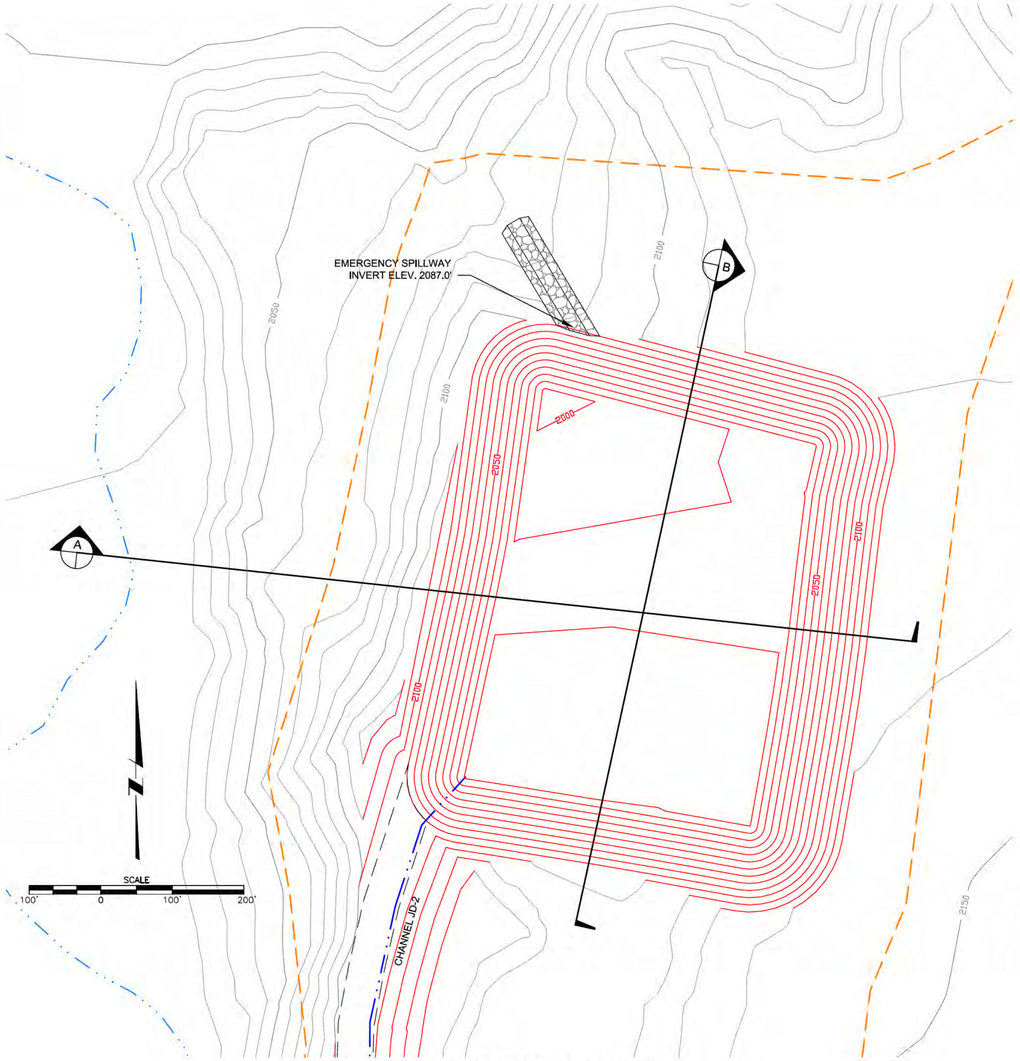
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. D9-2

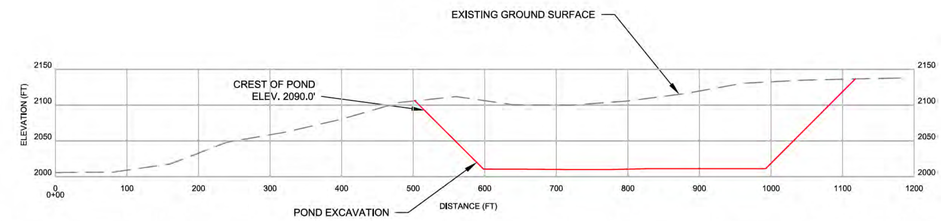
REV. 1

PLATE D9-2

SEDIMENT POND JD-1 DESIGN



PLAN VIEW POND JD-2



POND JD-2 CROSS SECTION A

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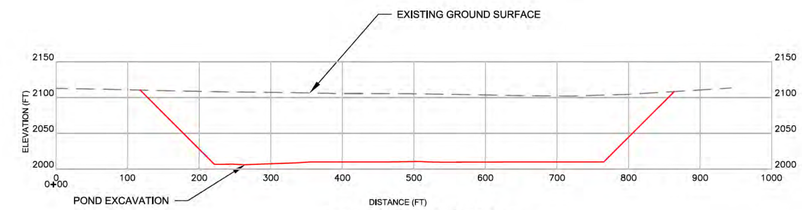

POND JD-2 CROSS SECTION B

SCALE
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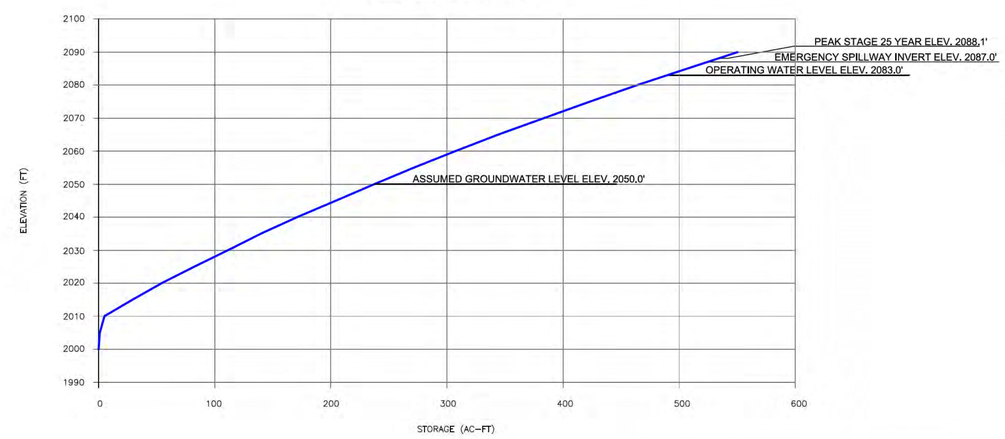
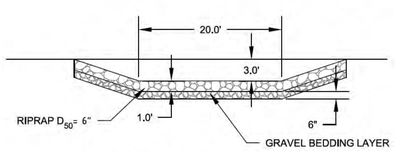
POND JD-2
STAGE/ELEVATION CURVE





EMERGENCY SPILLWAY

LEGEND

- 2000 — PROPOSED POND JD-2 CONTOUR AND ELEVATION, FT
- 2000 — APPROXIMATE EXISTING CONTOUR AND ELEVATION, FT
- EXISTING STREAM/DRAINAGE
- PROPOSED INITIAL FIVE YEAR DISTURBANCE AREA
- PROPOSED ACCESS ROAD
- PROPOSED DRAINAGE CHANNEL

Channel	Flow Q (cfs)	Slope (%)	Bottom Width (ft)	Depth of Flow (D) (ft)	Freeboard (ft)	Total Depth (ft)	Rip Rap D50 (in)
SPILLWAY	58.3	10	20	0.5	2.5	3.0	6

PROFESSIONAL ENGINEER'S STATEMENT

I, Thomas E. Leidich, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

10/25/11
DATE

STATE OF ALASKA 49TH THOMAS E. LEIDICH EM 12365 REGISTERED PROFESSIONAL ENGINEER

NOTES:

- HORIZONTAL DATUM IS ALASKA STATE PLANE CO-OR. ZONE-4, NAD 27.
- VERTICAL DATUM IS MEAN SEA LEVEL
- AERIAL PHOTOGRAPHY BY AERO-METRIC, INC., ANCHORAGE DIVISION.
- AERIAL TOPOGRAPHY BY STERO MODELING METHOD FLIGHT DATE JUNE 23, 2000.
- AERIAL MAPPING BY LIDAR METHOD FLIGHT DATE MAY 30, 2005.

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
1	06/11	TEL	UPDATED SUBMITTAL
0	1/10	TEL	ORIGINAL SUBMITTAL

DESIGN BY: MWH
DRAWN BY: JMB
CHECK BY: TEL
DWG FILE:
XREF DWG FILE:

USIBELLI COAL MINE INC

SEDIMENT POND JD-2 DESIGN

JUMBO DOME MINE

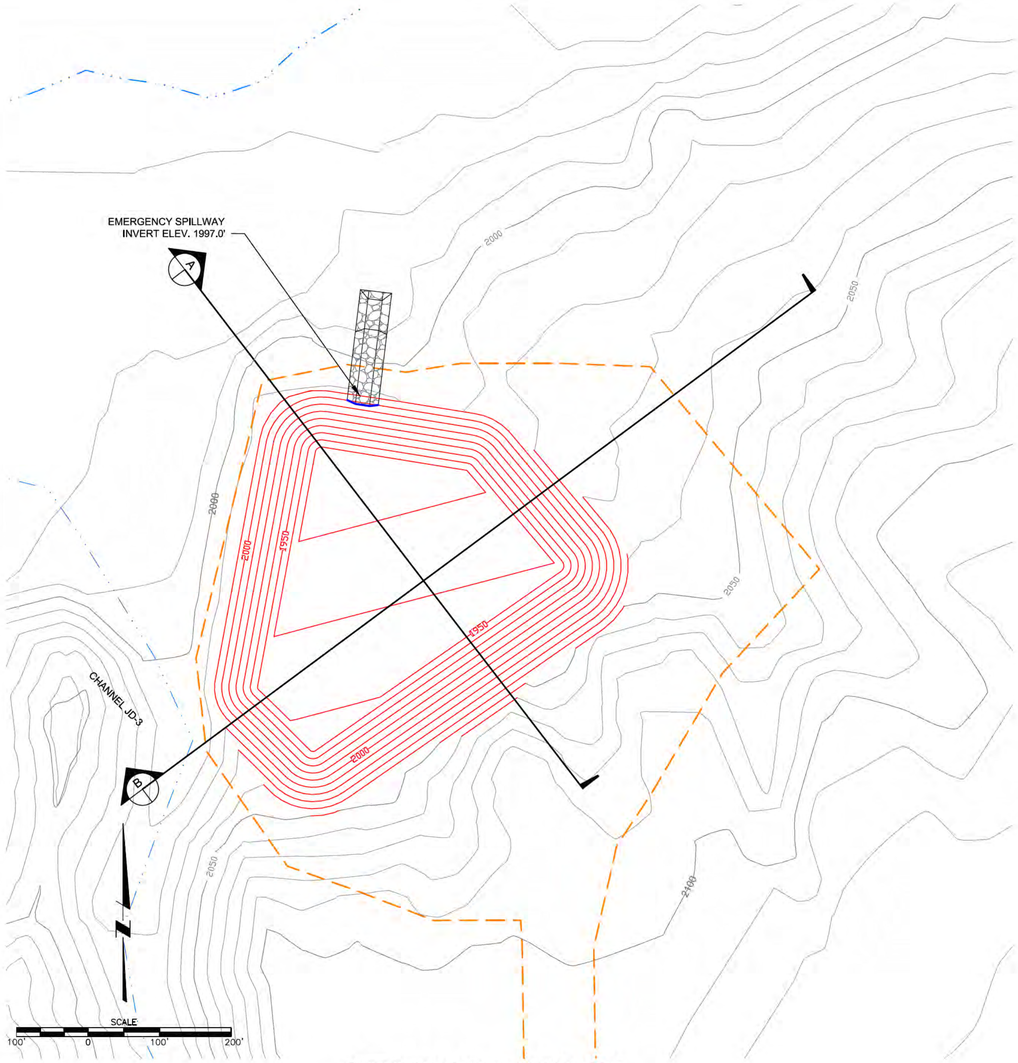
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. D9-3

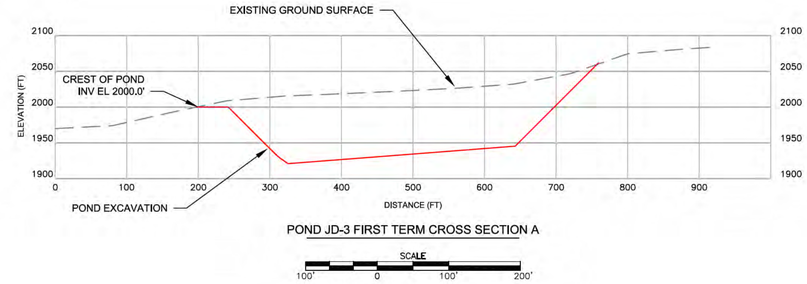
REV. 1

PLATE D9-3

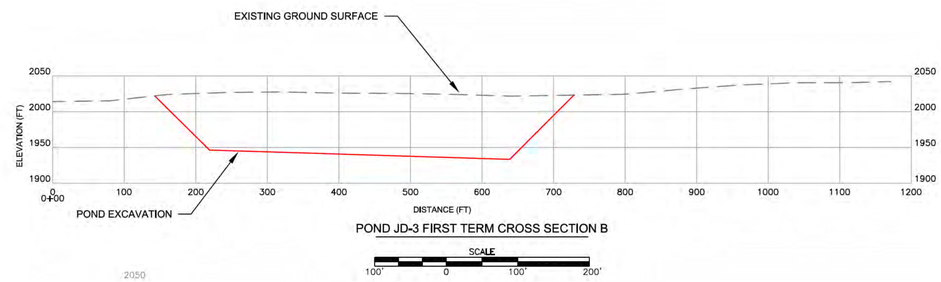
SEDIMENT POND JD-2 DESIGN



PLAN VIEW POND JD-3 FIRST TERM

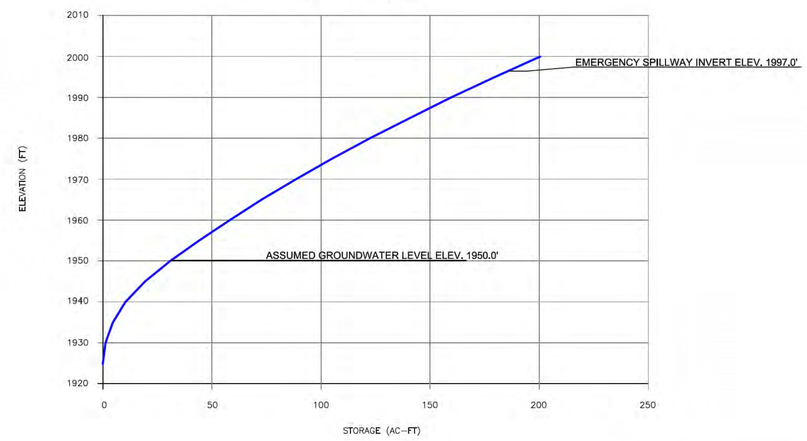


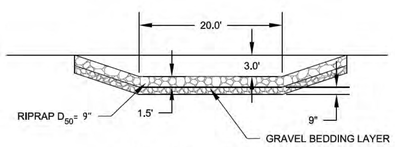
POND JD-3 FIRST TERM CROSS SECTION A



POND JD-3 FIRST TERM CROSS SECTION B

POND JD-3 FIRST TERM
STAGE/ELEVATION CURVE





EMERGENCY SPILLWAY

SEE DRAWING 9-5 FOR SPILLWAY DESIGNS

LEGEND

- PROPOSED POND JD-3 FIRST TERM CONTOUR AND ELEVATION, FT
- APPROXIMATE EXISTING CONTOUR AND ELEVATION, FT
- EXISTING STREAM/DRAINAGE
- PROPOSED INITIAL FIVE YEAR DISTURBANCE AREA

PROFESSIONAL ENGINEER'S STATEMENT

I, Thomas E. Leidich, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

10/25/11
DATE

STATE OF ALASKA 49TH THOMAS E. LEIDICH EM 12365 REGISTERED PROFESSIONAL ENGINEER

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- AERIAL TOPOGRAPHY BY STERO MODELING METHOD FLIGHT DATE JUNE 23, 2000.
- AERIAL MAPPING BY LIDAR METHOD FLIGHT DATE MAY 30, 2005.

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0	1/10	TEL	ORIGINAL SUBMITTAL

DESIGN BY: MWH
DRAWN BY: JMB
CHECK BY: TEL
DWG FILE:
XREF DWG FILE:

SEDIMENT POND JD-3 FIRST TERM DESIGN

JUMBO DOME MINE

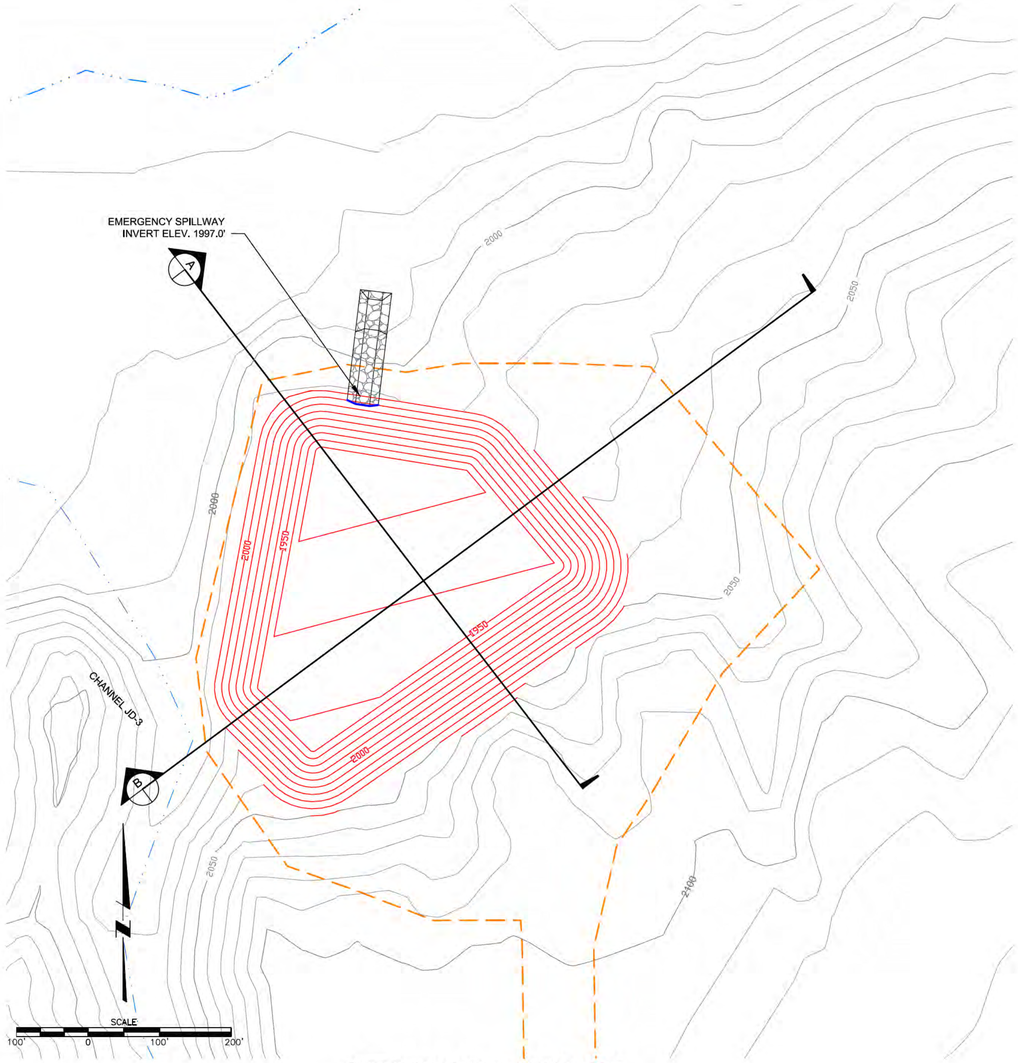
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. D9-4

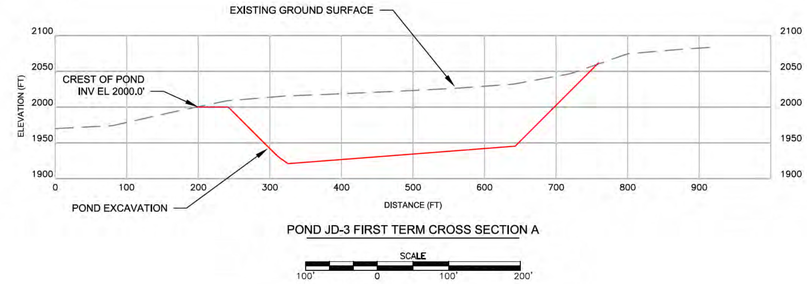
REV. 1

PLATE D9-4

SEDIMENT POND JD-3 DESIGN FIRST TERM



PLAN VIEW POND JD-3 FIRST TERM



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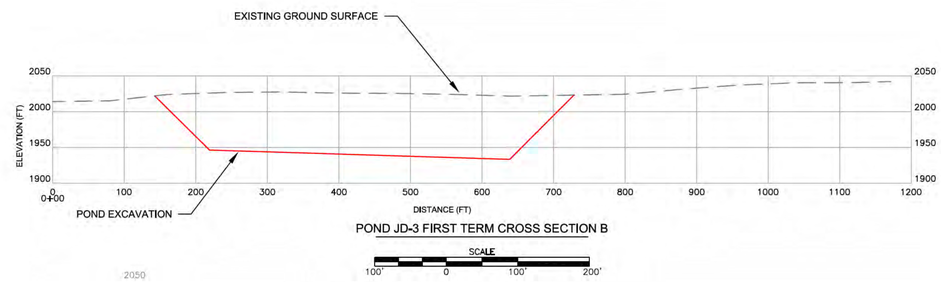

POND JD-3 FIRST TERM CROSS SECTION B

POND JD-3 FIRST TERM
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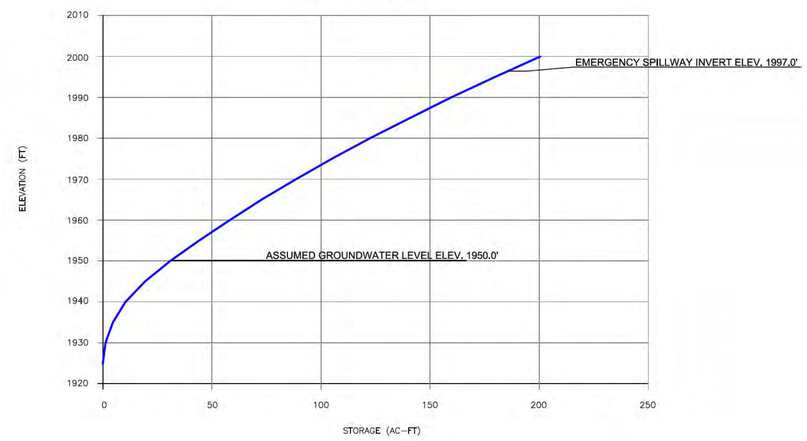

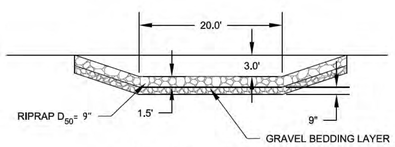

EMERGENCY SPILLWAY

SEE DRAWING 9-5 FOR SPILLWAY DESIGNS

LEGEND

- PROPOSED POND JD-3 FIRST TERM CONTOUR AND ELEVATION, FT
- APPROXIMATE EXISTING CONTOUR AND ELEVATION, FT
- EXISTING STREAM/DRAINAGE
- PROPOSED INITIAL FIVE YEAR DISTURBANCE AREA

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SEDIMENT POND JD-3 FIRST TERM DESIGN

JUMBO DOME MINE

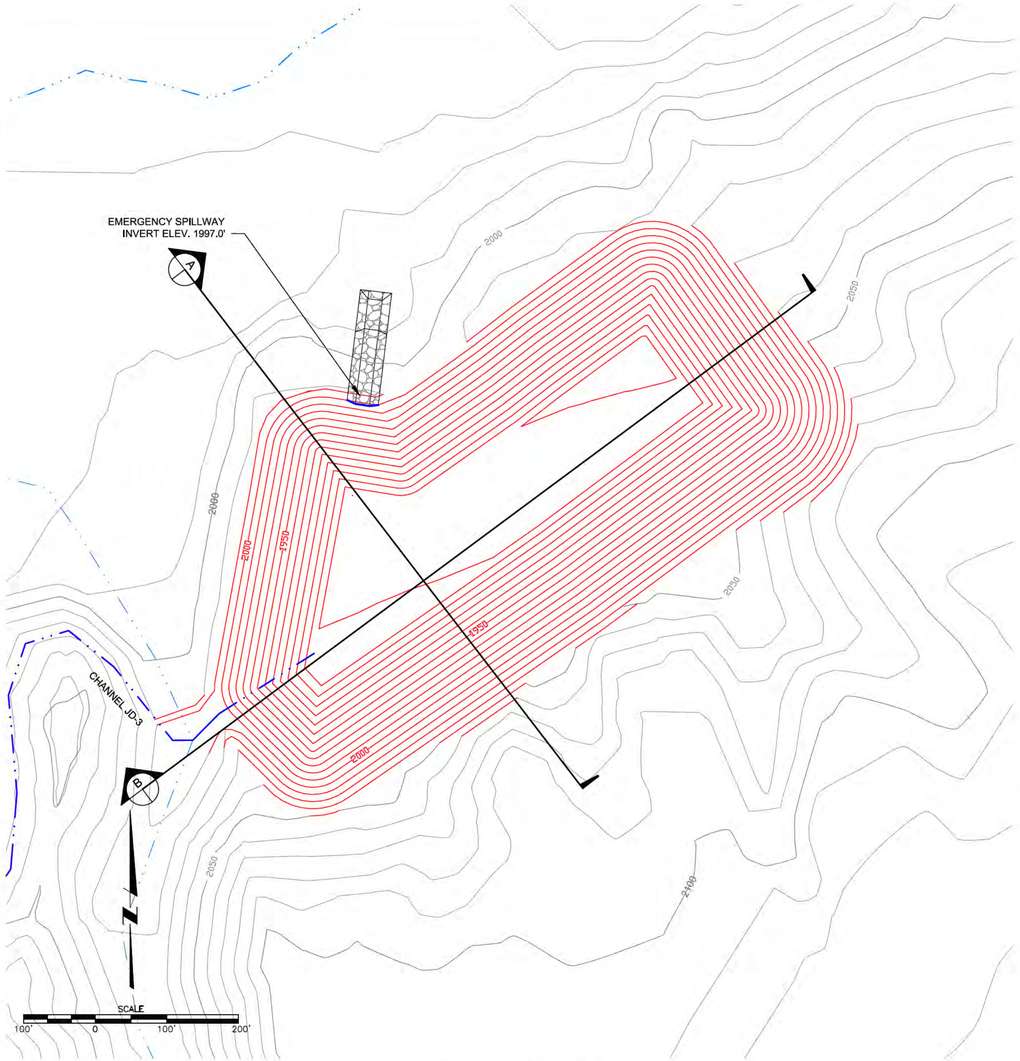
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. D9-4

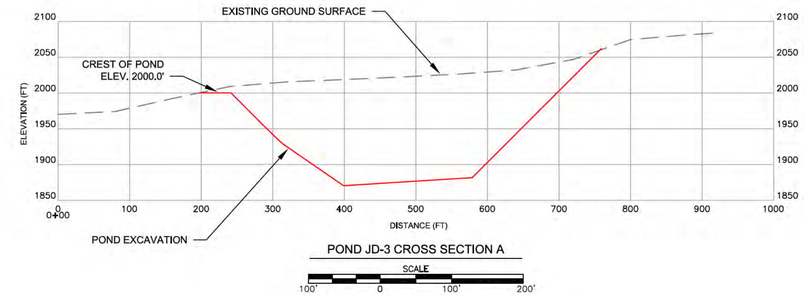
REV. 1

PLATE D9-5

SEDIMENT POND JD-3 CONCEPTUAL DESIGN



PLAN VIEW POND JD-3



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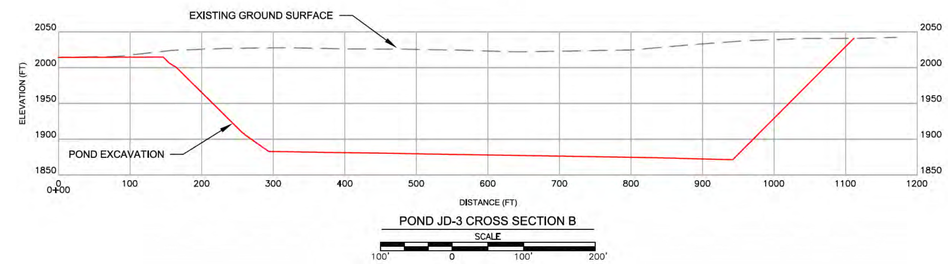
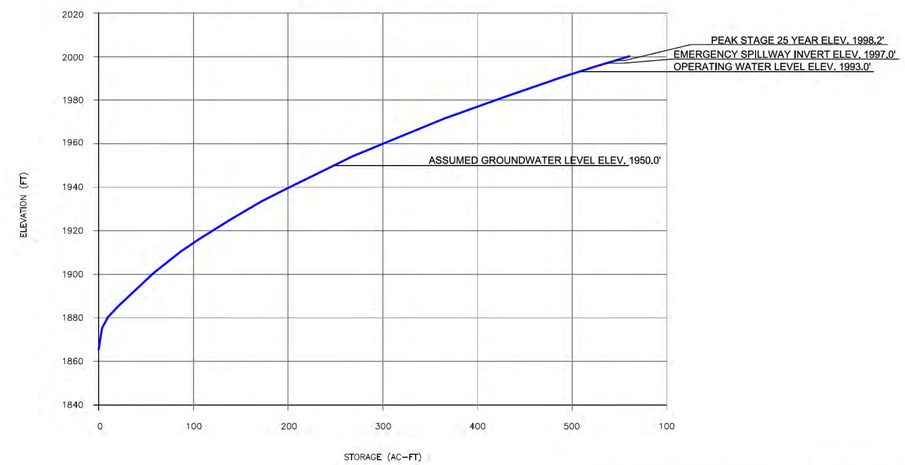
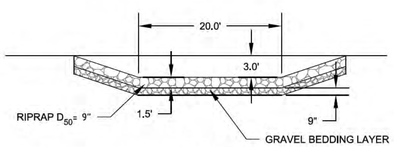


POND JD-3 CROSS SECTION B

POND JD-3
STAGE/ELEVATION CURVE





EMERGENCY SPILLWAY

Channel	Flow Q (cfs)	Slope (%)	Bottom Width (ft)	Depth of Flow (D) (ft)	Freeboard (ft)	Total Depth (ft)	Rip Rap D50 (in)
SPILLWAY	67	20	20	0.4	2.3	3.0	9

LEGEND

- PROPOSED POND JD-3 CONTOUR AND ELEVATION, FT
- APPROXIMATE EXISTING CONTOUR AND ELEVATION, FT
- EXISTING STREAM/DRAINAGE
- PROPOSED INITIAL FIVE YEAR DISTURBANCE AREA
- PROPOSED DRAINAGE CHANNEL

PROFESSIONAL ENGINEER'S STATEMENT

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DESIGN BY: MWH
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CHECK BY: TEL
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XREF DWG FILE:

USIBELLI COAL MINE INC

SEDIMENT POND JD-3 FINAL CONCEPTUAL DESIGN

JUMBO DOME MINE

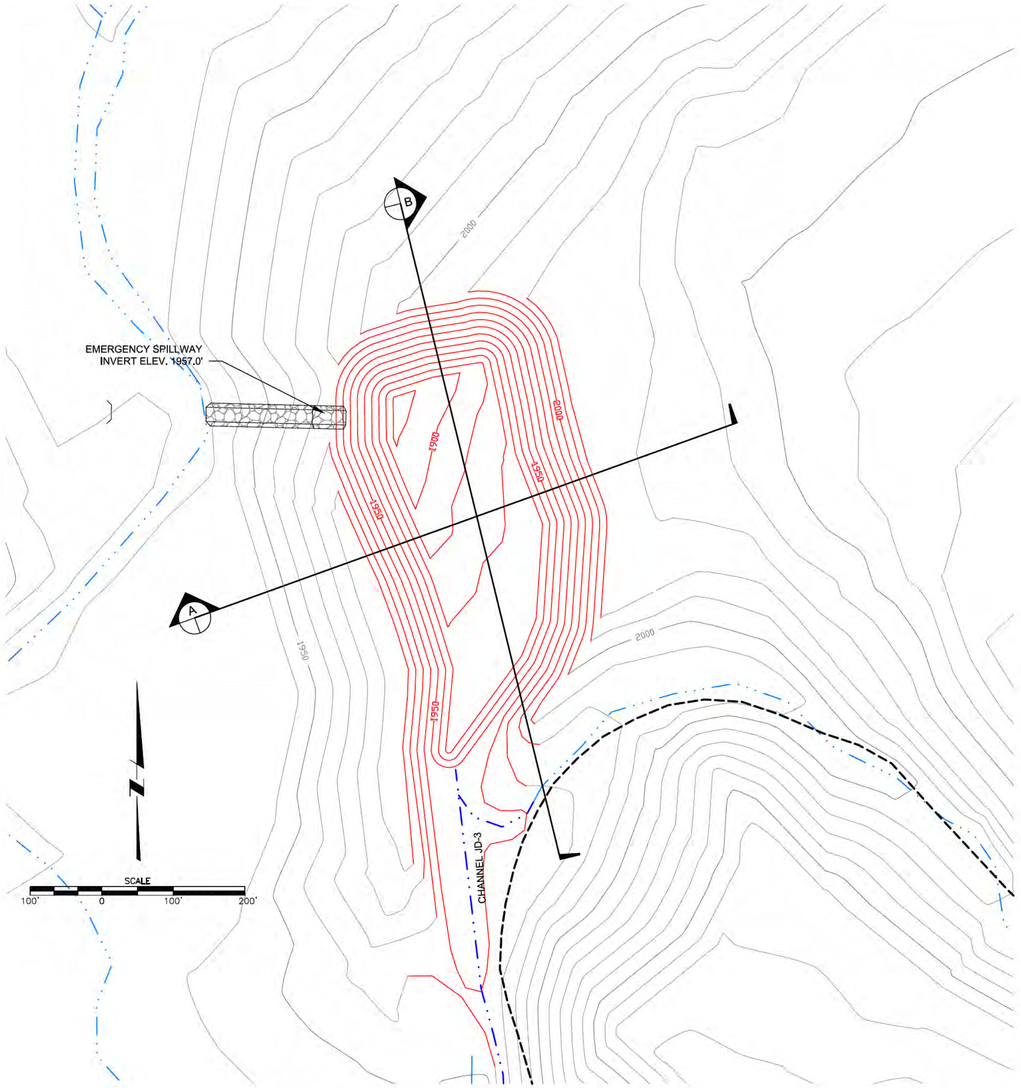
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. D9-5

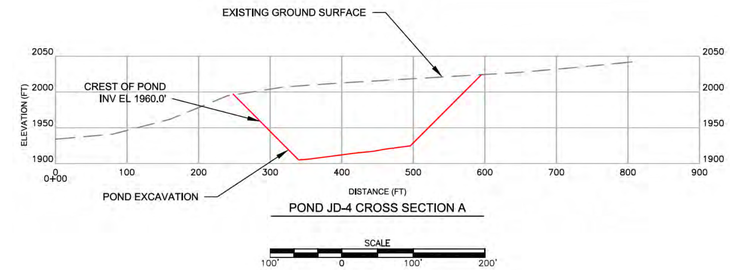
REV. 1

PLATE D9-6

SEDIMENT POND JD-4 CONCEPTUAL DESIGN



PLAN VIEW POND JD-4



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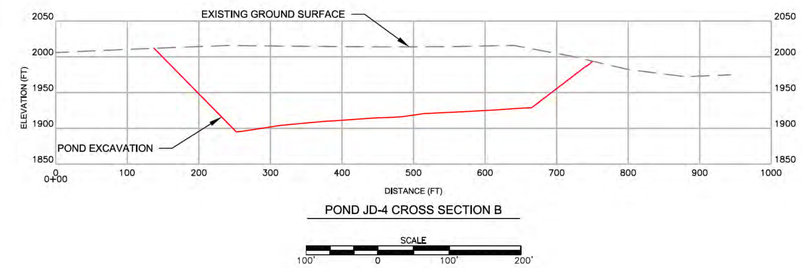
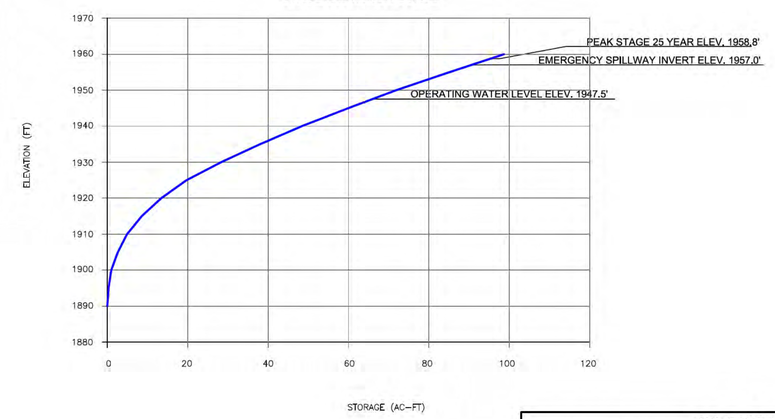
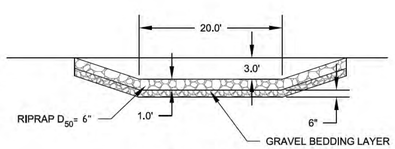


POND JD-4 CROSS SECTION B

POND JD-4
STAGE/ELEVATION CURVE





EMERGENCY SPILLWAY

Channel	Flow Q (cfs)	Slope (%)	Bottom Width (ft)	Depth of Flow (D) (ft)	Freeboard (ft)	Total Depth (ft)	Rip Rap D50 (in)
SPILLWAY	141	20	20	0.7	2.7	3.0	12

LEGEND

- 2000 — PROPOSED POND JD-4 CONTOUR AND ELEVATION, FT
- 2000 — APPROXIMATE EXISTING CONTOUR AND ELEVATION, FT
- EXISTING STREAM/DRAINAGE
- PROPOSED INITIAL FIVE YEAR DISTURBANCE AREA
- PROPOSED MINING BOUNDARY
- PROPOSED DRAINAGE CHANNEL

PROFESSIONAL ENGINEER'S STATEMENT

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DESIGN BY: MWH
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DWG FILE:
XREF DWG FILE:

SEDIMENT POND JD-4 CONCEPTUAL DESIGN

JUMBO DOME MINE

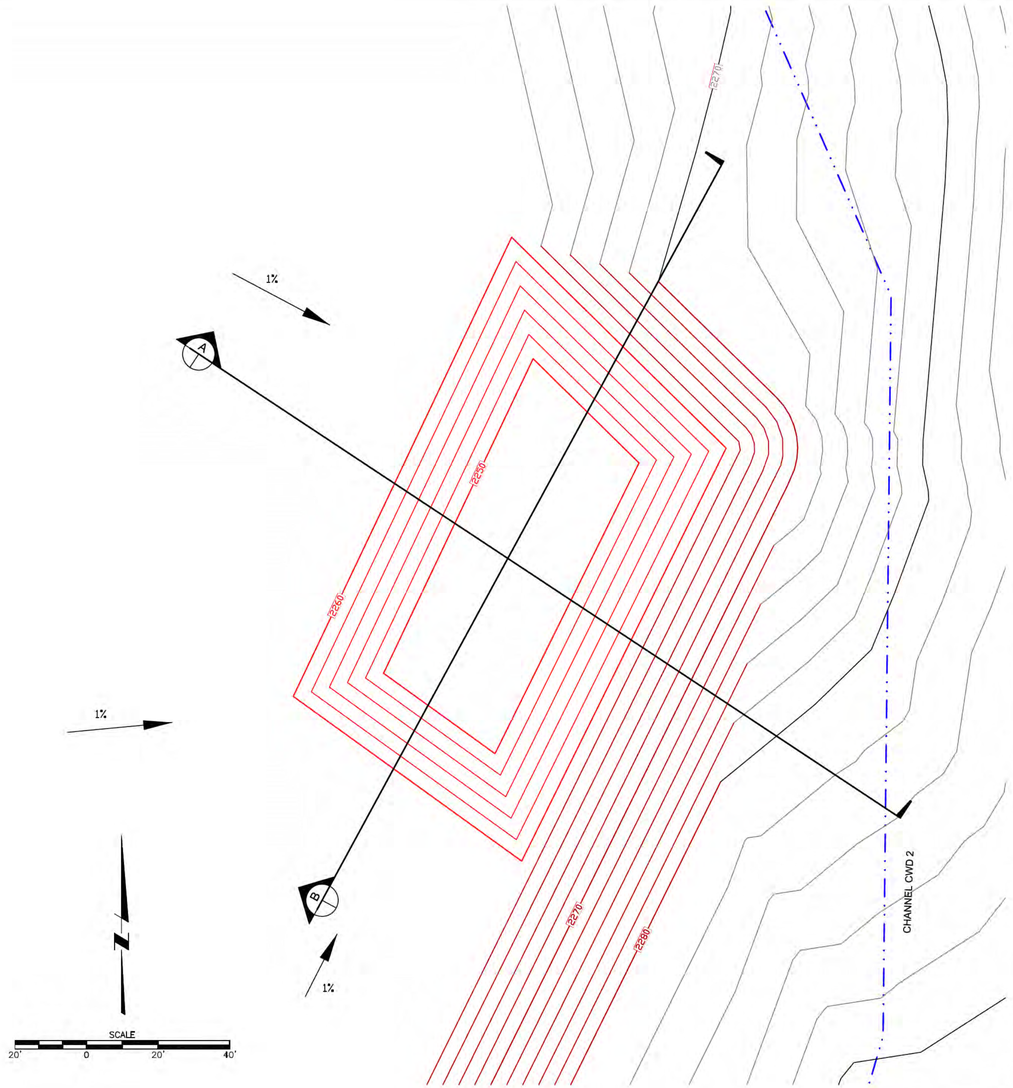
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. D9-6

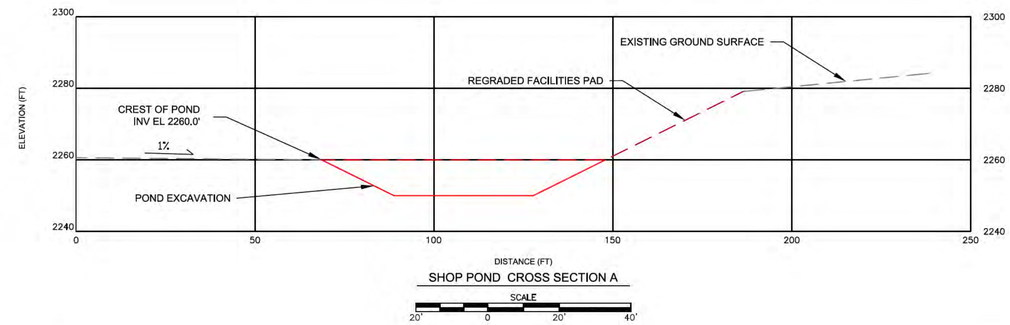
REV. 1

PLATE D9-7

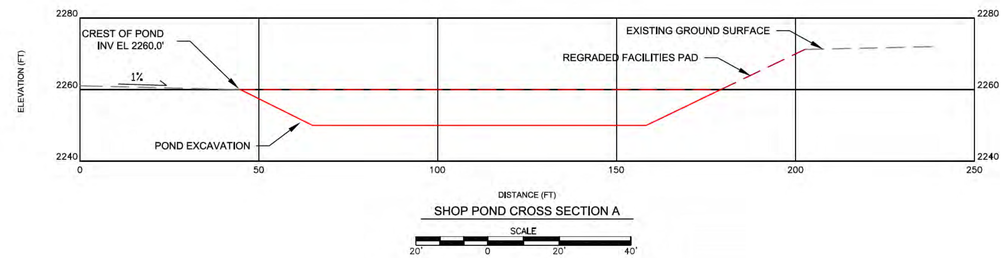
SHOP POND



PLAN VIEW SHOP POND



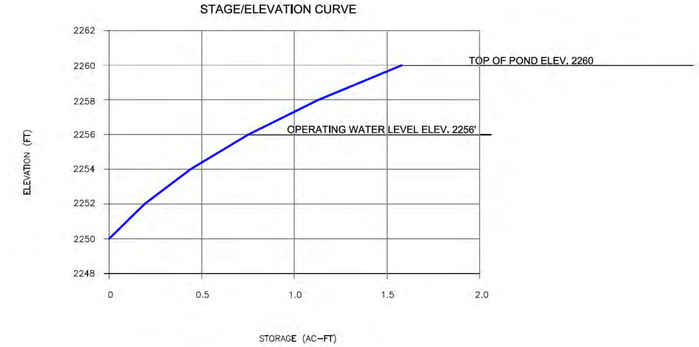
SHOP POND CROSS SECTION A



SHOP POND CROSS SECTION A

POND JD-4

STAGE/ELEVATION CURVE



LEGEND

2000	PROPOSED POND JD-4 CONTOUR AND ELEVATION, FT
2000	APPROXIMATE REGRADED FACILITIES PAD CONTOUR AND ELEVATION, FT
2000	APPROXIMATE EXISTING CONTOUR AND ELEVATION, FT
	PROPOSED DRAINAGE DITCH

PROFESSIONAL ENGINEER'S STATEMENT

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XREF DWG FILE:

USIBELLI COAL MINE INC. UCM

SHOP POND

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. D9-7

REV. 1

APPENDIX D-9-2

CULVERT DESIGN FOR MARGUERITE CREEK HAUL ROAD CROSSING

MWH

BUILDING A BETTER WORLD

TECHNICAL MEMORANDUM

TO:	*Tammy Scholten, Usibelli*	DATE:	*October 4, 2011*
FROM:	*Thomas Leidich, MWH* *Brandon Coleman, MWH*	REFERENCE:	*1009161*
SUBJECT:	*Culvert Design for Marguerite Creek Haul Road Crossing, Jumbo Dome Mine Area*		

DRAFT FOR CLIENT REVIEW

At the request of Usibelli Coal Mine, Inc., MWH investigated the installation of a culvert for use in the Jumbo Dome Mining Area near Healy, AK, on Marguerite Creek, at its intersection with the proposed haul road. This culvert will be designed to maintain compliance with the requirements set by the Alaska Department of Fish and Game (ADFG) and the Alaska Department of Transportation and Public Facilities (ADOT) regarding Design, Permitting, and Construction of Culverts for Fish Passage.

Completion of this analysis has included the following:

- Fish species and size were reported in a WHPacific report, "Fisheries Assessment for Marguerite Creek". The design fish species and size was recommended by ADFG, and the minimum stream depth in the culvert needed for fish of this size was obtained using the FISHPASS program from the ADFG.
- Flow analysis for the 2-year fish passage design flow (Q_2), based on USGS statistical flow estimation methods by Curran, et. al (2003).
- Flow analysis for the 50-year peak design flow (Q_{50}), and 100-year peak design flow (Q_{100}) was performed using a regression equation provided by Curran, et. al (2003).
- Determination of the size and style of culvert to be used for the haul road crossing using HY8.
- Riprap sizing and shear analysis on bedding material for the Q_{50} design flow

EXISTING STREAM CONDITIONS

The existing stream conditions were estimated based on a LIDAR survey conducted for the area and field observations by Usibelli Coal and MWH at the site. The existing stream profile average longitudinal slope was approximately 1.4 %. The ordinary highwater mark (OHW) is commonly defined in streams as a break in vegetation on the banks. Based on field measurements of Marguerite Creek in the area that culvert will be installed, the stream width at the OHW is approximately 15 ft. Photographs of Marguerite Creek are shown in **Attachment A**.

From the WHPacific assessment of fish habitat on Marguerite Creek, it was determined that the species of concern were the Arctic Grayling and Slimy Sculpin. Of the 105 grayling collected, the sizes ranged from 64 to 220 mm in length. The Slimy Sculpin lengths were not reported in the WHPacific report, but ADFG recommended a length of 50 mm be used for Slimy Sculpin. Therfore, fish Passage flows were checked for a 120 mm Arctic Grayling and a 50 mm Slimy Sculpin, as recommended by ADFG.

DESIGN FLOW

Marguerite Creek is an ungaged stream; the design fish passage flow was approximated using a statistical analysis for Alaska Region 6, where Marguerite Creek is located. It was recommended by ADFG to use the 2% exceedance flow (Q_2) for anadormous and resident fish spawning systems.

The following equations applied for the 2% exceedance flow on Marguerite Creek and the haul road culvert location:

$$Q_2 = 9.204 \times 10^{-2} A^{0.9782} p^{1.342}$$

Where:
A is the drainage area in square miles,
p is the mean annual precipitation in inches

The drainage area above the culvert area on Marguerite Creek is 10.05 mi^2. A mean annual precipitation of 30 in. was used based reported values for Alaska by Jones (1994).

As identified by ADFG, the design flow for the shear stress analysis on the bed material to be used in the culvert is based on the 50-yr peak streamflow (Q_{50}). As identified by MWH, the design flow for capacity in the culvert is the 100-yr peak streamflow (Q_{100}). These design flows were approximated using a regression analysis for Alaska Region 6.

The following equations applied for the 50-year peak streamflow (Q_{50}) and 100-year peak streamflow (Q_{100}), respectively:

$$Q_{50} = 186.7A^{0.8929} (ST+1)^{-0.2599}(F+1)^{-0.2124}$$
$$Q_{100} = 220.6A^{0.7764}(ST+1)^{-0.2616}(F+1)^{-0.2023}$$

Where:
A is the drainage area in square miles,
ST is the area of lakes and ponds (storage) in percent, and
F is the area of forest in percent.

A drainage area of 10.05 mi^2 for Marguerite Creek above the culvert area, zero storage, and a forested area of 70% were determined using aerial photography and Carlson Software for AutoCAD. Based on the equations presented above, the 2% exceedance flow (Q_2), the 50-year peak (Q_{50}) and 100-year peak (Q_{100}) streamflows were determined to be 84.5 cfs, 465.7 cfs, and 558.7 cfs, respectively. These calculations are shown in **Attachment B**.

CULVERT SIZING AND ALIGNMENT

The culvert was sized to provide hydraulic conditions suitable for fish passage during the 2% exceedance streamflow, and safely pass the 100-year peak streamflow without overtopping the Jumbo Dome haul road.

ADFG and ADOT guidelines require the following criteria for culvert fish passages:

- Culvert width is greater than 0.9 * OHW
- Culvert grade should approximate the channel slope, but in no instance should it deviate more than 1% for the natural grade

DRAFT - FOR CLIENT REVIEW

- Invert burial depths for circular culverts should be at least 40% of the culvert diameter

Based on the above criteria the following culvert design parameters were assumed for modeling:

- 15 ft diameter
- 6 ft burial depth
- 2% longitudinal slope
- Corrugated metal steel
- 2” x 6” corrugations

HY8, a program developed by the Federal Highway Administration was used to model the hydraulic parameters in the culvert for the 100-yr, 50-yr and 2-yr peak streamflow.

The outlet channel is designed to convey flow from the outlet of the culvert to the existing stream channel. The outlet channel assumed normal depth for the design flows, and no backwater effects from downstream structures. Channel dimensions that were assumed are shown in **Attachment C**.

Based upon the fish passage design discharge of 84.5 cfs, HY8 determined that the culvert would be outlet controlled (Type 3 Flow). This is a preferable energy grade profile for fish passage because the energy through the culvert is relatively constant. The minimum depth in the culvert for the fish passage design flow is 1.87 ft, which is the headwater depth at the culvert inlet. This depth is based on HY8 modeling results shown in **Attachment C**.

The road location was based on the most perpendicular alignment possible to Marguerite Creek while still maintaining a safe haul road route, within the permitted road corridor. The location of the road was selected to have the least amount of impact on Marguerite Creek and its tributaries. The inlet location was chosen reduce the angle between the existing channel and the culvert inlet to create a smooth transition into the culvert.

DRAFT
FOR CLIENT REVIEW

RIPRAP ANALYSIS

The riprap that will be used to backfill the culvert and line the downstream channel is an important design component. As per ADFG the substrate material should remain dynamically stable up to and including the 50-yr peak streamflow. The riprap calculations are shown in **Attachment D**.

Federal Highway Administration methodology for calculating permissible shear stress for the culvert substrate material was used for this analysis. The permissible shear stress for material with a D_{50} = 12 in. was found to be 15.92 lb/ft^2. Based on the maximum depth expected in the culvert for the Q_{50} design flow the maximum shear stress was estimated to be 8.51 lb/ft^2.

The gradation of the material is recommended to be a mix of ADOT Class 1 and Class 2 riprap. It was also important to include a percentage of fines and sands in the riprap to seal and voids and promote interlocking between the stones. The gradation of the material is shown in **Table 1**.

Table 1. MCHR Culvert Substrate and Channel Lining Gradation

Rock Size (in)	% Passing
36	-
24	90-95
12	25-75

Rock Size (in)	% Passing
8	5-30
No. 4 Sieve	10-20

Due to the length of the culvert it is important to create fish resting points utilizing the substrate material within the culvert. For the purpose of creating fish resting points, riprap ranging from 24-36 in. should be placed within the culvert every 4-6 ft with 40% of the stone protruding from the embedded material.

CULVERT SPECIFICATIONS

In compliance with the ADFG and ADOT regulations, a 15 ft diameter, corrugated circular galvanized, multiplate culvert was selected. This is a galvanized steel, multi-plate structure. Specific burial depths (substrate within the culvert) for circular culverts are provided by ADFG and ADOT, a minimum burial of 40% of the diameter is required for circular culverts. A burial depth of 6 ft is planned for the Marguerite Creek culvert, 40% of the culvert height. Based on design specifications for a culvert of this type a minimum of 6 ft of material will be placed between the top of the culvert and the road surface to provide adequate support for the loads expected on the haul road. See **Figures 1** and **2** in **Attachment E**.

Ice flows and plugging of the culvert are a concern due to location of the installation and the climatic conditions in Alaska. To protect the road and to keep the culvert free of ice during the spring and winter seasons an overflow culvert will be installed in the floodplain of Marguerite Creek. A 1 in. pipe will be installed through the culvert that can be filled with steam to remove ice from the culvert. This device is commonly referred to as an “ice worm”. These devices have been installed at other culverts at the Usibelli mine site with successful results.

In addition to the ice worm, an overflow culvert will be installed in the floodplain with the top elevation of the culvert parallel to the top of the MCHR fish passage culvert. This culvert will be 3 ft. in diameter and will pass approximately 60 cfs.

-DRAFT-
FOR CLIENT REVIEW

CONCLUSIONS AND RECOMMENDATIONS

The recommended culvert is a 15 ft diameter multiplate corrugated metal circular structure, approximately 220’ long with a longitudinal slope of 2%. The culvert will be backfilled to a depth of 6’ with suitable substrate material.

The recommended culvert design specifications will sufficiently meet each of the required fish passage criteria for the Arctic Grayling and Slimy Sculpin found in Marguerite Creek and will also be able to accommodate the design storm events.

Based upon the HY8 results, the peak design flow of 559 cfs the culvert will generate a hydraulic jump at the outlet. The exact location of this hydraulic jump is not known at this time, and erosion protection is recommended at the outlet of the culvert in the form of the specified riprap, to prevent potential scour.

The substrate material will be a mix of ADOT Class I and Class II riprap combined with finer material to seal voids in the riprap. This material will be dynamically stable up to the 50-yr design peak streamflow. Large stones (24”-36”) will be placed every 4-6 ft within the culvert with 40% of the stone protruding from the embedded material. This will create fish resting areas within the culvert.

Due to the project location and the potential for large ice flows during the winter season, a smaller relief culvert will be installed to help pass flow under the Jumbo Dome haul road if the MCHR culvert becomes obstructed by ice.

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REFERENCES

Alaska Department of Fish and Game. 2001. Memorandum of Agreement Between Alaska Department of Fish and Game and Alaska Department of Transportation and Public Facilities for the Design, Permitting, and Construction of Culverts for Fish Passage. Juneau, AK.

Alaska Department of Transportation and Public Facilities. 2004. Standard Specifications for Highway Construction.

Curran, J.H., Meyer, D.F., and Tasker, G.D., 2003. Estimating the magnitude and frequency of peak streamflows for ungaged sites on streams in Alaska and conterminous basins in Canada: U.S. Geological Survey Water-Resources Investigations Report 03-4188.

Curran, J.H., Wiley, J.B., 2003. Estimating Annual High-Flow Statistics and Monthly and Seasonal Low-Flow Statistics for Ungaged Site on Streams in Alaska and Conterminous Basins in Canada: U.S. Geological Survey Water-Resources Investigations Report 03-4114.

Jones, S.H., and Fahl, C.B., 1994. Magnitude and Frequency of Floods in Alaska and Conterminous Basins of Canada, U.S. Geological Survey Water-Resources Investigations Report 93-4179, Plate 2.

United States Department of Commerce, Weather Bureau. 1965. Two-to-Ten-Day Precipitation for Return Periods of 2 to 100 Years in Alaska. http://www.weather.gov/oh/hdsc/PF_documents/TechnicalPaper_No52.pdf

United States Department of Transportation, Federal Highway Administration. 2011. HY-8 Version 7.2.

United States Department of Transportation, Federal Highway Administration. 2005. Design of Roadside Channels with Flexible Linings Hydraulic Engineering Circular Number 15, Third Edition.

WHPacific, Inc. 2008. Fisheries Assessment for Marguerite Creek. Portland, OR. 30 p.

WHPacific, Inc. 2008. Stream Morphology Report, Marguerite Creek, Jumbo Dome Area. Portland, OR. 13 p.

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ATTACHMENTS

Attachment A: Photographs
Attachment B: Streamflow Calculations
Attachment C: HY8 Model
Attachment D: Riprap Calculations
Attachment E: Figures

Attachment A:
Photographs

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Approximate Inlet Location looking Upstream in Marguerite Creek

FOR REVIEW

Approximate Outlet Location looking Downstream in Marguerite Creek

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Attachment B:
Streamflow Calculations

-DRAFT-
FOR CLIENT REVIEW

Table 2. Estimating equations for annual high-duration flows in Regions 1-7, Alaska and conterminous basins in Canada

[**Estimating equation**: *O-Sn* , daily mean discharge for the water year October-September having an *n* -percent exceedance probability, in cubic feet per second; *A* , drainage area, in square miles; *P* , mean annual precipitation, in inches]

	Estimating equation					
	Constant	**Exponent for A**	**Exponent for P**	**Coefficient of determi-nation**	**Standard error of estimate, in percent**	**Estimate of discharge using user-supplied basin characteristics**
						User: Enter values in shaded area for this region (9999 indicates a dummy value that must be replaced)
						A = 10.05
						P = 30
	Region 6 (34 streamflow gaging stations)					
O-S 15	3.93E-03	1.075	1.87	0.99	29	27.13977007
O-S 10	8.14E-03	1.05	1.765	0.99	27	37.15960888
O-S 9	9.74E-03	1.045	1.736	0.99	27	39.83260735
O-S 8	1.20E-02	1.038	1.703	0.99	28	43.14864032
O-S 7	1.52E-02	1.031	1.664	0.99	28	46.94351555
O-S 6	1.95E-02	1.023	1.618	0.99	29	50.8042816
O-S 5	2.55E-02	1.015	1.577	0.99	29	56.55580269
O-S 4	3.60E-02	1.005	1.514	0.99	29	63.09015481
O-S 3	5.28E-02	0.994	1.445	0.99	29	71.33611372
O-S 2	9.20E-02	0.9783	1.342	0.99	31	84.46803516
O-S 1	0.2144	0.9512	1.193	0.99	33	111.3501473

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By BAC Date 10/3/11 Client Usibelli Sheet 1 of 1

Chkd. By Description Fish Passage Flow Estimation Job No. 1009161

AK Region 6 Annual High Duration Flow Estimation

$Q\text{-}S2 = 9.204 \times 10^{-2} A^{0.9783} p^{1.342}$

2% exceedance probablity

A = drainage area, mi^2 = 10.05 mi^2

p = mean annual precipitation, in = 30 in (WRI 93-4179, Plate 2)

$Q\text{-}S2 = 9.204 \times 10^{-2} (10.05)^{0.9783} (30)^{1.342}$

$Q\text{-}S2 = 84.468 \cong 84.5$ cfs

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FOR CLIENT REVIEW

Table 3. Regression equations for estimating 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year peak streamflows for unregulated streams in Regions 1-7, Alaska and conterminous basins in Canada

[Q_T, T-year peak streamflow, in cubic feet per second; A, drainage area, in square miles; ST, area of lakes and ponds (storage), in percent; P, mean annual precipitation, in inches; J, mean minimum January temperature, in degrees Fahrenheit; E, elevation, in feet; F, area of forest, in percent]

	Constant	Exponent for A	Exponent for ST	Exponent for P	Exponent for J	Average standard error of prediction (log units)	Average standard error of prediction (percent)	Average equivalent years of record	Estimate of recurrence interval Q_T using user-supplied characteristics	
	Region 6 (97 gaging stations)								**User:** Enter values in shaded area for this region (9999 indicates a dummy value that must be replaced)	
	Applicable range of variables:								**A=**	10.05
	A: 1.29-321,000; ST: 0-15; F: 0-100								**ST=**	0
									F=	70
Q2	52.87	0.8929	-0.2676		-0.3076	0.172	41	1.8	111.840	
Q5	88.08	0.8479	-0.2596		-0.2648	0.176	42	2.5	201.558	
Q10	115.7	0.8253	-0.2579		-0.2443	0.185	45	3.2	274.258	
Q25	154.8	0.8026	-0.2585		-0.2243	0.199	48	3.9	379.203	
Q50	186.7	0.7885	-0.2599		-0.2124	0.211	52	4.3	465.742	
Q100	220.6	0.7764	-0.2616		-0.2023	0.223	55	4.6	558.699	
Q200	256.6	0.7656	-0.2636		-0.1935	0.235	58	4.8	658.107	
Q500	307.7	0.7530	-0.2662		-0.1833	0.252	63	5.0	800.613	

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By BAC Date 10/3/11 Client Usibelli Sheet 1 of 1

Chkd. By Description Magureite Creek Streamflow Analysis Job No. 1009161

AK Region 6 Streamflow Regression Analysis

2-year

$Q_2 = 52.87 A^{0.8929} (ST+1)^{-0.2676} (F+1)^{-0.3076}$

A = drainage area, mi^2 = 10.05 mi^2

ST = storage, % = 0 %

F = forest area, % = 70 %

$Q_2 = 52.87 (10.05)^{0.8929} (0+1)^{-0.2676} (70+1)^{-0.3076}$

$Q_2 = 111.8398$ cfs $\cong$ 111.8 cfs

50-year

$Q_{50} = 186.7 A^{0.7885} (ST+1)^{-0.2599} (F+1)^{-0.2124}$

$Q_{50} = 186.7 (10.05)^{0.7885} (0+1)^{-0.2599} (70+1)^{-0.2124}$

$Q_{50} = 465.742$ cfs $\cong$ 465.7 cfs

100-year

$Q_{100} = 220.6 A^{0.7764} (ST+1)^{-0.2616} (F+1)^{-0.2023}$

$Q_{100} = 220.6 (10.05)^{0.7764} (0+1)^{-0.2616} (70+1)^{-0.2023}$

$Q_{100} = 558.699 \cong 558.7$ cfs

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Attachment C:
HY8 Model

-DRAFT-
FOR CLIENT REVIEW

Culvert Summary Table - MCHR

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
84.50	84.50	2115.77	1.72	**1.87**	3-M1t	1.20	0.99	2.25	2.25	2.53	1.93
131.92	131.92	2116.41	2.32	**2.51**	3-M1t	1.61	1.32	2.88	2.88	3.09	2.21
179.34	179.34	2116.98	2.83	**3.08**	3-M1t	1.97	1.64	3.40	3.40	3.56	2.42
226.76	226.76	2117.50	3.31	**3.60**	3-M1t	2.28	1.93	3.86	3.86	3.98	2.59
274.18	274.18	2117.99	3.76	**4.09**	3-M1t	2.59	2.17	4.27	4.27	4.38	2.73
321.60	321.60	2118.45	4.18	**4.55**	3-M1t	2.88	2.42	4.64	4.64	4.75	2.86
369.02	369.02	2118.89	4.58	**4.99**	3-M1t	3.15	2.67	4.98	4.98	5.10	2.97
416.44	416.44	2119.31	5.00	**5.41**	3-M1t	3.42	2.88	5.30	5.30	5.44	3.07
463.86	463.86	2119.73	5.43	**5.83**	3-M1t	3.68	3.09	5.60	5.60	5.77	3.16
465.70	465.70	2119.74	5.45	**5.84**	3-M1t	3.69	3.09	5.61	5.61	5.78	3.16
558.70	558.70	2120.52	6.28	**6.62**	3-M1t	4.19	3.50	6.16	6.16	6.41	3.32

Display
- Crossing Summary Table
- Culvert Summary Table — MCHR
- Water Surface Profiles
- Improved Inlet Table
- Customized Table — Options...

Geometry
- Inlet Elevation: 2113.90 ft
- Outlet Elevation: 2109.70 ft
- Culvert Length: 220.04 ft
- Culvert Slope: 0.0191
- Inlet Crest: 0.00 ft
- Inlet Throat: 0.00 ft

Plot
- Crossing Rating Curve
- Culvert Performance Curve
- Selected Water Profile
- Water Surface Profile Data

Outlet Control: Profiles

Help | Flow Types... | Edit Input Data... | Energy Dissipation... | Export Report | Adobe PDF (*.pdf) | Close

HY8 Model Results

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FOR CLIENT REVIEW

Attachment D:
Riprap Calculations

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Client: *Usibelli*
Project: *MCHR Culvert Shear Stress Analysis*
Description: *The shear stress on the selected lining for the MCHR bed material*

Sheet: 1 **of** 1
Date: *10/17/2011*
Job No: *1009161*
By: *Brandon Coleman* **Chkd**

MCHR Bed Material Shear Stress Analysis

INPUT DATA		
Depth of Flow	**6.82**	ft
Specific Weight of Water	**62.4**	lb/ft^2
Specific Weight of Rock	**155**	lb/ft^2
Slope of Channel	**0.02**	ft/ft
Assumed D50 of Rock	**1**	ft

$\tau_d = \gamma d S_o$	8.51136	lb/ft^2	Maximum shear stress	
$V_x =$	4.39208	ft/s	Maximum Velocity	
$F^* = \tau_d/(\gamma_s-\gamma_w)d_s$	0.091915		Shield parameter, unitless	0.15
$Re = V_x D_{50}/\nu$	3.61E+05		Reynolds Number, unitless	
$\tau_p = \tau^* (\gamma_s-\gamma_w)D_{50}$	13.89	lb/ft^2	Permissible shear stress	

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Attachment E:
Figures

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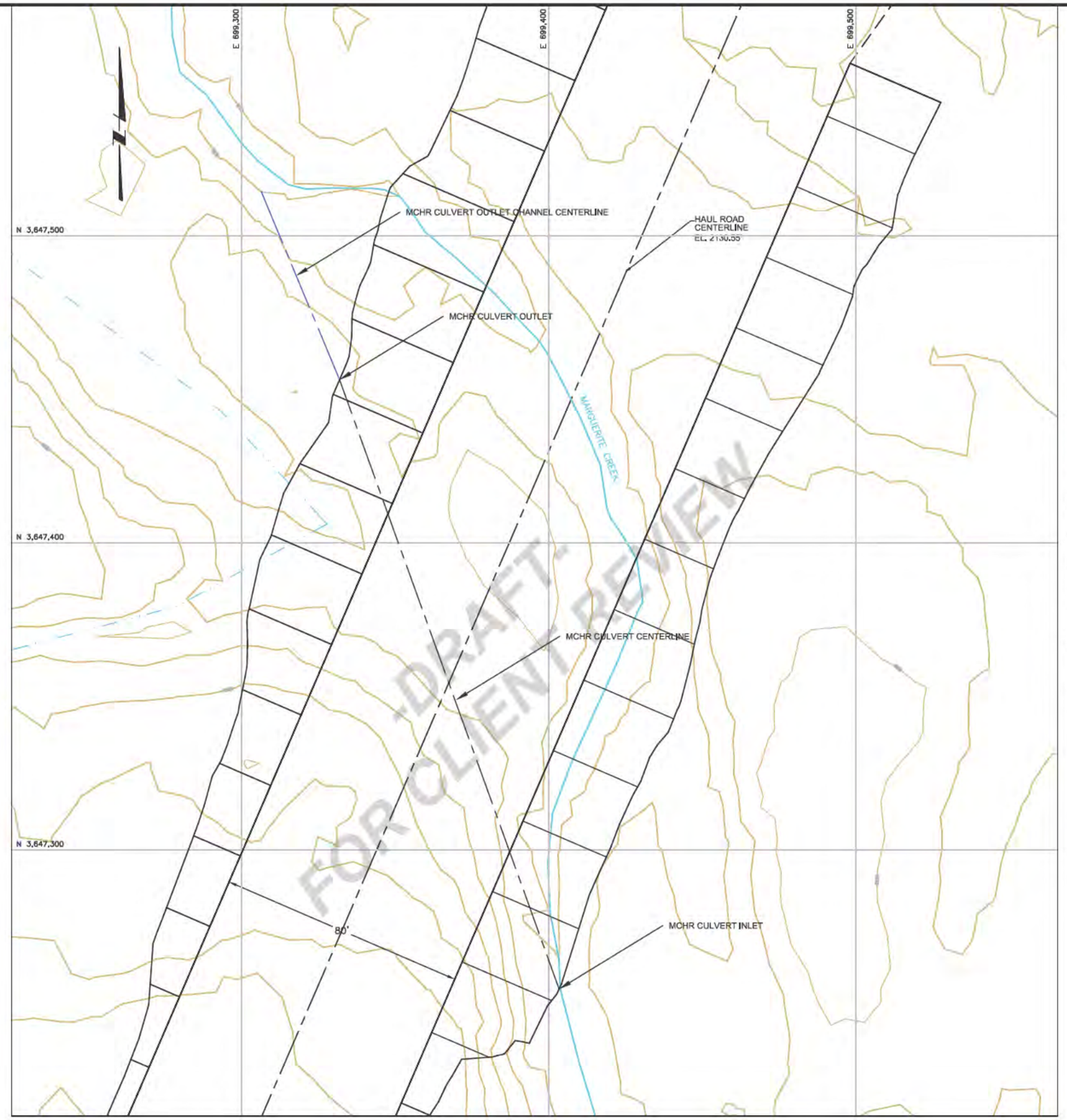

PLAN

SCALE

20' 0 20' 40'

CONTOUR INTERVAL = 2'

LEGEND:

- 2000 — APPROXIMATE EXISTING GROUND SURFACE CONTOUR AND ELEVATION, FEET
- ROAD
- NATURAL DRAINAGE
- MCHR CULVERT CENTERLINE

NOTES:

1. The existing slope of Marguerite Creek is approximately 1.4%.
2. The design slope of the culvert is 2.0%
3. The culvert is 15 ft diameter with the bottom 6 ft backfilled with suitable streambed material
4. The outlet channel will have a 15 ft bottom width, 2H:1V sideslopes, and 0.20% slope.
5. For a design profile of the culvert and outlet channel see Figure 2.

DRAFT 8/18/11

REV	DESCRIPTION	TECH	ENG	DATE
B	ADFG COMMENTS INCORPORATED	CHF	BC	08/16/11
A	DRAFT	CHF	LF	01/03/11

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DRAWN BY	C. FOWLER	01/03/11
CHECKED BY	B. COLEMAN	01/03/11
APPROVED BY		
PROJECT MANAGER		
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: USIBELLI COAL MINING CO.

PROJECT: MARGUERITE CREEK HAUL ROAD CROSSING

TITLE: CULVERT ALIGNMENT

MWH

FIGURE 1

REVISION B

FILE NAME 1009161D001

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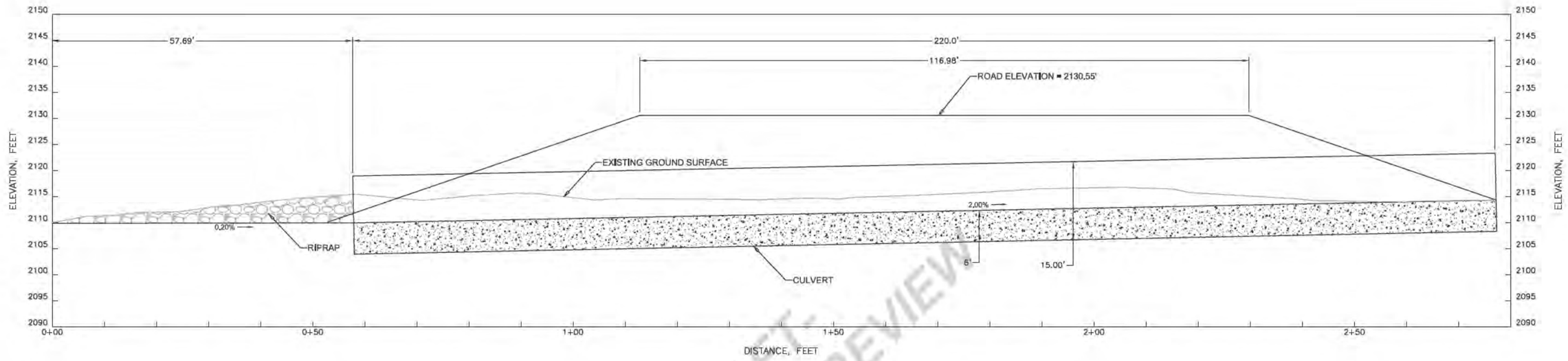
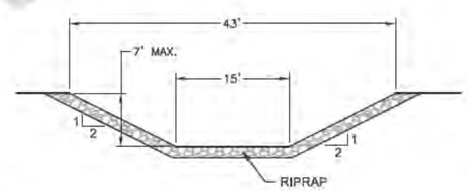


A CULVERT PROFILE

SCALE 10' 0 10' 20'



B TYPICAL OUTLET CHANNEL CROSS-SECTION

SCALE 10' 0 10' 20'

LEGEND:

- - - - - - - - EXISTING GROUND SURFACE

SUBSTRATE FOR CULVERT BURIAL

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DRAWN BY	C. FOWLER	01/03/11
CHECKED BY	B. COLEMAN	08/18/11
APPROVED BY		
PROJECT MANAGER		
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: USIBELLI COAL MINING CO.

PROJECT: MARGUERITE CREEK HAUL ROAD CROSSING

TITLE: CULVERT DETAILS

MWH

FIGURE: 2

REVISION: B

FILE NAME: 1009161D002

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SECTION 10.0

RECLAMATION PLAN

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10.0 RECLAMATION PLAN

10.1 GENERAL RECLAMATION PLAN

Reclamation of mining-related disturbance will occur as an integral part of ongoing mining operations. Reclamation of mine disturbance areas will focus on backfilling of mine pits, elimination of depressions that could impound significant quantities of water, establishment of stable post-mining slopes and drainage configurations, and establishment of a stable, self-sustaining vegetation community consistent with the proposed post-mining land use. The reclamation plan as outlined in the following sections will be implemented for all mine disturbance areas within the Jumbo Dome mine area permit boundary as shown on Plate D2-1, General Facility Arrangement, and for the collection and conveyance ditches as shown on plate D9-1, Drainage and Sediment Control Plan. The Jumbo Dome long-term haul road is proposed for retention as a post-mining feature and will be reclaimed in a manner that stabilizes road embankments and provides long-term use of the road.

The reclamation activities, practices, and considerations that will be implemented for mine disturbance areas within the Jumbo Dome Mine permit area, are described in the following sections:

- Post-mining Land Use
- Backfilling Operations
- Grading Plans
- Post-mining Topography
- Monitoring of Regraded Spoils
- Post-mining Drainage Control
- Topsoil Replacement
- Revegetation Plans
- Reclamation Timetable
- Reclamation Costs

An annual report will be submitted each year. It will give a brief overview of the mining, reclamation, and permit maintenance that took place during the previous year. The report will include the following:

MINING AND RECLAMATION: (To be submitted on map/table)

- Acres disturbed
- Acres backfilled and regraded (Phase I)
- Acres top-soiled, seeded, fertilized and drainage control constructed (Phase II)
- Areas planted with woody species (Phase III) (will only be texturally discussed)

TOPSOIL:

- Volume of topsoil salvaged
- Volume of topsoil replaced
- Volume of topsoil stockpiled
- Gross comparison of actual to original baseline estimated volumes

MISCELLANEOUS:

- Insurance-general liability on building
- Bond amount changes, if any
- Blasting notice
- Annual water quality report summary
- Table of cumulative list of major and minor revisions (to be supplied by DMWM to UCM)

The acreages will be totaled (and subtotaled, if appropriate) and marked by present year and cumulative life-of-mine. The map and/or tables will depict roads and exception areas to contemporaneous reclamation (see Plate D2-3, Reclamation Plan). The information will include results of the annual monitoring of vegetation for areas that have been planted but not yet approved for the Phase III bond release. The vegetation monitoring is not intended to have the rigor, statistical precision, nor formality required for bond release but is expected to require a lesser level of effort and give a general understanding of the progress toward the bond release standards.

10.2 PROPOSED POST-MINING LAND USE

Consistent with the pre-mining land use and the prevailing use of surrounding undeveloped lands, UCM proposes to reclaim mine disturbance areas within the Jumbo Dome mine area to the primary post-mining land use of wildlife habitat. Public recreation will be a related secondary land use. These proposed primary and secondary post-mining uses are consistent with the Tanana Basin Area Plan for State Lands.

To address the secondary land use component of public recreation, UCM is proposing to leave the Jumbo Dome long-term haul road in place after mining has been completed. This road will provide long-term public access to State land. The portions of the main Jumbo Dome haul road system that will be incorporated into the post-mining land use are depicted on Plate D10-1.

10.3 BACKFILLING OPERATIONS

Backfilling operations will generally occur concurrently with ongoing mine development and pit advance. Mine development and production spoil materials will be placed as backfill in excavated pit areas to achieve the final design post-mining configuration as shown on Plate D10-1, Approximate Final Reclamation Contours and Post-Mining Drainage Control Plan. Initial boxcut spoil will be placed in the out-of-pit spoil dumps depicted on Plate D5-1, Out Of Pit Spoil Pile Design. A detailed discussion of overburden and interburden excavation and disposal, including out-of-pit spoil placement, is presented in Section D5.0, Pit Excavation Plan.

The maximum distance between the active backfilled crest and the completed backfilling operations will be 600 feet (See Figure D2-1, Typical Cross Section for Mining and Reclamation). Within this backfilled area, certain in-pit roads and ramps will be left in place to provide continued access for coal removal operations within the advancing active pit areas. The in-pit roads that will be exceptions to the spatial distance criteria for backfilling operations are depicted on Plate D2-3, Reclamation Plan. These roads are needed for the natural progression of the mining operations. When the roads are no longer needed, they will be regraded and topsoil will be placed, followed by seeding.

Backfill handling and placement methods will vary depending on the type of mining equipment being utilized and the availability of backfill areas. For blast casting, controlled blasting will be

utilized to move overburden and interburden materials from the highwall to the spoil side of the pit. The mechanics of blast casting result in relatively high swell factors (bank to reconsolidated), and can be on the order of 20 to 35 percent. For truck/shovel operations, spoil material from the active working face will be hauled by rear-dump haulage trucks and placed as backfill behind the advancing pit, in other backfill areas such as road cuts or low areas, or in the out-of-pit spoil areas. Backfill placement will be either by end-dumping over the edge of the advancing backfill dump(s) or by dumping and spreading the spoil material on the surface of the dump(s). In some areas, truck/shovel methods will be utilized to pre-strip in advance of the dragline with backfilling and grading of the spoil ridges occurring concurrently during truck dump construction. Backfill placed by haul trucks will also consolidate under the weight of overlying spoils and normal truck traffic will result in additional compaction resulting in anticipated final swell factors ranging from 15 to 20 percent.

For dragline operations, spoil materials will be backfilled directly into the previous dragline cut by the dragline as it advances, resulting in a series of relatively uniformly spaced parallel spoil ridges. Dragline spoils will consolidate over time from the weight of overlying spoils resulting in final swell factors which are anticipated to range from 15 to 30 percent based on material characteristics and UCM's previous experience.

Given the fact that the recoverable coal seams will generally be mined from their outcrop and significant depths of overburden exist at the final pit limits, normal backfilling operations will result in effective coverage of any exposed coal seams. Analysis of overburden and interburden materials, as described in Part C, Chapter III, Overburden and Interburden Assessment, indicates that these materials are not potentially acid-forming, toxic-forming, or alkalinity-producing; therefore, no special handling or disposal measures are necessary.

10.4 GRADING PLAN

Once backfill levels approach the design post-mining configuration, final backfilling and grading will occur to establish the design configuration. For dragline operations, grading will involve the use of mobile equipment to level the spoil ridges and establish a uniform surface with major depressions eliminated. For truck/shovel operations, grading will occur in conjunction with final backfilling to establish the stable design configuration. Final graded slopes will be consistent

with the pre-mining slopes, and will not exceed 3H:1V. Generally, final regrading of backfilled areas and out-of-pit spoils will limit effective slopes to a maximum of 4H:1V; however, there may be a few select areas such as regraded slopes for cuts in virgin ground and individual sections of backfill slopes that will not exceed 3H:1V. Irregularities of rough backfilling will be allowed to form undulations in the finish regrade with 3H:1V maximum slope between undulations. Grading plans have been designed to assure long-term stability, eliminate significant depressions which could impound water and highwall exposures, establish undulations to minimize the erosion potential associated with long unbroken slopes, and incorporate permanent post-mining drainages in the final regraded configuration. Slight depressions will be left in the location of the ponds and in areas conducive to the reestablishment of wetlands. The final regraded surface will be left in a roughened condition to minimize runoff and promote a good bond between the regraded spoils and the replaced soil materials.

Reclamation of out-of-pit spoil piles will occur on a phased basis as spoil pile construction proceeds. Areas where spoil placement is no longer occurring, and which will not be affected by future spoil placement, will be regraded and reclaimed as soon as operationally feasible to minimize the total un-reclaimed mine disturbance area. The main haul road and facility areas will also be regraded to 3H:1V slopes or less to blend with surrounding undisturbed and reclaimed terrain. UCM proposes to retain this haul road to provide general post-mining access.

10.5 POST-MINING TOPOGRAPHY

The design post-mining topography is illustrated on Plate D10-1, Approximate Final Reclamation Contours and Post-mining Drainage Control Plan, and Plate D10-2, Cross Sections of Pre-mining and Post-mining Topography. The post-mining configuration has been designed consistent with all applicable regulatory requirements to restore mine disturbance areas to a stable configuration consistent with post-mining land uses. The post-mining configuration, as illustrated on Plate D10-1, is designed for elimination of significant depressions and highwall exposures, establishment of a stable configuration, re-establishment of an effective drainage configuration, and blending of regraded areas with surrounding undisturbed and reclaimed terrain. The post-mining configuration will include slight depressions to enhance re-establishment of wetlands. These depressions will be located at ponds JD-1 through JD-4 and

within areas that are conducive to the reestablishment of wetlands. The proposed post-mine configuration has a factor of safety greater than 1.3, based on site geotechnical analyses as referenced and described in Appendix D5-1 of Section D5.0.

10.6 MONITORING OF REGRADED SPOILS

Regraded mine disturbance areas, including spoil pile outslopes, will be visually monitored semi-annually during the first 3 years following completion of reclamation and then at least annually for the remainder of the reclamation liability period. In the annual report, an Engineer's inspection report will be inserted. Monitoring will focus on identification and characterization of any indications of significant surficial or mass instability or erosion such as slumps, depressions, displacement of vegetation, changes in watercourses, or excessive riling, gullies, or sedimentation. Geochemical characterization of overburden and interburden materials as discussed in Part C, Chapter III, Overburden and Interburden Assessment, indicates that these materials are not potentially acid-forming, toxic-forming, or alkalinity-producing; therefore, no monitoring of overburden suitability is planned.

If operational or other considerations preclude immediate topsoil replacement and revegetation for specific areas, UCM will monitor these areas on a more frequent basis to assure prevention of excessive rill or gully erosion. Monitoring of bare regraded spoil areas will occur after major precipitation events, and any excessive gully erosion that would impair topsoil placement will be repaired and stabilized in a timely manner. In certain cases, gully erosion may represent secondary drainage establishment. Where appropriate, such secondary drainages may be graded to tie into designed post-mining drainage channels, top soiled, and revegetated or lined with gravel.

10.7 POST-MINING DRAINAGE CONTROL PLAN

Reclamation of mine disturbance areas, including backfilling, regrading, topsoil replacement, and revegetation, is the primary mechanism for assuring effective control of post-mining drainage. The regraded configuration, as discussed in Sections D10.4 and D10.5 and illustrated by Plate D10-1, Approximate Final Reclamation Contours and Post-mining Drainage Control Plan, is designed with reduced slope gradients relative to the pre-mining condition and surface

undulations to minimize overland flow velocities and limit channelization of flow except in designed post-mining drainages. Grading along the contour, soil material replacement, surface preparation, and revegetation will all work together to minimize surface runoff and limit both runoff flows and surface erosion. The detailed sediment and drainage control plan for the first 5-year permit term is presented in Section D9.0.

The post-mining drainage configuration, as illustrated by Plate D10-1, has been designed to approximate the pre-mining drainage configuration and density as an integral component of the design post-mining topography. Permanent post-mining drainage channels will be designed to safely pass the peak flows resulting from the 10-year, 24-hour design storm with a minimum freeboard of 1.0 foot. Drainage channels outside of the active mining area will include berming of the available topsoil along the length of the ditch, gravel lining (where applicable), and temporary seeding for erosion control. Once they are no longer needed, the ditches will be regraded, the available topsoil re-spread, and final re-seeding will be completed. All channels were designed using SEDCAD+ computer model. The methodology, assumptions, and input parameters utilized in the channel designs are discussed in Appendix D9-1, Drainage and Sediment Control Plan, Methodology, and Assumptions. The SEDCAD+ computer printouts for the post-mining channel designs are presented in Appendix D10-1, Post-Mining Channels SEDCAD+ Computer Printouts. Each channel was designed for a range of slopes anticipated over the channel length. The results of the channel design are shown on Figure 10-1, Jumbo Dome Post-Mining Channel Design Summary. Where peak flow velocities are greater than 6 fps, riprap will be used to prevent channel degradation. Where riprap lining is not required 3-inch minus gravel will be used to line the channels.

The ponds used to contain the water runoff during mining are not permanent structures. Near the end of the bonding period, when water quality from the regraded mine area is such that they are no longer needed, the ponds will be drained and backfilled creating slight depressions to allow establishment of wetlands and drainage.

10.8 TOPSOIL REPLACEMENT

All topsoil material recovered from mine disturbance areas, including roads, sedimentation ponds, mining areas, and the out-of-pit spoil dump will either be stockpiled or directly replaced

on regraded areas. All topsoil will be removed from stockpiles at the completion of mining and replaced on regraded areas. From a sequencing standpoint, topsoil replacement operations will lag behind active backfilling and grading by up to 200 feet or approximately 800 feet from the active spoil crest (see Figure D2-1, Typical Cross-Section for Mining and Reclamation). This 200-foot buffer allows maneuvering room for the truck/shovel operation to continue dumping backfill up to the design post-mining grade.

Topsoil replacement will involve recovery of topsoil materials from either removal areas or stockpiles using dozers, front-end loaders or shovels, and haul trucks. The material will be replaced on backfilled and regraded areas using a dozer and/or grader and spread to a relatively uniform depth. As previously discussed in Section D3.4, UCM will replace a minimum of 12-inches of topsoil on all mine disturbance areas. Replaced topsoil will be left in a roughened condition to minimize wind and water erosion, increase surface moisture content, and to help hold and promote germination and establishment of seed. If compacted soils are a problem then the compacted area will be furrowed to help facilitate revegetation. Additional details relative to soil removal, storage, and replacement practices are provided in Section D3.0, Topsoil Handling.

10.9 REVEGETATION PLAN

10.9.1 Background

Following topsoil placement, all mine disturbance areas will be revegetated by seeding with a mixture of native and adaptive introduced species and planting a variety of woody plant species native to the area. Revegetation objectives are twofold. The first objective is to quickly establish a ground cover to control erosion. The second and primary revegetation objective is to encourage natural reinvasion of native vegetation to create diverse plant communities that are capable of supporting the post-mining land use of wildlife habitat. This second objective will be accelerated by planting native shrub species into the regraded areas.

10.9.2 Plantings

Mine reclamation areas will be seeded between May 15 and August 15 to facilitate seed germination and provide an adequate growing season for initial establishment and erosion control. The selected seed mixture is summarized on Table D10-1, Proposed Revegetation Seed

Mixture, and consists of a variety of species dominated by indigenous native grasses and contains no invasive species. Seed application rate will be approximately 43 pounds per acre. The selected species included in the revegetation seed mixture reflect UCM's reclamation experience over the past 25 years in the Healy area and the recommendations of the Alaska Plant Material Center. Reseeded areas will be fertilized at the time of seeding and in year 3 and 5, at a minimum, following seeding to encourage rapid initial establishment and long-term growth. Fertilizer application will be at a rate of 450 pounds of 20-20-10 fertilizer per acre. Adjustments will be made to the fertilizer schedule based on annual monitoring. In most cases, no surface preparation will be necessary prior to seeding since topsoil will be left in a roughened condition following placement; however, if excessive compaction in any area exists which would hinder seed germination and growth, the area will be furrowed prior to seeding. Both seed and fertilizer will be applied either aerially by fixed-wing aircraft or by mechanical broadcasting using a low-ground-pressure all - terrain vehicle.

TABLE D10-1 PROPOSED REVEGETATION SEED MIX

Common Name	***Percent of Seed Mix***
'Wainwright' Slender Wheatgrass	*10%*
'Nortran' Tufted Hairgrass	*10%*
'Arctared' Fescue	*30%*
'Boreal' Red Fescue	*25%*
Annual Ryegrass	*10%*
Durar Hard Fescue	15%
Total	***100%***

A variety of native woody plant species including felt-leaf willow, alder, and white spruce, will be transplanted in reclamation areas. Transplanting activities will be scheduled for June through August in order to take advantage of warmer conditions and increased soil moisture levels. Planting materials will include bare-root stock, cuttings, and tubeling transplants with ongoing evaluation of success rates for the various types of planting stock. Woody transplants will be established in clumps distributed over the reclaimed area to encourage effective propagation and provide an initial vegetative culture to support future natural seeding and reinvasion. Plantings will vary in shape and location to take advantage of favorable slope and aspect conditions including wet areas, water drainage embankments for willow and cottonwood and drier areas for birch and spruce where feasible.

Irrigation may be used to facilitate revegetation efforts.

10.9.3 Monitoring

The annual report to DNR-DMLW will give an updated summary of UCM revegetation efforts. When a sampling unit becomes a candidate for bond release, additional vegetation monitoring will be implemented. Results from this monitoring will give the option of adjusting the planting schedule if it appears that bond release criteria will not be achieved over the next 3-5 years.

The following bond release standards are proposed:

Erosion Control Standard

An erosion control standard of 70% ground cover which includes live vegetation, dead vegetative mat, incidental woody debris, stones or gravel and litter in quantities that will resist erosion.

UCM may request that DNR-DMLW allow a lower standard in those areas where a lesser cover will control erosion and allow faster regeneration. Examples might include flat slopes or scarified areas downwind of planted seedlings.

The 70% standard is based on professional judgment as a value high enough to control erosion in the Jumbo Dome area including slopes that are predominantly 4H:1V. It is an accepted fact that

the higher the grass cover the lower the natural reinvasion of native species into newly seeded area. A lower standard would result in faster natural revegetation but would risk greater erosion.

Woody Vegetation Standard

An average of 450 woody stems per acre on at least two-thirds of any area for which bond release is requested. To be counted, each stem must be at least 8 inches tall, except for spruce and dwarf birch which may be 4 inches tall.

The standard is chosen to represent a level of stem establishment that indicates natural revegetation is occurring at a rate that will produce a permanent native vegetation community over time. It is adapted from the Division of Forestry Reforestation standard for Region II (Interior Boreal Forest).

The reasoning for the standard applying to two-thirds of the area is to recognize the benefits of diversity. Up to one-third of the area may be open areas/grassland which, if disturbed throughout the area, will provide edge effect and provide more valuable habitat than a uniform vegetation community, even if that community is internally diverse.

Diversity Standard

In each area requested for bond release, at least three woody species must be present with at least 20% of the density being made up of at least two species.

10.9.4 Bond Release Methodology

The following bond release methodology will apply to any request for final bond release unless another methodology is mutually agreed by UCM and the Department of Natural Resources.

1. Outline the boundary of a bond release area**.** UCM will, whenever practical, request bond release for logical units. Examples might include a completed out-of-pit spoil pile, or all reclaimed areas within a 100-acre area or within a five-year permit term. Because exact areas cannot be specified in advance(i.e., at the time of their permit application), UCM will jointly agree on bond release areas with the Department before bond release is requested.

2. Outline 2/3 of the acreage to which the woody shrub and the diversity standards apply. The woody shrub standard applies to 2/3 of any area on which final bond release is requested. The 1/3 of the area that is outside this standard may be outlined any time up to the time that final bond release is requested. The 1/3 area on which the standard does not apply may be in one part of the bond release unit, or be broken up into smaller areas spread throughout the unit. Distributing the non-woody shrub areas will serve to help spread out the edge effect and diversity for which the standard was devised.

3. Site Visit by the Department**.** After the two steps above have been completed, representatives of UCM and the Department will walk the area proposed for bond release. Cover will be measured using the method referenced for foliage cover in the *Pre-mining Vegetation Inventory, Hoseanna Creek Basin, Usibelli Coal Mine; November 1, 1992*. Dot Helms (p 8-9). Or any similar and generally accepted method of measuring ground cover.

4. Establish sampling units for the erosion control standard (i.e., to measure ground cover) throughout the area proposed for bond release. Sampling units may be located in any method designed to achieve random distribution throughout the area proposed for bond release. Cover will be measured using the method referenced for foliage cover in the *Pre-mining Vegetation Inventory, Hoseanna Creek Basin, Usibelli Coal Mine; November 1, 1992.* Dot Helms (p 8-9). Or any similar and generally accepted method of measuring ground cover.

5. Establish sampling units to measure the number and type of woody stems in 2/3 of the acreage to which the woody shrub and diversity standards apply. As with sampling units for the erosion control standard, sampling units may be located by any method designed to achieve random distribution throughout the area proposed for bond release.

- Within randomly established plots of a standard size, all woody stems greater than eight inches (and spruce and dwarf birch greater than four inches) will be counted and characterized by species.
- Bond release will not be requested unless all sampling units have a minimum of 100 woody stems.
- All stems growing from a single “clump” will be counted as a single stem.

10.9.5 Statistical Tests

Simple statistical tests may be necessary to determine whether the erosion control and woody stem standards have been met. The diversity standard is tested by directly comparing the total woody stem counts by species with the diversity standard. If the data distributions are skewed, then transformations such as logarithmic and arc sin will be considered.

With respect to the erosion control standard, measurements will be made on at least 10 sampling units to determine whether ground cover meets the erosion control standard. Measurements will also be made on at least 10 sampling units for woody density and diversity standards. Because the erosion control standard applies to the entire area requested for bond release, and woody vegetation and diversity standards apply to only two-thirds of the area, all sampling units will not be the same.

The following tests will be used to determine whether the criteria have been met.

<u>Number of Sampling Units</u> – For these tests, the minimum number of sampling units to be sampled will be determined according to the formula below:

$$nmin = t^2 s^2 /(dxave)^2$$

Where nmin = Minimum number of sampling units in the bond release request; t = t-value for a one-tailed t-test for 90% confidence and n-1 degrees of freedom s = standard deviation of the observations from each sampling unit (cover, number of stems) xave = arithmetic mean of the observations from each sampling unit (cover, number of stems) d = percentage of mean required for adequacy of sampling = 10% (0.1) for cover and 20% (0.2) for stocking.

<u>Comparison against the standards (ground cover, number of woody stems)</u> – The results from the sampling units will be compared against the standard using the formula below:

$$tn - 1 \leq \underline{(xave - xstd)} (s/\sqrt{n})$$

Where t = t-value for a one-tailed t-test with a 0.1 alpha error and n-1 degrees of freedom, xave =

arithmetic mean of the individual sampling units (cover,number of stems), xstd = 11 AAC 90.457(b) provides that success is achieved at 90% of the cover and stocking standards; therefore: xstd for the number of woody stems is 90% of 450 or 405 stems/acre xstd for ground cover is 90% of 65% or 58.5% (.585).

s = standard deviation of the sampling units

n = the number of sampling units

If, for each standard, the number of sampling units is greater than or equal to nmin as calculated above, and the calculated t-value is less than or equal to the standard value as indicated above, the appropriate standard (erosion control or woody vegetation density) will be considered to be achieved.

The diversity standard is tested directly comparing the total woody stem counts by species with the diversity standard. The test either passes or fails, and no more elaborate statistics are necessary.

10.10 RECLAMATION OF SUPPORT FACILITIES

The following support facilities will be reclaimed as part of the reclamation of the Jumbo Dome Mine.

- Explosive Storage Facilities - These facilities would include magazines and tanks for storage of explosives, blasting agents and blasting accessories. Magazines typically used for this purpose are skid mounted and would simply be removed at the end of mining.
- Powerline - The overhead electrical transmission line providing power to run the dragline and other mine facilities will be removed when no longer needed for mining. The substation and associated facilities would also be removed at the same time.
- The shop building and fuel storage tanks will be removed and the facilities pad will be regarded to blend into the surrounding terrain.

Reclamation of all support facilities will include removal of the facilities, clean up of the area to remove all trash and debris, grading as appropriate, topsoil and revegetation in accordance with the revegetation plan in Section D10.9.

10.11 RECLAMATION TIMETABLE

As previously noted in Section D10.1, reclamation will occur as an integral part of ongoing mining operations. Generally, reclamation will occur contemporaneously with progressive mining with backfilling and grading occurring in sequence with mining advance. By the end of the first 5-year permit term, approximately 131 acres, or roughly 27% of the area disturbed during the first 5 years of mining is scheduled to be reclaimed.

Under normal conditions, backfilling and grading will lag the active spoil crest by no more than 600 feet, with a 200-foot buffer zone between the leading edge of the final grading area and the topsoil replacement limit as illustrated by Figure D2-1, Typical Cross-Section for Mining and Reclamation. Areas where this will not be true are identified on Plate D2-3 (Reclamation Plan). These areas are relatively small and must remain open for extended periods during active mining to provide access for ongoing and future mining and reclamation operations. They will ultimately be reclaimed when no longer needed.

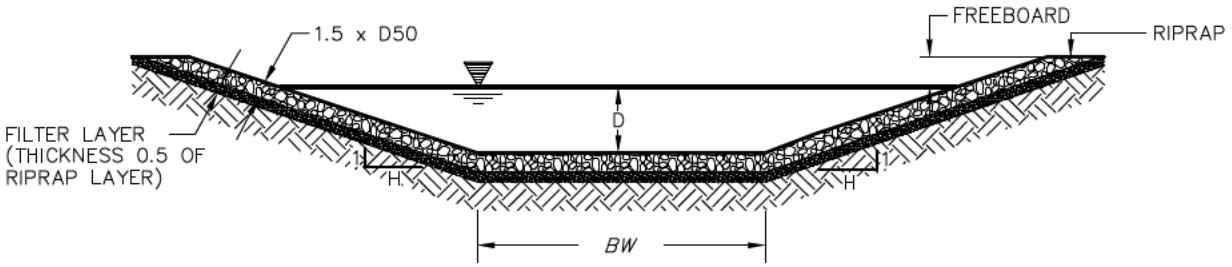
10.12 RECLAMATION COSTS

During the first 5-year permit term, the maximum reclamation cost for early closure will occur at the end of year 5. Table D10-2 provides a breakdown of the reclamation cost estimate at the end of year 5 and includes direct, indirect, and subcontractor costs. This cost estimate includes funds for removing the facilities and regarding, topsoiling and revegetating the disturbed area. A detailed breakdown of the cost estimate of the Reclamation Bond can be found in Appendix D10.2.

TABLE D10-2 JUMBO DOME RECLAMATION BOND COST ESTIMATE	
DIRECT COST ITEMS	**YEARS 1-2**
Earthmoving	$2,885,000
Revegetation (Seed Bed Prep.)	$22,000
Aerial Seeding & Fertilizing	$234,000
Facility Removal	$232,000
TOTAL DIRECT COSTS	$3,372,000
INDIRECT COST ITEMS	
Mobilization & Demobilization @ 4.0%	$135,000
Contingency Allowance @ 4.0%	$135,000
Engineering Redesign Fee @ 4.0%	$135,000
Contractor Profit & Overhead @ 15.0%	$506,000
Reclamation Management Fee @ 4.0 %	$67,000
TOTAL INDIRECT COSTS	$978,000
TOTAL	$4,350,000

FIGURE D10-1

JUMBO DOME POST-MINING CHANNEL DESIGN SUMMARY



TYPICAL RIPRAP LINED CHANNEL

Channel	Flow Q (cfs)	Slope (%)	Bottom Width (BW) (ft)	SIDESLOPE H:1V (ft)	Depth of Flow (D) (ft)	Velocity (fps)	Freeboard (ft)	Total Depth (ft)	Rip Rap (in)
PMC-1	55.36	8.4	5	3	0.95	7.48	1.0	1.95	9
PMC-2	114.74	8.4	5	3	1.41	8.82	1.0	2.41	12
PMC-3	24.85	9.2	5	3	0.59	6.29	1.0	1.59	6
PMC-4 L	94.47	6.1	10	3	0.99	7.36	1.0	1.99	9
PMC-4	88.2	10.7	10	3	0.85	8.27	1.0	1.85	12
PMC-5	185.4	6.9	5	3	1.85	9.54	1.0	2.85	12
PMC-6	18.0	7.3	5	3	0.52	5.34	1.0	1.52	6
PMC-7	116.1	10.8	10	3	1.02	8.77	1.0	2.02	14
PMC-8	34.33	11.4	10	3	0.70	6.97	1.0	1.7	10
PMC-9	31.5	4.5	5	3	0.77	5.64	1.0	1.77	6
PMC-9 L	170.3	6.6	5	3	1.78	9.25	1.0	2.78	12

REV. No.	DESCRIPTION OF REVISION	BY	DATE
	DRAFT FOR REVIEW	BAC	12/09

MWH

DESIGNED: B.COLEMAN
DRAWN: B.COLEMAN
CHECKED: T.LEIDICH
DATE: 12/09

PROJECT:

DRAWING: JUMBO DOME MINE
PMT CHANNEL SUMMARY

REVISION: 0
PROJECT NUMBER: 1005742
Figure No.: D10-1

APPENDIX D10-1

POST MINE CHANNEL DESIGN AND SUMMARY

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Post Mine Channel 1 (PMC-1)

Bandon Coleman

MWH
1801 California St.
Ste. 2900
Denver, CO 80202

Phone: (303) 291-2222
Email: brandon.a.coleman@mwhglobal.com

General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	10 yr - 24 hr
Rainfall Depth:	2.000 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	PMC-1

#1
Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	128.200	128.200	55.36	8.60

Structure Detail:

Structure #1 (Null)

PMC-1

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	128.200	0.269	0.000	0.000	86.000	F	55.36	8.602
	Σ	**128.200**						**55.36**	**8.602**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	33.33	100.00	300.00	4.610	0.018
		6. Grassed waterway	17.66	800.00	4,530.01	6.300	0.199
		8. Large gullies, diversions, and low flowing streams	8.43	140.00	1,660.02	8.710	0.052
#1	**1**	**Time of Concentration:**					**0.269**

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Post Mine Channel 2 (PMC-2)

Bandon Coleman

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1801 California St.
Ste. 2900
Denver, CO 80202

Phone: (303) 291-2222
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General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	10 yr - 24 hr
Rainfall Depth:	2.000 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	PMC-2

#1
Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	283.500	283.500	114.74	18.96

Structure Detail:

Structure #1 (Null)

PMC-2

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	283.500	0.317	0.000	0.000	86.000	F	114.74	18.964
	Σ	**283.500**						**114.74**	**18.964**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	33.33	100.00	300.00	4.610	0.018
		6. Grassed waterway	28.00	1,725.00	6,160.01	7.930	0.215
		8. Large gullies, diversions, and low flowing streams	8.36	220.00	2,630.00	8.670	0.084
#1	**1**	**Time of Concentration:**					**0.317**

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Post Mine Channel 3 (PMC-3)

Post Mine Channel 4 (PMC-4)

Post Mine Channel 4 Lower (PMC-4 Lower)

Bandon Coleman

MWH
1801 California St.
Ste. 2900
Denver, CO 80202

Phone: (303) 291-2222
Email: brandon.a.coleman@mwhglobal.com

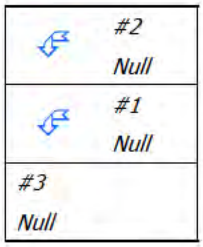
General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	10 yr - 24 hr
Rainfall Depth:	2.000 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#3	0.000	0.000	PMC-3
Null	#2	==>	#3	0.000	0.000	PMC-4
Null	#3	==>	End	0.000	0.000	PMC-4 Lower



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#2	220.900	220.900	88.20	14.80
#1	36.700	36.700	24.85	2.59
#3	0.000	257.600	94.47	17.39

Structure Detail:

Structure #2 (Null)

PMC-4

Structure #1 (Null)

PMC-3

Structure #3 (Null)

PMC-4 Lower

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	220.900	0.328	0.000	0.000	86.000	F	88.20	14.800
	Σ	**220.900**						**88.20**	**14.800**
#1	1	36.700	0.108	0.000	0.000	86.000	F	24.85	2.594
	Σ	**36.700**						**24.85**	**2.594**
#3	Σ	**257.600**						**94.47**	**17.395**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	33.33	100.00	300.00	4.610	0.018
		6. Grassed waterway	16.22	60.00	370.00	6.040	0.017
		8. Large gullies, diversions, and low flowing streams	9.17	220.00	2,400.01	9.080	0.073
#1	**1**	**Time of Concentration:**					**0.108**
#2	1	3. Short grass pasture	33.33	100.00	300.00	4.610	0.018
		6. Grassed waterway	19.27	740.00	3,840.00	6.580	0.162
		8. Large gullies, diversions, and low flowing streams	10.69	560.00	5,240.01	9.800	0.148
#2	**1**	**Time of Concentration:**					**0.328**

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Post Mine Channel 5 (PMC-5)
Post Mine Channel 6 (PMC-6)

Bandon Coleman

MWH
1801 California St.
Ste. 2900
Denver, CO 80202

Phone: (303) 291-2222
Email: brandon.a.coleman@mwhglobal.com

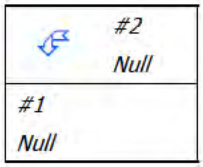
General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	10 yr - 24 hr
Rainfall Depth:	2.000 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	PMC-5
Null	#2	==>	#1	0.000	0.000	PMC-6



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#2	35.800	35.800	18.01	2.44
#1	551.800	587.600	185.43	39.14

Structure Detail:

Structure #2 (Null)

PMC-6

Structure #1 (Null)

PMC-5

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#2	1	35.800	0.143	0.000	0.000	86.000	F	18.01	2.440
	Σ	**35.800**						**18.01**	**2.440**
#1	1	551.800	0.531	0.000	0.000	86.000	F	176.51	36.700
	Σ	**587.600**						**185.43**	**39.140**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	33.33	100.00	300.00	4.610	0.018
		6. Grassed waterway	26.07	1,950.00	7,480.00	7.650	0.271
		8. Large gullies, diversions, and low flowing streams	6.86	470.00	6,850.01	7.850	0.242
#1	**1**	**Time of Concentration:**					**0.531**
#2	1	3. Short grass pasture	20.00	50.00	250.00	3.570	0.019
		6. Grassed waterway	11.15	175.00	1,570.01	5.000	0.087
		8. Large gullies, diversions, and low flowing streams	7.27	80.00	1,100.00	8.090	0.037
#2	**1**	**Time of Concentration:**					**0.143**

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Post Mine Channel 7 (PMC-7)

Post Mine Channel 8 (PMC-8)

Post Mine Channel 9 (PMC-9)

Post Mine Channel 9 Lower (PMC-9 Lower)

Bandon Coleman

MWH
1801 California St.
Ste. 2900
Denver, CO 80202

Phone: (303) 291-2222
Email: brandon.a.coleman@mwhglobal.com

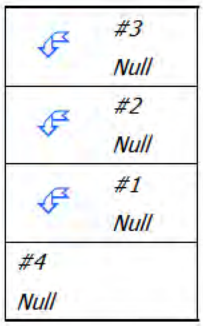
General Information

Storm Information:

Storm Type:	NRCS Type I
Design Storm:	10 yr - 24 hr
Rainfall Depth:	2.000 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	#4	0.000	0.000	PMC-7
Null	#2	==>	#4	0.000	0.000	PMC-8
Null	#3	==>	#4	0.000	0.000	PMC-9
Null	#4	==>	End	0.000	0.000	PMC-9 Lower



Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#3	66.500	66.500	31.49	4.44
#2	50.700	50.700	34.33	3.58
#1	273.300	273.300	116.06	18.25
#4	31.900	422.400	170.34	28.44

Structure Detail:

Structure #3 (Null)

PMC-9

Structure #2 (Null)

PMC-8

Structure #1 (Null)

PMC-7

Structure #4 (Null)

PMC-9 Lower

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#3	1	66.500	0.202	0.000	0.000	86.000	F	31.49	4.444
	Σ	**66.500**						**31.49**	**4.444**
#2	1	50.700	0.119	0.000	0.000	86.000	F	34.33	3.584
	Σ	**50.700**						**34.33**	**3.584**
#1	1	273.300	0.280	0.000	0.000	86.000	F	116.06	18.254
	Σ	**273.300**						**116.06**	**18.254**
#4	1	31.900	0.182	0.000	0.000	86.000	F	15.66	2.164
	Σ	**422.400**						**170.34**	**28.445**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	47.17	125.00	265.00	5.490	0.013
		6. Grassed waterway	28.39	1,570.00	5,530.01	7.990	0.192
		8. Large gullies, diversions, and low flowing streams	10.84	290.00	2,675.00	9.870	0.075
#1	**1**	**Time of Concentration:**					**0.280**
#2	1	3. Short grass pasture	18.87	50.00	265.00	3.470	0.021
		6. Grassed waterway	23.78	440.00	1,850.00	7.310	0.070
		8. Large gullies, diversions, and low flowing streams	11.43	120.00	1,050.00	10.140	0.028
#2	**1**	**Time of Concentration:**					**0.119**
#3	1	3. Short grass pasture	21.67	65.00	300.00	3.720	0.022
		6. Grassed waterway	25.81	520.00	2,015.00	7.620	0.073
		8. Large gullies, diversions, and low flowing streams	4.48	110.00	2,455.02	6.350	0.107
#3	**1**	**Time of Concentration:**					**0.202**
#4	1	3. Short grass pasture	15.00	45.00	300.00	3.090	0.026
		6. Grassed waterway	8.81	145.00	1,645.01	4.450	0.102
		8. Large gullies, diversions, and low flowing streams	6.64	100.00	1,505.00	7.730	0.054
#4	**1**	**Time of Concentration:**					**0.182**

Table D10-1. Jumbo Dome Channel Design Summary

RIPRAP DESIGN - SAFETY FACTORS METHOD

DATE: October 22, 2009
PROJECT: Usibelli Jumbo Dome Channels
OBJECTIVE: Estimate riprap size in drainage channels
CALCULATIONS BY: Brandon Coleman, E.I.T.

INPUT PARAMETERS						RIPRAP SIZING - FHA METHODOLOGY (Stability Factor = 1.2)							CALCULATED CHANNEL PARAMETERS					
Channel ID	Channel Slope (ft/ft)	Bottom Width (ft)	Side Slope "z"H:1V (ft)	Design Flow (cfs)	Recommended Riprap (in)	Calculated D50 (in)	Specific Gravity of rock, SG	Correction Factor	Angle of Repose, (deg)	sin	sin	K1	Estimated Manning's n	Depth of Flow (ft)	Wetted Perimeter (ft)	Flow Area (sq ft)	Flow Velocity (ft/s)	Froude Number
PMC-1	0.0843	5	3	55.36	9	6.24	2.65	1.00	42.00	0.32	0.67	0.88	0.0448	0.945	10.98	7.40	7.48	1.58
PMC-2	0.0836	5	3	114.74	12	8.37	2.65	1.00	42.00	0.32	0.67	0.88	0.0467	1.410	13.92	13.01	8.82	1.58
PMC-3	0.0917	5	3	24.85	6	4.72	2.65	1.00	42.00	0.32	0.67	0.88	0.0427	0.585	8.70	3.95	6.29	1.63
PMC-4 Lower	0.0609	10	3	94.47	9	5.81	2.65	1.00	42.00	0.32	0.67	0.88	0.0427	0.990	16.26	12.84	7.36	1.44
PMC-4	0.1069	10	3	88.20	9	8.89	2.65	1.00	42.00	0.32	0.67	0.88	0.0464	0.850	15.38	10.67	8.27	1.73
PMC-5	0.0686	5	3	185.43	12	9.27	2.65	1.00	42.00	0.32	0.67	0.88	0.0453	1.845	16.67	19.44	9.54	1.53
PMC-6	0.0727	5	3	18.01	6	3.08	2.65	1.00	42.00	0.32	0.67	0.88	0.0413	0.515	8.26	3.37	5.34	1.46
PMC-7	0.1084	10	3	116.06	12	9.70	2.65	1.00	42.00	0.32	0.67	0.88	0.0485	1.015	16.42	13.24	8.77	1.70
PMC-8	0.1143	5	3	34.33	9	5.90	2.65	1.00	42.00	0.32	0.67	0.88	0.0469	0.695	9.40	4.92	6.97	1.68
PMC-9	0.0448	5	3	31.49	6	2.98	2.65	1.00	42.00	0.32	0.67	0.88	0.0385	0.765	9.84	5.58	5.64	1.30
PMC-9 Lower	0.0664	5	3	170.34	12	8.62	2.65	1.00	42.00	0.32	0.67	0.88	0.0451	1.780	16.26	18.41	9.25	1.51

Robinson Method was used for sizing riprap on slopes steeper than 10%
1. A SG of 2.65 was used for riprap analysis

APPENDIX D10-2

DETAIL RECLAMATION BOND COST CALCULATIONS

Summary of Jumbo Dome 2011 Reclamation Bond Costs

First Five Year Term

Direct Cost Items			
Earthmoving/Drain Construction		$	2,884,975
Revegetation (seed bed prep)		$	21,558
Aerial Seeding & Fertilizing		$	233,545
Facility Removal		$	231,500
Subtotal Direct Costs		**$**	**3,371,578**
Indirect Cost Items			
	(percent)		
Mobilization & Demobilization	4.0	$	134,863
Contingency Allowance	4.0	$	134,863
Engineering Redesign Fee	4.0	$	134,863
Contracor Profit & Overhead	15.0	$	505,737
Reclamation Management Fee	2.0	$	67,432
Subtotal Indirect Costs		**$**	**977,758**
Grand Totals		**$**	**4,349,336**

Summary Calculation of Earthmoving Costs
1st Term - Mining

Task	Equipment	Operating Costs	Labor Costs	Unit Cost	Total Hours	Quantity BCY	Sub Total
Regrade	D10R Bulldozer	$266.00	$52.24		2,956	1,162,148	$940,642
Drill and Blast				$ 0.30		966,667	$290,000
Topsoil Respread				$1.75		579,671	$1,014,424
Roads	D8R Bulldozer	146.75	$52.24		46		$352,646
Drainage Construction	D8R Bulldozer	$146.75	$52.24		470		$93,486
	966 Loader	$101.00	$52.24		265		$40,609
	15 CY Truck	$115.67	$52.24		265		$44,497
	Riprap Screened			$8.00		7950	$63,600
	Labor Tasks		$52.24		153		$7,973
	Geocloth			$1.75		21,200	$37,100
					TOTAL		**$2,884,975**

Summary Calculation of Earthmoving Costs
1st Term - Mining

Task	Equipment	Operating Costs	Labor Costs	Unit Cost	Total Hours	Quantity BCY	Sub Total
Regrade	D10R Bulldozer	$266.00	$52.24		2,956	1,162,148	$940,642
Drill and Blast				$ 0.30		966,667	$290,000
Topsoil Respread				$1.75		579,671	$1,014,424
Roads	D8R Bulldozer	146.75	$52.24		46		$352,646
Drainage Construction	D8R Bulldozer	$146.75	$52.24		470		$93,486
	966 Loader	$101.00	$52.24		265		$40,609
	15 CY Truck	$115.67	$52.24		265		$44,497
	Riprap Screened			$8.00		7950	$63,600
	Labor Tasks		$52.24		153		$7,973
	Geocloth			$1.75		21,200	$37,100
					TOTAL		**$2,884,975**

Equipment Costs (input by DNR)

Dataquest Guide	Dataquest	AK factor	subtotal	Fuel (g/hr)	$/gal	$/hr	TOTAL
D10R Bulldozer (w/EROPS*)	$ 152.00	1.25	$ 190.00	20	3.8	$76.00	**$266.00**
D8R Bulldozer (w/EROPS)	$ 87.00	1.25	$ 108.75	10	3.8	$38.00	**$146.75**
966F Loader	$ 58.00	1.25	$ 72.50	7.5	3.8	$28.50	**$101.00**
15 cy Truck	$ 74.86	1.20	$ 89.83	6.8	3.8	$25.84	**$115.67**

Jumbo Dome Drain Costs

Cut Terrace Drain, Lay Geocloth, Screen and Haul and Spread Riprap

	Amount	Rate (units per hr)	Rip-Rap BCY	Cloth	Labor	D8N	Loader	Truck
Cut Drain	10,600 LF	125				84.8		
Lay Cloth	Assume coverage of 2 sq. yd. Per ft of ditch							
	10,600 LF	325		21,200 sq. yd.	33			
Rip-Rap	Assume an average coverage rate of 0.75 BCY per LF ditch							
	10,600 LF	30	7,950			265	265	265
	**See UCM Backup Calculation for Riprap Support production cost of $8 per BCY							
	***See Morrison-Knudsen Riprap Caluclation (Backup Data)							
	Haul 3720 CY of Riprap With 15 CY Truck							
	Assume a Production Rate of 30 CY/Hr. with 966 Loader and 15 CY truck							
	Spread Riprap With D8N Dozer Hours							
Pond Regrade	Settling Pond Regrade (only include removal of decants)							
	3	40 hr per unit			120	120		
Totals			**7950**	**21,200 sq. yd.**	**153**	**470**	**265**	**265**

Drainage subcalcs (back-calculate to find 2002 assumptions)

Given:

LF Ditch	8200
D8 Hrs	238
BCY Rip-Rap	3720
LF Cloth	5,000
Loader Hours	124
Truck Hours	124

Calculated Assumptions:	**2002**	**Use in 2004**
Dozer rate (LF/Hr)	34.5	125.0
Rip-Rap Req'd (BCY/ft)	0.5	0.75
Loader/Truck/Spread Rate (BCY/Hr)	30.0	30.0
Geocloth (Sq. Yd. per LF ditch)	0.6	2

Jumbo Dome Revegetation Costs		
Total Disturbed Area (Acres)		359.3
Subcontract Costs		
Aerial Seeding & Fertilizing	$650 /acre	$233,545
Direct Cost		
Seedbed Preparation	$60 /acre	$21,558
Total Costs		$255,103

Jumbo Dome Facilities Removal				
Powerline Removal				
Ft		2500		
$ per ft	$	6.00	$	15,000.00
Substation				
Remove skid mounted equipment			$	3,700.00
Shop				
Cu Ft		640,000		
$ per cuft	$	0.33	$	211,200
Powder Magazine - Structure Removal			$	1,600.00
Total Costs			$	231,500.00

**Acreage under facilities included in revegetation calculations elsewhere

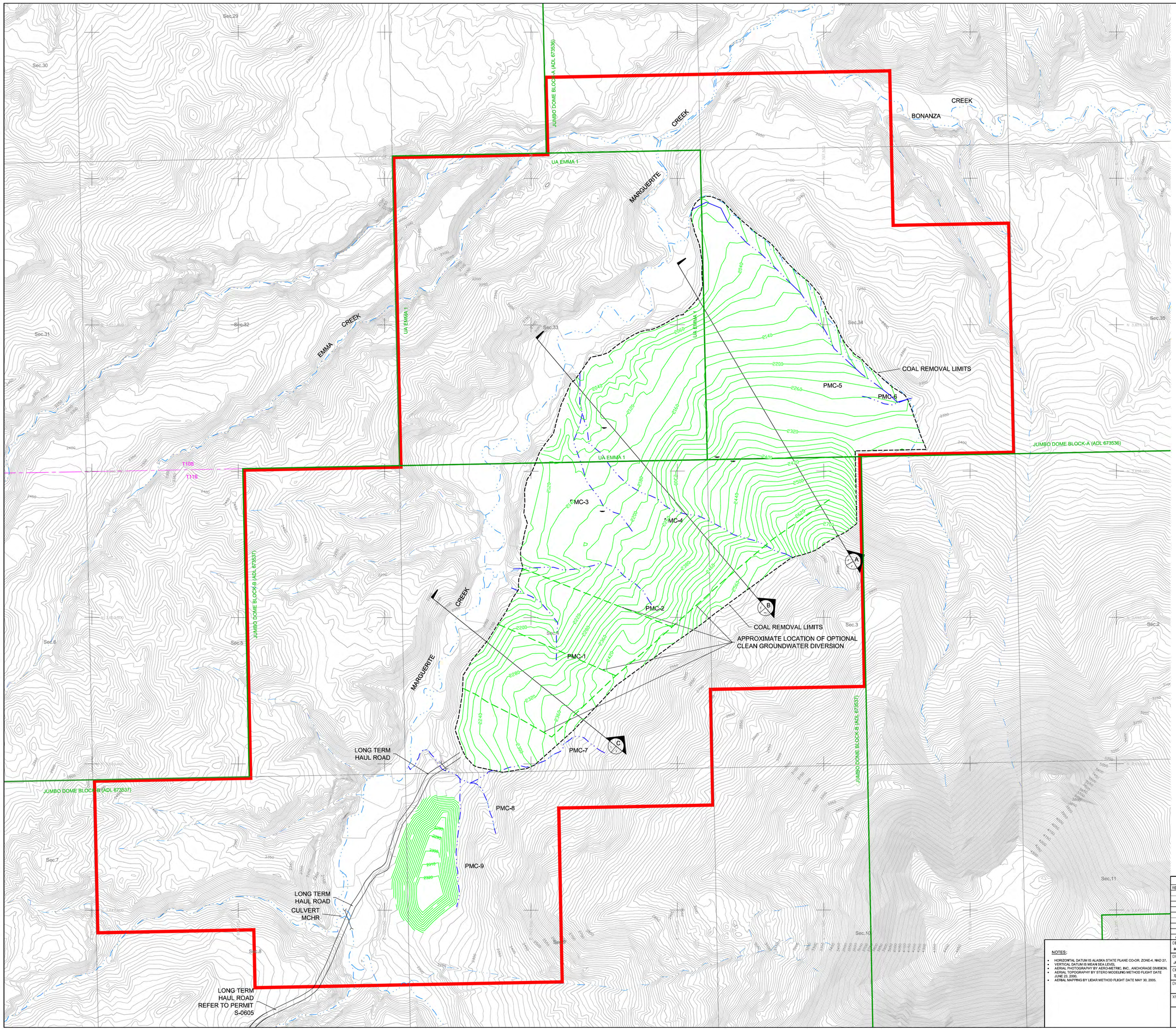
Jumbo Dome First 5 Year Term Regrade Volumetrics and Drainage Construction Volumes

Task	Area	Length	Regrade Volume	Push Distance	Grade (%)	Rate Calculation Base Rate	Material Weight	Operator	Material Factor	Slot Dozing	Visibility	Work Hour	Grade	Equipment	Net Rate	Hours
Pit Regrade																
Spoil	6500	2900	698,148	350	-30	550	0.81	0.75	1.2	1.05	1	0.83	1.6	D10R-SU	560	1247
Highwall	10800	2900	812,000	250	-30	700	0.81	0.75	0.8	1.05	1	0.83	1.6		475	1709
Blast Cast (30%)			348,000													
Subtotal			*1,510,148*													
Grand Total			**1,510,148**											D10R-SU		**2956**

Topsoil Redistribution	**Area (ac)**	**Depth (ft)**	**Quantity (BCY)**	**Drainage Length**	**Equipment**	**Acres**
Pit and Ponds	263.8	1	425,597		Truck/Loader/Dozer	
Spoil Pile, Fac., Roads	95.5	1	154,073		Truck/Loader/Dozer	
Subtotal	*359.3*		*579,671*			
Drain Construction	**See Drain Cost Sheet for details**					
PMC 1				1,700		
PMC 2				3,600		
PMC 7				2,700		
PMC 8				2,600		
				10,600		
	Length	Production ft/hr	Hours			
Roads (Rip and Regrade)	**4600**	**100**	46		D8H	
Furrow-Seed-Fertilize						359.3

PLATE D10-1

APPROXIMATE FINAL RECLAMATION CONTOURS AND POSTMINING DRAINAGE CONTROL PLAN



LEGEND

- PROPOSED PERMIT BOUNDARY
- COAL LEASE BOUNDARY
- SECTION LINE
- TOWNSHIP/RANGE LINE
- APPROXIMATE EXISTING CONTOUR AND ELEVATION, FT
- EXISTING STREAM/DRAINAGE
- PROPOSED INITIAL FIVE YEAR DISTURBANCE AREA
- PROPOSED MINING BOUNDARY
- PROPOSED POWERLINE
- PROPOSED CULVERT
- PROPOSED POST MINING CONTOUR AND ELEVATION, FT
- PROPOSED POST MINING DRAINAGE CHANNEL

PROFESSIONAL ENGINEER'S STATEMENT

I, Thomas E. Leidich, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

10/25/11
DATE

STATE OF ALASKA 49TH THOMAS E. LEIDICH EM 12365 REGISTERED PROFESSIONAL ENGINEER

SCALE
500' 0 500' 1000'

NOTES:

- HORIZONTAL DATUM IS ALASKA STATE PLANE CO-OR. ZONE-4, NAD 27.
- VERTICAL DATUM IS MEAN SEA LEVEL
- AERIAL PHOTOGRAPHY BY AERO-METRIC, INC., ANCHORAGE DIVISION.
- AERIAL TOPOGRAPHY BY STERO MODELING METHOD FLIGHT DATE JUNE 23, 2000.
- AERIAL MAPPING BY LIDAR METHOD FLIGHT DATE MAY 30, 2005.

SUBJECT REVISIONS

REV.	DATE:	BY:	DESCRIPTION
1	06/11	TEL	UPDATED SUBMITTAL
0	1/10	TEL	ORIGINAL SUBMITTAL

DESIGN BY: MRH
DRAWN BY: JMB
CHECK BY: TEL
DWG FILE:
XREF DWG FILE:

USIBELLI COAL MINE, INC.

APPROXIMATE FINAL RECLAMATION CONTOURS AND POSTMINING DRAINAGE CONTROL PLAN

JUMBO DOME MINE

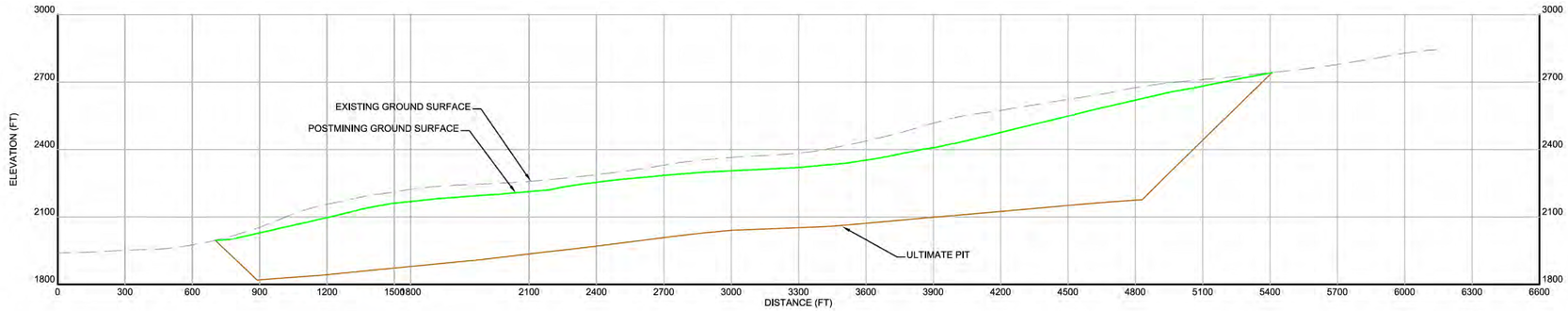
USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. D10-1

REV. 1

PLATE D10-2

CROSS SECTIONS OF PREMINING AND POSTMINING TOPOGRAPHY



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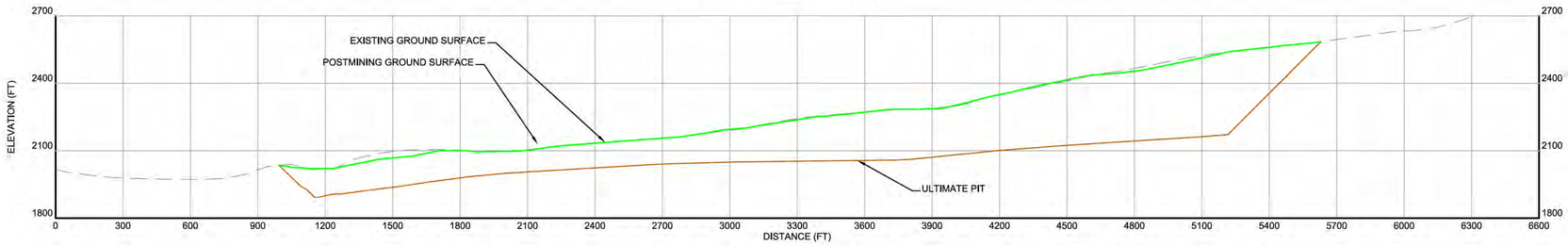

B POST MINING CROSS SECTION

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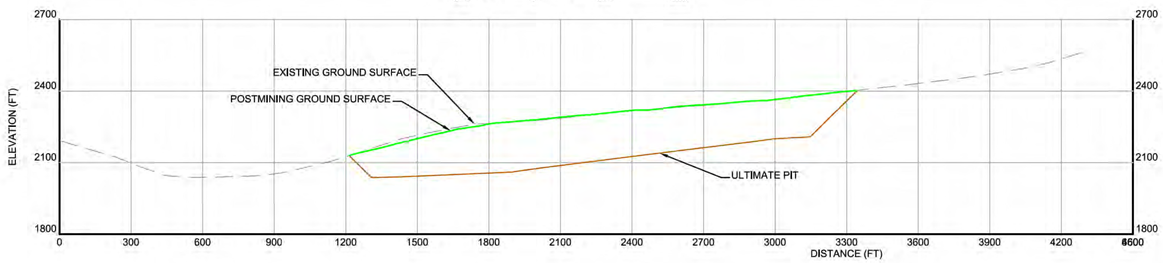

C POST MINING CROSS SECTION

SCALE
300' 0 300' 600'

PROFESSIONAL ENGINEER'S STATEMENT

I, Thomas E. Leidich, state that this map was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

10/25/11
DATE

STATE OF ALASKA 49TH
THOMAS E. LEIDICH
EM 12365
REGISTERED PROFESSIONAL ENGINEER

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REV.	DATE:	BY:	DESCRIPTION
1	06/11	TEL	UPDATED SUBMITTAL
0	1/10	TEL	ORIGINAL SUBMITTAL

DESIGN BY: MWH
DRAWN BY: JMB
CHECK BY: TEL
DWG FILE:
XREF DWG FILE:

USIBELLI COAL MINE INC

CROSS SECTIONS OF PREMINING AND POSTMINING TOPOGRAPHY

JUMBO DOME MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743

PLATE No. D10-2

REV. 1

SECTION 11.0

FISH AND WILDLIFE PROTECTION PLAN

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11.2 Summary Of Important Resources D11-1
11.3 General Wildlife Protection Strategy D11-1
11.3.1 Sediment Control D11-2
11.3.2 Topographic Controls D11-2
11.4 References D11-3

11.0 FISH AND WILDLIFE PROTECTION PLAN

11.1 INTRODUCTION

The Alaska Surface Coal Mining Program regulations require that each application include a plan to minimize or prevent disturbance and adverse impact to fish and wildlife resources (11 AAC 90.081). This plan addresses that requirement with emphasis on mitigation measures.

11.2 SUMMARY OF IMPORTANT RESOURCES

The vegetation and wildlife studies that have been conducted in the area (Part C, Chapters VIII and IX) indicate that the Jumbo Dome Mine area is typical of upland habitats in the vicinity, providing habitat for moose, bear, furbearers and songbirds. For the most part, wildlife abundance and habitat values are not exceptional. There is no critical wildlife habitat in the vicinity of the Jumbo Dome Mine project. Probably the most important wildlife species occurring in and near the permit area is moose. Moose are considered important because of their wide ranging distribution over the Tanana Basin, and their value as a subsistence and sport harvest species. There is also a residential and spawning population of arctic grayling and a residential population of slimy sculpin in Marguerite Creek.

11.3 GENERAL WILDLIFE PROTECTION STRATEGY

The value of strip-mined lands as wildlife habitat in the contiguous United States has been known for many years (Riley 1957). Characteristics of surface mined lands that are considered attributes of good wildlife habitat include topographic diversity, irregularity of vegetation and interspersion of micro habitats. These diversity features, which are also readily accessible in the undisturbed native habitats surrounding the proposed Jumbo Dome Mine project, greatly mediate any negative effects caused by mining disturbance. There are no threatened, endangered or other sensitive species known to occur in the proposed mine area so no special mitigation measures are deemed necessary.

The fact that animal populations are healthy and coal mining has been actively occurring in the general project area for over 75 years suggests that local wildlife populations have developed a successful coexistence strategy and are not greatly disturbed by mining activities. The goal of the Fish and Wildlife protection plan will be to introduce and encourage habitat diversity through a variety of management techniques which are discussed below. The reclamation plan will include the planting of trees and shrubs which will encourage greater use by a more diverse group of wildlife species.

Fish protection strategies as required by AS 16.05.841 will be met by designing crossings of Marguerite Creek to meet all requirements of Alaska Department of Fish and Games Guidelines. See Appendix D9.2: Marguerite Creek Culvert Design (This crossing is permitted under related ASMCRA permit S-0605 for the Jumbo Dome Road Corridor. Additionally all blasting efforts will meet or exceed the Alaska Department of Fish and Games Blasting Standards for the Protection of Fish.

Bird protection strategies as required by The Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c) and the Migratory Bird Treaty Act (16 U.S.C 703-712) will include practicable attempts to avoid "take" of protected birds and/or their nests. These efforts may include nest surveys and restricting vegetative clearing during migratory bird nesting periods. If take of an eagle is unavoidable, a permit will be obtained in accordance with 50 CFR Parts 13 and 22.

11.3.1 Sediment Control

Drainage and sediment controls for the proposed Jumbo Dome Mine project will be implemented to minimize the effects of the mining operation on the prevailing hydrologic balance by controlling, collecting and treating disturbed area runoff. Drainage from undisturbed areas will be diverted away from areas of disturbance to maintain the existing undisturbed drainage water quality. As mining progresses, drainage from disturbed areas will be collected and conveyed to drainage control structures

located throughout the mine area. Drainage controls to collect and contain runoff from disturbed land within the project area will be implemented prior to any disturbance in an area.

11.3.2 Topographic Controls

The postmining topography depicted on Plate D10-1 will create differing micro climatic conditions conducive to vegetation and wildlife habitat diversity. This topographic landscape, combined with the revegetation program described in Section D10.0 will facilitate the reestablishment of diverse wildlife habitat types that are capable of supporting both game and non-game species.

11.4 REFERENCES

Dames and Moore 1994. Northern intertie, revised macro-corridor study and project alternative study.

Riley, C. V. 1954. The utilization of reclaimed coal striplands for the production of wildlife. Trans. North Amer. Wildl. Conf. 19:324-337.

Woodward-Clyde Consultants 1979. Biological observations of two proposed power plant sites near Nenana and Healy, Alaska, Anchorage, Alaska.

SECTION 12.0

PROTECTION OF HYDROLOGIC BALANCE AND WATER QUALITY

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12.0 PROTECTION OF THE HYDROLOGIC BALANCE AND WATER QUALITY

12.1 INTRODUCTION

Mining and reclamation plans for the Jumbo Dome Mine area are designed to prevent or minimize off-site hydrologic impacts and comply with applicable provisions of Federal and State regulations. Measures for the protection of hydrologic balance and water quality which have been incorporated as an integral part of the mining and reclamation plans reflect consideration of site-specific surface and ground water conditions as described in Part C, Chapters IV, V, and VI, Hydrogeology, Surface Water Hydrology, and Surface and Ground Water Rights and Use, respectively. Despite the application of the all reasonable control and mitigation measures, certain hydrologic impacts may result from mining-related disturbance. This section identifies and discusses hydrologic control and mitigation measures and evaluates the Probable Hydrologic Consequences (PHC) of the proposed mining and reclamation operations.

12.2 OVERVIEW OF SURFACE AND GROUND WATER PROTECTION

Protection of surface and ground water resources will involve both operational and reclamation measures including but not limited to the following primary controls:

- Minimizing the area and duration of surface disturbance.
- Use of diversion and collection channels and associated drainage structures to effectively control surface runoff and erosion.
- Use of sedimentation ponds to limit sediment loading for water use and potential land application disposal
- Potential use of land application ponds for water disposal.
- Collection, storage, and use of mine inflows.
- Surface and ground water monitoring during and following mining and reclamation operations to identify and evaluate any significant changes in water quantity and quality.

- Reclamation of mine disturbance areas to control erosion and siltation, restore surface drainage patterns, and reestablish ground water recharge relationships.
- Management of exploration drillholes and wells.

These measures are outlined and discussed in the following sections.

12.3 MINE AND ANCILLARY FACILITIES

Hydrologic protection for mine and ancillary facilities will be designed and implemented in phases with the initial phase corresponding to the first 5-year mining plan as described in Section D2.0: Life of Mine Plan and Section, D5.0:Pit Excavation, and the final phase corresponding to the reclamation phase as described in Section D10.0: Reclamation Plan. Generally, hydrologic protection for the operational phases will focus on operational drainage and sediment control and handling of pit inflows as described in Section D9.0, Drainage and Sediment Control. Hydrologic protection for the reclamation phase will focus on restoration of surface drainage patterns and conditions, erosion and sedimentation protection, restoration of recharge conditions, and monitoring to evaluate the effectiveness of both operational and reclamation measures as described in Section 10.0, Reclamation Plan. The hydrologic protection plans, for both the operational and reclamation phases, address all mining-related disturbance including ditches and sedimentation ponds, roads, topsoil stockpiles, mine pits, and out-of-pit spoil piles as shown on Plate D2-1, General Facilities Arrangement.

12.4 STREAM CHANNEL DIVERSIONS/RELOCATIONS

The one surface drainage which will be affected by mining operations in the Jumbo Dome Mining area is Marguerite Creek. All of the tributary creeks to Marguerite Creek are ephemeral in their upper reaches, becoming perennial near their confluence with Marguerite Creek due to spring discharge at and near the coal outcrops of 3 and 4 seams towards Marguerite Creek itself. There will be no net change in drainage basin area and no change to the grade of the creek. Currently, the creek grade averages between 1 and 3% in the vicinity of the proposed mining area. Under a related permit for the Jumbo Dome Road Corridor project a culvert (MCHR) was permitted as part of ASMCRA S-0605 to convey creek flow designed a peak discharge of a 100 year storm event and a low flow discharge for passage of fish. Additional culverts (HR-1 and HR-2 will be constructed

for a tributary drainage to Marguerite Creek just north of the proposed out-of-pit spoils pile where it enters the proposed mining area.

Most of the tributary drainages to Marguerite Creek within the proposed mining area will be mined out during mining. The proposed permanent long-term haul road will be established during mining which will run approximately northeast through the southern box cuts and then continue northeast approximately paralleling the alignment of Marguerite Creek. The tributary drainages to Marguerite Creek will be reestablished within the proposed mining area as shown on Plate D10-1, Approximate Final Reclamation Contours and Post Mining Drainage Control Plan. Completion of preliminary designs for post mining drainages is included in Appendix D10-1.

12.5 DRAINAGE AND SEDIMENT CONTROL

In order to prevent or minimize potential adverse impacts to the surface hydrologic environment, either within or beyond the boundaries of the Jumbo Dome Mine disturbance area, UCM will construct, operate, and maintain drainage and sediment control structures within and adjacent to active mining areas. Drainage and sediment control objectives include:

1) Diversion of flows from undisturbed upgradient areas around the mining disturbance to limit the potential for erosion from these flows and minimize additional sediment contributions to the receiving drainages; and

2) Interception of runoff from mine disturbance, areas and controlled routing of the resultant flows through designed channels and sedimentation ponds to minimize potential related erosion and allow settlement of suspended solids prior to use or discharge into land application ponds.

As shown on Plate D9-1, the proposed drainage and sediment control network will consist of the following components:

Clean Water Diversion Channel and Disturbed Area Runoff Collection Channels

Diversion Channels OOPS-1, OOPS-2, JD-2, JD-3, JD-4, CWD-1,CWD 2, CWD 3, and CWD 4 - Channel CWD-1, CWD-2, CWD-4 will intercept the undisturbed area drainage from the area upgradient of the proposed mining area and divert it to the natural drainages which discharge to Marguerite Creek. Channel CWD -3 is temporary and will divert clean water around Pond JD-2 until mining disturbance reaches the water shed above it. Channels OOPS-1, OOPS-2, JD-2, JD-3 and JD-4 will collect runoff from the disturbed mining areas and route it into Sedimentation Ponds JD-1, JD-2, JD-3, and JD-4, to be located along the eastern side of Marguerite Creek. Since all channels are temporary, they are designed to convey the runoff produced by the 10-year, 24-hour storm event.

Culverts HR-1and HR-2 - Culverts HR-1 and HR-2 will be installed at the points where the Jumbo Dome long-term haul road and the shop access road crosses the un-named ephemeral tributary drainage to Marguerite Creek north of the out-of-pit spoils pile location. Temporary culverts are designed to convey the runoff produced by the 10-year, 24-hour storm event. Permanent Culverts are designed to convey the 100 year, 6-hour storm event.

Sedimentation Ponds

Sedimentation Ponds JD-1, JD-2, JD-3, and JD-4 – Four temporary containment ponds will be constructed to contain runoff from disturbed areas prior to discharge to Marguerite Creek. Ponds JD-1, JD-2 and JD-3 First Term will be constructed during the first 5-year term. The pond system is designed to provide zero discharge during a 100-yr, 6-hour storm event per 11 AAC90.336 (b). All ponds have an emergency spillway designed to safely pass the peak discharge from the 25-year, 24-hour storm event. All 4 ponds will be incised with 1H:1V interior slopes.

The proposed drainage and sediment control network is graphically illustrated on Plate D9-1, Drainage and Sediment Control Plan, and design details and operating and maintenance practices for Ponds JD-1 and JD-2 are discussed in Section D9.0, Drainage and Sediment Control.

12.6 SEDIMENTATION POND MAINTENANCE

Maintenance of sedimentation ponds and associated structures will involve periodic inspections (see Section 9.5, Part D). As required, silt or debris accumulations will be removed from pond inlets, culverts, discharge structures, and outlet channels. If sediment accumulates within the pond basin(s) to a level corresponding to 70 percent or more of the design sediment storage capacity, sediment removal operations will be scheduled at the first reasonable opportunity during the subsequent year. UCM will install visual measuring devices to assist in determining pond storage capacity. Sediment removed from the ponds will be placed within mine backfill areas. If stability, erosion, or other concerns are noted during the pond inspections, UCM will evaluate the situation and proceed with appropriate remedial measures on a timely basis.

12.7 PIT INFLOWS

Based on extensive previous mining experience in the area, in essentially the same geologic sequence, and based on some preliminary ground water modeling performed using aquifer test data, UCM anticipates pit ground water inflows not to exceed approximately 110 gallons per minute (gpm) for an assumed 250-ft wide pit. Some minor surface water inflows are also anticipated, however, they will be limited by topography, the mining sequence, upgradient diversions, and operational drainage control measures within the active pit area including temporary in-pit ditches and berms.

Aquifer tests were performed in 2009 and 2010. In 2009, it was calculated that the total combined discharge into the pit from 3 and 4 seams was estimated at 174,000 GPD (120 gpm), most of it coming from 3 seam. In 2010, utilizing results of both year's field aquifer testing, the total combined discharge into the pit from 3 and 4 seams was estimated at 156,000 GPD (109 gpm), most of it coming from 3 seam.

.

To the extent possible, water resulting from pit inflows will be controlled within active pit areas to minimize any adverse impacts on mining or safety. Any water that cannot be controlled in the pit will be pump to pond JD-2. Controls will include small temporary ditches, berms, in-pit sumps to intercept, route, and control pit water. Water accumulations in the pit will be controlled using the methods described in Part D, Section 9.3. Additionally, UCM may employ a clean groundwater diversion system to divert clean groundwater from the above pit coal seam to the below pit coal seam as shown in figure D9-2.

12.8 MINE WATER USAGE

The Jumbo Dome Mine is designed as a zero discharge mine (during 100-yr, 6-hour storm event). An anticipated 0.24 acre-ft per day of water will be maintain in the pit. An estimated 0.16 acre-ft per day of water will infiltrate in the sedimentation ponds based on modeling. The remainder of the Jumbo Dome Water Management Plan consists of dust abatement, irrigation, evaporation, snow sublimation, and if necessary land application. All water use estimates are conservative and include a safety factor to account for equipment breakdowns and inclement weather.

Dust abatement is an operational consumptive water use required by MSHA and ADEC. Dust abatement on the 5.6 mile haul road to the Jumbo Dome Mine will be a continuous effort during all shifts from mid April to mid October. A conservative estimate of 0.663 acre feet per day is anticipated water use for dust abatement.

Irrigation is an operational consumptive water use to enhance vegetation growth for erosion control. Irrigation water use will increase during the life of the mine as more acres are reclaimed. A conservative estimate for irrigation water use is 0.16 acre-ft/acre/day. In the first two years of the first mine term, the irrigation will be restricted to the topsoil pile. In later years of the first mine term, irrigation efforts will include the out-of-pit spoil pile and the box cut reclamation area.

Evaporation may be enhanced by the use of evaporation units. These units are proposed to be installed in one or all of the sedimentation ponds. This enhanced method of evaporation would be operational between May and September. The water use rate is dependent upon the number of units deployed. A conservative estimate for evaporation is 0.024 acre-ft per day. Evaporation rates are based on data from the Denali National Park weather station. Denali National Park is located approximately 20 miles from the site and has a similar climate to the Jumbo Dome project site.

Snow sublimation may be enhanced by incorporating snow making of the pond supernatant. Studies of snow sublimation in the arctic and sub-arctic of Alaska have shown that sublimation rates can range from 10 to 50% of the winter precipitation. UCM used a conservative number of 15% sublimation rate in the water balance calculations based on the use of one snowmaking machine. Actual rates may be considerably higher. Sublimation is a function of air temperature, humidity, and wind speed variations associated with changing weather patterns and space dependant variations related to local surface roughness, vegetation, proximity to open water/ocean and other environmental factors.

Land application, if needed, is the proposed water disposal method for any water that cannot be eliminated through the consumptive uses of dust abatement, irrigation, and evaporation. Approximately 20 acres is proposed for the land application site. The proposed site is located within the coal mining limits and therefore will not create additional disturbance beyond the mine life. The area will primarily be used during the early years of mining. The area will be mined through in subsequent permit terms when it is no longer necessary for water management. A conservative estimate of 0.48 acre-ft per day is used in the water balance. Field studies will be conducted during the summer of 2011 to determine the actual infiltration rate in the land application site. All land application will be in accordance with the Alaska Department of Environmental Conservation Land Application Permit.

If UCM is unable to maintain the operational level in the ponds, using the water management strategies mentioned above, UCM may pursue obtaining an ADEC surface water discharge permit.

12.9 MONITORING OF SURFACE WATER QUALITY AND QUANTITY

In order to allow timely identification and provide a basis for evaluation of any mining-related changes in surface water quality or quantity, UCM will implement and maintain an ongoing program of surface water monitoring during the period of active mining and reclamation operations. As the primary receiving drainages, operational surface water monitoring will focus on Marguerite Creek. Ongoing upgradient and downgradient monitoring of Marguerite Creek will identify any mining-related changes in Marguerite Creek.

Surface water operational monitoring will be conducted as required by an Alaska Department of Environmental Conservation land application permit, if it is implemented. Surface water monitoring required for SMCRA will be conducted in accordance with Table D12-1. This table may be modified pending potential changes to the monitoring requirement to introduce uniformity in sampling of all active mining areas under UCM operations.

TABLE D12-1 SURFACE POST-MINING MONITORING PLAN	
Tri-Annual (Beginning in 2011 and continuing in 2014)	
Locations	Parameters
Above mining development in Marguerite Creek Below mining development before confluence of Marguerite Creek with Emma Creek	*(Field Parameters)* Water Levels Dissolved Oxygen pH Conductivity Temperature Turbidity *(Major Anions)* Chloride (D) Sulfate (D) *(Major Cations)* Calcium (D) Magnesium (D) Potassium (D) Sodium (D) (*Nutrients*) Ammonia (D) Nitrate as Nitrogen (D) Nitrate as Nitrogen (D) Total Phosphate (D) *(General and Physical Characteristics)* Alkalinity Total Dissolved Solids Total Suspended Solids *(Trace Metals and Elements)* Aluminum (D and T) Antimony (D and T) Arsenic (D and T) Barium (D and T) Beryllium (D and T) Boron (D and T) Cadmium (D and T) Chromium (D and T) Cobolt (D and T) Copper (D and T) Iron (D and T) Lead (D and T) Magnesium (D and T) Manganese (D and T) Mercury (D and T) Molybdenum (D and T) Nickel (D and T) Selenium (D and T) Solicon (D and T) Silver (D and T) Thallium (D and T) Vanadium (D and T) Zinc (D and T)

The table above was prepared after review of the baseline results from the 2002-2010 sampling program. There were no parameters tested which indicated significant potential for degradation to the waters of Marguerite Creek. Under this program, if the sites listed for Marguerite Creek ever indicate a significant change in chemistry, UCM will conduct an investigation in coordination with ADEC and ADNR to determine the source of the excursion.

12.10 MONITORING OF GROUND WATER QUALITY AND QUANTITY

In order to allow timely identification and provide a basis for evaluation of any mining-related changes in ground water quality or quantity, UCM will implement and maintain an ongoing program of ground water monitoring during the period of active mining and reclamation operations.

The basic ground water monitoring program is designed to measure changes in water levels and chemistry during and following mining and in the recharge to backfilled mine areas. Two upgradient monitoring wells will be sampled in the two main mineable seams, 4 and 3, along with 4 downgradient wells in each of the four seams, 6, 5, 4, and 3. All monitoring wells are expected to remain throughout the mine life. Of the 19 wells depicted on Plate CIV-1, Monitoring Well Locations, six will be utilized for this long-term monitoring program. Further, UCM plans to install two additional monitoring wells in or near the backfilled mine area to monitor spoil re-saturation, recharge conditions, and spoil water quality. These 2 wells will be located within the first 5-year mining limits as shown on Plate B-1, Permit Term Information. Groundwater monitoring will include sampling and analysis for the parameters listed in Table D12-2.

As in the surface water baseline data, review of the groundwater quality data did not indicate any unusual parameters which may cause degradation to the surrounding area. There are slightly higher levels of iron and manganese in the groundwater than in the surface water which is typical of groundwater quality. If changes are noted from the above sample points during mining, additional sample points may be added to better define the extent and source of the change.

Groundwater operational monitoring will also be conducted as required by an Alaska Department of Environmental Conservation Land Application Permit for the groundwater monitoring wells located above and below the land application site, if it is implemented.

TABLE D12-2

GROUNDWATER OPERATIONAL AND POST-MINING MONITORING PLAN

Annual (Beginning the 1st year of mining activity)

Locations	Parameters
6 Seam[1] 08JD04 (downgradient) 5 Seam 10JD04 (downgradient) 4 Seam 10JD02 (upgradient) 08JD05 (downgradient) 3 Seam 10JD01 (upgradient) 10JD03 (downgradient)	Water Levels

Tri-Annual (Beginning in 2010 and continuing in 2013, etc.)

Locations	Parameters	
6 Seam[1] 08JD04 (downgradient) 5 Seam 10JD04 (downgradient) 4 Seam 10JD02 (upgradient) 08JD05 (downgradient) 3 Seam 10JD01 (upgradient) 10JD03 (downgradient) Backfill Spoils Resaturation Wells[1] 2 Wells to be installed during first 5-year mining term *Notes*: (1) Will be installed soon after backfill operations in this area are complete.	*(Field Parameters)* Water Levels Dissolved Oxygen pH Conductivity Temperature Turbidity *(Major Anions)* Chloride (D) Sulfate (D) *(Major Cations)* Calcium (D) Magnesium (D) Potassium (D) Sodium (D) (*Nutrients*) Ammonia (D) Nitrate as Nitrogen (D) Nitrate as Nitrogen (D) Total Phosphate (D) *(General and Physical Characteristics)* Alkalinity Total Dissolved Solids Total Suspended Solids	*(General and Physical Characteristics)* Alkalinity Total Dissolved Solids Total Suspended Solids *(Trace Metals and Elements)* Aluminum (D and T) Antimony (D and T) Arsenic (D and T) Barium (D and T) Beryllium (D and T) Boron (D and T) Cadmium (D and T) Chromium (D and T) Cobolt (D and T) Copper (D and T) Iron (D and T) Lead (D and T) Magnesium (D and T) Manganese (D and T) Mercury (D and T) Molybdenum (D and T) Nickel (D and T) Selenium (D and T) Solicon (D and T) Silver (D and T) Thallium (D and T) Vanadium (D and T) Zinc (D and T)

Notes: 1. Well 08JD04 was damaged and abandoned in 2011 and replacement well will be installed in 2012.

12.11 PLANS FOR EROSION AND SILTATION CONTROL, SURFACE DRAINAGE AND GROUND WATER RECHARGE RESTORATION

During the operational period, surface drainage, erosion, and siltation will be effectively controlled by the drainage and sediment control measures previously discussed in Sections 12.4 and 12.5. In conjunction with active mining operations, ongoing reclamation of mine disturbance areas will result in a stable surface configuration, restoration of surface drainage patterns, and reestablishment of a stable, self-sustaining vegetation community as described in Section 10.0, Reclamation Plan. These components of the reclamation plan are designed to be effective in controlling surface runoff, erosion, and siltation. Backfilling of mine disturbance areas will locally impact recharge conditions since coal seam outcrop recharge areas will be eliminated from the direct vicinity. Backfill re-saturation will, however, over time provide a mechanism for direct recharge to the coal seams and associated overburden and interburden sequences. When evaluating potential ground water recharge impacts, it is important to note that the outcrop recharge areas that will be impacted by mining are so limited in aerial extent relative to the total aquifer recharge area that any effects on recharge will be negligible.

12.12 MEASURES TO MANAGE EXPLORATION DRILLHOLES AND WELLS

Consistent with the DNR guidelines for drillhole abandonment, any exploration drillholes or monitoring wells which will not be utilized for ongoing long-term monitoring will be plugged and abandoned in such a manner as to preclude transfer of waters between two or more ground water aquifers or the ground and surface water systems. Plugging and abandonment will be done in accordance with procedures in UCM's approved exploration permit. This involves sealing each completion interval with a mixture of 20 percent bentonite, 20 percent cement, and 60 percent drill cuttings, establishing a surface plug to a minimum depth of 12 feet below the natural ground surface using the same materials.

12.13 HYDROLOGIC CONSEQUENCES OF THE OPERATION

The proposed Jumbo Dome mining and reclamation operations will result in temporary localized surface and ground water impacts which will generally be controlled, minimized, or mitigated by the operational and reclamation measures discussed in the preceding sections

As stated previously, the Jumbo Dome Mine will not disturb significant portions of Marguerite Creek or adjacent surface water resources within the general vicinity of the operation. There will be no significant lithologic change, as the subsurface material will be the same as pre-mining (with the exception of quaternary gravel deposits, which will be replaced by Suntrana/Lignite formation spoil). Vegetation cover will be temporarily decreased until the post mining revegetation cover is fully established. The following table illustrates the surface effects.

TABLE D12-3
EFFECTS OF MINING ON DRAINAGE BASIN AREAS
(all numbers in Acres)

Drainage Basin	Pre Mining Basin Area	Disturbed by Mining (Life of Mine)	Post Mining Reclaimed Areas	Percent of Original Basin Area [1]
Marguerite Creek	9,933	1111.6	1111.6	11%

NOTES:
1 - Represents post mining acreage that is reclaimed and discharging to basin compared to original total basin area. Final basin area in the post mining configuration will actually be different from the original.

Certain minor long-term hydrologic impacts may result from the proposed operations, however, these impacts will not significantly affect surface or ground water quality or quantity; significantly alter ground water recharge, storage, or discharge relationships; or result in significant changes in the overall hydrologic balance in the mine disturbance or adjacent areas. The following sections identify and describe the anticipated hydrologic consequences of the proposed mining and related operations with separate discussions for surface water and ground water systems.

12.13.1 Surface Water Consequences

The following summarizes the primary surface water consequences anticipated to result from the proposed mining and related activities:

- Direct disturbance to the associated contributing (tributary) drainage areas of Marguerite Creek.
- Elimination of a number of existing seeps and springs through both direct disturbance and through loss or reduction of flow due to drawdowns associated with pit excavation and drainage.
- Reductions in baseflows to Marguerite Creek due to loss or reduction of spring and seep discharge, which may be offset by the clean groundwater diversion that will intercept flow from 3 and 4 coal seams and route it directly into Marguerite Creek.
- Changes in infiltration and runoff characteristics for mine disturbance areas.
- If a surface water discharge permit is obtained, there may be minor changes in surface water chemistry resulting from effluent limitations established under APDES permitting requirements.

The anticipated surface water consequences are briefly described in the following sections.

Direct Disturbance Impacts

There are no direct disturbance to Marguerite Creek as part of this project. The project will directly affect some of the ephemeral streams on the east side of Marguerite Creek as the mine progresses through these drainages.

Seeps and Springs

Mining will result in dewatering of the coal seam aquifers within a drawdown area between 200 and 2,000 feet laterally from the mining limits, as discussed under the subsequent ground water consequences section. Because seeps and springs in the vicinity of the area to be mined generally reflect ground water discharge at the coal seam outcrops, dewatering will result in loss or reduction of seep and spring flows. Some seeps and springs may also be directly affected by mine disturbance, being excavated as mining proceeds. Some seeps and springs result from the infiltration and subsurface collection of storm water runoff in the rubble above the sandstone. These seeps may be spatially moved up gradient as a result of mining. In most cases, re-saturation of backfilled mine spoils will not result in restoration of a potentiometric surface which will intersect the ground surface and, therefore, the existing minimal ground water discharge as seeps and springs is expected to be permanently diminished. Seeps that originate from the rubble may reestablish themselves with minimal impact.

Stream Baseflow

As described in Chapter V, Surface Water Hydrology; the source of base flow in most area tributary drainages is seep and spring discharge. Springs and seeps originating from the coal seams to be mined are expected to be lost as contributors to stream base flow. Mining will intercept nearly all of the seep zones east of Marguerite Creek in the vicinity of the proposed mining area. Impacts are expected to be minimal, since the normal baseflow for Marguerite Creek is high. Changes in baseflow will have little or no effect on the overall Marguerite Creek hydrologic system.

Operation of the sedimentation ponds will significantly reduce suspended solid levels in the sedimentation pond system. The sedimentation ponds are a zero discharge design for all mine drainage. Storm water discharges will be covered under the Multi Sector General Permit for Sector H, Coal Mines and Coal Mine Related Facilities. UCM has modeled the expected infiltration from the ponds that will continue to contribute to stream baseflow. Irrigation and the potential land application are water management methods that may also contribute to stream

baseflow. Consumptive uses of dust suppression and evaporation will divert water from stream baseflow.

Changes in Infiltration and Runoff Characteristics

The removal of vegetative cover and disturbance of surface materials may result in temporary increases in infiltration for mine disturbance areas. Backfilling, grading, topsoil replacement, and revegetation will generally address those factors which would result in the temporary increases in infiltration rates. Removal of the coal seam outcrops, mixing of mine spoil materials and the dewatering of the coal seams will also affect infiltration and runoff characteristics. Elimination of the relatively high permeability coal seam outcrops is expected to reduce the infiltration and recharge, which occurred in the outcrop areas under pre-mining conditions.

Based on UCM's experience in the area with mine spoils in the same lithology and sequence and from laboratory testing, spoil materials have a much lower hydraulic conductivity than pre mining aquifers. For both backfilled areas and out-of-pit spoil piles this characteristic may result in reduced infiltration, slow spoil resaturation, limited ground water recharge, and increased surface runoff. It should be noted that low infiltration potential is the primary reason why significant resaturation of the out-of-pit spoils is not anticipated and why spoil springs are not expected to develop. Minor increases in runoff may be beneficial, potentially offsetting the loss of seep and spring contributions to stream flows in the affected drainages.

Changes in Surface Water Chemistry and Constituent Concentrations

Given the analysis results for overburden and interburden materials presented in Chapter CIII, Overburden and Interburden Assessment, which indicate that these materials are not potentially acid-forming, toxic-forming, or alkalinity-producing, significant changes in surface water chemistry or constituents are not anticipated as a result of mining. Minor shifts in surface water chemistry may occur as a result of (1) increased exposure of overburden, interburden materials and topsoil, (2) possible leaching of residue left from the blasting process, particularly the

nutrients ammonia and nitrate, and (3) the use and leaching of fertilizer in the revegetation process. However, revegetation will fairly rapidly diminish these influences on surface water chemistry.

Minor increases in TDS from the values of 20 to 1,200 milligrams per liter (mg/l) typical of area surface waters are also possible due to exposure, weathering, and leaching of overburden and interburden materials. Increases in TSS values are anticipated for disturbed area runoff during active mining and reclamation and during the reclamation liability period. These temporary increases will be addressed through operation of the drainage, sediment control, best management practices, and the proposed land application system. Reclamation is expected to result in effective restoration of pre-mining hydrologic conditions with TSS levels for reclaimed area runoff corresponding to baseline levels.

12.13.2 Ground Water Consequences

The following summarizes the primary ground water consequences anticipated to result from the proposed mining and related activities:

- Localized dewatering of aquifer units as a result of excavation and consequent pit drainage.
- Alteration of recharge, storage, and discharge characteristics and relationships.
- Localized changes in ground water levels.
- Minor changes in ground water chemistry.

The anticipated ground water consequences are briefly described in the following sections.

<u>Dewatering of Aquifer Units</u>

The target coal seams are the primary aquifers described in Chapter CIV, Hydrogeology. Mining of these units will result in both direct drainage of the excavated materials and indirect drainage

from these units where they are exposed in pit highwalls and sidewalls. Progressive drainage from the coal seams will result in ground water drawdowns and a reduction in the potentiometric surface for each of these confined aquifers in the vicinity of the mine pits. Based on a range of permeability's for these units of 1.7×10^{-3} to 6.2×10^{-4} ft/min, the limit of potential drawdowns is expected to range from approximately 200 to 2,000 feet laterally and downgradient from the mining limits. UCM may employ a clean groundwater diversion as shown in Figure 9-2 to minimize the the coal seam aquifer dewatering. Localized depression of the potentiometric surface will tend to induce ground water flow toward the mined area as the hydrologic system adjusts to reestablish equilibrium. A shift in ground water flows toward the mine pits will also result in localized and temporary alteration of ground water flow patterns in the immediate vicinity.

On completion of mining and subsequent backfilling and regrading, continued ground water inflow and infiltration of surface precipitation will result in resaturation of backfilled mine spoils and reestablishment of an equilibrium potentiometric surface. Given the relatively high permeability of the coal seams and historically low infiltration rates for backfilled mine spoils, the equilibrium potentiometric surface is expected to establish above the relatively impermeable 3 Seam under-clay and extend to a point somewhere between this lower limiting unit and the pre-mining potentiometric surface and gradient for the 3 Seam aquifer. Recharge from the resaturated mine spoils will be reestablished for the 3 Seam in the mined area and to a limited extent, a portion of 4 Seam. However, within the drawdown limits, 5 and 6 Seams is expected to remain in a drained condition. Long-term dewatering of 6 Seam in the immediate mine vicinity is not expected to have any significant effect on these aquifers in downgradient areas or regionally since the affected area is so small relative to both aquifer recharge area and total areal extent of the aquifers.

Alteration of Recharge, Storage, and Discharge Characteristics and Relationships

As noted in the preceding section, mining will result in ground water drainage from mined materials and exposed coal seams, overburden, and interburden. Recharge will be reestablished, at least for the 3 Seam, from resaturated backfilled spoils as described above. Given the relatively limited recharge

areas which will be affected relative to total aquifer recharge area and the fact that the individual confined aquifers are not totally hydrologically isolated, resultant effects on either individual aquifers or the overall ground water system should be negligible.

Mining-related disturbance will also result in both short- and long-term changes in recharge within the mined area. Removal of vegetative cover and disturbance of mined materials will temporarily increase the potential for both runoff and infiltration with decreased potential for evaporative loss. Increased infiltration for disturbed areas may result in minor and temporary increases in localized recharge. Backfilling, grading, soil material replacement, and revegetation will result in changes in runoff and infiltration potential relative to the pre mine condition. Until such time as vegetation becomes reestablished, infiltration and consequent recharge potential is expected to continue to be increased due to roughened topsoil conditions and reduced evaporative losses. With effective vegetative reestablishment and consolidation of mine spoils, however, infiltration is expected to be significantly reduced along with subsequent recharge potential.

While not a major operation in the Jumbo Dome mine plan, the removal of the footwall clays beneath the 3 seam is possible for a limited area in the west portion of the mine area. The potential effects of this are minor. With respect to the spoil recharge and the re-establishment of the 3 seam aquifer, this could create a leaky floor. However, with a small impact area, coupled with the low transmissivity of the underlying sandstones and schists, and the geometric location of this area isolating it from the majority of the mining area, this will not significantly affect the aquifer restoration.

Ground water storage effects will be limited to the loss of that storage associated with the portions of the coal seam aquifers removed by mining. This loss will be partially, or wholly, offset by replacement storage in the more porous resaturated backfill material. In any case, storage losses would be negligible, given the limited affected area relative to the overall ground water system.

Given the direction of ground water movement, mining-related ground water discharge effects will be limited to the effects on seeps and springs previously addressed in the discussion of surface water consequences.

Localized Changes in Ground Water Levels

As addressed in the discussion of aquifer dewatering effects, the equilibrium potentiometric surface within the backfilled mine spoils is expected to approximate a lower elevation equivalent of the pre-mining potentiometric surface for the 3 Seam aquifer. Within the mined area and extending out to the projected drawdown limits, a cone of depression may remain for the 4 and 6 coal seams. This change in ground water levels for the 4 and 6 Seams represents a very localized condition and will not significantly affect ground water levels, direction of ground water movement, flow gradients in these aquifers, or the general ground water system beyond the drawdown limits. There are no current groundwater users within the zone of depression and, because of the depth and remoteness of the aquifer, none are likely in the future.

Changes in Ground Water Quality

Given the analysis results for overburden and interburden materials presented in Chapter CIII, Overburden and Interburden Assessment, which indicate that these materials are not potentially acid-forming, toxic-forming, or alkalinity-producing, significant changes in ground water chemistry or constituents are not anticipated as a result of mining. As in the surface water discussion, the introduction of blasting agents in the mining process (ammonium nitrate, a common fertilizer) and fertilizers in the revegetation process may temporarily increase the nutrients in the groundwater through the leaching process. These will only have a limited period of application and will be absorbed on the surface as the revegetation process takes hold.

Short-term increases in TDS values might be expected due to the increased porosity of backfilled spoils. However, it is anticipated that mining will have no significant affect on groundwater quality.

12.14 COMPLIANCE WITH THE CLEAN WATER ACT

The drainage and sediment control measures which will be implemented in conjunction with the proposed Jumbo Dome mining and reclamation activities in combination with reclamation

measures for mine disturbance areas will effect compliance with all applicable provisions of the Clean Water Act and corresponding State implementing statutes and regulations. Compliance under an APDES permits for storm water and potentially for a land application permit and surface water discharge permit will assure that all mine discharges meet applicable stream effluent criteria.

SECTION 13.0

AIR POLLUTION CONTROL PLAN

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13.0 AIR POLLUTION CONTROL PLAN

13.1 GENERAL AIR PROTECTION PLAN

The only sources of potential air pollutants associated with the Jumbo Dome Mine will be overburden and coal removal operations and haul road traffic. There will be no coal processing within the Jumbo Dome mine area. Control of fugitive dust emissions has been and will continue to be an important potential environmental impact concern as well as an important safety matter. Dust control programs are an integral part of mining and will continue to be as mine operations expand into the Jumbo Dome area. Dust control plans have been developed to control potential emissions from the following specific activities:

- haul road dust
- open burning
- wind erosion control

13.2 HAUL ROAD CONTROL

Fugitive dust generation from haul road traffic is typically the most substantial source of potential air pollutants from coal mines. At the Jumbo Dome Mine, fugitive dust will be controlled through a combination of design and operational controls. Most of the haul roads, with the exception of the in-pit hauls roads, will be surfaced with gravel to provide a coarse tire contact material and minimize smaller particle dust generation. Haul roads will also be watered with a water truck, as needed, except when freezing conditions would cause ice build-up on roadways. During such conditions, haul road watering will be suspended.

13.3 OPEN BURNING

UCM does not currently have specific plans for open burning but regards this as an option for disposal of excessive vegetation from clearing activities. If open burning is needed, appropriate permits form Division of Forestry will be procured prior to commencement of burning operations.

13.3 WIND EROSION CONTROL

Although the generally damp or frozen ground conditions prevailing at the mine site limit the opportunity for wind erosion and dispersion of dust particles, wind erosion controls will be used for both environmental protection and safety reasons. UCM's experience at Gold Run Pass over the last 20 years has shown that prompt vegetative re-establishment provides the single most effective means of controlling wind erosion. Therefore mining practices have been designed so that the extent of exposed disturbed areas will be the minimum amount necessary to facilitate logical mining and reclamation activities. Reclamation will occur concurrently with mining operations as described in Section D10.0 thereby minimizing the potential unprotected soil exposure period. Topsoil stockpiles will be seeded during the first favorable period following placement to prevent erosive material losses.

SECTION 14.0

PROTECTION OF PUBLIC PARKS AND HISTORIC PLACES

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14.0 PROTECTION OF PUBLIC PARKS AND HISTORIC PLACES

14.1 PUBLIC PARKS AND HISTORIC AREAS IN THE MINE VICINITY

There are no known public park areas or cultural or historic sites in or adjacent to the permit area. A plan for protection of these areas is therefore not included in this permit application.

14.2 MEASURES TO MINIMIZE IMPACTS

In the event that evidence of cultural or historic sites is discovered during mining, disturbance to the area will be suspended until it has been cleared by the State Historic Preservation Officer.