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J7-Jr MSHA DAM DESIGN REPORT

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1.0 INTRODUCTION

In accordance with Mine Safety & Health Administration (MSHA) regulations 30CFR216-2(a) and the appropriate Office of Surface Mining (USDOI-OSM) regulations, this report presents the results of the investigations and design studies performed for the J7-Jr sediment retention and storm water control dam located at Peabody Western Coal Company's (PWCC) Kayenta Mine. The MSHA identification number for the dam will be 1211-AZ-09-01195-09. The dam is located in the Red Peak Valley wash. Approximate location of the dam is longitude 110° 19' 52", latitude 36° 26' 13". Approximate coordinates for the center of the dam are N 39,650, E 48,178. The watershed for the J7-Jr impoundment is shown on Drawing 3. Designed and OSM approved diversion ditches will be used to direct runoff from the areas on the west edge of the watershed into the J7-Jr impoundment. Construction of the dam is projected to begin in the first half of 2001. The dam is proposed as a permanent structure after closure of mine activities. The final permanent impoundment design evaluation will be submitted to the appropriate regulatory agencies approximately two years before final bond release is anticipated.

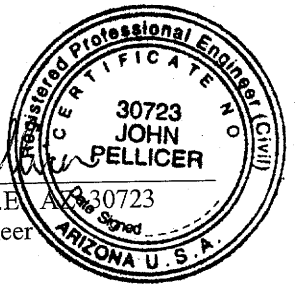
The J7-Jr impoundment is considered a Natural Resources Conservation Service (NRCS) Class (A) low hazard dam since there is no one living in the downstream flood plain.

The design of the J7-Jr sediment retention and storm water control dam complies with the MSHA standards for Surface Coal Mines (30CFR77.216). References to this Report on the requirements of 30CFR77.216-2(a)(1)-(17) are indicated in the following Table 1.1.

TABLE 1.1
REFERENCES TO 30CFR77.216-2(A)

1	Name of operators, address, name of the impoundment, MSHA identification number	MSHA Dam 1211-AZ-09-01195-09, referred to as J7-Jr, is owned and operated by Peabody Western Coal Company, Kayenta Mine, P.O. Box 605 Kayenta, Arizona 86033
2	Location of impoundment, USGS Map	Drawings 1and 2, Yucca Hill, Arizona USGS 7½ Min. Map
3	Purpose of the structure	Intercept and retain sediment and control runoff originating from mine disturbance within the watershed area shown on Drawing 3
4	Name and size of the watershed	Upper Red Peak Valley Wash. Location is shown on Drawings 2 and 3, Watershed area=3960 acres or 6.2 mi.
5	Physical and engineering properties of foundation materials	Section 4
6	Physical and engineering properties of materials used, site preparation and construction, date of construction	Sections 6 and 7, Start construction first half of 2001.
7	Details of embankment structure	Drawings 5-9, Table 2.1
8	Instrumentation	Instrumentation will consist of piezometers and settlement monuments as indicated in Drawing 9, Section 7.9 and 7.10. Monitoring will be performed according to Section 2.4.
9	Area-capacity curve	Appendix E (1/2 6-hour PMP Output)
10	Runoff attributable to PMP	Section 6.1.1 and Appendix E.11
11	Runoff attributable to design storm	Section 6.1.1 and Appendix E.4
12	Description of hydraulic structures	Section 6.1.2
13	Stability factors of safety	Section 6.3
14	Coal mine working areas	Drawing 3, No surface and underground coal mining within 500 feet of structure.
15	Construction surveillance and monitoring	Drawing 9, Section 2.4 and Section 7
16	General provisions for abandonment	Section 2.3
17	Registered engineers statement	Section 1

The design of the J7-Jr MSHA Dam is in accordance with current, prudent engineering practices for the maximum volume of water and sediment which can be impounded in Dam 1211-AZ-09-01195-09 and for the passage of runoff from the designed storm which exceeds the capacity of the impoundment.



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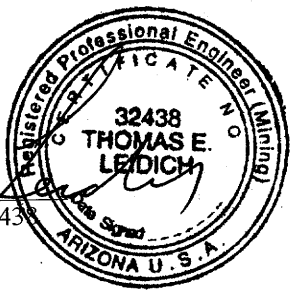

Thomas E. Leidich, P.E. AZ 32438
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Date

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2.0 PROJECT DESCRIPTION

2.1 PURPOSE AND DESIGN CRITERIA

The purpose of the J7-Jr dam is to comply with 30CFR816, the Office of Surface Mining (OSM)'s regulations, 30CFR216 of the MSHA regulations and to intercept and retain sediment originating from mine disturbance within the watershed area shown on Drawing 3. In addition, the dam will contain the 10-year, 24-hour storm within the same watershed. Run-off from the areas along the west side of the watershed will be diverted into the J7-Jr impoundment by means of ditches designed to convey the flow induced by the 100-year, 6-hr storm. The alignment of these ditches is also shown in Drawing 3. The ditches will be designed and approved in accordance with OSM regulations.

The dam includes an emergency spillway and a decant system. These structures are shown in plan and section views on Drawings 7 and 8. The purpose of the decant system is to drain excess water from the impoundment after the occurrence of regular precipitation events, therefore, maintaining the impoundment capacity to contain the 10-year, 24-hr storm. The invert of the decant inlet determines the maximum level of sediments allowed in the impoundment during operation. Sediments will be removed from the impoundment area to maintain the level beneath this maximum or a revised design plan will be submitted for regulatory approval. The removed sediments will be disposed in authorized areas of the mine. In addition PWCC will have the option to raise the spillway and the top of the embankment, to allow for 1' – 2' of future sediment storage.

The purpose of the emergency spillway is to allow the controlled discharge of flow originating from ½ the general 6-hour PMP storm event, therefore, preventing overtopping of the dam. The invert level of the spillway has been located so as to maintain a minimum 3-ft freeboard when the design storm occurs.

2.2 OPERATING POOL RESTRICTIONS

Sediment in the impoundment is expected to accumulate at a rate of 24.9 acre-feet per year. The elevation of the invert of the decant system inlet has been determined to allow sediment accumulation for approximately 12 years. The difference in elevation between the invert of the emergency spillway and the invert of the decant system inlet allows the containment of the runoff originating from the 10-year, 24-hr storm event. This total runoff volume has been calculated as 220.7 acre-feet. After the runoff has been contained for an adequate period, and it has been determined that it meets regulatory water quality standards, it may be discharged through the decant system. In addition, PWCC may utilize the water for dust control or other mine related purposes during the life of the mine.

The emergency spillway has been designed to discharge the flow originating from ½ the general 6-hour PMP storm event. It was conservatively assumed that the ponding water level is at the elevation of the invert of the emergency spillway to determine the spillway design capacity.

2.3 DESIGN SUMMARY

The J7-Jr dam will be constructed as a homogeneous earthfill embankment with a low permeability upstream liner and a downstream toe drain. The dam foundation consists of firm consolidated soils

and bedrock in approximately 70% of the footprint area. The remaining 30% will be founded on soils with some degree of compressibility. Calculations supported by extensive laboratory testing indicated that differential settlement would be minimal and would not affect the integrity of the dam (Section 6.4). In addition, the low permeability upstream liner will control seepage or piping in the unlikely event that some minor cracks develop in the embankment fill. The geosynthetic clay liner (GCL), proposed as the low permeability upstream liner allows a peak strain of 15 percent and a strain at failure of 50 percent. Seepage through and beneath the dam will be minimal due to the low permeability of the embankment fill, GCL and foundation material. A low permeability blanket will be extended upstream to minimize seepage through the foundation and abutments. A toe drain will be included on the downstream toe of the dam to control the phreatic surface within the embankment fill. The upstream slope of the dam will be protected with riprap to prevent erosion caused by wave action and direct precipitation. The 4:1(H:V) downstream slope will be vegetated to prevent erosion caused by wind and direct precipitation. Riprap will also be placed along the intersection of the dam downstream face with the abutments.

Foundation preparation for the dam will consist in clearing and grubbing of the footprint and excavation of natural soils until bedrock or consolidated soils are reached, or to a minimum depth of 10 ft below the existing ground surface. The foundation soils will be compacted to 95 percent of their maximum dry density obtained from the Standard Proctor (ASTM D698) method prior to placement of fill. The grain-size distributions of the materials proposed for the construction of the embankment are indicated in Section 7.

The embankment fill will be built in four phases. All phases will be completed before the dam is operable. The first phase will be built to provide a base for the toe drain. The second phase will consist in building the toe drain. The third phase will be built to allow deployment and placement of the low permeability liner (GCL). The upstream face of the third phase will be cleaned of large particles and compacted prior to deployment of the low permeability liner. The fourth phase will consist of the placement of fill over the low permeability liner and extension of the low permeability blanket. This fourth phase will bring the crest to its final elevation. A geotextile will be placed over the final upstream face and blanket. The geotextile will be covered with a layer of riprap. Riprap will be placed carefully over the geotextile so that is not punctured. Details of construction of the four phases are shown in Drawing 6. The toe drain (Phase 2) and homogeneous fill (Phases 1, 3 and 4) will be compacted in horizontal lifts. The contacts between horizontal lifts will be scarified and moisture conditioned to allow bonding.

A gravel base material will be placed and compacted on the crest of the dam. Embankment instrumentation will consist of three settlement monuments and three piezometers on the dam crest centerline. Two additional piezometers will be placed on the downstream slope (Drawing 9). The bottom tip of the piezometers will be placed immediately above the contact between the fill and bedrock.

An abandonment plan for the impoundment will be submitted to the regulatory agency at least two years prior to final abandonment. The stability of the dam will be re-evaluated based on the monitoring and inspections performed during operation. The hydrology of the watershed and the hydraulic aspects of the structure will also be re-evaluated.

The most relevant design aspects of the J7-Jr embankment project are summarized in Table 2.1.

TABLE 2.1 J7-Jr EMBANKMENT DESIGN INFORMATION	
Impoundment	
Allowable Sediment Storage Volume (Operation)	303 acre-ft
10-year 24-hour Storm Volume	221 acre-ft
Total Impoundment Capacity	555.8 acre-ft
Hydrology:	
Watershed Area	3960.3 acres / 6.2 sq. mi.
Embankment:	
Crest width	25 ft
Crest length	1300 ft
Crest elevation	6719
Maximum Embankment Height	49 ft
Average Upstream slope	3.3:1 (H:V)
Average Downstream slope	4:1 (H:V)
Estimated Excavation Volume	230,000 cubic yards
Estimated Homogeneous Fill Volume	316,500 cubic yards
Estimated Toe Drain Volume	13,500 cubic yards
Decant System:	
Gate Type	18 in diameter Valve or Slidegate
Maximum Flow Capacity	21.9 ft^3/s
Elevation of Inlet Invert	6702'
Emergency Spillway:	
Spillway Type	Riprap Lined Trapezoidal Channel
Elevation of Invert	6710'
Spillway Width	70 ft
Peak Discharge	1523 ft^3/s
Peak Storage (1/2 6-hour PMP)	718.1 ac-ft
Minimum Freeboard Required	3 ft

Material for the homogeneous fill will be borrowed from areas close to the dam. Part of the borrow material will be obtained from the foundation excavations along the footprint of the dam. Most of the borrow material will be excavated from the impoundment area. Drain and filter material may be obtained from permitted borrow areas within the PWCC property.

2.4 INSPECTION AND MONITORING

Settlement monuments will be monitored every three months for a period of one year after completion of construction. If no significant differential settlements (difference in settlement between adjacent monuments is greater than 0.7 ft) are encountered during the first year, the monitoring frequency of the settlement monuments will be extended to once every six months.

Water level measurements will be taken from the piezometers every 7 days after the completion of dam construction. The water level within the impoundment will be measured concurrently with the piezometer levels. The maximum allowable piezometer readings are shown on Table 2.2.

The dam and hydraulic structures will be inspected by a Certified MSHA Impoundment Inspector every 7 days after dam construction. Based on the provisions included in the design of the J7-Jr MSHA Dam, no need for repairs are anticipated. Defects detected during periodic inspections will be reported immediately to the Owner. The Owner will promptly order repair of the defects. These repairs will be performed according to prudent engineering practices.

Water level monitoring and dam inspection will occur every 7 days for a period of two years. Owner will then submit all data collected to MSHA District Manager and, based on satisfactory performance, will request a decrease of monitoring and inspection to every 30 days.

TABLE 2.2
MAXIMUM PIEZOMETER READINGS

Piezometer	Maximum Reading
P-1	6701
P-2	6691
P-3	6701
P-4	6681
P-5	6670

3.0 SITE GEOLOGY

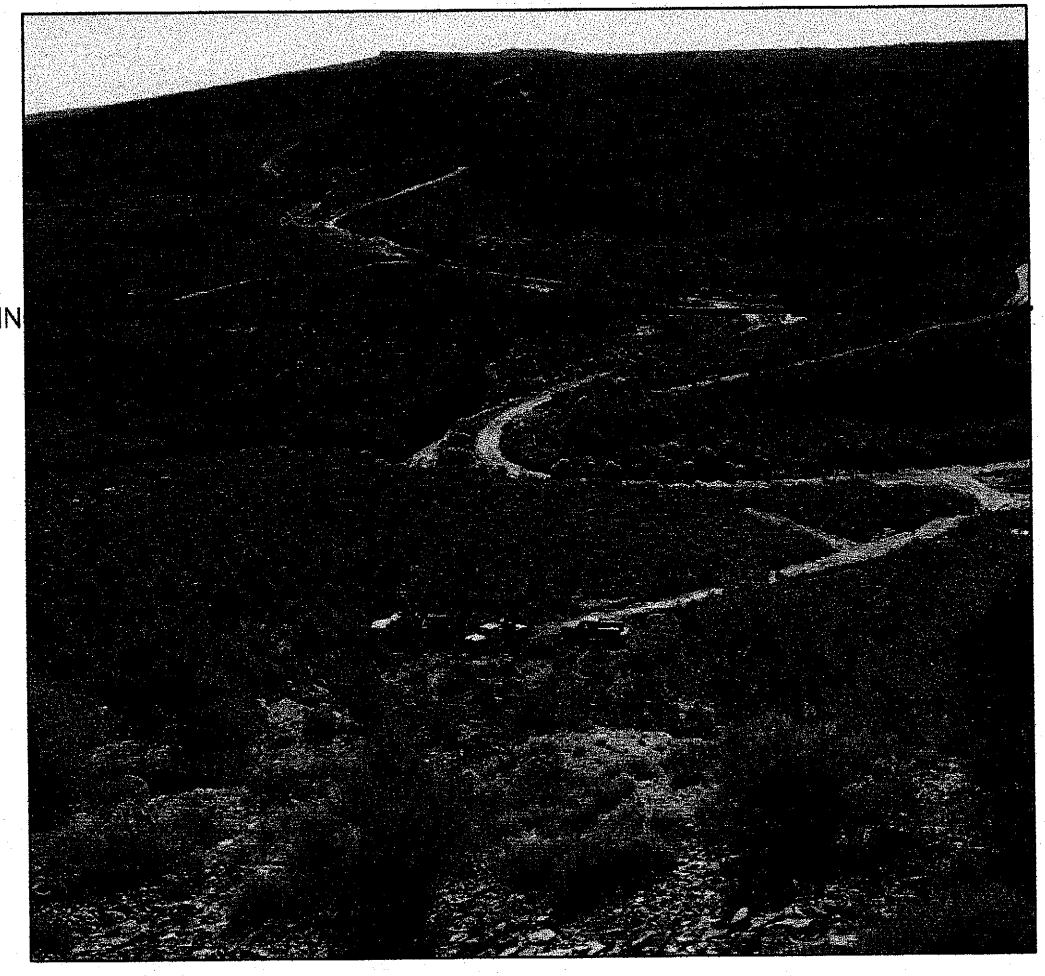
The J7-Jr MSHA Dam is located on Black Mesa, a moderately dissected highland region within the Colorado Plateau, which slopes gently to the southwest. Rocks of the Black Mesa region are predominantly sedimentary and have been gently folded and eroded (Dames & Moore, 1986). The Mesaverde Group is the geologic unit found in the mine area. The Mesaverde Group is locally subdivided into three formations. From oldest too youngest, these are the Toreva Formation, the Wepo Formation and the Yale Point Sandstone. The Wepo formation is the only consolidated geologic unit exposed at the dam site.

The Wepo Formation consists of a complex sequence of intercalated paludal sandstone, shale, siltstone, mudstone and coal units. The siltstone and mudstone units range in color from dark olive gray, through light olive brown, to medium light gray. Frequently these units are highly carbonaceous and may contain sandstone lenses and zones. Sandstone units are commonly yellowish gray and are frequently extremely argillaceous. Some of the sandstone units are very well cemented (Dames & Moore, 1986).

Quaternary unconsolidated materials overly the bedrock. These materials were derived from the weathering of surface formations. Residual soils, transported as slope wash, are deposited in the lower areas of the valley. These soils reflect the character of the parent bedrock. Shales and mudstones have weathered to clayey and silty soils of low to medium plasticity. Soils derived from sandstone consist of silty fine sands, generally with no plasticity. More resistant bedrock fragments are included in the soils as gravel size material (Dames & Moore, 1986).

The proposed dam site and impoundment is located in the Red Peak Valley Wash. The local relief at the dam site is moderately steep along the north abutment and gentle towards the south abutment. Bedrock outcrops are clearly visible on the north abutment. Bedrock stratifications are visible on cuts caused by erosion at the lower part of the drainage. Bedrock in the form of shale and mudstone was evidenced at very shallow depths in the test pits and borings performed in the high areas close to the south abutment. Alluvial materials are deposited on the bottom of the valley to a variable thickness. Sporadic but intense precipitation, normal during the summer and early fall seasons, has resulted in channeled runoff which has alternately eroded and redeposited the alluvial material along the sides of the valley forming terraces of up to 30 feet thick with steep incised channels (see Fig. 3.1).

DAM LOCATION



REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	2/00	Troncoso	Bevel	Troncoso

MONTGOMERY WATSON

PROJECT No.: 1342052

AutoCAD FILE: FIG3-1.DWG

SCALE: Not to Scale

FIGURE No: 3.1

PEABODY WESTERN COAL COMPANY

GENERAL VIEW OF DAM SITE LOCATION

4.0 GEOTECHNICAL INVESTIGATION

Geotechnical investigations for the J7-Jr MSHA Dam at the Kayenta Mine were performed to analyze and design the embankment according to MSHA regulations. Investigations were performed in the area of the embankment footprint and in the areas of potential borrow sources. The investigations included test borings, test pits, field permeability tests, laboratory tests and surface reconnaissance. In addition, previous geotechnical and geology studies were reviewed and used as complementary information.

The proposed location of the dam is shown on Drawings 1, 2, 3 and 4, along with the coordinates of test pits, borings and sandstone outcrops. Photograph views are also identified in Drawing 4. The photographs identified in Drawing 4 are presented in Appendix A.

4.1 DESCRIPTION OF FIELD AND LABORATORY INVESTIGATIONS

Field investigations consisted of test borings and test pits performed on the proposed footprint area of the dam and borrow sources.

In the Fall of 1999, test borings were performed with a CME-75 drill rig. Borings were drilled with a hollow stem auger until bedrock was encountered. Rock core drilling was continued in some of the borings and continuous NQ diameter rock core samples were recovered. Samples of the unconsolidated material were obtained by means of split spoon samplers and Shelby tubes. The samples from the split spoon samplers were obtained using the Standard Penetration Test (SPT). Locations of the borings are presented in Drawing 4. Detailed stratigraphic profiles of the borings are presented in Appendix B. Four packer tests were performed to determine the hydraulic conductivity of the rock.

Test pits were performed with a backhoe and disturbed samples were obtained from relevant strata. Locations of the test pits are presented in Drawing 4. Detailed stratigraphic profiles of the test pits are presented in Appendix B. Cross sections that show subsoil stratigraphy beneath the dam are also presented in Drawing 4.

Soil classification, shear strength properties, compaction characteristics, consolidation characteristics and permeability of remolded soils was obtained from tests performed in a qualified laboratory. Results of the laboratory tests are shown in Appendix C.

4.2 OVERBURDEN SOIL CLASSIFICATION

Overburden samples extracted from the borings were classified according to the Unified Soil Classification System. Sieve analysis and Atterberg limits were performed on soils below the proposed footprint of the dam and potential borrow sources.

The stratigraphic profiles beneath most of the footprint of the dam indicate a predominance of silty sands (SM) and low plasticity clays (CL). An approximately 15 ft thick strata of low plasticity clay was identified on the upper north abutment of the proposed dam. Detailed descriptions of the soils and their USCS classification are presented in Appendix C along with sieve analyses and Atterberg limits results.

Potential soils for drain or filter layers for the dam were identified at the J21, N6 and J19 Scoria stockpiles. These soils classified as silty sands (SM), poorly graded gravels (GP-GM) and silty gravels (GM).

4.3 ROCK CLASSIFICATION

The sedimentary rocks identified at the site are part of the Wepo Formation. As shown in the borehole logs (Appendix B), the types of rock encountered consist of sandstone, shale, siltstone, claystone, mudstone and coal. These different types of rocks appear interlayered and with varying thickness.

The sandstones are composed of fine-grained particles. They appear slightly weathered and with medium to high Rock Quality Designation (RQD)'s. Joints are planar and irregular with no filling or opening. Interbedded layers of siltstone, claystone, mudstone and shales were encountered in all borings. They appear weak and with variable RQD's. Joints are irregular and rough. Coal fragments and thin coal layers were encountered sporadically within the different sedimentary rocks. The maximum thickness of a coal layer encountered was 4 inches.

4.4 DENSITY AND COMPACTION CHARACTERISTICS OF OVERBURDEN SOILS

As indicated in the stratigraphic profiles, there are two major types of soils present beneath the footprint of the dam: fine silty sands and low plasticity clays. The specific gravities for the fine sands and clays are 2.6 and 2.62, respectively.

"In-situ" densities of the clay strata were calculated from the undisturbed samples extracted with the Shelby tubes. Dry densities ranged from 97.1 to 108.6 lbs/ft^3 with natural moisture contents between 20.2 and 24.5 percent. Densities for the silty sands beneath the proposed footprint of the dam were estimated from the blow counts obtained from the SPT's. Densities ranged between 95 and 120 lbs/ft^3 with an average value of 115 lbs/ft^3. The density measured on a sample extracted with a Shelby tube indicated a dry density of 95.3 lbs/ft^3 with natural moisture content of 4.4 percent.

The compaction characteristics of the silty sands that are proposed as borrow materials were determined from a Standard Proctor test (ASTM D698). A maximum dry density of 115.4 lbs/ft^3 and optimum moisture content of 12.1 percent was obtained. Compaction requirements for the homogeneous embankment fill will be specified as 95 percent of the maximum dry density obtained from the Standard Proctor test (ASTM D698).

4.5 SHEAR STRENGTH CHARACTERISTICS OF SOILS

The shear strength characteristics of the silty sands proposed for the structural fill of the dam were determined on remolded samples extracted from the test pits performed on potential borrow areas. Consolidated undrained triaxial tests with pore water pressure measurements (ASTM D4767) were performed on samples compacted to 95 percent of their maximum dry density as obtained from the Standard Proctor test.

The results of the triaxial shear tests are presented in the form of a Modified Mohr-Coulomb plots (p-q diagram) in Fig. 4.1. From the p-q diagram it can be deduced that the compacted soil has an effective friction angle of 36.4 degrees and cohesion of 187 lbs/ft^2. Details of the test data are presented in Appendix C.

An unconfined compression test was performed on an undisturbed sample extracted from the clay strata with a Shelby tube. A total stress shear strength cohesion of 2.55 psi was deduced from this test.

The shear strength of the native silty sand soils was deduced from the SPT's (see Appendix D.1). Based on the results of the SPT's, a conservative friction angle of 31 degrees was considered for these soils.

4.6 COMPRESSIBILITY CHARACTERISTICS OF SOILS

The compressibility characteristics of the silty sands underlying the proposed footprint of the dam were determined from the correlation between the "in-situ" density and published data. Based on the grain size distribution and blow counts recorded in the SPT's, an average secant compression modulus of 201 ksf was determined. Details of the calculations are found in Appendix D.1. A Denver Swell Test was also performed on these soils to determine their compressibility characteristics upon saturation. The results indicate that saturation would induce a settlement of 1 percent. The results of the Denver Swell Test are shown in Appendix C.

The compressibility of the clay strata beneath part of the dam footprint was deduced from a consolidation test performed on an undisturbed sample extracted from boring PW-B1 at a depth of 22 feet. The results indicate a compression index of 0.3 and a coefficient of consolidation of 0.2 ft^2/day. The details of the calculations and laboratory test data are found in Appendix D.2.

4.7 STRENGTH CHARACTERISTICS OF ROCK

Strength characteristics of the different rocks encountered were evaluated based on point load tests performed on samples cut and extracted from the core. The average point load indexes for the different types of rocks present at the site are indicated in Table 4.1. Results of known correlations and details of the calculations performed to determine the point load index; unconfined compressive strength and tangent elasticity modulus are presented in Appendix D.3.

TABLE 4.1
AVERAGE ROCK TYPE STRENGTH PROPERTIES

Rock Type	Point Load Index	Unconfined Compressive Strength	Elasticity Tangent Modulus
	(lbs/in^2)	(lbs/in^2)	(lbs/in^2)*10^6
Sandstone	187	4192	1.22
Siltstone	193	4322	1.25
Shale	25	551	0.27
Claystone/Mudstone	29	653	0.29

4.8 PERMEABILITY CHARACTERISTICS OF SOILS AND ROCK

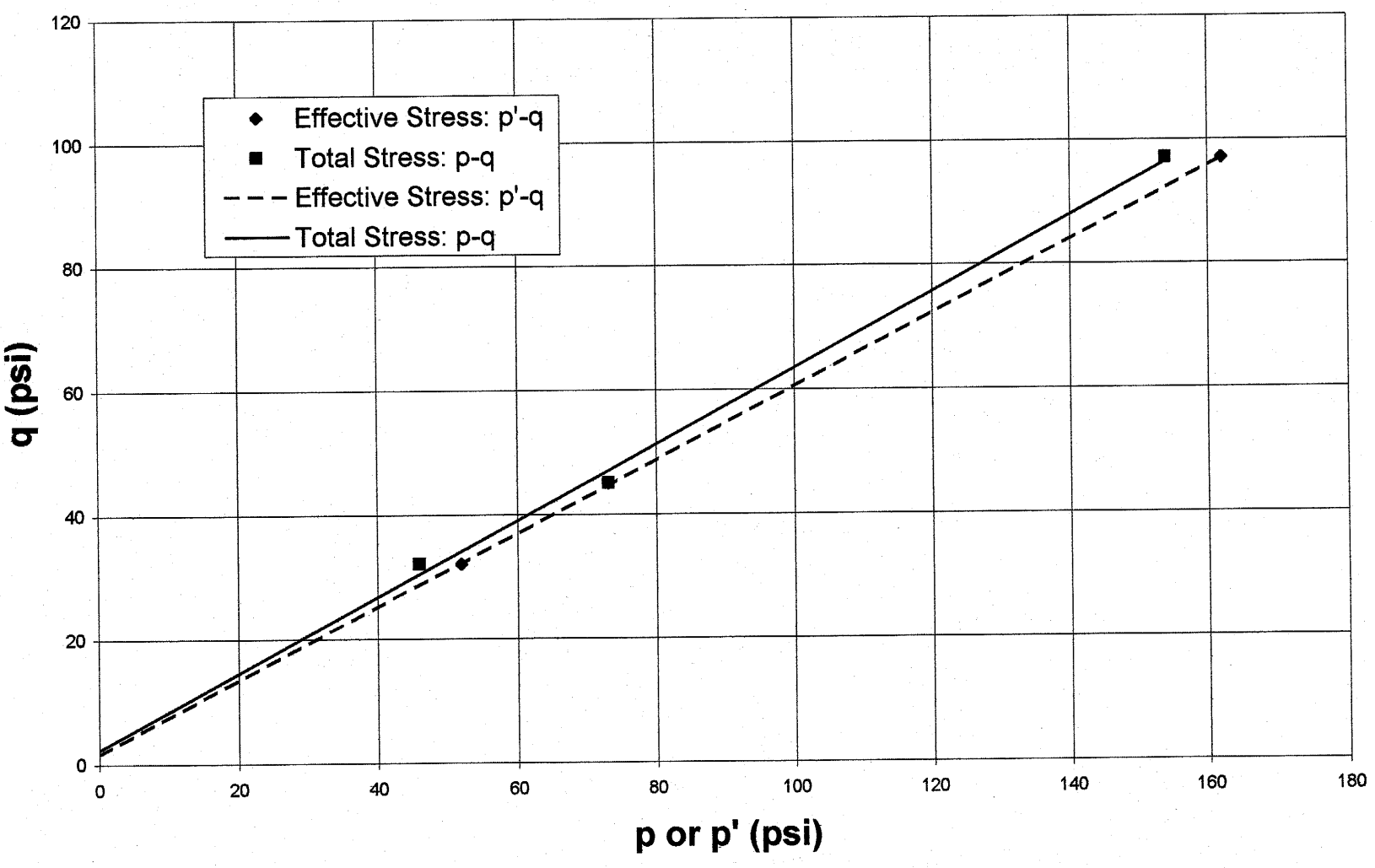
Permeabilities were measured "in-situ" and in the laboratory. Packer tests were performed to determine the hydraulic conductivity of the underlying sedimentary rocks. The results are summarized in the following Table 4.2. Details of the calculations and test data are presented in Appendix C.

TABLE 4.2
PERMEABILITIES DERIVED FROM PACKER TESTS

Boring	Depth tested (ft)	Rock Type	Pressure (ft of water)	Permeability (cm/s)
PW-B1	71 to 79	Sandstone	67.3	1.3e-4
PW-B1	71 to 79	Sandstone	88.1	1.7e-4
PW-B5	44 to 54	Siltstone	99.7	8.2e-6
PW-B5	44 to 54	Siltstone	120.5	5.3e-6
PW-B5	44 to 54	Siltstone	143.6	3.2e-5
PW-B5	54 to 64	Claystone	107.4	1.6e-5
PW-B5	54 to 64	Claystone	130.5	5.1e-6
PW-B5	54 to 64	Claystone	148.6	6.8e-6
PW-B6	44 to 54	Shale	97.1	2.4e-5
PW-B6	44 to 54	Shale	120.2	2.9e-5
PW-B6	44 to 54	Shale	143.3	5.6e-5

Constant head tests were performed on compacted silty sand samples to determine the permeability of the structural fill of the embankment. The samples were compacted to 90 percent of their maximum dry density as determined from the Standard Proctor tests. These tests resulted in a permeability of 5.3e-4 cm/s. This permeability is considered conservative from a permeability standpoint since the structural fill will be built with 95 percent degree of compaction. Constant head tests were also performed on compacted Scoria material. These resulted in a permeability of 5.5e-3 cm/s. Details of the test data and calculations are presented in Appendix C.

Fig. 4.1 Modified Mohr-Coulomb Diagrams for Embankment Fill



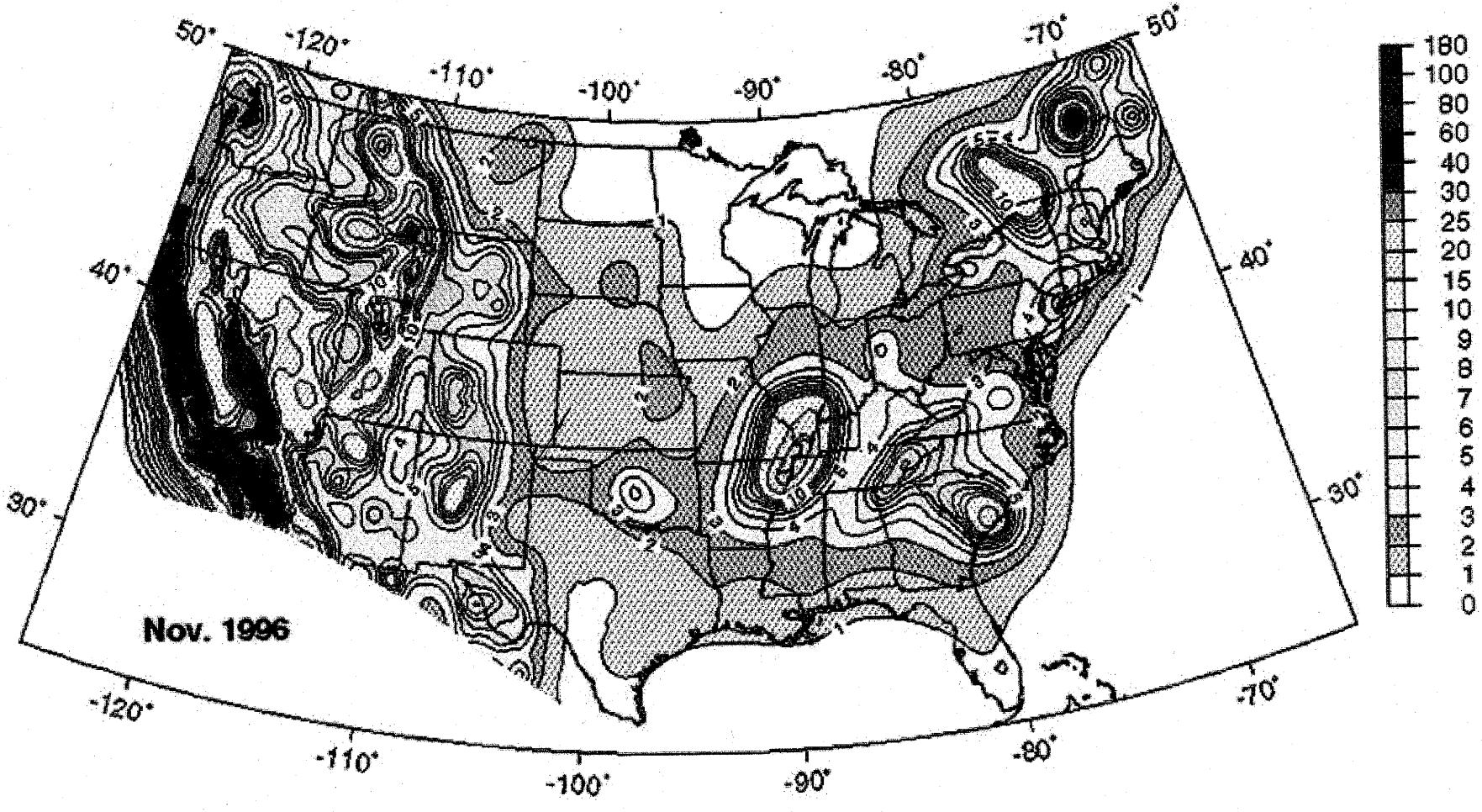
5.0 SEISMICITY

The proposed dam site is located in the south-central portion of the Colorado Plateau. The Colorado Plateau is a major continental block that has been uplifted since Late Tertiary time. Studies describe the Plateau as a stable block of slow regional uplift with little internal distortion, bounded by provinces of somewhat greater activity to the east and south, and high activity to the west (Sergent, Hauskins & Beckwith, 1985).

Studies by Algermissen indicate that the central part of the Colorado Plateau has significantly less earthquake activity than at the margins. For the site area, USGS has estimated a horizontal peak acceleration of less than 0.04g in rock with a 90% probability of not being exceeded in 50 years (Fig. 5.1). Since the operational life of the projected dam is approximately 50 years, the horizontal acceleration of 0.04g is considered appropriate to evaluate the stability of the dam under earthquake loading conditions during operation. Since the dam will also remain as a permanent structure after closure of mine activities, the peak acceleration obtained for a maximum probable earthquake was used to evaluate the stability for abandonment conditions. This peak acceleration was 0.1g according to the results of previous studies performed by Sergent, Hauskins & Beckwith (1985).

Fig. 5.1: Peak Acceleration (%) with 10% Probability of Exceedance in 50Years

Site: NEHRP B-C boundary



U.S. Geological Survey

6.0 DESIGN ANALYSIS

6.1 HYDROLOGY AND HYDRAULICS

The hydrology analysis performed for Structure J7-Jr follows the methodologies and assumptions used for all previous temporary and permanent impoundment structures at the Kayenta Mine. These methods and assumptions have proved to be adequate for drainage structures constructed at the mine site. The methods and analyses utilized for the hydrology and hydraulics for the structure can be found in documents entitled "General Report, Kayenta and Black Mesa Mines, Navajo County, Arizona, for Peabody Western Coal Company", December, 1985 (PAP), Chapter 6, Attachment D, Volume 2, and "Sediment and Water Control Facility Plan" pages 11 to 49 (Chapter 6) of the existing Office of Surface Mining (OSM) permit.

Structure J7-Jr has a 3,960.3-acre tributary drainage area and is located in a subwatershed of Red Peak Valley Wash of the Kayenta Mine. The Red Peak Valley Wash is a tributary to the Moenkopi Wash. The "worst case" anticipated watershed is classified as 17% undisturbed, 60% reclaimed, 17% spoil and 6% mining.

6.1.1 Hydrology

The hydrologic analysis was completed using the computer program SEDCAD4. J7-Jr will collect runoff from the J19, J21, and J23 mining areas. In addition, the height of the structure from the upstream embankment toe to the emergency spillway invert is 40 feet. According to 1983 MSHA guidelines for low hazard, impounding structures with a 40' height, ½ the probable maximum precipitation (PMP) is required for the design storm event. The general storm was used in the analysis. The precipitation for the General 6-hour PMP for the Kayenta mine is 5.96 in. (U.S. Dept. of Commerce, 1984). One half of the PMP equals 2.98 in. Calculations for the General 6-hour PMP are presented in Appendix E.4. The local storm 6-hour PMP was considered; however, as stated in Hydrometeorological Report No. 49 (Dept. of Commerce, 1984) the local storm occurs over small areas or only over a small portion of larger watersheds, and we believe it would not be appropriate for a 6.2 square mile watershed to utilize the local PMP over the entire watershed. The rainfall distribution used was the Type II distribution which is used for all similar structures at the Kayenta Mine (see Chapter 6, OSM permit). The storage capacity of the J7-Jr MSHA Dam was analyzed using the 10-year, 24-hour storm. To insure that adequate storage is maintained, an 18 in. (diameter) gated decant pipe will be installed through the embankment in order to keep the pond operating level at 6702'. The total runoff attributable to the General 6-hour PMP is 1,270 ac.-ft. (refer to Appendix E.11), however, this information has not been included in the design of the J7-Jr MSHA Dam since it is classified as low-hazard, and therefore, the PMP storm does not apply.

The following parameters were used in the hydrologic analysis:

TABLE 6.1
HYDROLOGIC ANALYSIS PARAMETERS

Description	Units
Water Course (Length)	3.691 miles
Elevation Difference (Height)	475 feet
Time of Concentration, T_c	1.093 hours
SCS Curve Number	81
Rainfall Depth	
10-year, 24 hour storm	2.1 inches
100-year, 6-hour storm	2.4 inches
½ General PMP (5.96 inch)	2.98 inches
Drainage Area	3,960.3 ac / 6.2 sq. mi.

Time of concentration and curve number calculations are shown in Appendix E.1.

6.1.2 Hydraulics

The SEDCAD4 computer program was used to evaluate inflow to the structure, outflow from the structure, and the resulting water surface elevations. The initial conditions and results of the analysis are summarized in the following text and tables (supporting calculations are presented in Appendix E.3 and E.4).

TABLE 6.2
J7-Jr SEDIMENTATION POND HYDRAULICS TABLE

Initial Reservoir Volume Condition	Units	10-Yr., 24-Hr Storm	½ 6-Hr. PMP Storm
		Empty	Full to emergency spillway
Inflow			
Peak Flow	ft^3/s	1,105.9	3085.4
Volume	ac-ft	220.7	428.4
Storage			
Storage Capacity @ Emergency Spillway Invert	ac-ft	555.8	555.8
Storage Capacity @ Principal Spillway Invert	ac-ft	303.1	303.1
Active Storage (between principal and emergency spillways)	ac-ft	252.7	252.7
Outflow			
Peak Flow	ft^3/s	N/A	1523
Emergency Spillway Invert Elevation	msl	6710'	6710'
Decant System Invert Elevation	msl	6702'	6702'
Embankment Crest Elevation	msl	6719'	6719'
Peak Stage	msl	N/A	6713.8'
Freeboard, Min. Required / Actual	ft	N/A	3.0/5.2
Emergency Spillway Channel			
Flow Depth	ft	N/A	3.8
Normal Velocity / Critical Velocity	fps	N/A	4.3/7.1
Width	ft	N/A	70
Outflow Channel			
Slope (max)	%	N/A	12
Velocity	fps	N/A	11.9
Width	ft	N/A	70
Flow Depth	ft	N/A	1.7
Mannings "n"	--	N/A	0.059
Riprap $D_{50\ Calculated}$	in	N/A	12
Riprap $D_{50\ Design}$	in	N/A	15

The emergency spillway and outflow channel has been designed so they can safely pass the peak flow from ½ of the General 6-hour PMP event. Both the spillway and outflow channel will be trapezoidal in shape, with alignment and dimensions as shown on Drawing 7. A conservative approach has been taken in the modeling and design of the emergency spillway. The water level of the impoundment area has been assumed to be at the invert of the emergency spillway (6710') when the design storm occurs. This results in a design peak flow of 1,523 ft^3/s. This is conservative, since the normal operating level of the impoundment is 6702' (elevation of the decant pipe inlet). Modeling of the

impoundment during the design storm with the water level set at the 6702' elevation produced a peak flow of only 458 ft^3/s. Design dimensions are shown on the following Table 6.3 and the SEDCAD4 modeling output files are presented in Appendix E.3, E.4 and E.6.

TABLE 6.3
SPILLWAY DESIGN DIMENSIONS

	Units
Design Peak flow	1523 ft^3/s
Minimum Channel Depth, w/Freeboard	
(Spillway)	6.8 feet
(Outflow)	3.0 feet
Channel Width	70 feet
Channel Length	
(Spillway)	44 feet
(Outflow)	300 feet
Side Slopes (Horizontal to Vertical)	3:1or flatter
Average Slope	
(Spillway)	<0.5 %
Maximum Slope	
(Outflow)	12.0 %
Spillway Elevation	6710 feet

The riprap protection on the outflow extends beyond the spillway channel toe into the natural drainage. Refer to Drawing 7, for riprap locations.

In order to maintain adequate storage to contain the 10-year, 24-hour storm event, the water level in the pond will be maintained at or below the 6702' elevation. This will provide approximately 252.6 ac-ft of storage (220.7 ac-ft required). The water level in the pond will be controlled by a decant system consisting of an HDPE 18 in. (diameter) smooth-walled pipe with an inlet at El. 6702' (refer to Drawing 8). The HDPE pipe will be installed through the embankment at an approximate 3.5% grade and aligned to discharge into the armored outflow of the emergency spillway. The inlet to the decant pipe will be equipped with a knife gate valve or slide gate or equivalent to control discharges. A trash rack will be installed at the inlet to prevent clogging. Controls for the valve will extend vertically to a catwalk where an employee can control the valve manually. The catwalk will be placed at an elevation of 6711' (a foot above the invert of the emergency spillway, refer to Drawing 8). Examples of knife gate valves and slide gates provided by "Red Valve" and "Hydro Gate" are shown in Appendix E.10. Anti-seep collars will be attached to the pipe barrel at approximately 30-foot centers to help prevent piping. The dimensions of the collars are designed so as to increase the flow path along the decant pipe by 15%, as recommended by the NRCS (a calculation brief is presented in Appendix E.9). Using HDPE, corrosion will be eliminated and due to the proposed location of the pipe, differential settlement of the embankment will cause only slight, if any, deformation of the pipe.

Pipe sections will be fused together forming water-tight fit by manufacturers procedures described in Appendix E.11. A Plexco 20SD21 pipe has been selected due to its ability to be buried 20 feet. (Refer to Calcs, Appendix E.12). Deflection of the pipe is expected to be minimal. (See Section 6.4.)

The decant system has been designed such that the 18 in. pipe will de-water the pond from the invert of the emergency spillway (El. 6710') to El. 6703' in less than 10 days. At the 6703' elevation, the impoundment has the capacity to contain the total runoff of the 10-year, 24-hour storm event, as measured from the invert of the emergency spillway (6710') to the 6703' level. Dewatering calculations are included in Appendix E.5. The location and cross-section of the proposed decant pipe is shown on Drawings 7 and 8. It is likely that the normal operating water level will be below

6702' since PWCC plans to use ponded water from the impoundment for dust control at the mine site.

Two diversion channels (refer to Drawing 3, for location) will be constructed to divert runoff from small watersheds located to the North of the embankment to the J7-Jr impoundment. The designs of these channels will comply with permit requirements and will be submitted to OSM for review and approval prior to their construction.

6.1.3 Stage Capacity

The impoundment stage-capacity table (see Appendix E.4) is based on the 1997 aerial survey conducted by PWCC. The capacity of J7-Jr is approximately 555.8 ac-ft, measured at the invert of the emergency spillway. The final capacity of the impoundment could increase due to planned topsoil removal operations and borrow areas located upstream of the dam. A stage/storage graph for the impoundment is provided in Appendix E.4 (refer to ½ 6-hour PMP SEDCAD4 output).

The calculations for the sediment load entering structure J7-Jr were made utilizing the Revised Universal Soil Loss Equation with the following parameters:

TABLE 6.4
SEDIMENT LOAD PARAMETERS

	Factor	Value
Rainfall Factor	R	40
Soil Erodibility Factor	K	0.31
Slope Factor	LS	6.03
Cover Factor	C	0.35
Erosion Control Factor	P	0.61

Given the size and the long configuration of the watershed, a Sediment Delivery Ratio of 80% was utilized. Sediment yield calculations are shown in Appendix E.2.

The hydrologic analysis gives the storage volume required to contain the 10-year, 24-hour storm and the storage volume available for storing sediment. The storage capacity for J7-Jr and the results of the sediment inflow analysis are summarized in the following Table 6.5.

TABLE 6.5
J7-Jr STORAGE CAPACITY

	Units
Total Storage Capacity	555.8 acre-ft
10-year, 24-hour Storm Capacity (220 acre-ft required)	252.6 acre-ft
Available Sediment Storage Capacity (@ El. 6702)	303.1 acre-ft
Sediment Inflow Rate	24.9 acre-ft/yr.
Sediment Storage Life	12.2 years

6.2 SEEPAGE ANALYSIS

A finite element seepage analysis was performed with the computer program SEEP/W to determine seepage and the phreatic surface within the dam. Since the dam will be founded over rock and soils, both conditions were analyzed for seepage (see Appendix D.4). The embankment was modeled as a homogeneous fill with a low permeability liner along the upstream face and a toe drain at the downstream end of the embankment. Foundation preparation will consist of excavation and removal of materials with high organic content. Surface soils will be excavated to a depth of at least 10 ft or until bedrock is encountered.

Conservative conditions and material properties were used in the analysis. The water level was assumed at El. 6713'. This water level corresponds to the elevation of 3' higher than the invert of the emergency spillway. The properties of the materials used in these analyses are listed in Table 6.6. The permeabilities for the embankment fill and sandstone were deduced from the results of the laboratory and field packer tests, respectively. The permeabilities for the toe drain were also deduced from laboratory tests. A conservative permeability value was assumed for the native silty sand and clay soil.

TABLE 6.6
MATERIAL PROPERTIES FOR SEEPAGE ANALYSIS

Material	Permeability (cm/s)
Embankment fill	6e-4
Geosynthetic Clay Liner	1e-9
Toe drain	5e-3
Native SM/CL soil	1e-3
Native clay soil	1e-6
Sandstone	2e-4

According to the seepage analyses performed, the maximum flow of water expected when the impoundment is full of water is 0.53 ft^2/hr per unit length of embankment. A conservative estimate of the total seepage for the indicated conditions is 0.2 ft^3/s. This value is obtained by multiplying the flow per unit length and the length of the embankment (1300-ft). The toe drain will collect approximately 45 percent of this flow. Details of the seepage analysis are included in Appendix D.4. Based on the low seepage flows obtained in these analyses, a keyway was not considered necessary for the J7-Jr MSHA Dam.

In addition, the low permeability blanket that will extend upstream will minimize potential localized seeps that may develop along the abutments and foundation. These seeps are expected to be minimal since strata with higher permeabilities than those used in the model were not encountered in the proposed dam foundation during the subsurface exploration program.

Additional seepage control measures will be taken during construction of the embankment. These will include scarification of foundation and fill material between compacted layers, and compaction of low permeability blanket with moisture contents higher than optimum.

6.3 STABILITY ANALYSES

Stability analyses were performed with the computer program SLOPE/W (see Appendix D.5). Two different foundation configurations were modeled for the stability analyses. The first configuration modeled a sandstone foundation. The second configuration modeled alluvial soils consisting of silty

sands with interbedded clay layers. The dam was modeled as a homogeneous fill embankment with a toe drain and an upstream low permeability GCL liner. A weak interface was assumed between the fill and the toe drain to account for the possibility of using a geotextile as a filter between these two materials. A conservative phreatic surface obtained from the seepage analyses was used in the slope stability model. This phreatic surface was obtained by assuming a water level at El. 6713'. The analyses are conservative because a higher phreatic surface increases pore water pressures in the soils and lowers the factors of safety.

Slope stability analyses were performed for temporary and permanent load conditions. The stability of the upstream face of the dam was evaluated for static, pseudo-static, rapid drawdown, and construction conditions. Construction conditions were assumed by placing a line load at the upstream face that simulates heavy equipment working on the fill over the GCL.

The soil properties used in the stability analyses are summarized in the following Table 6.7 and Appendix D.5.

TABLE 6.7
SOIL PROPERTIES FOR SLOPE STABILITY ANALYSES

Material	Unit Weight (lbs/ft³)	Effective ϕ'	Effective c' (lbs/ft²)	Total ϕ	Total c (lbs/ft²)
Structural embankment fill	138	36.4	187	36	187
GCL or Geotextile Soil Interface	-	27	0	27	0
GCL Interior Plane	-	-	-	25	0
Native SM/ML	138	31	0	31	0
Native clay	125	-	-	0	$S_u/\sigma' = 0.27$
Sedimentary rock	140	0	10000	0	10000

The strength properties for the structural embankment fill, native clays and sedimentary rocks were obtained from laboratory tests. The strength properties of the native SM/ML soils were deduced from the blow counts determined from the Standard Penetration Tests.

The results of the slope stability analyses are summarized in the following Table 6.8 and details are included in Appendix D.5.

TABLE 6.8
RESULTS OF SLOPE STABILITY ANALYSES

Foundation	Slope	Condition	Factor of Safety
Sedimentary rock	Upstream	Static	2.52
		Seismic (pseudo-static, 0.04g)	2.05
		Rapid draw-down	2.35
		During Construction	2.50
	Downstream	Static	3.11
		Seismic (pseudo-static, 0.1g)	2.15
Alluvial soil	Downstream	Static	1.58
		Seismic (pseudo-static, 0.1g)	1.22

The factors of safety (FOS) obtained are higher than those required by MSHA (FOS>1.5 for static conditions and FOS>1.2 for seismic conditions).

6.4 SETTLEMENT ANALYSIS

Based on the soil conditions in the dam site area, settlement will occur in two phases: immediate during construction and post-construction (see Appendix D.2). Immediate settlement during construction will occur due to the compressibility of the underlying rock and alluvial soils. These deformations will occur during construction and therefore will not induce differential settlement in the embankment. Post-construction settlement will occur due to consolidation of the interbedded clay layers and saturation of the silty sand soils. These post-construction deformations may induce differential settlements. Creep of the embankment fill is estimated as 0.25 percent of the height. Differential settlement induced by creep would be minimal. A 1-ft thick gravel base will be placed on the embankment crest to account for any possible settlement due to creep.

The maximum allowable differential settlement for a homogeneous earthfill dam is conservatively estimated as 2 percent of the height of the section that is subject to differential settlement. Based on the subsurface exploration, the section that would be subject to differential settlement is located close to the north abutment. The height of the dam in this area is 35 ft; therefore the allowable differential settlement is 0.7 ft.

Based on the Denver Swell Tests performed on the silty sands encountered beneath the dam footprint and the high densities of these soils deduced from the SPTs, settlement due to saturation is expected to be 0.35 ft. Based on the consolidation test performed on the clay deposits encountered beneath the dam, post-construction settlement due to consolidation is expected to be 1.8 inches. Total differential settlement therefore is conservatively estimated as 0.5 ft, which is less than the allowable 0.7-ft. Details on the calculations of settlement are presented in Appendix D.2.

6.5 DESIGN OF UPSTREAM GEOSYNTHETIC CLAY LINER

A Geosynthetic Clay Liner (GCL) will be placed on the upstream side of the embankment to control seepage. A GCL is a factory manufactured hydraulic barrier consisting of a low permeability material, supported by geotextiles which are held together by needle punching or stitching. The GCL will have a maximum permeability of 1e-9 cm/s and will be able to withstand 15 percent tensile strain at peak strength and 50 percent at failure.

The embankment will be built in two phases to install and protect the GCL. In the first phase the embankment will be built to El. 6716.9', with a crest width of 15-ft. An intermediate bench 15-ft wide will be placed on the upstream face of the embankment at El. 6700'. The purpose of this intermediate bench is to provide an intermediate anchorage point for the GCL and improve stability. The GCL will be anchored at the crest of the first phase, the intermediate bench and at the upstream toe. The second phase of the embankment will be built by placing a 25-ft wide fill over the GCL on the upstream face of the embankment bringing the crest to El. 6719'. The details for the construction and placement of the GCL are indicated in Drawing 6.

6.6 DESIGN OF TOE DRAIN

The toe drain has been designed to lower the water table within the embankment to the elevation of the downstream toe. The drain will be built with gravels or sands and will have a minimum permeability of 5e-3 cm/s when compacted to 95% of maximum dry density as obtained from the Standard Proctor method. A geotextile filter will be placed over and under the toe drain. The geotextile filter will be nonwoven, will have a minimum Apparent Opening Size (AOS) of 50 (per ASTM D 4751) and will have a minimum permeability of 5e-3 cm/s (per ASTM D 4491). The

geotextile will be a Mirafi 160N or equivalent. Details of the placement of the geotextile filter are shown on Drawing 6. Details of the geotextile filter calculations are shown in Appendix D.6.

6.7 CREST DESIGN

Settlement due to creep of the embankment fill has been conservatively estimated as 2 inches. A 12-inch gravel base will be placed over the embankment fill, therefore additional crest elevation to account for embankment creep will not be necessary. This base material will consist of locally available gravel from a stockpile used for construction of roads at the mine.

6.8 FREEBOARD

A minimum freeboard of 3 ft is required by MSHA regulation. The actual freeboard for the dam is 5.2 ft.

6.9 UPSTREAM AND DOWNSTREAM SLOPE PROTECTION

Upstream slope protection will consist of riprap placed over a geotextile filter. Based on wave action, riprap will have a minimum D_{50} of 12 inches and a D_{max} of 24 inches (see Appendix D.7). Riprap will be placed in a layer thickness of at least 18 inches. A maximum of 5 percent by weight of sand particles will be allowed in the riprap. The geotextile filter will have a minimum AOS of 70 and minimum impact strength of 90 ft*lbs. The geotextile will be a Mirafi 160N or equivalent. Calculation details are shown in Appendix D.7.

The downstream slope of the J7-Jr embankment will be topsoiled and vegetated using the same procedures utilized for other reclamation areas at the Kayenta Mine. Seed mixes and reclamation practices will be used as approved in the existing Kayenta Mine permit . During topsoiling activities, contour furrows will be left perpendicular to the slope that will aid in the establishment of vegetation. Based on these reclamation procedures, no erosion or stability problems are anticipated with the downstream slope of the J7-Jr embankment.

7.0 CONSTRUCTION SPECIFICATIONS

The Construction Specifications indicated in this Section are to be used only for the construction of the J7-Jr MSHA Dam. The following definitions apply throughout this Section:

- The Owner: Peabody Western will own and operate the facility.
- The Design Engineer: Montgomery Watson prepared the Design Report presented herein in conjunction with the Project Drawings.
- The Contractor: The Owners forces or an individual, firm or corporation who has entered into agreement with the Owner to build the J7-Jr MSHA Dam.
- The Construction Quality Assurance Engineer (CQA Engineer): Owners forces, individual, firm or corporation who has entered into agreement with the Owner to verify that the J7-Jr MSHA Dam is constructed according to design specifications.

Fill for the embankment will be placed in four phases described as follows:

- Phase I: Placement and compaction of embankment fill to elevation at the base of the toe drain.
- Phase II: Placement and compaction of toe drain.
- Phase III: Placement and compaction of embankment fill to El. 6716.9'.
- Phase IV: Placement and compaction of embankment fill to El. 6719'.

These four phases are shown in Drawing 6. The geotextile and GCL will be placed according to the same design drawings. The GCL will be placed after completion of Phase III. The low permeability blanket will be placed during Phase IV. The protective layers (riprap for the upstream face and gravel base for the low permeability blanket) will be placed after completion of Phase IV. Finally, piezometers and settlement monuments will be installed after completion of the gravel base on the crest of the dam.

Any changes to these Specifications shall be submitted to the Design Engineer and Owner for approval.

The design Drawings referenced in this document are provided for permitting purposes. These Drawings will be used as a basis for detailed Construction Drawings that will be completed before beginning of earthworks.

7.1 FOUNDATION PREPARATION AND TREATMENT

7.1.1 Clearing, Grubbing, and Stripping Embankment Area

All vegetation, debris, and unsuitable overburden soils shall be removed from all areas that will receive fill. Materials to be removed include overburden soils unsuitable as embankment foundation, surface boulders and loose rock, organic material including stumps and roots, and other material determined to be unsuitable by the CQA Engineer. All material that might interfere with the bond between the embankment fill and the foundation or compaction of the embankment fill shall be removed.

7.1.2 Clearing, Grubbing, and Stripping Borrow Areas

All vegetation, debris, and other deleterious materials shall be removed from the borrow areas. Materials to be removed include all materials that do not meet the requirements of Section 7.5.1 for embankment fill. Cleared materials shall be disposed of in areas designated by the Owner.

7.1.3 Excavation

The overburden soils within the embankment footprint area shall be excavated to the contact of relatively sound rock or to firm native soils. The exact depth of excavation shall be determined by the CQA Engineer on the basis of field observations. Boring logs presented in the Drawings are for information only and represent conditions only at the specific locations. Depths indicated are not to be construed as excavation limits. Excavation side slopes outside the foundation footprint shall not be steeper than 2:1 (H:V). The side slopes of the excavation shall be stripped clean of debris and loose soil. It is recommended that temporary excavations are no steeper than 2:1 (H:V), however, the Contractor may use steeper slopes according to his experience and specific site conditions.

7.1.4 Foundation Preparation

Areas that will receive embankment fill or toe drain material will be approved by the CQA Engineer prior to placement material. Loose rock, rock cliffs, ledges and overhangs, and sharp irregularities shall be removed to provide satisfactory foundation contours. The foundation soils will be compacted to 95 percent of their maximum dry density obtained from the Standard Proctor (ASTM D698) method prior to placement of fill.

Areas of exposed fine-grained native soil foundation shall be kept moist to avoid desiccation cracking. Operation of equipment on the soil foundation shall be minimized to avoid disturbance. Disturbed or loose soil shall be removed prior to placement of embankment fill or drainage layer material. The soil foundation surface under the embankment fill shall be scarified to improve the bond between the soil foundation and the embankment fill. The soil foundation under the toe drain material shall not be scarified.

Clay and shale foundations shall be protected from freezing by placing a temporary cover of at least one-foot of previously excavated material. Final excavation shall be followed without delay by placement of embankment or drainage layer material as required. Exposed finished shale and clay surfaces shall be kept moist at all times.

7.2 REMOVAL OF WATER FROM FOUNDATIONS

7.2.1 General

The contractor shall construct and maintain all necessary cofferdams, channels, flumes, drains, sumps, and/or other temporary diversion and protective works; shall furnish the required materials; and shall furnish, install, maintain, and operate all necessary pumping and other equipment for removal of water from the various parts of the work and for maintaining the foundations and other

parts of the work free from water. After having served their purpose all cofferdams or other protective works upstream from the dam shall be removed from the stream channel or leveled so as not to interfere with the operation, capacity, or usefulness of the impoundment. The CQA Engineer shall approve of the removal or leveling of these structures. The Contractor shall be responsible for repair and costs associated with repair of damage to the foundations, structures, or any other parts of the work caused by floods, water, or failure of any part of the cofferdams or protective works.

7.2.2 Plan

Prior to beginning any work on removal of water from foundations the Contractor shall submit to the CQA Engineer for approval a water control plan showing his proposed method. The plan may be placed in operation on approval but the Contractor will not be relieved from full responsibility for the adequacy of the diversion and protective works.

7.2.3 Removal of Water from Foundation Excavations

The Contractor's method of removal of water from foundation excavations shall be subject to the approval of the CQA Engineer. Although it is not anticipated, excavations for parts of embankment foundations that extend below the water table shall be de-watered. The de-watering shall be accomplished in a manner that will maintain stability of the excavated slopes and will result in all construction operations being performed with no standing water. The Contractor will also be required to control seepage along the bottom of the embankment foundation. Control of seepage may require supplementing the other de-watering systems by pipe drains leading to sumps equipped with pumps for removal of the water.

7.3 TOE DRAIN MATERIAL

7.3.1 Material Specifications

The toe drain shall consist of coarse-grained materials. These materials may be obtained from the coarse N6, J19 and J21 Scoria stockpiles at the mine site. The material shall meet the following gradation limits as determined by ASTM D422:

TABLE 7.1
TOE DRAIN GRADATION LIMITS

Sieve Size (U.S. Standard)	Percent Passing by Weight
6 inch	100
3 inch	60-100
3/8 inch	25-45
#4	15-35
#20	5-28
#200	0-14

The material shall be free of vegetation, organic matter, debris, and other deleterious material. Care shall be taken during construction not to contaminate the toe drain material with fine-grained soils. All contaminated toe drain material shall be stripped and removed.

7.3.2 Placement and Compaction

Toe drain material shall be placed over a geotextile filter in a manner that will not puncture or tear the geotextile. The maximum loose lift thickness shall be 1.5 ft. The toe drain material shall be compacted to 95 percent of maximum dry density as determined by the Standard Proctor (ASTM D698) method with compaction equipment approved by the CQA Engineer.

7.4 GEOTEXTILE FILTER

7.4.1 Material Specifications

The geotextile filter for the embankment fill/toe drain interface shall be non-woven with a minimum Apparent Opening Size (AOS) of 50 as determined by ASTM D4751 and a minimum permeability of 5e-3 cm/sec as determined by ASTM D4491. The geotextile filter for the embankment fill/upstream slope protection interface will have a minimum AOS of 70 and minimum impact strength of 90 ft*lbs. The geotextile filter will be Mirafi 160N or an approved equivalent.

7.4.2 Placement

The geotextile filter shall be placed on all surfaces required to completely separate the specified materials. The CQA Engineer shall approve surfaces on which geotextile filter material will be placed. Surfaces for placement of geotextile filter material will be free of sharp rocks or irregularities that could puncture the material. The geotextile shall be placed from the top of slopes downward. Overlap between sheets of geotextile will be at least 2 ft or as recommended by the manufacturer and approved by the Design Engineer.

Material placed on the geotextile shall be placed in a manner that minimizes the chances of puncturing the fabric. The method for placement of material on the geotextile shall be approved by the CQA Engineer. Anchor trenches will be constructed where required by the Drawings.

7.5 EMBANKMENT FILL

7.5.1 Material Specifications

Embankment fill material can be obtained from borrow areas in the impoundment area or other areas approved by the Owner. The embankment fill material will consist of silty sand and fall within the following gradation limits as determined by ASTM D422:

TABLE 7.2
SILTY SAND GRADATION LIMITS

Sieve Size (U.S. Standard)	Percent Passing by Weight
3 inch	100
#10	90-100
#20	85-100
#40	60-100
#100	35-75
#200	25-40

The material shall be free of vegetation, organic matter, debris, and other deleterious material. Soils excavated from the foundation area that meet the gradation criteria may be used as embankment fill.

7.5.2 Placement and Compaction

The embankment fill material shall be placed and compacted with a maximum loose thickness of 1 ft. Embankment fill materials shall be compacted to a minimum of 95 percent of maximum dry density as determined by the Standard Proctor (ASTM D698) method with compaction equipment approved by the CQA Engineer. The moisture content during compaction shall be between 2 percent below and 3 percent above the optimum moisture content.

7.6 GEOSYNTHETIC CLAY LINER

7.6.1 Material Specifications

The geosynthetic clay liner (GCL) shall have a permeability of less than 1e-9 cm/sec and will be able to withstand 15 percent tensile strain at peak strength and 50 percent tensile strain at failure. The GCL shall be Bentofix™ supplied by National Seal Company, Aurora, Illinois or an approved equivalent. Shear box testing should be performed on the GCL prior to installation to verify the friction angle of the material is equal or greater than 25 degrees under site specific conditions. The GCL will be placed in the shear box between two layers of embankment fill material compacted to the specified density. This testing shall be performed according to ASTM D5321.

7.6.2 Placement

The embankment will be built in four phases. In the third phase the embankment will be built to El. 6716.9', with a crest width of 15 ft. An intermediate bench 15-ft wide will be placed on the upstream face of the embankment at El. 6700'. The GCL will be anchored at the crest of the third phase, the intermediate bench and at the upstream toe. The GCL will be placed from the top of the slope down. The fourth phase of the embankment will be built by placing a 25 ft wide fill over the GCL on the upstream face of the embankment bringing the crest to El. 6710'. The details for the construction and placement of the GCL are indicated in Drawing 6. Overlap between GCL sheets will be at least 2 ft or as recommended by the manufacturer and approved by the Design Engineer.

7.7 SLOPE PROTECTION

7.7.1 Material Specifications

Upstream slope protection will consist of riprap placed over a geotextile filter. The riprap will have a minimum D_{50} of 12 inches and a D_{max} of 24 inches. Riprap will be placed in a layer thickness of at least 18 inches. A maximum of 5 percent by weight of sand particles will be allowed in the riprap.

The downstream slope of the J7-Jr embankment will be topsoiled and vegetated.

7.7.2 Placement and Compaction

Riprap will be placed mechanically from the bottom of the slope to the top in a manner approved by the CQA Engineer that minimizes the chances of damaging the geotextile filter fabric.

Seed mixes, mulch, and topsoil will be used as approved in the existing Kayenta mine permit. Contour furrows will be left perpendicular to the slope during topsoiling activities.

7.8 GRAVEL BASE

7.8.1 Material Specifications

Gravel base material shall be placed over the crest of the dam and upstream low permeability blanket. This material will consist of gravels that are currently used to stabilize the roads within the mine.

7.8.2 Placement and Compaction

The gravel base material shall be placed in a maximum loose thickness of 1.5 ft. The material shall be compacted to 95 percent of maximum dry density as determined by the Standard Proctor (ASTM D698) method with compaction equipment approved by the CQA Engineer.

7.9 PIEZOMETERS

Piezometers shall be installed in the embankment immediately after construction of the fill. Three piezometers shall be installed on the crest, along the centerline of the embankment. Two additional piezometers will be installed on the downstream slope. The piezometers shall be open standpipes vented to the atmosphere with at least 10-ft of screened interval. The screened interval shall be located approximately 5 feet above the interface between the foundation and the embankment fill. An appropriate filter material shall be used to protect the screen from clogging.

7.10 SETTLEMENT MONUMENTS

Settlement monuments shall be installed in the embankment immediately after construction of the fill. Three settlement monuments shall be installed along the centerline of the embankment. The settlement monuments shall be permanent steel tubes mounted on a steel plate. The steel plate shall be buried in the fill at a minimum depth of 5 ft beneath the embankment crest. A steel survey cap shall be placed on top of the steel tube.

7.11 DECANT PIPE AND SHUT-OFF VALVE INSTALLATION

The decant pipe shall be installed according to the alignment as shown on the Drawings. The pipe shall be an 18-in. diameter smooth-walled HDPE pipe with wall thickness as recommended by manufacturers design detail. The decant pipe shall be installed concurrent with embankment construction. The embankment fill material shall be placed and hand-compacted around the pipe and anti-seep collars with a maximum lift thickness of 1 ft. Embankment fill materials shall be compacted to a minimum of 95 percent of maximum dry density as determined by ASTM D698 with

compaction equipment approved by the CQA Engineer. The moisture content during compaction shall be between 2 percent below and 3 percent above the optimum moisture content.

The shut-off valve and vertical stem extension shall be installed per manufactures design detail. The catwalk shall be installed per Federal and local regulations.

7.12 EMERGENCY SPILLWAY

The emergency spillway shall be constructed to the alignment and specifications as shown on the Drawings. The spillway shall be constructed concurrent with embankment construction and its foundation compacted to the same specifications as the embankment.

A geotextile filter shall be installed at the interface between the graded spillway and the armored surface. The geotextile filter will have a minimum AOS of 70 and minimum impact strength of 90 ft*lbs. The geotextile filter will be Mirafi 160N or an approved equivalent. Installation of the geotextile shall be according to manufacturer specifications.

The bedding material shall follow the gradation limitations as shown in Table 7.1. Riprap protection of the spillway shall be of durable rock as approved by the CQA Engineer and have a minimum D_{50} size of 15 in. and a minimum thickness of 23 in.

7.13 GENERAL REQUIREMENTS

7.13.1 Compaction Methods and Equipment

Compaction of the embankment fill material shall be obtained by the use of a grid-type or sheepsfoot roller. The surface of each lift shall be scarified before placement of the next lift.

7.13.2 Weather Limitations

Embankment fill and toe drain material shall not be constructed when the air temperature is 35 degrees F and falling unless approved in the field by the CQA Engineer. It shall be the responsibility of the Contractor to protect all areas of completed surface against any detrimental temperature effects. The methods for protection against temperature effects shall be approved by the CQA Engineer. Acceptable methods for controlling freezing include covering the fill surface with loose dry soil for protection and removal of frozen surface prior to placement of fill. The CQA Engineer will determine when areas damaged by freezing shall be reconditioned and re-compacted in conformance with the requirements of this specification.

7.14 QUALITY CONTROL

7.14.1 General

The CQA Engineer shall be responsible during construction of the J7-Jr MSHA Dam for the following:

- Construction observation for quality control,
- Materials testing for compliance with specifications, and
- Reports.

The Owner shall be responsible for all surveying and verification of lines and grades.

7.14.2 Construction Observations

The CQA Engineer shall act as the Owner's representative, shall be the interpreter of the site construction specifications, and shall make observations and tests as considered necessary to assess and accept the quality of the work. Continuous observation and tests of construction operations shall be made by a geotechnical engineering technician under the direction of the CQA Engineer.

7.14.3 Testing

7.14.3.1 Toe Drain

Particle size analysis (ASTM D422) shall be performed once each 9,000 cubic yards of material placed. In-place moisture-density (ASTM D1556 or ASTM D2922) testing shall be performed once for each 1,500 cubic yards of material placed with at least one test per lift. The moisture-density relationship (ASTM D698) shall be determined and will be repeated when borrow materials change or at least once for every 9,000 cubic yards of material placed.

7.14.3.2 Embankment Fill

Particle size analysis (ASTM D422) shall be performed once each 9,000 cubic yards of material placed. In-place moisture-density (ASTM D1556 or ASTM D2922) testing shall be performed once for each 1,500 cubic yards of material placed with at least one test per lift. The moisture-density relationship (ASTM D698) shall be determined and will be repeated when borrow materials change or at least once for every 9,000 cubic yards of material placed.

7.14.3.3 Geotextile and GCL

Quality control testing to establish the properties specified in this document on the geotextile and GCL shall be performed by the manufacturer. Quality Control certificates shall be issued by the manufacturers of the GCL and the geotextile to the Owner or other designated party for each delivery of material. The certifications shall be signed by the quality control manager of the GCL and geotextile manufacturer or other responsible party.

Shear box testing should be performed on the GCL prior to installation to verify the friction angle of the material is equal or greater than 25 degrees under site specific conditions. The GCL will be placed in the shear box between two layers of embankment fill material compacted to the specified density. This testing shall be performed according to ASTM D5321.

7.14.3.4 Upstream Slope Protection

Upstream slope protection shall be tested on grade after placement for particle size.

7.14.4 Quality Control Reports

The CQA Engineer shall submit reports of observations and tests to the Owner.

A daily log of construction activities shall be maintained at the job site. The log shall report the construction activities, the test program for the day, the date, the temperature, and the general weather conditions. A copy of the daily log will be available for inspection by the Owner and regulatory agencies.

Test reports shall be submitted to the owner within seven days of the tests. A copy of all test results will be maintained at the construction site.

Test results shall include the following:

- Date issued,
- Project title and number,
- Date of testing and/or sampling,
- Type of test,
- Location of test, and
- Observations regarding compliance or noncompliance with Construction Drawings and Specifications.

The CQA Engineer shall submit a final quality control report certifying the project is completed in accordance with Construction Drawings and Specifications and presenting all test results, as-built plans, and other supporting data upon completion of construction.

8.0 REFERENCES

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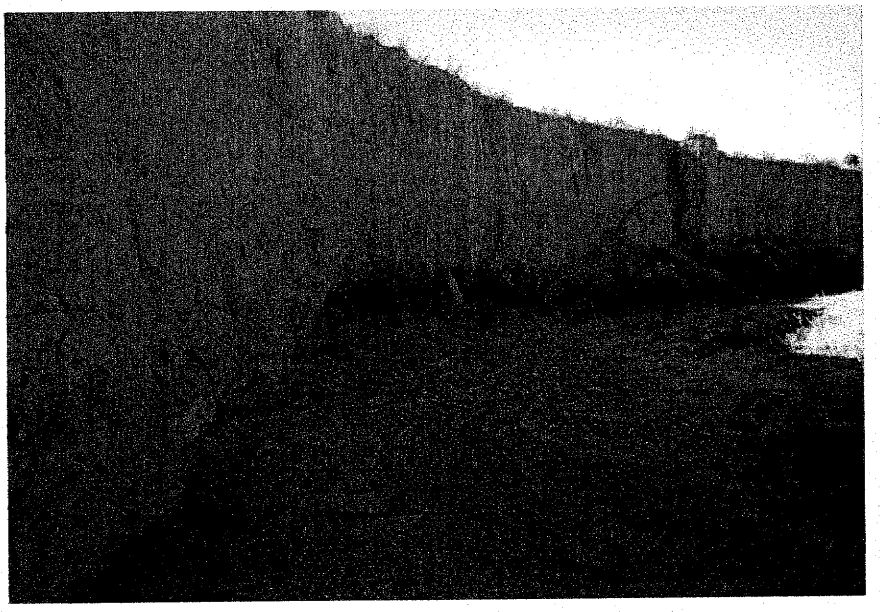

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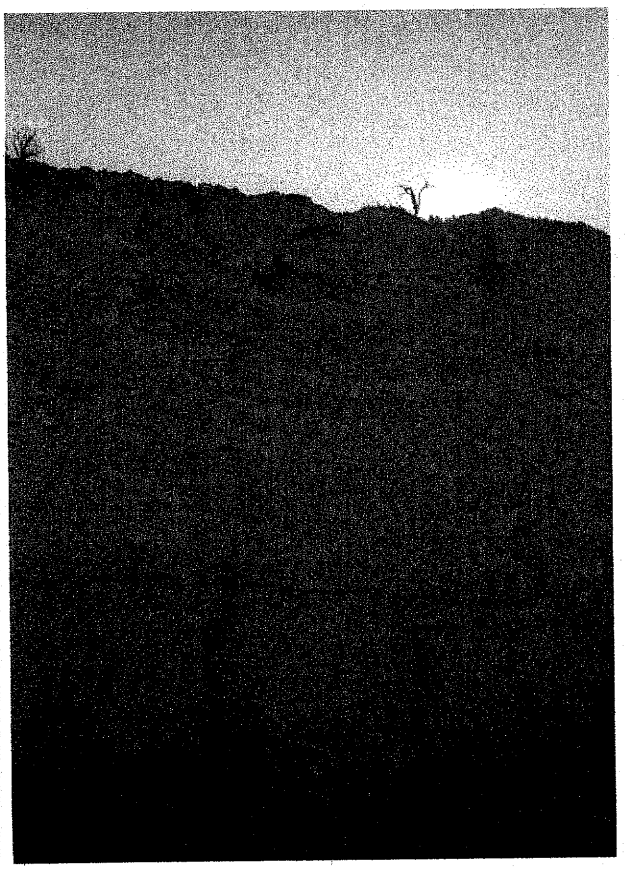

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FIGURE No: 1

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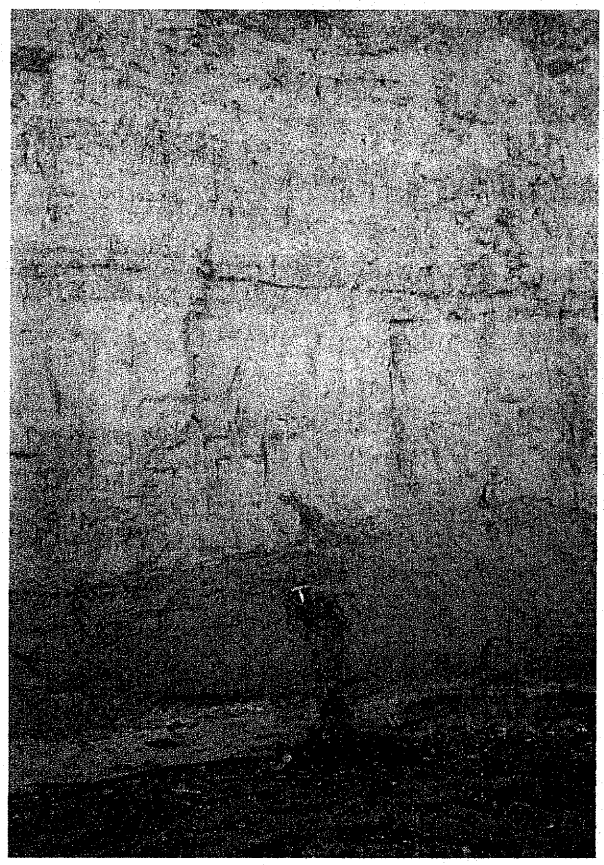

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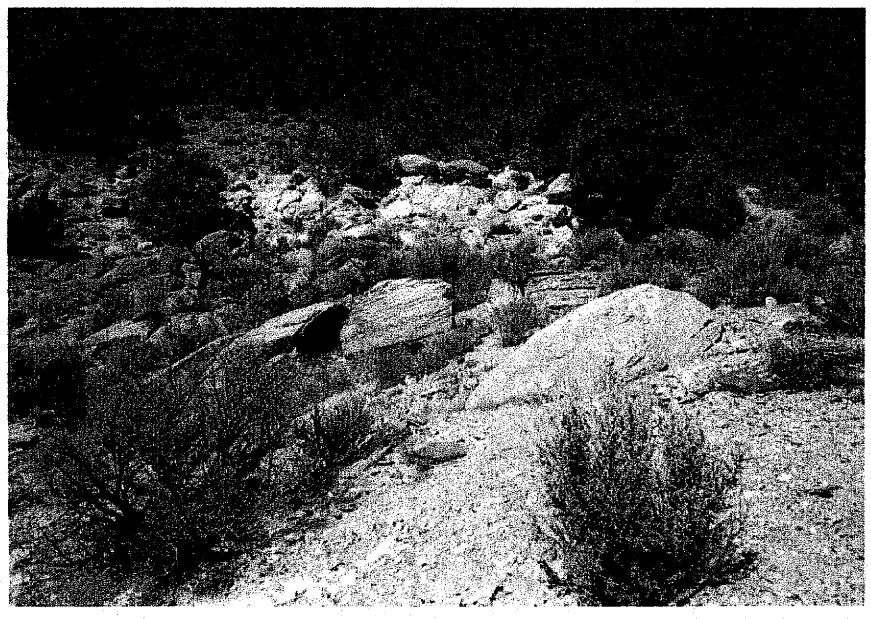

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FIGURE No.: 2

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PHOTO 5

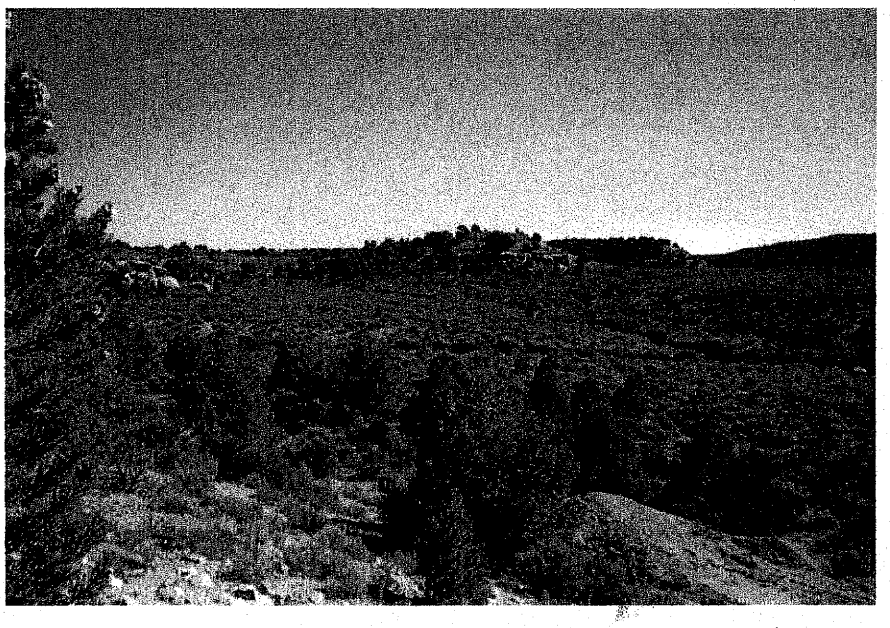

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FIGURE No: 3

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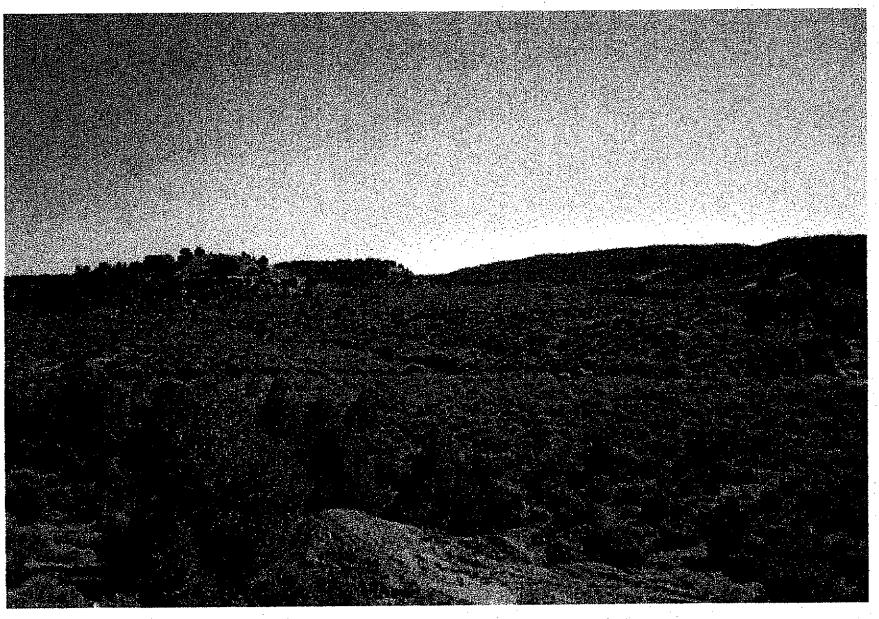

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FIGURE No: 4

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PHOTO 9

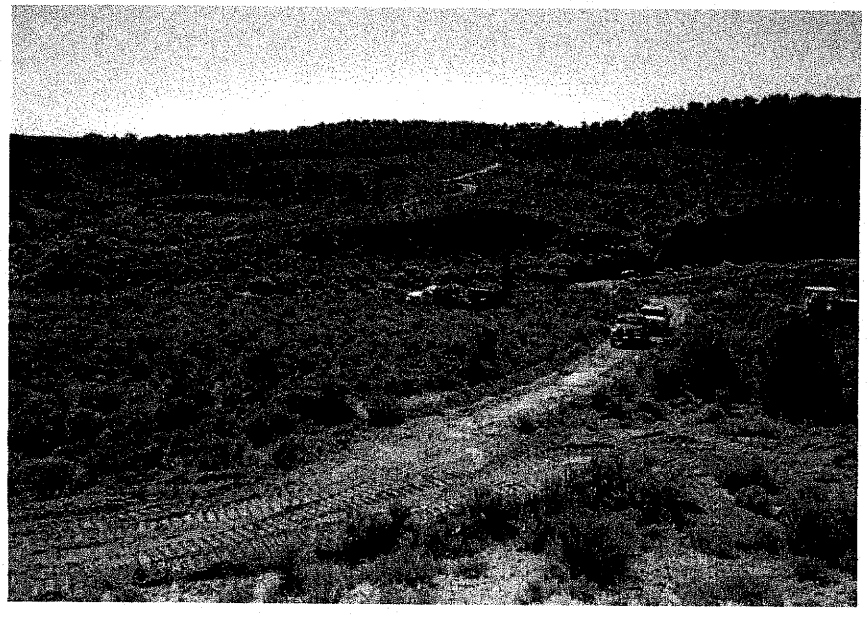

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FIGURE No: 5

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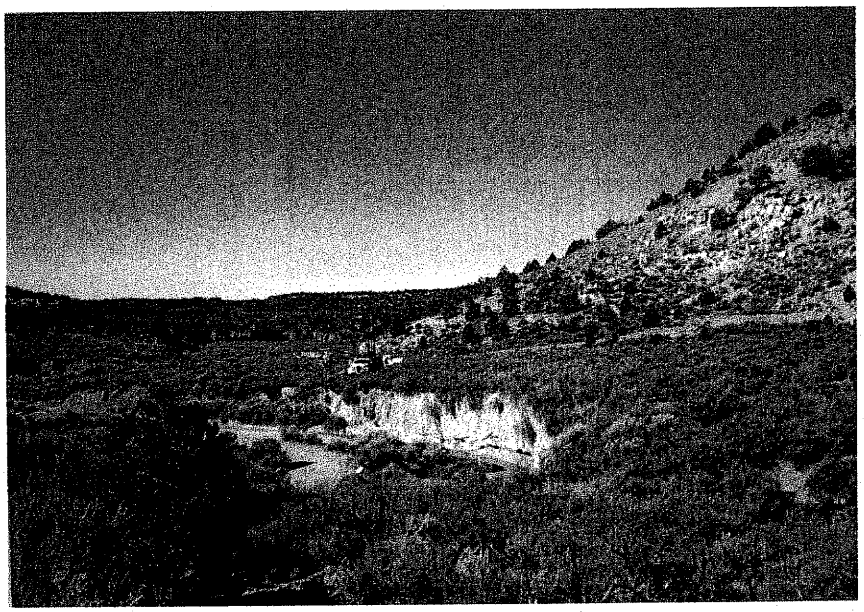

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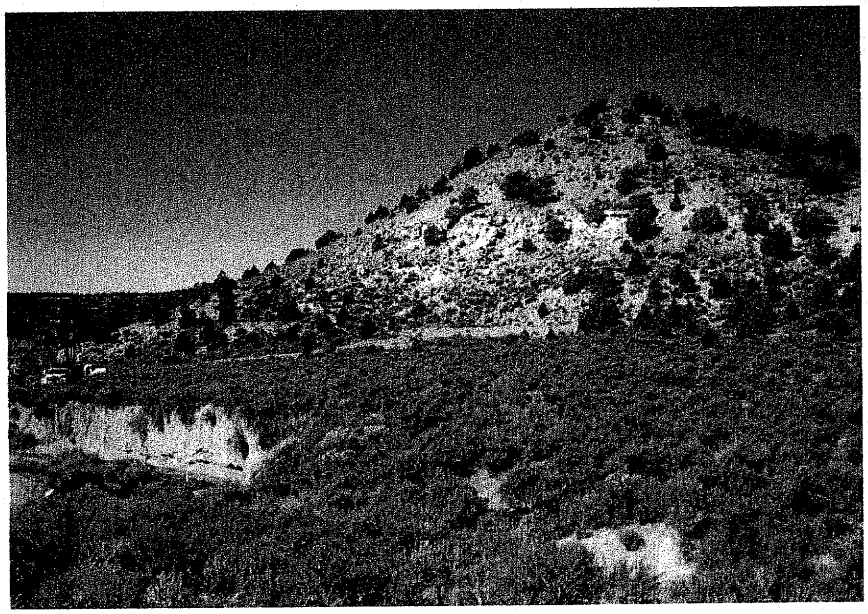

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FIGURE No: 6

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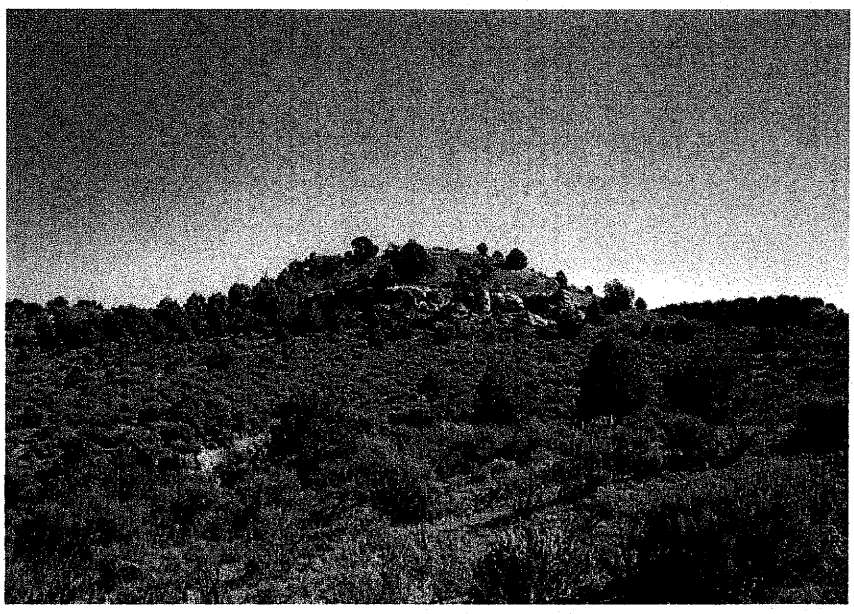

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FIGURE No: 7

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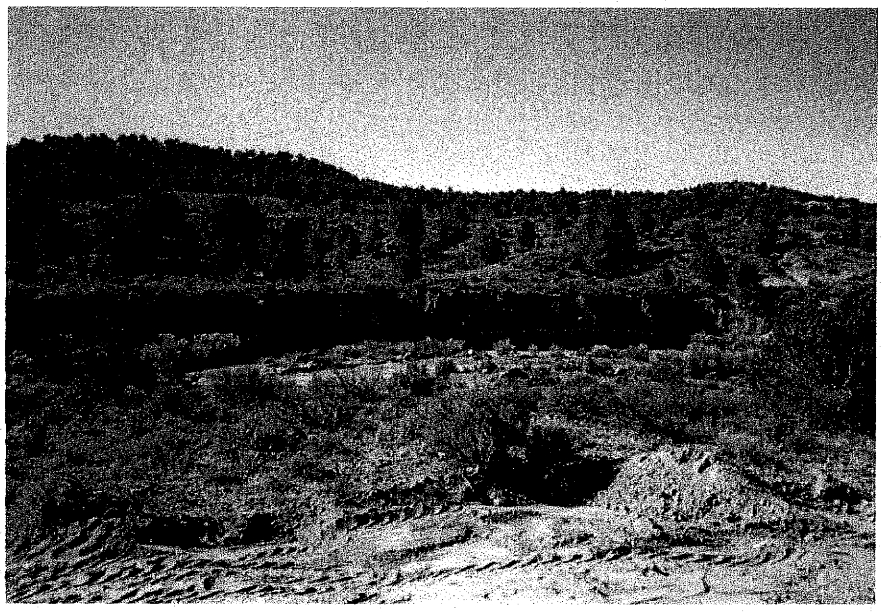

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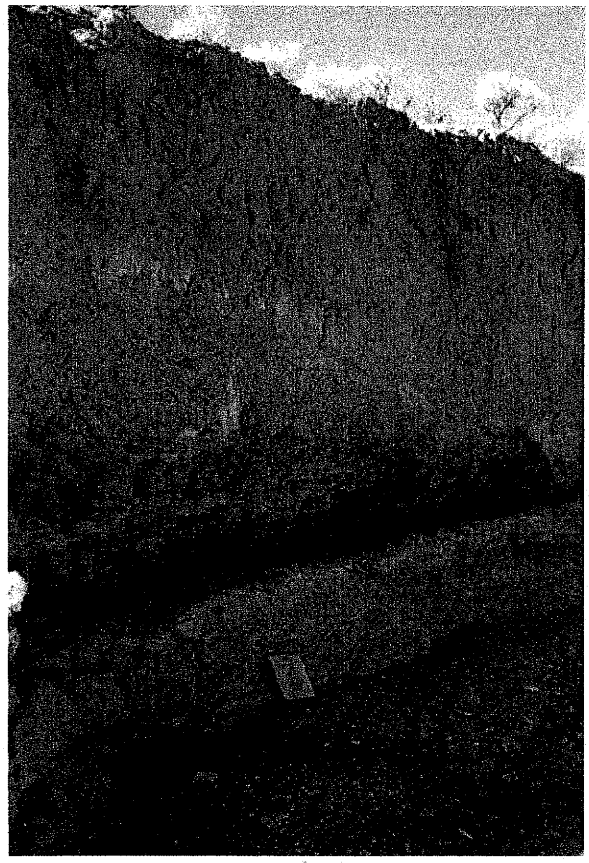

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FIGURE No.: 8

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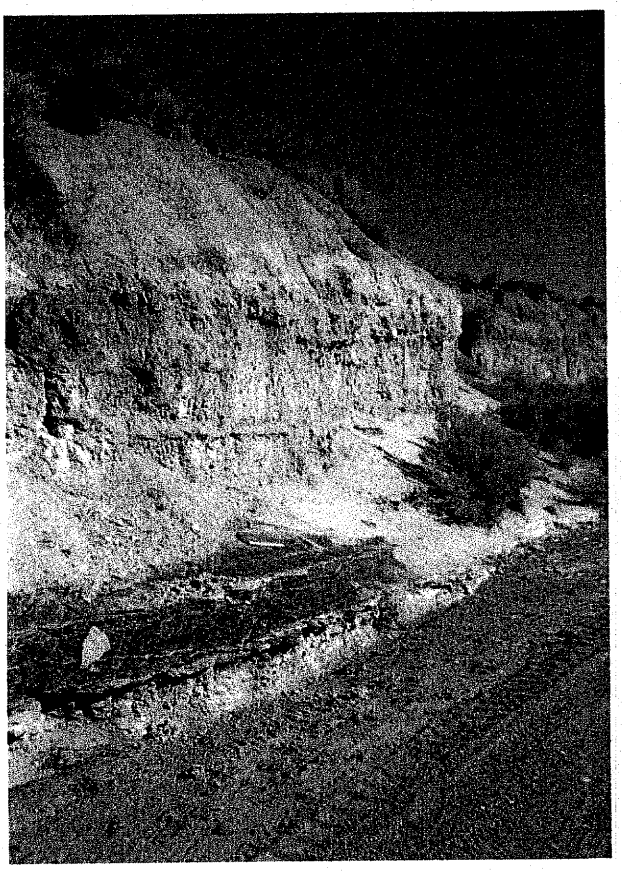

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FIGURE No: 9

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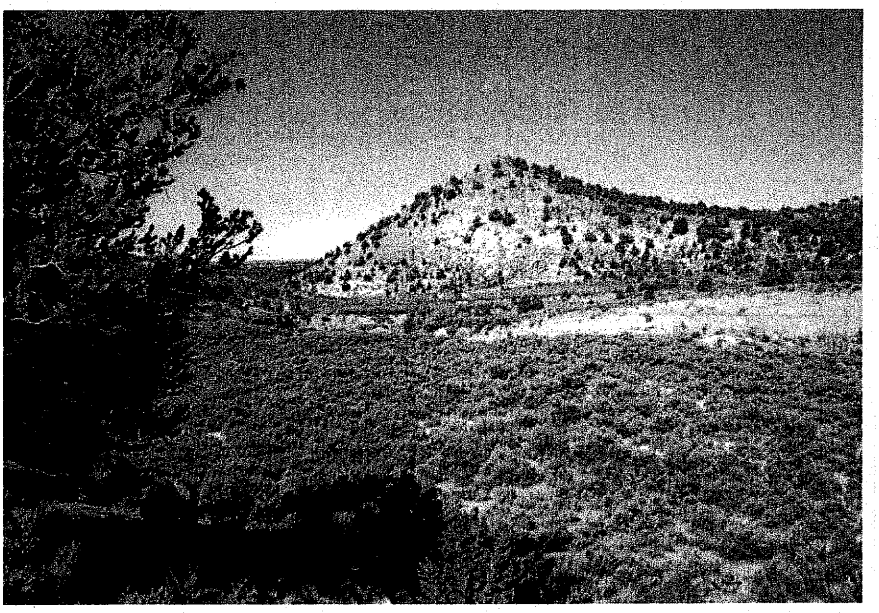

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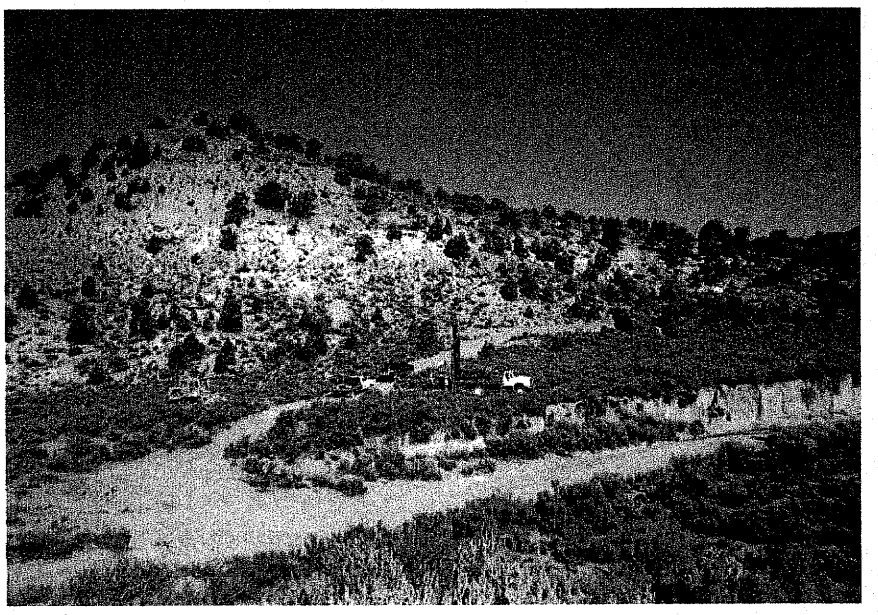

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FIGURE No: 10

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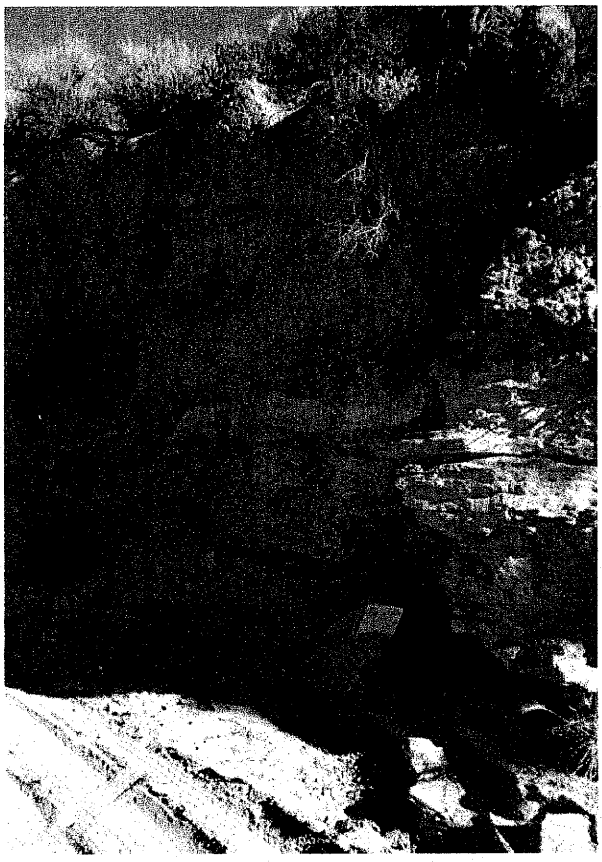

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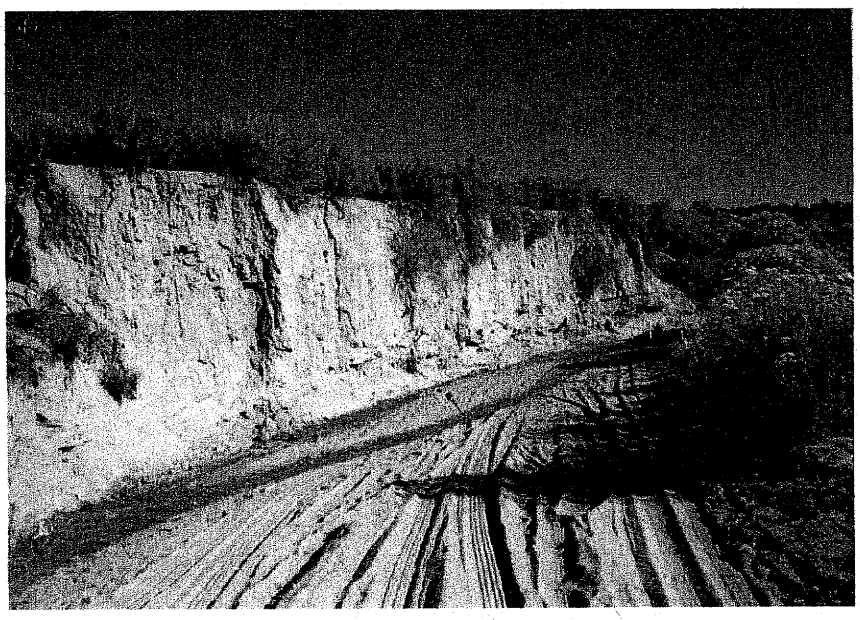

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FIGURE No.: 11

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Appendix B

Boring and Test Pit Logs

(see Drawing 4 for Locations)

PROJECT: **PEABODY WESTERN** DATE: 25 Oct 99 BOREHOLE NUMBER: **PW-B1**

BOREHOLE LOCATION: N -39,626.2, E 47,638.6 SURFACE ELEVATION: 6652.9' LOGGED BY: DK

DRILLING COMPANY: Heber Mining & Exploration DRILLER: Mark Stroud DRILLRIG: CME-75

DATE/TIME STARTED: 19 Oct 99, (10:30) DATE/TIME FINISHED: 20 Oct 99; (13:10) PAGE 1 OF 3

WATER DEPTH: 24.5 ft. BTOC DATE/TIME OF DEPTH: 25 Oct 99; (11:00) CASING STICK-UP: 2.4 ft.

DEPTH FEET	SOIL DESCRIPTION	LITHOLOGY	USCS CLASS	NO.	TYPE	BLOW COUNT/6"	DEPTH FEET
5	ALLUVIUM SILT and CLAY with trace sand, stiff, yellowish red brown (5yr 4/6), fine grained, plastic, moist, rounded particles, interbedded sandy silt and clay layers, reaction with hydrochloric acid (HCL), MH/CH.		CL	1	SPT	9-7-7	5
10	CLAY with brown sandstone clasts, interbedded clay and siltstone layers. Note: Driller indicated groundwater was encountered at 12 ft.		CL	2	SPT	10-11-9	10
15	Firm, brown (7.5yr 4/4), highly plastic, wet, no reaction with HCL.		CL	3	SPT	3-3-4	15
20	Note: Shelby tube sample collected at a depth of 21.5 to 23.5 ft.			4	SPT	1-3-3	20
					ST		
25				5	SPT	2-2-3	25
30				6	SPT	3-3-3	30
35	Very dark gray, (7.5yr 3/1) stiff			7	SPT	4-4-5	35
40	Sandy CLAY, dark gray, (7.5yr 4/1), clasts.		CL	8	SPT	4-5-7	40

STANDARD PENETRATION TEST
▲ 'N' BLOWS PER FOOT
20 40 60 80
WATER CONTENT, PERCENT & RANGE
Wp Wn WL
20 40 60 80

PIEZOMETER NOTES
Concrete
Schedule 40 PVC

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B1.Dwg
SCALE: NA
FIGURE No.:

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: 4/14/99 BOREHOLE NUMBER: **PW-B1**

BOREHOLE LOCATION: N -39,626.2, E 47,638.6 SURFACE ELEVATION: 6652.9' LOGGED BY: DK

DRILLING COMPANY: Heber Mining & Exploration DRILLER: Mark Stroud DRILLRIG: CME-75

DATE/TIME STARTED: 19 Oct 99, (10:30) DATE/TIME FINISHED: 20 Oct 99; (13:10) PAGE 2 OF 3

WATER DEPTH: 24.5 ft. BTOC DATE/TIME OF DEPTH: 25 Oct 99; (11:00) CASING STICK-UP: 2.4 ft.

DEPTH FEET	SOIL DESCRIPTION	LITHOLOGY	USCS CLASS	NO.	TYPE	BLOW COUNT/6"	DEPTH FEET	STANDARD PENETRATION TEST ▲ 'N' BLOWS PER FOOT 20 40 60 80 / WATER CONTENT, PERCENT & RANGE Wp Wn WL 20 40 60 80	PIEZOMETER NOTES
	Same description as previous page.								
45	BEDROCK Sandstone, multicolored green, red, orange, brown, shale, and claystone clasts.			9	SPT	9-11-15	45	▲	
50	BEDROCK SANDSTONE, very dense, gray (5y 6/1), and pale olive (5y 6/4), fine grained, subrounded particles, partially cemented, (WEPO FORMATION).			10	SPT	50/5"	50	▲	Schedule 40 PVC Gravel Screen
55				11	SPT	50/5"	55	▲	
60				12	SPT	28-27 50/5"	60	▲	
65				13	SPT	50/3"	65	▲	
70	Started coring at 66.5 ft.						70		

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B1.Dwg
SCALE: NA FIGURE No:

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: *19 Oct 99* BOREHOLE NUMBER: **PW-B1**

BOREHOLE LOCATION COORDINATES: LOGGED BY: *D. Kraemer*

ELEVATION: *6652.9'* REFERENCE POINT: DATUM: DRILLRIG: *CME-75*

INCLINATION: *Vertical* AZIMUTH: *NA* FLUSH: *Water* FEED: *10 ft.*

TOTAL DEPTH: *89 ft.* BIT TYPE: *NQ - Longyear Series 2* PAGE *3* OF *3*

GROUND WATER DEPTH: *24.5 ft. BTOC* DATE/TIME OF DEPTH: *25 Oct 99; (11:00)* PIEZOMETER STICK-UP: *2.4 ft.*

CORE DIA./DEPTH	RUN TIME (minutes)	WATER RECOVERY (%)	ROCK TYPE: LITHOLOGY	ROCK TYPE: DESCRIPTION	DEPTH (Feet)	CORE RECOVERY DATA: T.C.R. (Length - %)	CORE RECOVERY DATA: R.Q.D. (Length - %)	FRACTURES (Per Foot)	DISCONTINUITY DATA: Subsurface Testing & Condition	STRENGTH DATA: WEATHERING INDEX	STRENGTH DATA: STRENGTH INDEX	STRENGTH DATA: POINT LOAD INDEX (PSI)	PIEZOMETER NOTES
				SANDSTONE SLIGHTLY WEATHERED, MEDIUM STRONG, MODERATELY FRACTURED, GRAY (10YR 5/1), CONSISTING MOSTLY OF QUARTZ WITH SOME FELDSPAR AND TRACE MICA, FINE GRAINED, ROUNDED SAND GRAINS, INTERBEDDED, VERY DARK GRAY, (2.5YR 3/1) SHALE LAYERS UP TO 1" THICK, YELLOW, (2.5Y 7/6) CLAYSTONE DEPOSITS UP TO 1" BY 1/2" WIDE, SOFT, PARTIALLY WEATHERED TO CLAY, (WEPO FORMATION)	70				START CORING @ 66.5 FT.				Grout
		90					.5' 79%	4	J, PL & I, SM-VR NO INFILLING 0-30°	W2	R3		
		70		CLEAN SANDSTONE LAYER	75		2.5'/5' 50%	2					
				1" THICK, YELLOW CLAYSTONE LAYER				4.5	MORE HIGHLY FRACTURED				
				HIGHLY WEATHERED SHALE ON FRACTURES. PREDOMINATELY SANDSTONE, MEDIUM GRAINED, HIGHER PERCENTAGE OF MICA.	80								
		70		SILTSTONE				1					
				SHALE, BLACK, (10YR 2/1) SILTSTONE WITH SHALE FRAGMENTS	85								
				CORED TO A TOTAL DEPTH OF 89 FT.	90								
					30								
					35								
					40								

ABBREVIATIONS

T.C.R. - Total Core Recovery
R.Q.D. - Rock Quality Designation
P.T.Z. - Packer Test Zone

J - Joint
F - Fault
S - Shear
B - Bedding
FO - Foliation

PL - Planar
C - Curved
U - Undulating
ST - Stepped
I - Irregular

P - Polished
K - Slickensided
SM - Smooth
R - Rough
VR - Very Rough

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Draft	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01160100
AutoCAD FILE: 052-PW-B1-CL
SCALE: AS NOTED
FIGURE No:

Peabody
PEABODY COAL COMPANY
Western Division

Pond J7Jr

PROJECT: **PEABODY WESTERN** DATE: *20 Oct 99* BOREHOLE NUMBER: **PW-B2**

BOREHOLE LOCATION: *N -39,692.4, E 47,508.9* SURFACE ELEVATION: *6664.2'* LOGGED BY: *DK*

DRILLING COMPANY: *Heber Mining & Exploration* DRILLER: *Mark Stroud* DRILLRIG: *CME-75*

DATE/TIME STARTED: *20 Oct 99; (16:45)* DATE/TIME FINISHED: *21 Oct 99; (11:20)* PAGE *1* OF *2*

WATER DEPTH: *35.4 ft. b.g.s.* DATE/TIME OF DEPTH: *21 Oct 99; (08:05)* CASING STICK-UP: *NA*

DEPTH FEET	SOIL DESCRIPTION	LITHOLOGY	USCS CLASS	NO.	TYPE	BLOW COUNT/6"	DEPTH FEET	STANDARD PENETRATION TEST ▲ 'N' BLOWS PER FOOT (20 40 60 80) / WATER CONTENT, PERCENT & RANGE Wp Wn WL (20 40 60 80)	PIEZOMETER NOTES
5	ALLUVIUM CLAY with trace sand and gravel, very stiff, yellowish red brown (5yr 4/6), fine grained, light reddish brown, (5yr 6/4), angular sand grains consisting of shale, gravel consists of sandstone, dry, reaction, with hyrdrochloric acid (HCL), low plasticity.						5		
10			CL	1	SPT	8-8-10	10	▲	
15	Gravel layer consisting of claystone clasts						15		
20	SAND, with some silt, compact, fine grained, strong brown, (7.5yr 4/6), subangular to rounded shale fragments, dry.		SM	2	SPT	10-10 12	20	▲	
25							25		
30	CLAY, very stiff, very dark brown, (7.5yr 2.5/3) and yellowish red, (5yr 5/8), plastic, moist.		CL	3	SPT	6-8-9	30	▲	
35	Encountered groundwater @ 35.4 ft. b.g.s.						35		
40	Silty clay			4	SPT	3-4-5	40	▲	
	Shelby tube sample collected @ 42-43 ft.				ST				

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B2.Dwg
SCALE: NA
FIGURE No:

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: *20 OCT 99* BOREHOLE NUMBER: **PW-B2**

BOREHOLE LOCATION: *N -39,692.4, E 47,508.9* SURFACE ELEVATION: *6664.2'* LOGGED BY: *DK*

DRILLING COMPANY: *Heber Mining & Exploration* DRILLER: *Mark Stroud* DRILLRIG: *CME-75*

DATE/TIME STARTED: *20 Oct 99, (16:45)* DATE/TIME FINISHED: *21 Oct 99; (11:20)* PAGE *2* OF *2*

WATER DEPTH: *35.4 ft. b.g.s.* DATE/TIME OF DEPTH: *21 Oct 99; (08:05)* CASING STICK-UP: *NA*

DEPTH FEET	SOIL DESCRIPTION	LITHOLOGY	USCS CLASS	NO.	TYPE	BLOW COUNT/6"	DEPTH FEET	STANDARD PENETRATION TEST ▲ 'N' BLOWS PER FOOT 20 40 60 80 / WATER CONTENT, PERCENT & RANGE Wp Wn WL 20 40 60 80	PIEZOMETER NOTES
45	Same description as previous page.		CL				45		
50	CLAY with some sand consisting of shale fragments, very dark gray, (7.5yr 3/1), with trace orange.		CL	5	SPT	6-5-6	50	▲	
55	Some SAND and GRAVEL consisting of sandstone and shale, dark yellowish brown, (10yr 4/6), variable color, green, red, black.			6	SPT	5-6-9	55	▲	
60	BEDROCK SANDSTONE, very dense, gray (10yr 6/1), and strong brown, (7.5yr 5/8), fine to medium grained, subrounded to rounded, interbedded sand and silt layers. (WEPO FORMATION)			7	SPT	50/5"	60	▲	
65							65		
70	Drilled to a total depth of 60 ft.						70		

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01186100
AutoCAD FILE: 052-PW-B2.Dwg
SCALE: NA FIGURE No:

Peabody COAL COMPANY Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: *21 Oct 99* BOREHOLE NUMBER: **PW-B3**

BOREHOLE LOCATION: *N -40,088.7, E 47,704.7* SURFACE ELEVATION: *6691.1'* LOGGED BY: *DK*

DRILLING COMPANY: *Heber Mining & Exploration* DRILLER: *Mark Stroud* DRILLRIG: *CME-75*

DATE/TIME STARTED: *21 Oct 99, (12:50)* DATE/TIME FINISHED: *21 Oct 99; (15:15)* PAGE *1* OF *1*

WATER DEPTH: *No detection* DATE/TIME OF DEPTH: *N/A* CASING STICK-UP: *N/A*

DEPTH FEET	SOIL DESCRIPTION	LITHOLOGY	USCS CLASS	NO.	TYPE	BLOW COUNT/6"	DEPTH FEET	STANDARD PENETRATION TEST ▲ 'N' BLOWS PER FOOT (20 40 60 80) / WATER CONTENT, PERCENT & RANGE (Wp Wn WL; 20 40 60 80)	PIEZOMETER NOTES
5	ALLUVIUM Clayey SAND, compact, red (2.5 yr 5/6) subrounded to rounded, dry		SC/ ML	1	SPT	4-6-7	5	▲	
10							10		
15							15		
20	Fine grained gravel, pink, red, orange.			2	SPT	17-27-26	20	▲	
25							25		
30	BEDROCK SILTSTONE/CLAYSTONE, hard, light yellowish/ brown (10 yr 6/4), thin bedded, slightly weathered. (WEPO FORMATION)		CL	3	SPT	50/3"	30	▲	
	Drilled to a total depth of 32'								
35							35		
40							40		

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B3.Dwg
SCALE: NA FIGURE No:

Peabody COAL COMPANY Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: *21 Oct 99* BOREHOLE NUMBER: **PW-B4**

BOREHOLE LOCATION: *N -40,467.4, E 47,863.2* SURFACE ELEVATION: *6708.0'* LOGGED BY: *DK*

DRILLING COMPANY: *Heber Mining & Exploration* DRILLER: *Mark Stroud* DRILLRIG: *CME-75*

DATE/TIME STARTED: *21 Oct 99, (15:55)* DATE/TIME FINISHED: *22 Oct 99; (08:40)* PAGE *1* OF *1*

WATER DEPTH: *No detection* DATE/TIME OF DEPTH: *N/A* CASING STICK-UP: *N/A*

DEPTH FEET	SOIL DESCRIPTION	LITHOLOGY	USCS CLASS	NO.	TYPE	BLOW COUNT/6"	DEPTH FEET	STANDARD PENETRATION TEST ▲ 'N' BLOWS PER FOOT 20 40 60 80 / WATER CONTENT, PERCENT & RANGE Wp Wn WL 20 40 60 80	PIEZOMETER NOTES
	ALLUVIUM Silt/ sand		SM/ ML						
5	SAND, fine-med. grained, reddish yellow (5 yr 6/8), subrounded to rounded particles.		SP	1	SPT	20-23-24	5	▲	
10	CLAY/SILT with little sand and gravel, fine grained, hard , brown, (7.5 yr 5/4), with red and orange clay deposits, gravel consists of gray sandstone and black shale, no plasticity, dry		CL	2	SPT	21-35-44	10	▲	
15							15		
20							20		
25	BEDROCK Sandstone, fine grained, light gray (7.5 yr 7/1), subrounded to rounded particles (WEPO FORMATION)			3	SPT	100/1"	25		
	Drilled to a total depth of 25'								
30							30		
35							35		
40							40		

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01160100
AutoCAD FILE: 052-PW-B4.Dwg
SCALE: NA FIGURE No.

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: 22 Oct 99 BOREHOLE NUMBER: **PW-B5**

BOREHOLE LOCATION: N -40350.2, E 47,783.9 SURFACE ELEVATION: 6700.2' LOGGED BY: DK

DRILLING COMPANY: Heber Mining & Exploration DRILLER: Mark Stroud DRILLRIG: CME-75

DATE/TIME STARTED: 22 Oct 99, (09:10) DATE/TIME FINISHED: 22 Oct 99; (16:35) PAGE 1 OF 2

WATER DEPTH: No Detection DATE/TIME OF DEPTH: NA CASING STICK-UP: NA

DEPTH FEET	SOIL DESCRIPTION	LITHOLOGY	USCS CLASS	NO.	TYPE	BLOW COUNT/6"	DEPTH FEET	STANDARD PENETRATION TEST ▲ 'N' BLOWS PER FOOT 20 40 60 80 / WATER CONTENT, PERCENT & RANGE Wp Wn WL 20 40 60 80	PIEZOMETER NOTES
5							5		
10	ALLUVIUM SANDY SILT, firm, fine grained, brown, (7.5yr 5/4), subrounded to rounded sand, low plasticity, dry.		ML	1	SPT	20-21 26	10	▲	
15							15		
20	CLAY with trace sand, medium plasticity.		CL	2	SPT	13-15 17	20	▲	
25							25		
30	BEDROCK SILTSTONE, fine grained, yellowish brown, (10yr 5/6), thin bedded, black shale fragments, (Wepo Formation).			3	SPT	21-36 50/2"	30	▲	
35				4	SPT	39- 50/3"	35	▲	
40	Started coring at 37 ft.						40		

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B5.Dwg
SCALE: NA
FIGURE No:

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: 22 Oct 99 BOREHOLE NUMBER: **PW-B5**

BOREHOLE LOCATION COORDINATES: N -40350.2, E 47,783.9 LOGGED BY: D. Kraemer

ELEVATION: 6700.2' REFERENCE POINT: DATUM: DRILLRIG: CME-75

INCLINATION: Vertical AZIMUTH: NA FLUSH: Water FEED: 10 ft.

TOTAL DEPTH: 64 ft. BIT TYPE: NQ - Carbide Type L1 PAGE 2 OF 2

GROUND WATER DEPTH: No Detection DATE/TIME OF DEPTH: NA PIEZOMETER STICK-UP: NA

CORE DIA./DEPTH	RUN TIME (minutes)	WATER RECOVERY (%)	ROCK TYPE: LITHOLOGY	ROCK TYPE: DESCRIPTION	DEPTH (Feet)	CORE RECOVERY DATA: T.C.R. (Length - %) 25 50 75	CORE RECOVERY DATA: R.Q.D. (Length - %) 25 50 75	FRACTURES (Per Foot)	DISCONTINUITY DATA: Subsurface Testing & Condition	STRENGTH DATA: WEATHERING INDEX	STRENGTH DATA: STRENGTH INDEX	STRENGTH DATA: POINT LOAD INDEX (PSI)	PIEZOMETER NOTES
				SILTSTONE SILTSTONE WITH INTERBEDDED SHALE, WEAK, SLIGHTLY WEATHERED, DARK GRAY (5Y 4/1) (WEPO FORMATION)			0%		START CORING @ 37 FT. J, PL, VR	W2	R2		
					40		48/5' 96%	0					
				BLACK SHALE FRAGMENTS UP TO 1/2 INCH LONG BROWN CLAY DEPOSITS BLACK (10YR 2/1) SHALE	45		45/5' 90%	1	RUBBLE ZONE				
					50		33/5' 66%	3	RUBBLE ZONE				
				CLAYSTONE, DARK GRAY, (5YR 4/1) BLACK SHALE CLAYSTONE	55		88/10' 88%	1					
				CORED TO A TOTAL DEPTH OF 64 FT.	60 65								

ABBREVIATIONS

T.C.R. - Total Core Recovery
R.Q.D. - Rock Quality Designation
P.T.Z. - Packer Test Zone

J - Joint
F - Fault
S - Shear
B - Bedding
FO - Foliation

PL - Planar
C - Curved
U - Undulating
ST - Stepped
I - Irregular

P - Polished
K - Slickensided
SM - Smooth
R - Rough
VR - Very Rough

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Draft	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B5-CL
SCALE: AS NOTED FIGURE No:

Peabody
PEABODY COAL COMPANY

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: *23 Oct 99* BOREHOLE NUMBER: **PW-B6**

BOREHOLE LOCATION: *N -47,462.8, E 39,528.6* SURFACE ELEVATION: *6680.5'* LOGGED BY: *DK*

DRILLING COMPANY: *Heber Mining & Exploration* DRILLER: *Mark Stroud* DRILLRIG: *CME-75*

DATE/TIME STARTED: *23 Oct 99, (09:40)* DATE/TIME FINISHED: *23 Oct 99; (14:45)* PAGE *1* OF *1*

WATER DEPTH: *No Detection* DATE/TIME OF DEPTH: *NA* CASING STICK-UP: *NA*

DEPTH FEET	SOIL DESCRIPTION	LITHOLOGY	USCS CLASS	SAMPLES NO.	SAMPLES TYPE	SAMPLES BLOW COUNT/6"	DEPTH FEET	STANDARD PENETRATION TEST ▲ 'N' BLOWS PER FOOT (20 40 60 80) / WATER CONTENT, PERCENT & RANGE (Wp Wn WL; 20 40 60 80)	PIEZOMETER NOTES
0							0		
5			CL				5		
10	ALLUVIUM CLAY with trace sand, very stiff, grayish brown, (10yr 5/2), low to medium plasticity, dry.			1	SPT	8-8-15	10	▲	
15							15		
20	BEDROCK CLAYSTONE, pale brown, (10yr 6/3) (WEPO FORMATION)			2	SPT	50/5"	20	▲	
25							25		
30	SHALE, black, (7.5yr 2.5/1)			3	SPT	26-50	30	▲	
35				4	SPT	25-48 50/3"	35	▲	
40	Started coring @ 37 ft.						40		

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B6.Dwg
SCALE: NA
FIGURE No:

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: *24 Oct 99* BOREHOLE NUMBER: **PW-B7**

BOREHOLE LOCATION: *N -39,641.7, E 48,137.8* SURFACE ELEVATION: *6697.3'* LOGGED BY: *DK*

DRILLING COMPANY: *Heber Mining & Exploration* DRILLER: *Mark Stroud* DRILLRIG: *CME-75*

DATE/TIME STARTED: *24 Oct 99, (08:35)* DATE/TIME FINISHED: *24 Oct 99; (09:30)* PAGE *1* OF *1*

WATER DEPTH: *No Detection* DATE/TIME OF DEPTH: *NA* CASING STICK-UP: *NA*

DEPTH FEET	SOIL DESCRIPTION	LITHOLOGY	USCS CLASS	NO.	TYPE	BLOW COUNT/6"	DEPTH FEET	STANDARD PENETRATION TEST ▲ 'N' BLOWS PER FOOT (20 40 60 80) / WATER CONTENT, PERCENT & RANGE (Wp Wn WL; 20 40 60 80)	PIEZOMETER NOTES
5	ALLUVIUM SILT with trace sand, firm, strong brown, (7.5yr 4/6), fine grained, angular particles, low plasticity, dry.		ML	1	SPT	5-3-4	5	▲	
10	Very stiff, trace claystone and shale gravels			2	SPT	4-6-8	10	▲	
15				3	SPT	9-12-17	15	▲	
20	SILTY SAND, compact, reddish brown, (5yr 5/4), subangular to subrounded particles.		SM	4	SPT	8-10-15	20	▲	
25	Sandy SILT		ML	5	SPT	19-20-21	25	▲	
30				6	SPT	13-13-17	30	▲	
35	SHALE, dark gray brown, (2.5y 4/2), thin bedded.			7	SPT	35-50/5"	35	▲	
40	Drilled to a total depth of 35 ft.						40		

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B7.Dwg
SCALE: NA
FIGURE No:

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: 24 Oct 99 BOREHOLE NUMBER: **PW-B8**

BOREHOLE LOCATION: N -39,666.5, E 48,344.5 SURFACE ELEVATION: 6699.9' LOGGED BY: DK

DRILLING COMPANY: Heber Mining & Exploration DRILLER: Mark Stroud DRILLRIG: CME-75

DATE/TIME STARTED: 24 Oct 99, (10:10) DATE/TIME FINISHED: 24 Oct 99, (11:30) PAGE 1 OF 1

WATER DEPTH: 40 ft. b.g.s. DATE/TIME OF DEPTH: 24 Oct 99 (11:15) CASING STICK-UP: NA

DEPTH FEET	SOIL DESCRIPTION	LITHOLOGY	USCS CLASS	NO.	TYPE	BLOW COUNT/6"	DEPTH FEET	STANDARD PENETRATION TEST ▲ 'N' BLOWS PER FOOT (20 40 60 80) / WATER CONTENT, PERCENT & RANGE Wp Wn WL (20 40 60 80)	PIEZOMETER NOTES
5	ALLUVIUM SILT with some sand, firm, red, (2.5yr 5/8), fine grained, subangular to subrounded particles, low plasticity, dry.		ML	1	SPT	2-3-3	5	▲	
10				2	SPT	4-6-7	10	▲	
15	SILTY SAND with trace gravel, compact, yellowish red, (5yr 5/6), fine grained, subangular to subrounded particles.		SM	3	SPT	6-8-11	15	▲	
20	SILT with thin bedding, pink claystone and gray sandstone clasts.		ML	4	SPT	13-30-30	20	▲	
25	SILTY SAND, compact, fine grained, strong brown, (7.5yr 5/8), subangular to subrounded particles.		SM	5	SPT	7-8-10	25	▲	
30	CLAY, very stiff, very dark gray (7.5yr 3/1), shale fragments, orange clay layers, plastic.		CL	6	SPT	8-9-11	30	● ▲	
35	SILTY SAND, compact, fine grained, strong brown, (7.5yr 5/8), subangular to subrounded particles, moist.		SM	7	SPT	5-6-9	35	● ▲	
40	CLAY, firm, reddish brown, (5yr 4/4), plastic, moist to wet.		CL	8	SPT	2-2-3	40	▲ ●	
	Drilled to a total depth of 40 ft.								

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B8.Dwg
SCALE: NA FIGURE No:

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: 24 Oct 99 BOREHOLE NUMBER: **PW-B9**

BOREHOLE LOCATION: N -39,876.5, E 47,813.2 SURFACE ELEVATION: 6658.0 LOGGED BY: DK

DRILLING COMPANY: Heber Mining & Exploration DRILLER: Mark Stroud DRILLRIG: CME-75

DATE/TIME STARTED: 24 Oct 99, (12:00) DATE/TIME FINISHED: 24 Oct 99; (12:30) PAGE 1 OF 1

WATER DEPTH: No Detection DATE/TIME OF DEPTH: NA CASING STICK-UP: NA

DEPTH FEET	SOIL PROFILE: SOIL DESCRIPTION	LITHOLOGY	SAMPLES: USCS CLASS	NO.	TYPE	BLOW COUNT/6"	DEPTH FEET	STANDARD PENETRATION TEST ▲ 'N' BLOWS PER FOOT (20 40 60 80) / WATER CONTENT, PERCENT & RANGE (Wp Wn WL; 20 40 60 80)	PIEZOMETER NOTES
0	ALLUVIUM SANDY SILT, fine grained, strong brown, (7.5yr 4/6), dry.		ML				0		
5	BEDROCK SHALE, gray, (2.5y 5/1). (WEPO FORMATION)			1	SPT	30-50 50/3"	5	▲	
10							10		
15							15		
20							20		
25							25		
30							30		
35							35		
40							40		

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B9.Dwg
SCALE: NA FIGURE No:

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: 24 Oct 99 BOREHOLE NUMBER: **PW-B10**

BOREHOLE LOCATION: N -39,853.6, E 47,526.3 SURFACE ELEVATION: 6651.4' LOGGED BY: DK

DRILLING COMPANY: Heber Mining & Exploration DRILLER: Mark Stroud DRILLRIG: CME-75

DATE/TIME STARTED: 12/Oct 99, (13:00) DATE/TIME FINISHED: 24 Oct 99; (14:50) PAGE 1 OF 1

WATER DEPTH: 26.7 ft. BTOC DATE/TIME OF DEPTH: 25 Oct 99; (11:00) CASING STICK-UP: 2.9 ft.

DEPTH FEET	SOIL DESCRIPTION	USCS CLASS	NO.	TYPE	BLOW COUNT/6"
0	ALLUVIUM CLAY, soft to firm, dark brown, (10yr 3/3), trace red, rounded claystone gravel, highly plastic, dry.	CL	1	GB	
10	SAND, loose, to compact, fine grained, reddish yellow (5yr 6/8).	SM			
15	SILT with some sand, fine grained, strong brown, (7.5yr 4/6), rounded, moist.	CL/ ML			
20	Note: Shelby tube sample collected at a depth of 22 to 24 ft.		2	SPT	2-2-2
				ST	
25					
30	BEDROCK SILTSTONE, gray, (7.5yr 6/1), fine grained, orange infilling on fractures.		3	SPT	22 100/4"
35			4	SPT	100/3"
40	Drilled to a total depth of 35 ft.				

STANDARD PENETRATION TEST
▲ 'N' BLOWS PER FOOT
20 40 60 80
WATER CONTENT, PERCENT & RANGE
Wp Wn WL
20 40 60 80

PIEZOMETER NOTES
Concrete
Cuttings
Schedule 40 PVC
Bent.
Gravel
Screen

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B10.Dwg
SCALE: NA FIGURE No.

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: 12/20/99 BOREHOLE NUMBER: **PW-B11**

BOREHOLE LOCATION: N -39,934.0, E 48,089.8 SURFACE ELEVATION: 6663.0' LOGGED BY: DK

DRILLING COMPANY: Heber Mining & Exploration DRILLER: Mark Stroud DRILLRIG: CME-75

DATE/TIME STARTED: 20 Dec. 99, (15:35) DATE/TIME FINISHED: 21 Dec. 99, (10:25) PAGE 1 OF 2

WATER DEPTH: No detection DATE/TIME OF DEPTH: N/A CASING STICK-UP: N/A

DEPTH FEET	SOIL DESCRIPTION	LITHOLOGY	USCS CLASS	NO.	TYPE	BLOW COUNT/6"	DEPTH FEET
	ALLUVIUM Silty sand		SM				
	BEDROCK Siltstone, dark gray (2.5 y 4/1)			1	SPT	50/4"	
5							5
	Started coring @ 7'						
10							10
15							15
20							20
25							25
30							30
35							35
40							40

SOIL PROFILE / SAMPLES

STANDARD PENETRATION TEST
▲ 'N' BLOWS PER FOOT
20 40 60 80

WATER CONTENT, PERCENT & RANGE
Wp Wn WL
20 40 60 80

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B11.Dwg
SCALE: NA FIGURE No:

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: 20 Dec 99 BOREHOLE NUMBER: **PW-B11**

BOREHOLE LOCATION COORDINATES: N -39,934.0, E 48,089.8 LOGGED BY: D. Kraemer

ELEVATION: 6663.0' REFERENCE POINT: DATUM: DRILLRIG: CME-75

INCLINATION: Vertical AZIMUTH: NA FLUSH: Water FEED: 5 ft.

TOTAL DEPTH: 19 ft. BIT TYPE: NO - Carbide Type L1 PAGE 2 OF 2

GROUND WATER DEPTH: No Detection DATE/TIME OF DEPTH: NA PIEZOMETER STICK-UP: NA

CORE DIA./DEPTH	RUN TIME (minutes)	WATER RECOVERY (%)	ROCK TYPE: LITHOLOGY	ROCK TYPE: DESCRIPTION	DEPTH (Feet)	CORE RECOVERY DATA: T.C.R. (Length - %) 25 50 75	CORE RECOVERY DATA: R.Q.D. (Length - %) 25 50 75	FRACTURES (Per Foot)	DISCONTINUITY DATA: Subsurface Testing & Condition	STRENGTH DATA: WEATHERING INDEX	STRENGTH DATA: STRENGTH INDEX	STRENGTH DATA: POINT LOAD INDEX (PSI)	PIEZOMETER NOTES
				SILTSTONE/SHALE					START CORING @ 7 FT.				
				SHALE/CLAYSTONE, SLIGHTLY WEATHERED, WEAK, VERY DARK GRAY, (10YR 3/1). (WEPO FORMATION)					J, I, VR	W2	R2		
								5	0 TO 20 DEGREE ANGLE				
				INTERBEDDED SHALE	10		5.8/7.5' 77%						
									6" HIGHLY FRACTURED ZONE		R2-R3		
				SILTSTONE, WEAK TO MEDIUM STRONG, DARK GRAY, (10YR 4/1) SHALE FRAGMENTS, COAL SEAMS UP TO 0.2" WIDE, TRACE QUARTZ									
				CLAYSTONE, WEAK	15		4.3/4.7' 91%	1			R2		
				COAL SEAM									
				CORED TO A TOTAL DEPTH OF 19 FT.	20								

ABBREVIATIONS

T.C.R. - Total Core Recovery
R.Q.D. - Rock Quality Designation
P.T.Z. - Packer Test Zone

J - Joint
F - Fault
S - Shear
B - Bedding
FO - Foliation

PL - Planar
C - Curved
U - Undulating
ST - Stepped
I - Irregular

P - Polished
K - Slickensided
SM - Smooth
R - Rough
VR - Very Rough

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Draft	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B11-CL
SCALE: AS NOTED
FIGURE No:

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: 12/22/99 BOREHOLE NUMBER: **PW-B12**

BOREHOLE LOCATION: N -40,246.4, E 48,042.2 SURFACE ELEVATION: 6704.0' LOGGED BY: DK

DRILLING COMPANY: Heber Mining & Exploration DRILLER: Mark Stroud DRILLRIG: CME-75

DATE/TIME STARTED: 22 Dec 99 (10:55) DATE/TIME FINISHED: 22 Dec 99; (14:10) PAGE 1 OF 2

WATER DEPTH: No detection DATE/TIME OF DEPTH: N/A CASING STICK-UP: N/A

DEPTH FEET	SOIL DESCRIPTION	LITHOLOGY	USCS CLASS	NO.	TYPE	BLOW COUNT/6"
5	ALLUVIUM Sandy SILT, strong brown (7.5 yr. 4/6) very stiff, fine grained, subangular white calcium carbonate, dry		ML	1	SPT	11-13-14
10	Orange & red clay, gray sandstone clasts			2	SPT	18-21-30
15	CLAY, stiff (7.5 yr. 4/3) brown		CL	3	SPT	11-14-19
20	Sandy SILT, strong brown (7.5 yr 4/6), very stiff, fine grained, subangular, orange & red clay, gray sandstone, dry		ML	4	SPT	12-13-16
25				5	SPT	12-18-26
30	BEDROCK Siltstone/ claystone			6	SPT	29-50/3
	Started coring @ 31.5'					
35						
40						

STANDARD PENETRATION TEST
▲ 'N' BLOWS PER FOOT
20 40 60 80

WATER CONTENT, PERCENT & RANGE
Wp Wn WL
20 40 60 80

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B12.Dwg
SCALE: NA FIGURE No:

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: *22 Dec 99* BOREHOLE NUMBER: **PW-B12**

BOREHOLE LOCATION COORDINATES: *N -40,246.4, E 48,042.2* LOGGED BY: *D. Kraemer*

ELEVATION: *6704.0'* REFERENCE POINT: DATUM: DRILLRIG: *CME-75*

INCLINATION: *Vertical* AZIMUTH: *NA* FLUSH: *Water* FEED: *10 ft.*

TOTAL DEPTH: *42 ft.* BIT TYPE: *NQ - Carbide Type L1* PAGE *2* OF *2*

GROUND WATER DEPTH: *No Detection* DATE/TIME OF DEPTH: *NA* PIEZOMETER STICK-UP: *NA*

CORE DIA./DEPTH	RUN TIME (minutes)	WATER RECOVERY (%)	ROCK TYPE: LITHOLOGY	ROCK TYPE: DESCRIPTION	DEPTH (Feet)	CORE RECOVERY DATA: T.C.R. (Length - %) 25 50 75	CORE RECOVERY DATA: R.Q.D. (Length - %) 25 50 75	FRACTURES (Per Foot)	DISCONTINUITY DATA: Subsurface Testing & Condition	STRENGTH DATA: WEATHERING INDEX	STRENGTH DATA: STRENGTH INDEX	STRENGTH DATA: POINT LOAD INDEX (PSI)	PIEZOMETER NOTES
				CLAYSTONE SLIGHTLY WEATHERED, WEAK, VERY DARK GRAY, (7.5YR 3/1). TRACE MICA. (WEPO FORMATION)					START CORING @ 32 FT.				
									J, PL, R YELLOW CLAY INFILLING 0 TO 45 DEGREE ANGLE	W2	R2		
				VERY WEAK ROCK	35		8'/10' 80%	2			R1		
				DARKER GRAY									
				BLACK COAL	40				RUBBLE ZONE				
				CORED TO A TOTAL DEPTH OF 42 FT.	45								

ABBREVIATIONS

T.C.R. - Total Core Recovery
R.Q.D. - Rock Quality Designation
P.T.Z. - Packer Test Zone

J - Joint
F - Fault
S - Shear
B - Bedding
FO - Foliation

PL - Planar
C - Curved
U - Undulating
ST - Stepped
I - Irregular

P - Polished
K - Slickensided
SM - Smooth
R - Rough
VR - Very Rough

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Draft	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B12-CL
SCALE: AS NOTED
FIGURE No:

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: 12/22/99 BOREHOLE NUMBER: **PW-B13**

BOREHOLE LOCATION: N -39,818.8, E 48,033.1 SURFACE ELEVATION: 6687.5' LOGGED BY: DK

DRILLING COMPANY: Heber Mining & Exploration DRILLER: Mark Stroud DRILLRIG: CME-75

DATE/TIME STARTED: 22 Dec 99, (15:05) DATE/TIME FINISHED: 22 Dec 99; (16:35) PAGE 1 OF 2

WATER DEPTH: No detection DATE/TIME OF DEPTH: N/A CASING STICK-UP: N/A

DEPTH FEET	SOIL DESCRIPTION	LITHOLOGY	USCS CLASS	NO.	TYPE	BLOW COUNT/6"	DEPTH FEET	STANDARD PENETRATION TEST ▲ 'N' BLOWS PER FOOT 20 40 60 80 / WATER CONTENT, PERCENT & RANGE Wp Wn WL 20 40 60 80	PIEZOMETER NOTES
5	ALLUVIUM Silty SAND, compact, red (2.5 yr. 5/6), fine grained, subrounded to rounded particles, dry		SM	1	SPT	8-7-10	5	▲	
10	Shelby tube sample collected @ 10'				ST		10		
15	Sandy SILT		ML	3	SPT	14-16-18	15	▲	
20	BEDROCK Siltstone/claystone with coal			4	SPT	8-15-18	20	▲	
25				5	SPT	50/4"	25	▲	
	Started coring @ 27'								
30							30		
35							35		
40							40		

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
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MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B13.0.wg
SCALE: NA FIGURE No:

Peabody COAL COMPANY Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: 22 Dec 99 BOREHOLE NUMBER: **PW-B13**

BOREHOLE LOCATION COORDINATES: N -39,818.8, E 48,033.1 LOGGED BY: D. Kraemer

ELEVATION: 6687.5' REFERENCE POINT: DATUM: DRILLRIG: CME-75

INCLINATION: Vertical AZIMUTH: NA FLUSH: Water FEED: 5 ft.

TOTAL DEPTH: 33 ft. BIT TYPE: NQ - Carbide Type L1 PAGE 2 OF 2

GROUND WATER DEPTH: No Detection DATE/TIME OF DEPTH: NA PIEZOMETER STICK-UP: NA

CORE DIA./DEPTH	RUN TIME (minutes)	WATER RECOVERY (%)	ROCK TYPE: LITHOLOGY	ROCK TYPE: DESCRIPTION	DEPTH (Feet)	CORE RECOVERY DATA: T.C.R. (Length - %) 25 50 75	CORE RECOVERY DATA: R.Q.D. (Length - %) 25 50 75	FRACTURES (Per Foot)	DISCONTINUITY DATA: Subsurface Testing & Condition	STRENGTH DATA: WEATHERING INDEX	STRENGTH DATA: STRENGTH INDEX	STRENGTH DATA: POINT LOAD INDEX (PSI)	PIEZOMETER NOTES
				SILTSTONE SLIGHTLY WEATHERED, WEAK, YELLOWISH BROWN, (10YR 5/4). TRACE MICA. (WEPO FORMATION) SHALE, VERY DARK GRAY (10YR 3/1)	30		3.9/6' 65%	1	START CORING @ 27 FT. BROKEN ZONE J, I,VR O TO 30 DEGREE ANGLE	W2	R3		
				CORED TO A TOTAL DEPTH OF 33 FT.	35 45								

ABBREVIATIONS

T.C.R. - Total Core Recovery
R.Q.D. - Rock Quality Designation
P.T.Z. - Packer Test Zone

J - Joint
F - Fault
S - Shear
B - Bedding
FO - Foliation

PL - Planar
C - Curved
U - Undulating
ST - Stepped
I - Irregular

P - Polished
K - Slickensided
SM - Smooth
R - Rough
VR - Very Rough

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Draft	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B13-CL
SCALE: AS NOTED
FIGURE No:

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: 12/21/99 BOREHOLE NUMBER: **PW-B14**

BOREHOLE LOCATION: N -39,345.6, E 47,730.5 SURFACE ELEVATION: 6681.5' LOGGED BY: DK

DRILLING COMPANY: Heber Mining & Exploration DRILLER: Mark Stroud DRILLRIG: CME-75

DATE/TIME STARTED: 21 Dec 99, (12:00) DATE/TIME FINISHED: 21 Dec 99, (16:15) PAGE 1 OF 3

WATER DEPTH: No detection DATE/TIME OF DEPTH: N/A CASING STICK-UP: N/A

DEPTH FEET	SOIL DESCRIPTION	LITHOLOGY	USCS CLASS	NO.	TYPE	BLOW COUNT/6"	DEPTH FEET	STANDARD PENETRATION TEST ▲ 'N' BLOWS PER FOOT 20 40 60 80 / WATER CONTENT, PERCENT & RANGE Wp Wn WL 20 40 60 80	PIEZOMETER NOTES
	ALLUVIUM		SM/ ML						
	Silty SAND, (7.5 yr 5/6), strong brown compact, fine grained, subangular to angular, dry								
5			SM	1	SPT	7-6-7	5	▲	
					ST				
	Shelby tube sample collected @ 7'-9'								
10				2	SPT	7-6-9	10	▲	
15	Dense, black, orange, red layers interbedded sand & silt			3	SPT	13-18-21	15	▲	
20	Silt/ clay with black coal fragments, orange staining			4	SPT	11-13-13	20	▲	
25				5	SPT	5-5-10	25	▲	
	Shelby tube sample collected @ 27'-29'				ST				
30	SILT/CLAY, med. plasticity		ML/ CL	6	SPT	3-5-10	30	▲	
35				7	SPT	3-5-7	35	▲	
40	Clay - black with trace sand						40		
	Shelby tube sample collected @ 40'-41.5'				ST				
	Clay - multi-colored, black shale/ coal, orange & yellow clay								

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B14.Dwg
SCALE: NA FIGURE No:

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: 12/21/99 BOREHOLE NUMBER: **PW-B14**

BOREHOLE LOCATION: N -39,345.6, E 47,730.5 SURFACE ELEVATION: 6681.5' LOGGED BY: DK

DRILLING COMPANY: Heber Mining & Exploration DRILLER: Mark Stroud DRILLRIG: CME-75

DATE/TIME STARTED: 21 Dec 99, (12:00) DATE/TIME FINISHED: 21 Dec 99, (16:15) PAGE 2 OF 3

WATER DEPTH: No detection DATE/TIME OF DEPTH: N/A CASING STICK-UP: N/A

DEPTH FEET	SOIL DESCRIPTION	LITHOLOGY	USCS CLASS	NO.	TYPE	BLOW COUNT/6"	DEPTH FEET	STANDARD PENETRATION TEST ▲ 'N' BLOWS PER FOOT 20 40 60 80 / WATER CONTENT, PERCENT & RANGE Wp Wn WL 20 40 60 80	PIEZOMETER NOTES
45	Same description as previous page.		CL	8	SPT	6-7-10	45	▲	
50	Note: driller indicated harder drilling @ 55'			9	SPT	7-9-11	50	▲	
55	BEDROCK Siltstone/ claystone			10	SPT	35-50 /3"	55	▲	
	Started coring @ 57 ft.								
60							60		
65							65		
70							70		

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01180100
AutoCAD FILE: 052-PW-B14.Dwg
SCALE: NA FIGURE No:

Peabody COAL COMPANY Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: *21 Dec 99* BOREHOLE NUMBER: **PW-B14**

BOREHOLE LOCATION COORDINATES: *N -39,345.6, E 47,730.5* LOGGED BY: *D. Kraemer*

ELEVATION: *6681.5'* REFERENCE POINT: DATUM: DRILLRIG: *CME-75*

INCLINATION: *Vertical* AZIMUTH: *NA* FLUSH: *Water* FEED: *10 ft.*

TOTAL DEPTH: *67 ft.* BIT TYPE: *NQ - Carbide Type L1* PAGE *3* OF *3*

GROUND WATER DEPTH: *No Detection* DATE/TIME OF DEPTH: *NA* PIEZOMETER STICK-UP: *NA*

CORE DIA./DEPTH	RUN TIME (minutes)	WATER RECOVERY (%)	ROCK TYPE: LITHOLOGY	ROCK TYPE: DESCRIPTION	DEPTH (Feet)	CORE RECOVERY DATA: T.C.R. (Length - %) 25 50 75	CORE RECOVERY DATA: R.Q.D. (Length - %) 25 50 75	FRACTURES (Per Foot)	DISCONTINUITY DATA: Subsurface Testing & Condition	STRENGTH DATA: WEATHERING INDEX	STRENGTH DATA: STRENGTH INDEX	STRENGTH DATA: POINT LOAD INDEX (PSI)	PIEZOMETER NOTES
				CLAYSTONE/SILTSTONE SLIGHTLY WEATHERED, VERY WEAK, VERY DARK GRAY, (7.5YR 4/1), SHALE FRAGMENTS, YELLOW CLAY. (WEPO FORMATION)					START CORING @ 57 FT.				
		100		SANDSTONE SLIGHTLY WEATHERED, VERY WEAK, (10YR 5/1), CONSISTING OF QUARTZ AND FELDSPAR, FINE TO MEDIUM GRAINED, SUBROUNDED SLIGHTLY WEATHERED, VERY WEAK, GRAINS, INTERBEDDED THIN BLACK SHALE.	60 65		93% 93%	0	J, PL, VR	W2 W1	R1 R3		
				CORED TO A TOTAL DEPTH OF 67 FT.	70								

ABBREVIATIONS

T.C.R. - Total Core Recovery
R.Q.D. - Rock Quality Designation
P.T.Z. - Packer Test Zone

J - Joint, F - Fault, S - Shear, B - Bedding, FO - Foliation

PL - Planar, C - Curved, U - Undulating, ST - Stepped, I - Irregular

P - Polished, K - Slickensided, SM - Smooth, R - Rough, VR - Very Rough

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Draft	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01186100
AutoCAD FILE: 052-PW-B14-CL
SCALE: AS NOTED FIGURE No:

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: 12/23/99 BOREHOLE NUMBER: **PW-B15**

BOREHOLE LOCATION: N -39,521.2, E 48,359.0 SURFACE ELEVATION: 6702.0' LOGGED BY: DK

DRILLING COMPANY: Heber Mining & Exploration DRILLER: Mark Stroud DRILLRIG: CME-75

DATE/TIME STARTED: 23 Dec 99, (09:25) DATE/TIME FINISHED: 23 Dec 99, (11:35) PAGE 1 OF 3

WATER DEPTH: 40 FT. B.G.S. DATE/TIME OF DEPTH: 23 Dec., 99, (10:15) CASING STICK-UP: N/A

DEPTH FEET	SOIL DESCRIPTION	LITHOLOGY	USCS CLASS	NO.	TYPE	BLOW COUNT/6"	DEPTH FEET
	SOIL PROFILE		SAMPLES				

STANDARD PENETRATION TEST ▲ 'N' BLOWS PER FOOT (20 40 60 80)

WATER CONTENT, PERCENT & RANGE (Wp Wn WL; 20 40 60 80)

PIEZOMETER NOTES

ALLUVIUM

5 Sandy SILT, strong brown, (7.5 yr. 5/6) Fine grained, dry — ML — GB

10

15

20

25 SAND, dense, fine - med. grained, angular to subangular, red & orange clay, gray sandstone clasts — SP — 2 SPT 8-12-18

30 CLAY, dark brown (10 yr 3/3), black shale fragments, high plasticity — CH — 3 SPT 5-6-9

35 Silty SAND, yellowish red, (5 yr 4/6), fine grained, rounded, interbedded clay layers — SM — 4 SPT 3-7-7

40 Wet - encountered GW @ 40' — 5 SPT 2-3-5

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01160100
AutoCAD FILE: 052-PW-B15.Dwg
SCALE: NA FIGURE No:

Peabody COAL COMPANY Western Division

J7Jr MSHA DAM

PROJECT: **PEABODY WESTERN** DATE: 12/23/99 BOREHOLE NUMBER: **PW-B15**

BOREHOLE LOCATION: N -39,521.2, E 48,359.0 SURFACE ELEVATION: 6702.0' LOGGED BY: DK

DRILLING COMPANY: Heber Mining & Exploration DRILLER: Mark Stroud DRILLRIG: CME-75

DATE/TIME STARTED: 23 Dec 99, (9:25) DATE/TIME FINISHED: 23 Dec 99; (11:35) PAGE 2 OF 3

WATER DEPTH: 40 ft. B.G.S. DATE/TIME OF DEPTH: 23 Dec., 99, (11:35) CASING STICK-UP: N/A

DEPTH FEET	SOIL DESCRIPTION	LITHOLOGY	USCS CLASS	NO.	TYPE	BLOW COUNT/6"	DEPTH FEET	STANDARD PENETRATION TEST ▲ 'N' BLOWS PER FOOT 20 40 60 80 / WATER CONTENT, PERCENT & RANGE Wp Wn WL 20 40 60 80	PIEZOMETER NOTES
	Same description as previous page.								
45	Interbedded silt & clay		ML/ CL	6	SPT	3-4-4	45	▲	
	Black clay with trace red clasts up to gravel size								
50	BEDROCK Fragmented Sandstone			7	SPT	2-4-5	50	▲	
55	More red & yellow color, gray sandstone clasts			8	SPT	2-4-5	55	▲	
60	BEDROCK Siltstone/ claystone with coal, very dark gray, (10 yr 3/1)			9	SPT	6-17-20	60	▲	
65	Drilled to a total depth of 65'			10	SPT	50-50	65	▲	
70							70		

LEGEND

SPT - Standard Penetration Test
ST - Shelby Tube
GB - Grab Sample
CT - Cuttings
BGS - Below Ground Surface
NM - No Measurement
NA - Not Applicable
PT - Penetration Sampler (3 Inch O.D.)
CS - Continous Sampler
BOH - Bottom of Hole
BR - Bedrock

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	DRAFT	1/00	DK	DK	JCT

MONTGOMERY WATSON

PROJECT No.: 1342052.01160100
AutoCAD FILE: 052-PW-B15.Dwg
SCALE: NA
FIGURE No:

Peabody
PEABODY COAL COMPANY
Western Division

J7Jr MSHA DAM

TEST PIT 1 (PW-TP1)		
Depth (cm)		Description
From	To	
0	40	Topsoil consisting of redish clayey silt. Moisture content is low. Relatively loose. Presence of thin roots.
40	100	Light redish clayey silt. Small amount of angular course sand to fine gravel size particles.Low moisture. Very consistent. Presence of white stains. Small amount of very small roots.
100	110	Angular pea size particles in a matrix of fine and silty sands. Low moisture content. Consistent. Presence of very small roots.
110	127	Highly fractured and weathered light yellowish sandstone.
127	145	Soft and highly fractured redish to brown mudstone. Presence of oxide stains.
145	157	Gray layered shale. Thin bedding of siltstone.
157	163	Highly fractured and weathered sandstone.
163	210	Gray layered shale.
210	245	Gray layered shale. Thin bedding of sandstone.

TEST PIT 2 (PW-TP2)		
Depth (cm)		Description
From	To	
0	40	Topsoil consisting of redish clayey silt. Moisture content is low. Relatively loose. Presence of thin roots.
40	60	Light redish clayey silt. Small amount of angular course sand to fine gravel size particles.Low moisture. Very consistent. Presence of large roots.
60	127	Light redish clayey silt. Small amount of angular course sand to fine gravel size particles.Low moisture. Very consistent. Small amount of roots.
127	176	Clean redish silts and fine sands. Very consistent.
176	283	Clean redish silts and fine sands. Very consistent. Presence of white stains.

TEST PIT 3 (PW-TP3)		
Depth (cm)		Description
From	To	
0	30	Topsoil consisting of layered brown clayey silt and fine sands.
30	90	Layers of gravelly sands and fine sands. Layers average 10 cm thick. Presence of roots.
90	160	Sands with some gravel size particles and large amount of fines. Gravel size particles are flat and sub-angular in shape. Dmax= 5 in. Layered stratification with lenses of finer material. Very loose. Small presence of roots.
160	200	Dark gray shale with streaks of white stains and black shades. Separates in plate shape particles. Very consistent. Sandstone block with oxide stains is encountered on opposite side of test pit. Block is underlain by a thin coal seam and shale.
200	330	Gray shale with streaks of white stains and black shades. Separates in plate shape particles. Very consistent.

TEST PIT 4 (PW-TP4)		
Depth (cm)		Description
From	To	
0	50	Topsoil consisting of layered brown clayey silt and fine sands.
50	120	Layers of gravelly sands and fine sands. Layers average 10 cm thick. Presence of roots.
120	180	Light red silts and fine sands. Dense and moist. Some presence of very small roots. Some sandstone cobbles with oxide stains.
160	200	Sands with gravel size particles and large amount of fines. Gravel size particles are flat and sub-angular in shape. Dmax= 5 in. Layered stratification with lenses of finer material. Very loose. Small presence of roots.
200	330	Light red silts and fine sands. Dense and moist. Some presence of very small roots. Some sandstone cobbles with oxide stains.

TEST PIT 5 (PW-TP5)		
Depth (cm)		Description
From	To	
0	50	Topsoil.
50	220	Redish brown silts and fine sands. Patches of organic material. Low moisture. Medium to loose density. Presence of small gravel size particles, Dmax=0.5 in.
220	330	Redish brown silts and fine sands. Very small amount of roots and organic material. Low moisture. Medium to loose density. Presence of small gravel size particles, Dmax=0.5 in.

TEST PIT 6 (PW-TP6)		
Depth (cm)		Description
From	To	
0	40	Topsoil.
40	180	Redish brown silts and fine sands. Patches of organic material. Low moisture. Medium to loose density. Presence of small gravel size particles, Dmax=0.5 in.
180	370	Redish brown silts and fine sands. Very small amount of roots and organic material. Low moisture. Medium to loose density. Presence of small gravel size particles, Dmax=0.5 in.

TEST PIT 7 (PW-TP7)		
Depth (cm)		Description
From	To	
0	30	Topsoil consisting of layered brown clayey silt and fine sands.
30	330	Redish brown silts and fine sands. Very small amount of roots and organic material. Low moisture. Medium to loose density. Presence of small gravel size particles, Dmax=0.5 in.

TEST PIT 8 (PW-TP8)		
Depth (cm)		Description
From	To	
0	60	Topsoil consisting of layered brown clayey silt and fine sands.
60	80	Very fractured but hard sandstone
80	300	Gray color shale. Presence of small roots to until depth of 150 cm.

TEST PIT 9 (PW-TP9)		
Depth (cm)		Description
From	To	
0	160	Weathered shale. Light gray color with presence of roots near the surface. Redish stains towards the bottom of the test pit.

Appendix C

Laboratory Test Results

PEABODY WE[illegible]N
1342052.01180100

TABLE 1
SUMMARY OF SOIL DATA

SAMPLE TYPE	SAMPLE NUMBER	SAMPLE DEPTH (ft)	DRY DENSITY (pcf)	U.S.C.S. SOIL CLASSIFICATION	DELIVERED MOISTURE (%)	ATTERBERG LIMITS			GRAIN SIZE DISTRIBUTION			SPECIFIC GRAVITY	MOIST/DEN RELATIONSHIP STANDARD PROCTOR		ADDITIONAL TEST COMMENTS (See Notes)
						LL	PL	PI	% FINER 3/4"	% FINER #4	% FINER #200		PCF (Dry)	MOIST (%)	
	TP-6:200			SM	3.3	NP	NP	NP	100	100	34	2.60	115.4	12.1	
	TP-7:280			SM	2.9	NP	NP	NP	100	100	41				
	TP-5:280			SM	2.4	NP	NP	NP	100	96	17		111.2	13.2	
	TP-2:150			CL	6.0	27	17	10	100	100	52	2.62			
	J21:SCORIA			SM	5.4	NP	NP	NP	75	52	16				
	N6:SCORIA			GP-GM	3.1	NP	NP	NP	65	43	10				
	J19:SCORIA			GM	4.3	27	17	10	56	35	18				
	PW-B1	22	97.1		24.5	29	15	14							5.09 psi*
	PW-B2	42-43	98.9		25.6	39	18	21							
	PW-B10	22-24	108.6		20.2	25	20	5							
	PW-B10	20			25.2	31	17	14			76.0				
	PW-B10	10			19.1	34	16	18			82.0				
	PW-B8	40			23.7	27	18	9			71.1				
	PW-B8	35		CL	15.7				100	100	55				
	PW-B8	30		CL	14.9				100	100	90				
	PW-B3	20		SC	3.3				100	92	19				
	PW-B2	10				32	18	14							
	PW-B2	50			24.8	41	21	20			72.2				
	PW-B1	5			15.8	29	17	12			69.5				
	PW-B1	15			24.7	45	19	26			93.1				
	PW-B1	25			23.9	31	17	14			73.8				

12-14-99;12:14PM;MONTGOMERY WATSON MW SANTIAGO 19037688009 # 2/ 13

PEABODY W[illegible]ERN
1342052.01180100

TABLE 1
SUMMARY OF SOIL DATA

SAMPLE TYPE	SAMPLE NUMBER	SAMPLE DEPTH (ft)	DRY DENSITY (pcf)	U.S.C.S. CLASSIFICATION	DELIVERED MOISTURE (%) =	ATTERBERG LIMITS			GRAIN SIZE DISTRIBUTION			SPECIFIC GRAVITY	MOIST/DEN RELATIONSHIP STANDARD PROCTOR		ADDITIONAL TESTS COMMENTS (See Notes)
						LL	PL	PI	% FINER 3/4"	% FINER #4	% FINER #200		PCF (Dry)	MOIST (%)	
	PW-B1	30			25.5	34	14	20			71.6				
	PW-B1	35			25.5	38	24	14			66.9				

NOTES:

LL = LIQUID LIMIT
PL = PLASTIC LIMIT
PI = PLASTIC INDEX
SL = SHRINKAGE LIMIT

T = TRIAXIAL TEST
U = UNCONFINED COMPRESSION TEST
C = CONSOLIDATION TEST
DS = DIRECT SHEAR TEST
RM = PERMEABILITY

NOTE: * UNCONFINED COMPRESSION PEAK STRENGTH

12-14-99;12:14PM;MONTGOMERY WATSON ; MW SANTIAGO ; 3037636003 ; # 3/ 13

MONTGOMERY WATSON/LAB TESTING/CO
003-2111-1

TABLE 1
SUMMARY OF SOIL DATA

SAMPLE TYPE	SAMPLE NUMBER	SAMPLE DEPTH (ft)	U.S.C.S. SOIL CLASSIFICATION	DELIVERED MOISTURE (%)	ATTERBERG LIMITS			GRAIN SIZE DISTRIBUTION			DRY DENSITY (pcf)	MOIST/DEN RELATIONSHIP STANDARD PROCTOR		ADDITIONAL TESTS COMMENTS (See Notes)
					LL	PL	PI	% FINER 3/4"	% FINER #4	% FINER #200		PCF (Dry)	MOIST (%)	
	PW-B1	10-12		5.1						34.8	96.1			C
	PW-B1	10-12		3.6							94.4			C

NOTES:
LL = LIQUID LIMIT
PL = PLASTIC LIMIT
PI = PLASTIC INDEX
SL = SHRINKAGE LIMIT
T = TRIAXIAL TEST
U = UNCONFINED COMPRESSION TEST
C = CONSOLIDATION TEST
DS = DIRECT SHEAR TEST
PERM = PERMEABILITY

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM C 117, C 136, D 421, D 422, D 1140, D 2216, D 2217

MONTGOMERY WATSON/LAB TESTING/CO 953-2903	SAMPLE #: TP-6:200 DEPTH (FT):

MOISTURE CONTENT (As tested)

Tare	M53
Weight Wet Soil & Tare, g	464.29
Weight Dry Soil & Tare, g	452.88
Weight Tare, g	103.01
Weight Water, g	11.41
Weight Dry Soil, g	349.87
Moisture, %	**3.26%**

#200 WASH (Percent Fines)

Tare	58
Weight Soil & Tare Before Wash, g	747.19
Weight Soil & Tare After Wash, g	577.30
Weight Tare, g	157.61
Weight Fines Lost, g	151.27
Weight Dry Soil, g	570.96
Fines Lost, %	**26.49%**

	SIEVE	Wt. Ret.	% Ret.	% Pass.	SIEVE
	6.000"	0.00	0.00%	**100.00%**	6.000"
Coarse Gravel	3.000"	0.00	0.00%	**100.00%**	3.000" Coarse Gravel
	1.500"	0.00	0.00%	**100.00%**	1.500"
	1.000"	0.00	0.00%	**100.00%**	1.000"
Fine Gravel	0.750"	0.00	0.00%	**100.00%**	0.750" Fine Gravel
	0.375"	0.00	0.00%	**100.00%**	0.375"
Coarse Sand	#4	0.15	0.03%	**99.97%**	#4 Coarse Sand
Medium Sand	#10	1.26	0.22%	**99.78%**	#10 Medium Sand
	#20	2.60	0.46%	**99.54%**	#20
Fine Sand	#40	7.87	1.38%	**98.62%**	#40 Fine Sand
	#60	42.75	7.49%	**92.51%**	#60
	#100	189.61	33.21%	**66.79%**	#100
	#200	378.52	66.30%	**33.70%**	#200
Fines	PAN	420.14	0.00%	**100.00%**	PAN Fines

% C GRVL:	**0.0%**		
% F GRVL:	**0.0%**	0.0%	
% C SAND:	**0.2%**		
% M SAND:	**1.2%**		
% F SAND:	**64.9%**	66.3%	
% FINES:	**33.7%**		
% TOTAL:	**100.0%**		

Wet Color: **Fine to coarse SAND**
Description: **and clay (SC)**

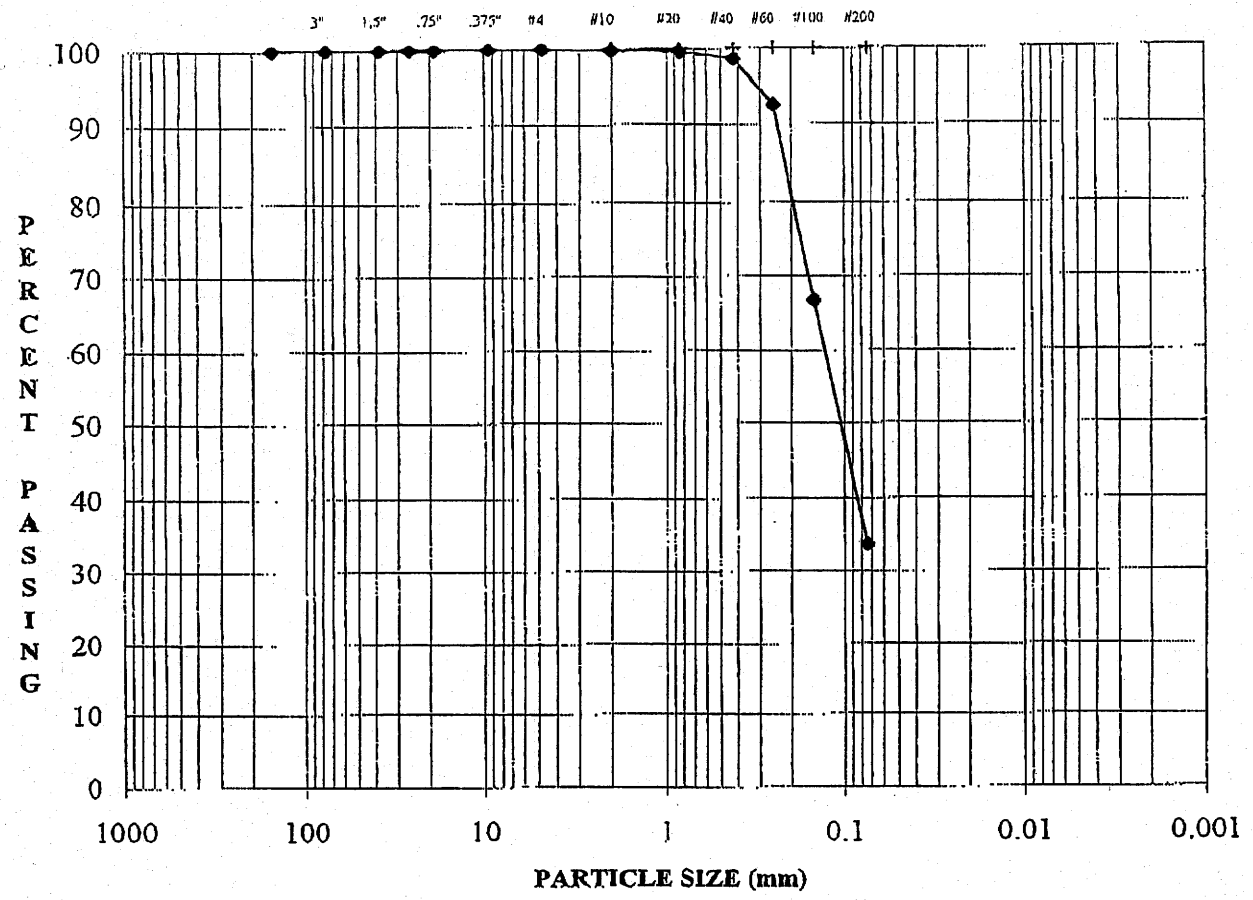
LL:	**LL**
PL:	**PL**
PI:	**PI**
Gs:	**2.60**

DATE:	03-Nov-99
TECH:	CW
REVIEW:	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

FROM : GOLDER ASSOCIATES PHONE NO. : 13039690468 Nov. 09 1999 04:24PM P3

PARTICLE-SIZE DISTRIBUTION ASTM D 421 AND D 422
US STANDARD SIEVE OPENING SIZES



COBBLES	Coarse	Fine	Cor	Med	Fine	Silt or Clay Size
	GRAVEL		SAND			FINES

SAMPLE #:	TP-6:200	MC (As tested):	3.3%
DEPTH (ft):		LL:	LL
		PL:	PL
DESCRIPTION:	Fine to coarse SAND and clay (SC)	PI:	PI
		Gs:	2.60

MONTGOMERY WATSON/LAB TESTING/CO
953-2903

DATE:	03-Nov-99
TECH:	CW
REVIEW:	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

FROM : GOLDER ASSOCIATES PHONE NO. : 13039690468 Nov. 09 1999 04:25PM P4

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM C 117, C 136, D 421, D 422, D 1140, D 2216, D 2217

MONTGOMERY WATSON/LAB TESTING/CO 953-2903	SAMPLE #: TP-7:280 DEPTH (FT):

MOISTURE CONTENT (As tested)

Tare	CW
Weight Wet Soil & Tare, g	435.80
Weight Dry Soil & Tare, g	426.33
Weight Tare, g	100.83
Weight Water, g	9.47
Weight Dry Soil, g	325.50
Moisture, %	**2.91%**

#200 WASH (Percent Fines)

Tare	069
Weight Soil & Tare Before Wash, g	574.56
Weight Soil & Tare After Wash, g	433.96
Weight Tare, g	155.45
Weight Fines Lost, g	128.75
Weight Dry Soil, g	407.26
Fines Lost, %	**31.61%**

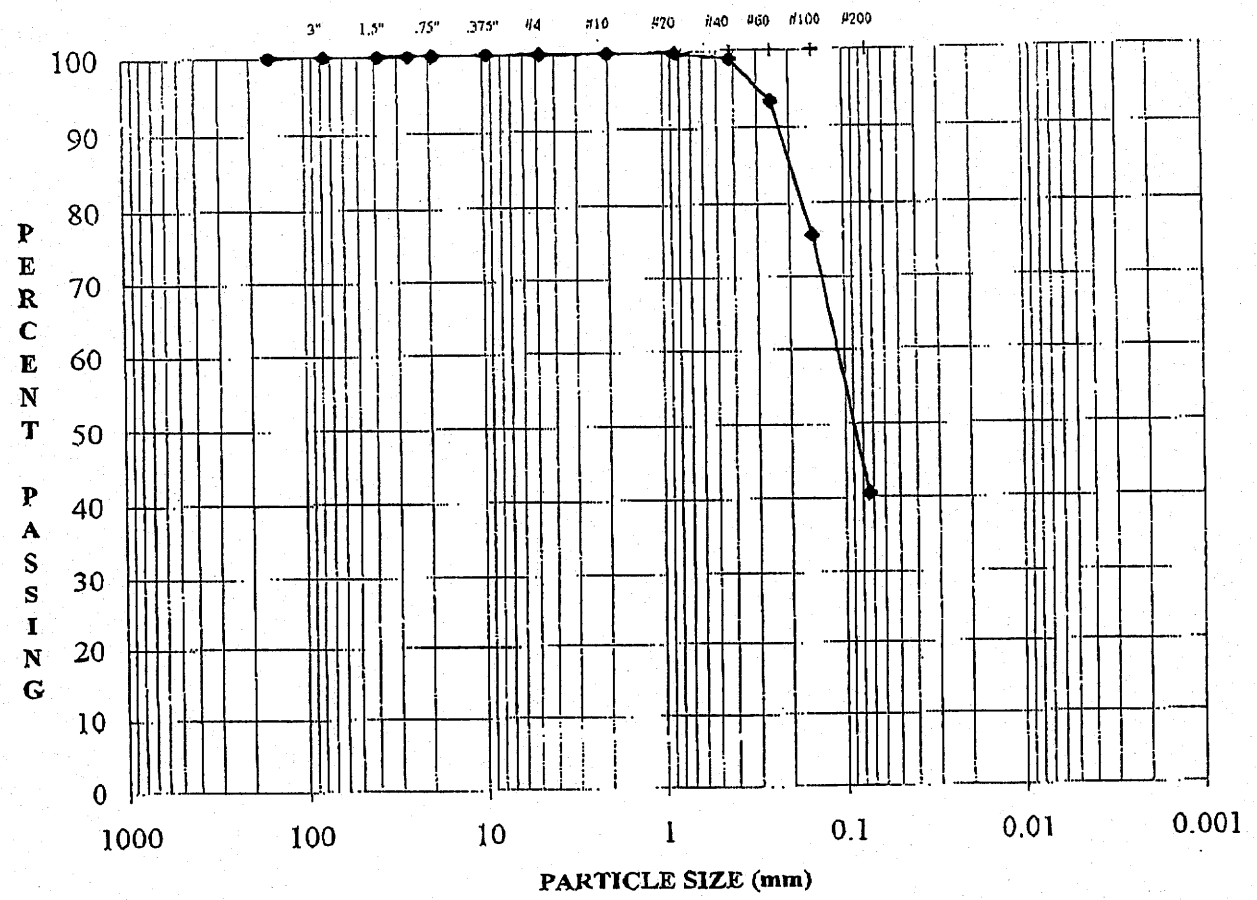
	SIEVE	Wt. Ret.	% Ret.	% Pass.	SIEVE	
	6.000"	0.00	0.00%	**100.00%**	6.000"	
Coarse Gravel	3.000"	0.00	0.00%	**100.00%**	3.000"	Coarse Gravel
	1.500"	0.00	0.00%	**100.00%**	1.500"	
	1.000"	0.00	0.00%	**100.00%**	1.000"	
Fine Gravel	0.750"	0.00	0.00%	**100.00%**	0.750"	Fine Gravel
	0.375"	0.00	0.00%	**100.00%**	0.375"	
Coarse Sand	#4	0.31	0.08%	**99.92%**	#4	Coarse Sand
Medium Sand	#10	0.74	0.18%	**99.82%**	#10	Medium Sand
	#20	1.50	0.37%	**99.63%**	#20	
Fine Sand	#40	4.53	1.11%	**98.89%**	#40	Fine Sand
	#60	26.34	6.47%	**93.53%**	#60	
	#100	98.66	24.23%	**75.77%**	#100	
	#200	242.09	59.44%	**40.56%**	#200	
Fines	PAN	278.70	0.00%	**100.00%**	PAN	Fines

% C GRVL:	**0.0%**		Wet Color:	**Fine to coarse SAND**	
% F GRVL:	**0.1%**	0.1%	Description:	**and clay,**	
% C SAND:	**0.1%**			**trace fine gravel (SC)**	
% M SAND:	**0.9%**		LL:	**LL**	
% F SAND:	**58.3%**	59.4%	PL:	**PL**	DATE: 03-Nov-99
% FINES:	**40.6%**		PI:	**PI**	TECH: CW
% TOTAL:	**100.0%**		Gs:	**Gs**	REVIEW: DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

FROM : GOLDER ASSOCIATES PHONE NO. : 13039690468 Nov. 09 1999 04:25PM P5

PARTICLE-SIZE DISTRIBUTION ASTM D 421 AND D 422
US STANDARD SIEVE OPENING SIZES



COBBLES	Coarse	Fine	Cor	Med	Fine	Silt or Clay Size
	GRAVEL		SAND			FINES

SAMPLE #:	TP-7:280
DEPTH (ft):	
DESCRIPTION:	Fine to coarse SAND and clay, trace fine gravel (SC)

MC (As tested):	2.9%
LL:	LL
PL:	PL
PI:	PI
Gs:	Gs

MONTGOMERY WATSON/LAB TESTING/CO
953-2903

DATE:	03-Nov-99
TECH:	CW
REVIEW:	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

FROM : GOLDER ASSOCIATES PHONE NO. : 13039690468 Nov. 09 1999 04:26PM P6

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM C 117, C 136, D 421, D 422, D 1140, D 2216, D 2217

MONTGOMERY WATSON/LAB TESTING/CO 953-2903	SAMPLE #: TP-5:280 DEPTH (FT):

MOISTURE CONTENT (As tested)

Tare	QT
Weight Wet Soil & Tare, g	448.23
Weight Dry Soil & Tare, g	440.11
Weight Tare, g	103.70
Weight Water, g	8.12
Weight Dry Soil, g	336.41
Moisture, %	**2.41%**

#200 WASH (Percent Fines)

Tare	ABC4
Weight Soil & Tare Before Wash, g	754.91
Weight Soil & Tare After Wash, g	648.61
Weight Tare, g	157.14
Weight Fines Lost, g	92.21
Weight Dry Soil, g	583.68
Fines Lost, %	**15.80%**

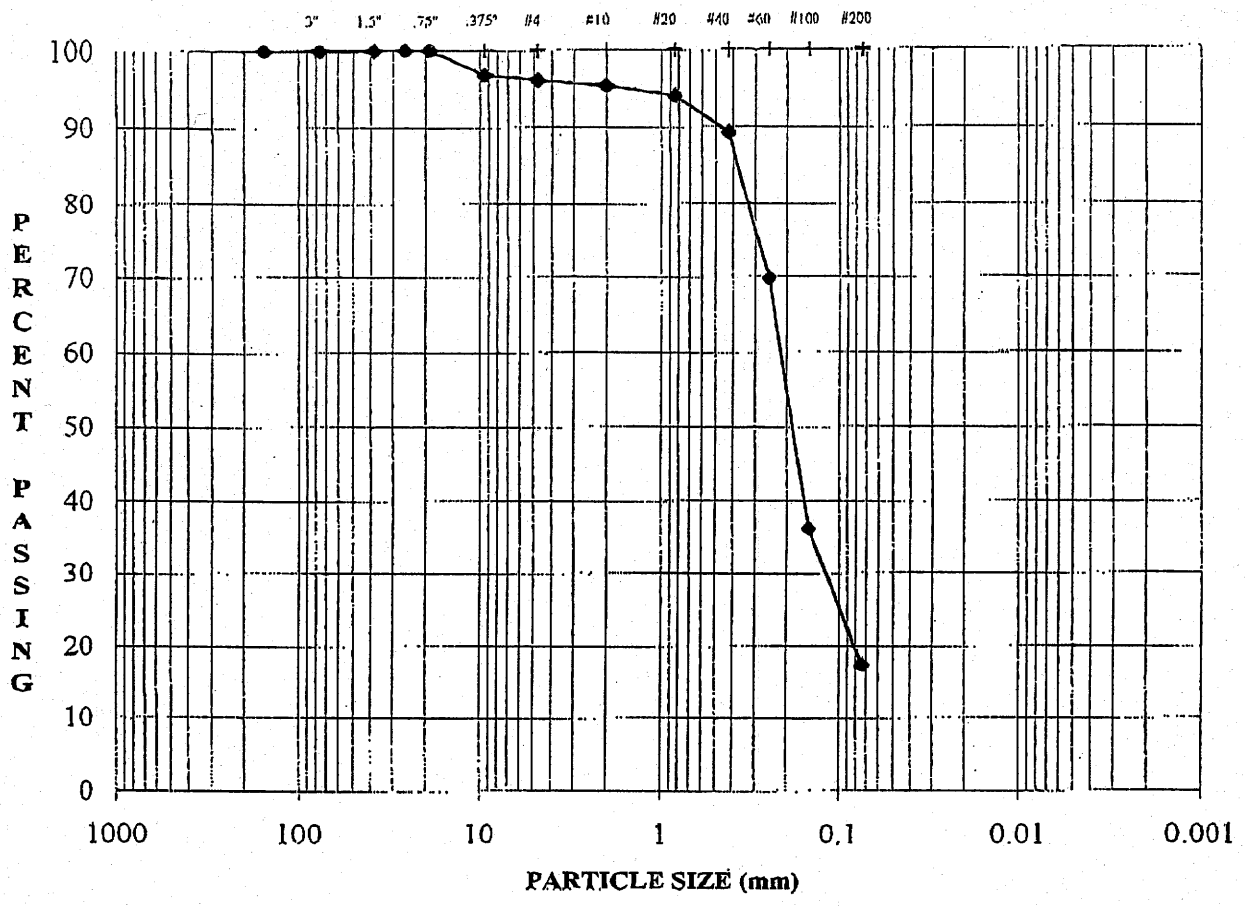
	SIEVE	Wt. Ret.	% Ret.	% Pass.	SIEVE	
	6.000"	0.00	0.00%	**100.00%**	6.000"	
Coarse Gravel	3.000"	0.00	0.00%	**100.00%**	3.000"	Coarse Gravel
	1.500"	0.00	0.00%	**100.00%**	1.500"	
	1.000"	0.00	0.00%	**100.00%**	1.000"	
Fine Gravel	0.750"	0.00	0.00%	**100.00%**	0.750"	Fine Gravel
	0.375"	18.64	3.19%	**96.81%**	0.375"	
Coarse Sand	#4	22.43	3.84%	**96.16%**	#4	Coarse Sand
Medium Sand	#10	26.76	4.58%	**95.42%**	#10	Medium Sand
	#20	34.60	5.93%	**94.07%**	#20	
Fine Sand	#40	61.98	10.62%	**89.38%**	#40	Fine Sand
	#60	176.46	30.23%	**69.77%**	#60	
	#100	372.43	63.81%	**36.19%**	#100	
	#200	482.66	82.69%	**17.31%**	#200	
Fines	PAN	492.32	0.00%	**100.00%**	PAN	Fines

% C GRVL:	**0.0%**		Wet Color:	**Fine to coarse SAND**	
% F GRVL:	**3.8%**	3.8%	Description:	**with some clay,**	
% C SAND:	**0.7%**			**trace fine gravel (SC)**	
% M SAND:	**6.0%**		LL:	**LL**	
% F SAND:	**72.1%**	78.8%	PL:	**PL**	DATE: 03-Nov-99
% FINES:	**17.3%**		PI:	**PI**	TECH: CW
% TOTAL:	**100.0%**		Gs:	**Gs**	REVIEW: DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

FROM : GOLDER ASSOCIATES PHONE NO. : 13039690468 Nov. 09 1999 04:27PM P8

PARTICLE-SIZE DISTRIBUTION ASTM D 421 AND D 422
US STANDARD SIEVE OPENING SIZES



COBBLES	Coarse	Fine	Cor	Med	Fine	Silt or Clay Size
	GRAVEL		SAND			FINES

SAMPLE #:	TP-5:280	MC (As tested):	2.4%
DEPTH (ft):		LL:	LL
		PL:	PL
DESCRIPTION:	Fine to coarse SAND with some clay, trace fine gravel (SC)	PI:	PI
		Gs:	Gs

MONTGOMERY WATSON/LAB TESTING/CO
953-2903

DATE:	03-Nov-99
TECH:	CW
REVIEW:	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

FROM : GOLDER ASSOCIATES PHONE NO. : 13039690468 Nov. 09 1999 04:26PM P2

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM C 117, C 136, D 421, D 422, D 1140, D 2216, D 2217

MONTGOMERY WATSON/LAB TESTING/CO 953-2903	SAMPLE #: TP-2:150 DEPTH (FT):

MOISTURE CONTENT (As tested)

Tare	A1
Weight Wet Soil & Tare, g	461.32
Weight Dry Soil & Tare, g	440.93
Weight Tare, g	101.93
Weight Water, g	20.39
Weight Dry Soil, g	339.00
Moisture, %	**6.01%**

#200 WASH (Percent Fines)

Tare	16E
Weight Soil & Tare Before Wash, g	728.62
Weight Soil & Tare After Wash, g	425.46
Weight Tare, g	156.69
Weight Fines Lost, g	270.71
Weight Dry Soil, g	539.48
Fines Lost, %	**50.18%**

	SIEVE	Wt. Ret.	% Ret.	% Pass.	SIEVE	
	6.000"	0.00	0.00%	**100.00%**	6.000"	
Coarse Gravel	3.000"	0.00	0.00%	**100.00%**	3.000"	Coarse Gravel
	1.500"	0.00	0.00%	**100.00%**	1.500"	
	1.000"	0.00	0.00%	**100.00%**	1.000"	
Fine Gravel	0.750"	0.00	0.00%	**100.00%**	0.750"	Fine Gravel
	0.375"	0.00	0.00%	**100.00%**	0.375"	
Coarse Sand	#4	0.00	0.00%	**100.00%**	#4	Coarse Sand
Medium Sand	#10	0.40	0.07%	**99.93%**	#10	Medium Sand
	#20	0.79	0.15%	**99.85%**	#20	
Fine Sand	#40	3.84	0.71%	**99.29%**	#40	Fine Sand
	#60	28.70	5.32%	**94.68%**	#60	
	#100	107.54	19.93%	**80.07%**	#100	
	#200	258.83	47.98%	**52.02%**	#200	
Fines	PAN	269.37	0.00%	**100.00%**	PAN	Fines

% C GRVL:	**0.0%**	
% F GRVL:	**0.0%**	0.0%
% C SAND:	**0.1%**	
% M SAND:	**0.6%**	
% F SAND:	**47.3%**	48.0%
% FINES:	**52.0%**	
% TOTAL:	**100.0%**	

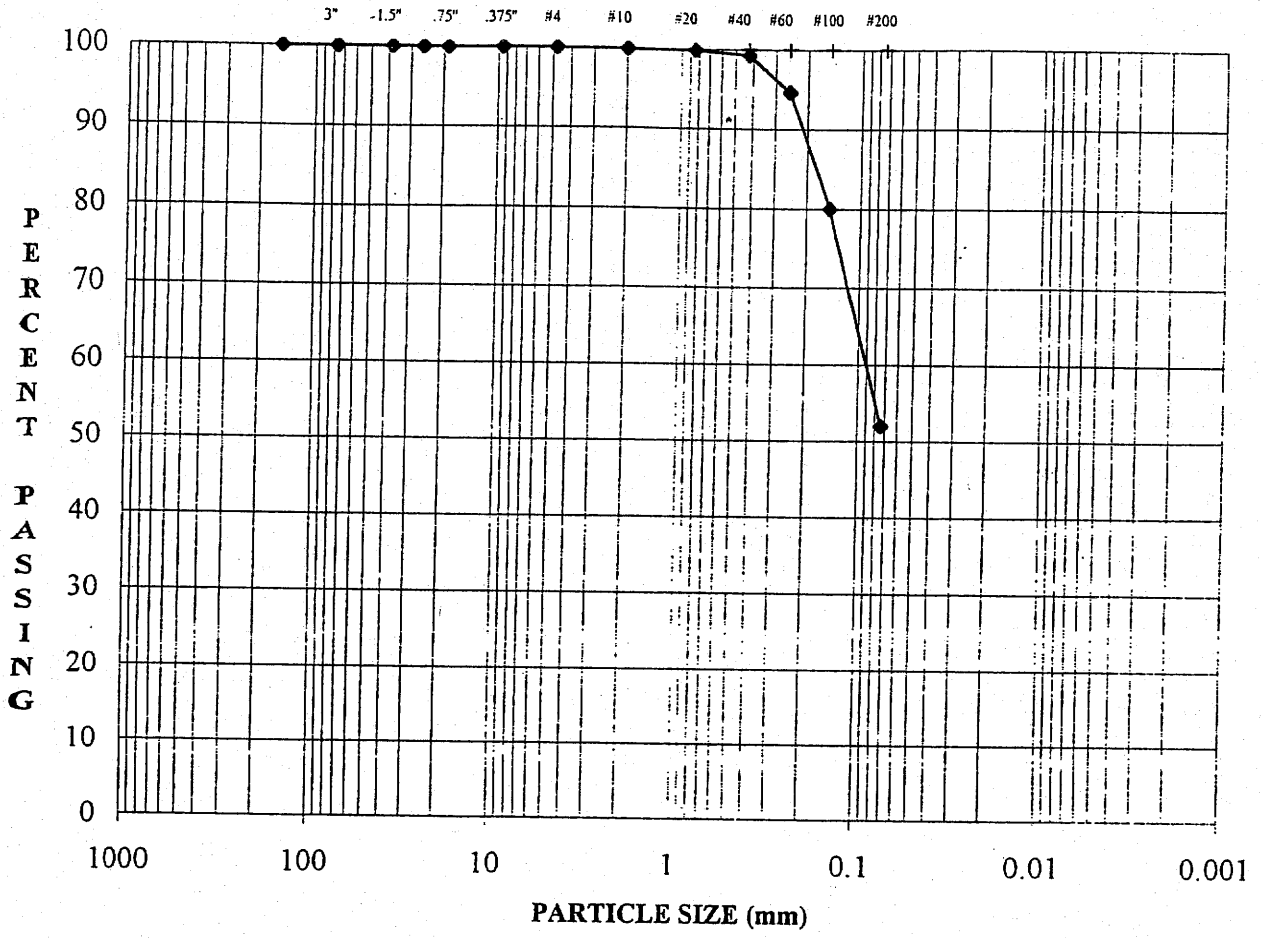
Wet Color: **CLAY and fine**
Description: **to coarse sand (CL)**

LL:	27
PL:	17
PI:	10
Gs:	2.62

DATE:	03-Nov-99
TECH:	CW
REVIEW:	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE-SIZE DISTRIBUTION ASTM D 421 AND D 422
US STANDARD SIEVE OPENING SIZES



COBBLES	Coarse	Fine	Cor	Med	Fine	Silt or Clay Size
	GRAVEL		SAND			FINES

SAMPLE #:	TP-2:150
DEPTH (ft):	
DESCRIPTION:	CLAY and fine to coarse sand (CL)

MC (As tested):	6.0%
LL:	27
PL:	17
PI:	10
Gs:	2.62

MONTGOMERY WATSON/LAB TESTING/CO
953-2903

DATE:	03-Nov-99
TECH:	CW
REVIEW:	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM C 117, C 136, D 421, D 422, D 1140, D 2216, D 2217

TERRAMATRIX/LAB TESTING/CO 953-2903	SAMPLE #: J19 SCORIA DEPTH (ft):

MOISTURE CONTENT (As tested)

Tare	6A
Weight Wet Soil & Tare, g	326.19
Weight Dry Soil & Tare, g	314.00
Weight Tare, g	31.91
Weight Water, g	12.19
Weight Dry Soil, g	282.09
Moisture, %	4.32%

#200 WASH (Percent Fines)

Tare	-
Weight Soil & Tare Before Wash, g	-
Weight Soil & Tare After Wash, g	-
Weight Tare, g	-
Weight Fines Lost, g	-
Weight Dry Soil, g	22,577.46
Fines Lost, %	-

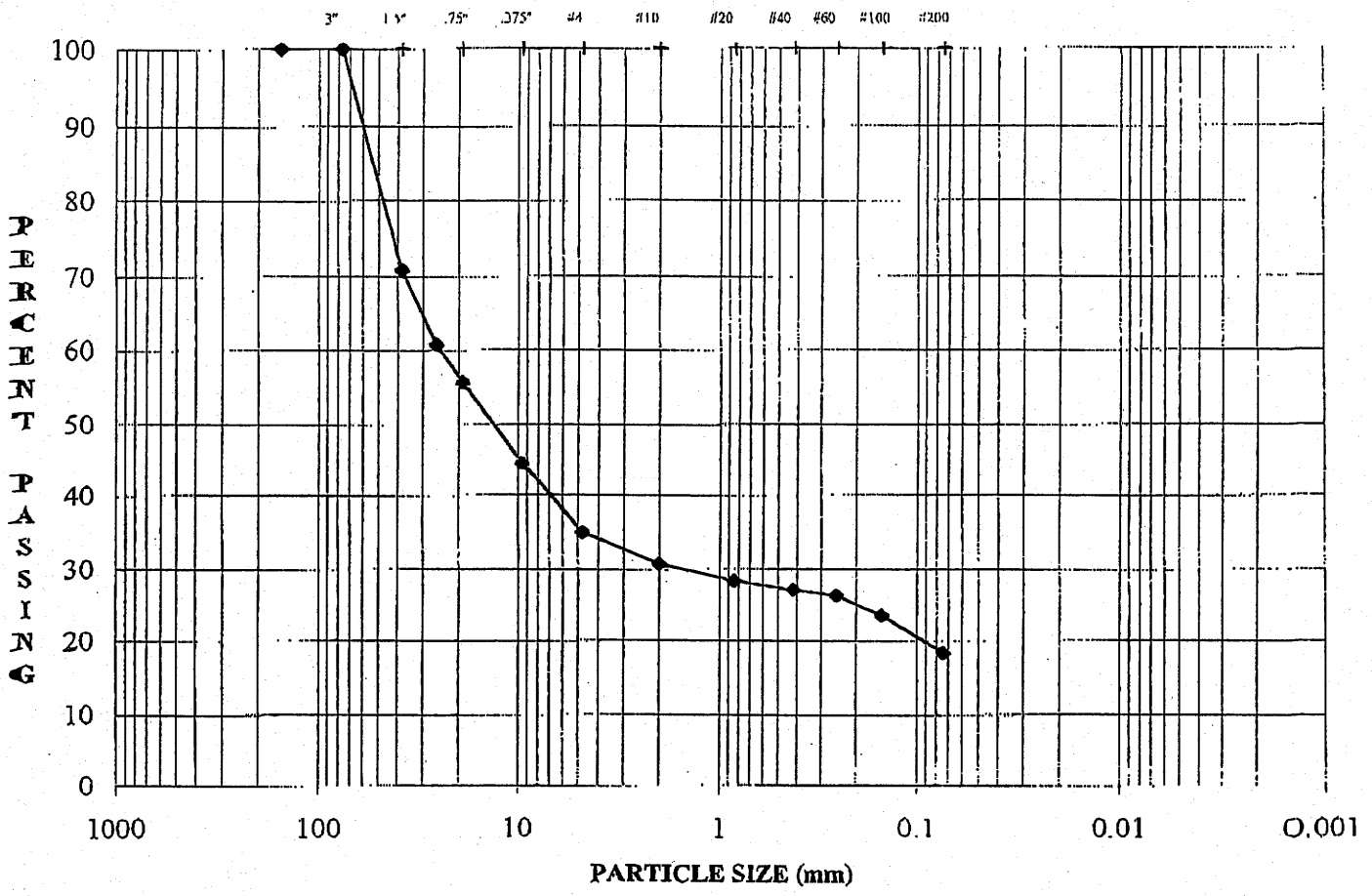
	SIEVE	Wt. Ret.	% Ret.	% Pass.	SIEVE
	6.000"	0.00	0.00%	100.00%	6.000"
Coarse Gravel	3.000"	0.00	0.00%	100.00%	3.000" Coarse Gravel
	1.500"	6,597.60	29.22%	70.78%	1.500"
	1.000"	8,879.50	39.33%	60.67%	1.000"
Fine Gravel	0.750"	10,005.40	44.32%	55.68%	0.750" Fine Gravel
	0.375"	12,521.50	55.46%	44.54%	0.375"
Coarse Sand	#4	14,678.40	65.01%	34.99%	#4 Coarse Sand
Medium Sand	#10	15,651.84	69.33%	30.67%	#10 Medium Sand
	#20	16,172.27	71.63%	28.37%	#20
Fine Sand	#40	16,448.08	72.85%	27.15%	#40 Fine Sand
	#60	16,641.20	73.71%	26.29%	#60
	#100	17,281.97	76.55%	23.45%	#100
	#200	18,444.27	81.69%	18.31%	#200
Fines	PAN	22,577.46	0.00%	100.00%	PAN Fines

% C GRVL:	44.3%	
% F GRVL:	20.7%	65.0%
% C SAND:	4.3%	
% M SAND:	3.5%	
% F SAND:	8.8%	16.7%
% FINES:	18.3%	
% TOTAL:	100.0%	

Wet Color:	Fine to coarse GRAVEL
Description:	with some fine to coarse sand, some clay (GC)
LL:	LL
PL:	PL
PI:	PI
Gs:	Gs
DATE:	08-Nov-99
TECH:	MJK
REVIEW:	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE-SIZE DISTRIBUTION ASTM D 421 AND D 422
US STANDARD SIEVE OPENING SIZES



COBBLES	Coarse	Fine	Cor	Med	Fine	Silt or Clay Size
	GRAVEL		SAND			FINES

SAMPLE #:	J19 SCORIA
DEPTH (ft):	
DESCRIPTION:	Fine to coarse GRAVEL with some fine to coarse sand, some clay (GC)

MC (As tested):	4.3%
LL:	LL
PL:	PL
PI:	PI
Gs:	Gs

TERRAMATRIX/LAB TESTING/CO
953-2903

08-Nov-99
MJK
DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM C 117, C 136, D 421, D 422, D 1140, D 2216, D 2217

TERRAMATRIX/LAB TESTING/CO 953-2903	SAMPLE #: N6 SCORIA DEPTH (ft):

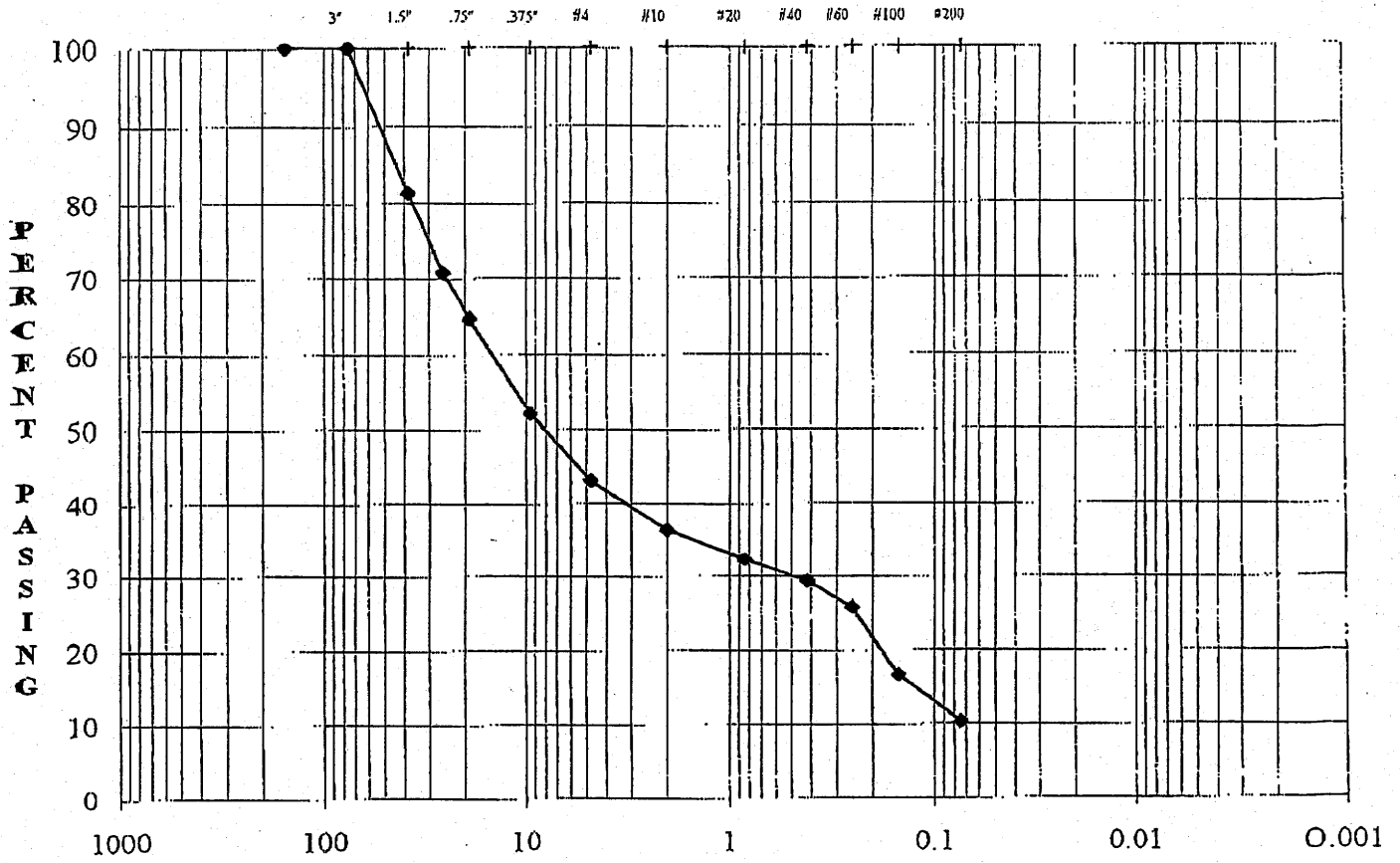
MOISTURE CONTENT (As tested)		#200 WASH (Percent Fines)	
Tare	9A	Tare	-
Weight Wet Soil & Tare, g	292.97	Weight Soil & Tare Before Wash, g	-
Weight Dry Soil & Tare, g	285.19	Weight Soil & Tare After Wash, g	-
Weight Tare, g	33.93	Weight Tare, g	-
Weight Water, g	7.78	Weight Fines Lost, g	-
Weight Dry Soil, g	251.26	Weight Dry Soil, g	20,724.68
Moisture, %	**3.10%**	Fines Lost, %	-

	SIEVE	Wt. Ret.	% Ret.	% Pass.	SIEVE	
	6.000"	0.00	0.00%	**100.00%**	6.000"	
Coarse Gravel	3.000"	0.00	0.00%	**100.00%**	3.000"	Coarse Gravel
	1.500"	3,855.40	18.60%	**81.40%**	1.500"	
	1.000"	6,078.30	29.33%	**70.67%**	1.000"	
Fine Gravel	0.750"	7,313.00	35.29%	**64.71%**	0.750"	Fine Gravel
	0.375"	9,911.30	47.82%	**52.18%**	0.375"	
Coarse Sand	#4	11,781.50	56.85%	**43.15%**	#4	Coarse Sand
Medium Sand	#10	13,185.34	63.62%	**36.38%**	#10	Medium Sand
	#20	14,037.18	67.73%	**32.27%**	#20	
Fine Sand	#40	14,648.16	70.68%	**29.32%**	#40	Fine Sand
	#60	15,409.06	74.35%	**25.65%**	#60	
	#100	17,292.60	83.44%	**16.56%**	#100	
	#200	18,596.01	89.73%	**10.27%**	#200	
Fines	PAN	20,724.68	0.00%	**100.00%**	PAN	Fines

% C GRVL:	**35.3%**		Wet Color:	**Fine to coarse GRAVEL**	
% F GRVL:	**21.6%**	56.8%	Description:	**and fine to coarse sand,**	
% C SAND:	**6.8%**			**little clay (GP-GC)**	
% M SAND:	**7.1%**		LL:	**LL**	
% F SAND:	**19.0%**	32.9%	PL:	**PL**	DATE: 08-Nov-99
% FINES:	**10.3%**		PI:	**PI**	TECH: MJK
% TOTAL:	**100.0%**		Gs:	**Gs**	REVIEW: DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE-SIZE DISTRIBUTION ASTM D 421 AND D 422
US STANDARD SIEVE OPENING SIZES



COBBLES	Coarse	Fine	Cor	Med	Fine	Silt or Clay Size
	GRAVEL		SAND			FINES

SAMPLE #:	N6 SCORIA
DEPTH (ft):	
DESCRIPTION:	Fine to coarse GRAVEL and fine to coarse sand, little clay (GP-GC)

MC (As tested):	3.1%
LL:	LL
PL:	PL
PI:	PI
Gs:	Gs

TERRAMATRIX/LAB TESTING/CO
953-2903

08-Nov-99
MJK
DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM C 117, C 136, D 421, D 422, D 1140, D 2216, D 2217

TERRAMATRIX/LAB TESTING/CO 953-2903	SAMPLE #: J21 SCORIA DEPTH (ft):

MOISTURE CONTENT (As tested)

Tare	X28
Weight Wet Soil & Tare, g	291.04
Weight Dry Soil & Tare, g	277.85
Weight Tare, g	33.56
Weight Water, g	13.19
Weight Dry Soil, g	244.29
Moisture, %	5.40%

#200 WASH (Percent Fines)

Tare	-
Weight Soil & Tare Before Wash, g	-
Weight Soil & Tare After Wash, g	-
Weight Tare, g	-
Weight Fines Lost, g	-
Weight Dry Soil, g	20,955.38
Fines Lost, %	-

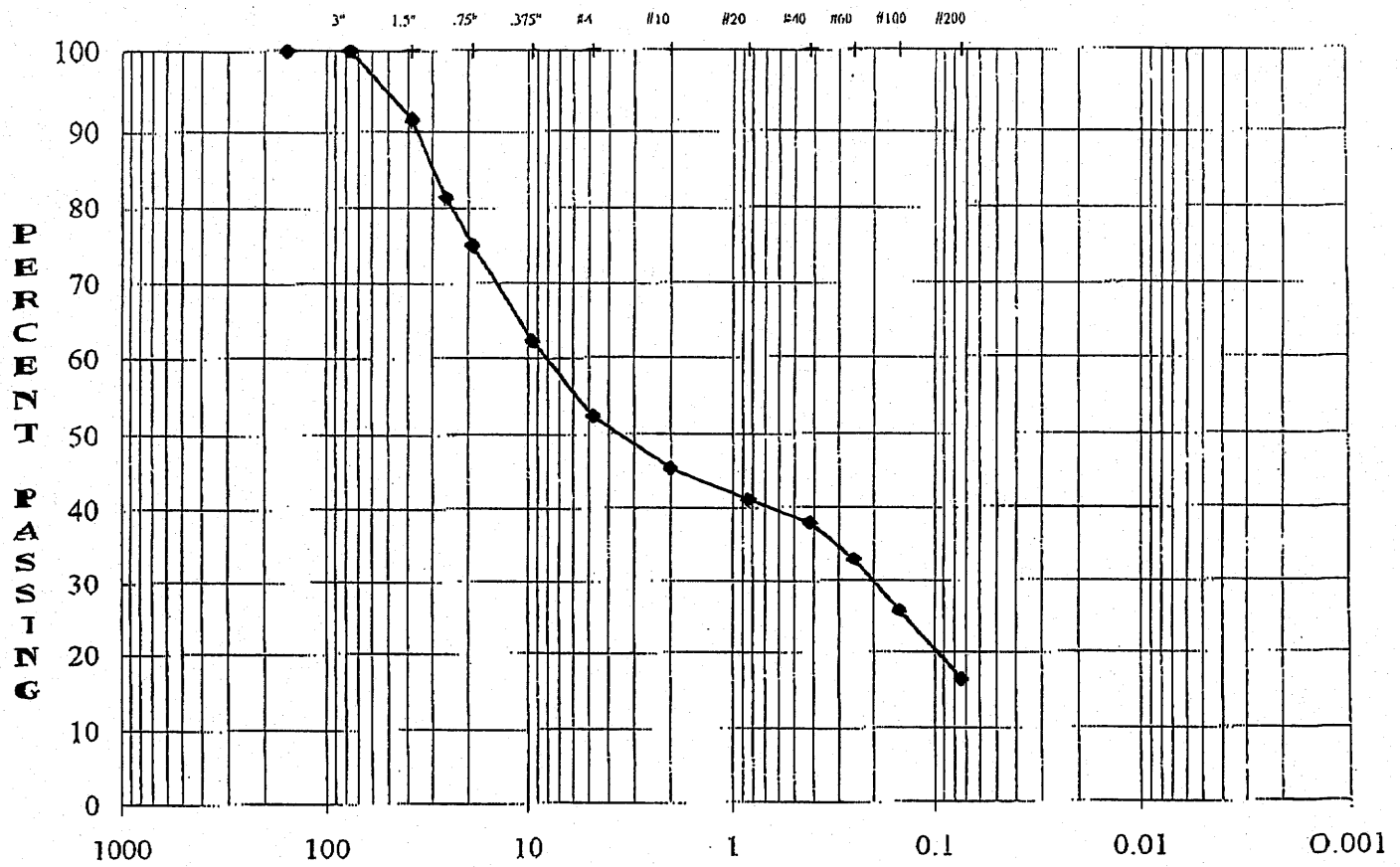
	SIEVE	Wt. Ret.	% Ret.	% Pass.	SIEVE
	6.000"	0.00	0.00%	**100.00%**	6.000"
Coarse Gravel	3.000"	0.00	0.00%	**100.00%**	3.000" Coarse Gravel
	1.500"	1,794.70	8.56%	**91.44%**	1.500"
	1.000"	3,896.60	18.59%	**81.41%**	1.000"
Fine Gravel	0.750"	5,232.30	24.97%	**75.03%**	0.750" Fine Gravel
	0.375"	7,906.20	37.73%	**62.27%**	0.375"
Coarse Sand	#4	9,972.20	47.59%	**52.41%**	#4 Coarse Sand
Medium Sand	#10	11,437.84	54.58%	**45.42%**	#10 Medium Sand
	#20	12,359.60	58.98%	**41.02%**	#20
Fine Sand	#40	13,018.80	62.13%	**37.87%**	#40 Fine Sand
	#60	14,036.36	66.98%	**33.02%**	#60
	#100	15,542.72	74.17%	**25.83%**	#100
	#200	17,535.92	83.68%	**16.32%**	#200
Fines	PAN	20,955.38	0.00%	**100.00%**	PAN Fines

% C GRVL:	25.0%	
% F GRVL:	22.6%	47.6%
% C SAND:	7.0%	
% M SAND:	7.5%	
% F SAND:	21.6%	36.1%
% FINES:	16.3%	
% TOTAL:	100.0%	

Wet Color:	Fine to coarse SAND
Description:	and fine to coarse gravel, some clay (SC)
LL:	LL
PL:	PL
PI:	PI
Gs:	Gs
DATE:	08-Nov-99
TECH:	MJK
REVIEW:	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE-SIZE DISTRIBUTION ASTM D 421 AND D 422
US STANDARD SIEVE OPENING SIZES



COBBLES	Coarse	Fine	Cor	Med	Fine	Silt or Clay Size
	GRAVEL		SAND			FINES

SAMPLE #:	J21 SCORIA
DEPTH (ft):	
DESCRIPTION:	Fine to coarse SAND and fine to coarse gravel, some clay (SC)

MC (As tested):	5.4%
LL:	LL
PL:	PL
PI:	PI
Gs:	Gs

TERRAMATRIX/LAB TESTING/CO
953-2903

08-Nov-99
MJK
DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM C 117, C 136, D 421, D 422, D 1140, D 2216, D 2217

JOB NAME	MONTGOMERY WATSON	**SAMPLE #:**	PW-B13
JOB NUMBER	003-2111-1	**DEPTH (FT):**	10-12 FT

MOISTURE CONTENT (As tested)

Tare	7-C
Weight Wet Soil & Tare, g	58.10
Weight Dry Soil & Tare, g	57.00
Weight Tare, g	24.62
Weight Water, g	1.10
Weight Dry Soil, g	32.38
Moisture, %	**3.40%**

#200 WASH (Percent Fines)

Tare	S9
Weight Soil & Tare Before Wash, g	232.48
Weight Soil & Tare After Wash, g	205.18
Weight Tare, g	158.53
Weight Fines Lost, g	24.87
Weight Dry Soil, g	71.52
Fines Lost, %	**34.77%**

	SIEVE	Wt. Ret.	% Ret.	% Pass.	SIEVE	
	6.000"	0.00	0.00%	**100.00%**	6.000"	
Coarse Gravel	3.000"	0.00	0.00%	**100.00%**	3.000"	Coarse Gravel
	1.500"	0.00	0.00%	**100.00%**	1.500"	
	1.000"	0.00	0.00%	**100.00%**	1.000"	
Fine Gravel	0.750"	0.00	0.00%	**100.00%**	0.750"	Fine Gravel
	0.375"	0.00	0.00%	**100.00%**	0.375"	
Coarse Sand	#4	0.00	0.00%	**100.00%**	#4	Coarse Sand
Medium Sand	#10	0.00	0.00%	**100.00%**	#10	Medium Sand
	#20	0.00	0.00%	**100.00%**	#20	
Fine Sand	#40	0.00	0.00%	**100.00%**	#40	Fine Sand
	#60	0.00	0.00%	**100.00%**	#60	
	#100	0.00	0.00%	**100.00%**	#100	
	#200	0.00	0.00%	**100.00%**	#200	
Fines	PAN	0.00	0.00%	**100.00%**	PAN	Fines

% C GRVL:	**0.0%**		Wet Color:	**DESCRIPTION**	
% F GRVL:	**0.0%**	0.0%	Description:		
% C SAND:	**0.0%**				
% M SAND:	**0.0%**		LL:	**LL**	
% F SAND:	**0.0%**	0.0%	PL:	**PL**	DATE: 27-Jan-00
% FINES:	**100.0%**		PI:	**PI**	TECH: DM
% TOTAL:	**100.0%**		Gs:	**Gs**	REVIEW: DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

ATTERBERG LIMITS
ASTM D 4318

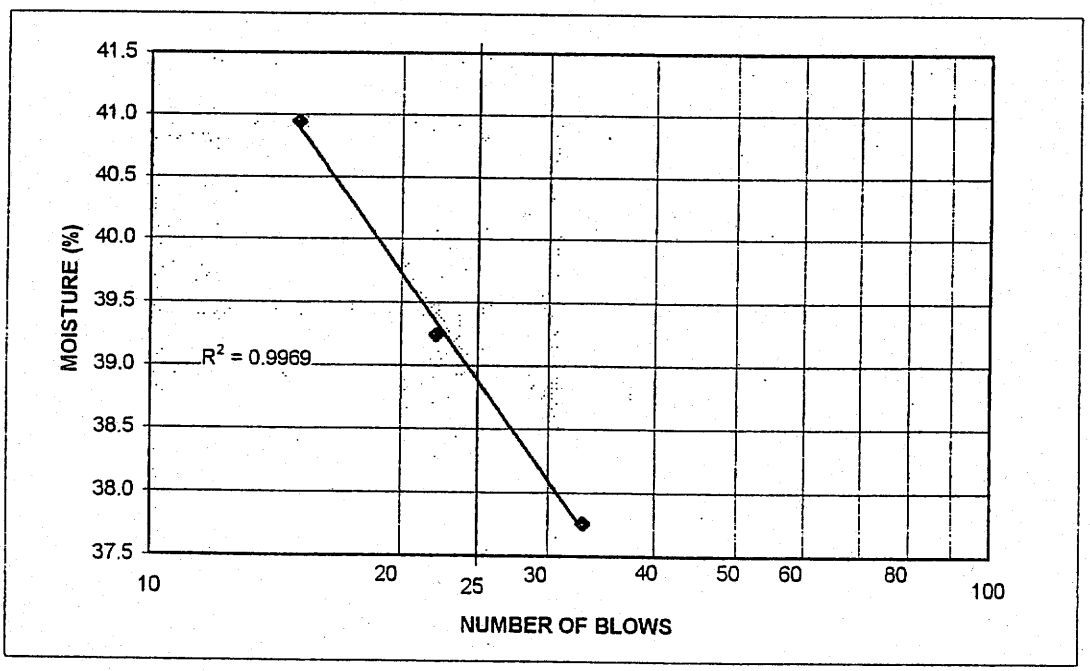
JOB NAME: **MONTGOMERY WATSON/LABTEST/C** DEPTH:
JOB NUMBER: **953-2903** SAMPLE NUMBER: **PWB2**

PLASTIC LIMIT

Tare	E7	F4
Weight Moist Soil & Tare, g	21.28	21.85
Weight Dry Soil & Tare, g	20.14	20.70
Weight Tare, g	13.90	14.27
Weight Moisture, g	1.14	1.15
Weight Dry Soil, g	6.24	6.43
Moisture, %	**18.3**	**17.9**

LIQUID LIMIT

Tare	F7	C1	H2
Weight Moist Soil & Tare, g	23.50	23.42	27.12
Weight Dry Soil & Tare, g	20.91	20.72	23.32
Weight Tare, g	14.05	13.84	14.04
Weight Moisture, g	2.59	2.70	3.8
Weight Dry Soil, g	6.86	6.88	9.28
Moisture, %	37.8	39.2	40.9
Number of Blows	33	22	15



LIQUID LIMIT: 39
PLASTIC LIMIT: 18
PLASTICITY INDEX: 21

DATE: 22-Nov-99
TECH: CW
REVIEW: DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

ATTERBERG LIMITS
ASTM D 4318

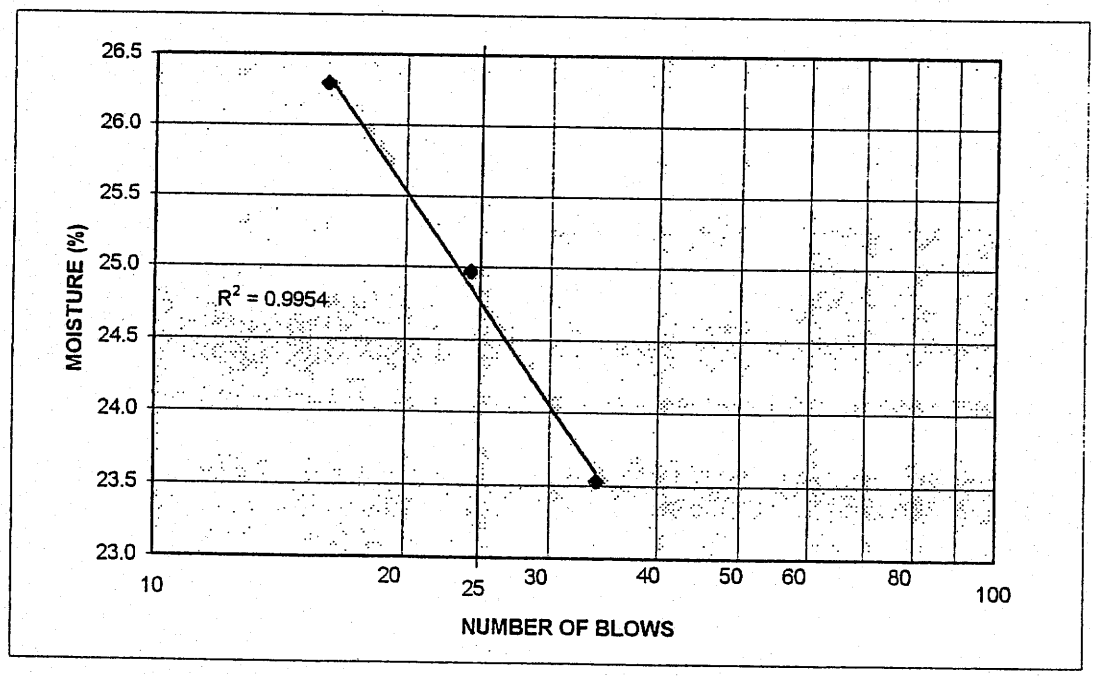
JOB NAME: **MONTGOMERY WATSON/LABTEST/C** DEPTH:
JOB NUMBER: **953-2903** SAMPLE NUMBER: **PWB10**

PLASTIC LIMIT

Tare	E5	F8
Weight Moist Soil & Tare, g	23.97	21.74
Weight Dry Soil & Tare, g	22.32	20.40
Weight Tare, g	14.20	13.75
Weight Moisture, g	1.65	1.34
Weight Dry Soil, g	8.12	6.65
Moisture, %	**20.3**	**20.2**

LIQUID LIMIT

Tare	D6	H6	G8
Weight Moist Soil & Tare, g	25.63	24.60	25.47
Weight Dry Soil & Tare, g	23.43	22.52	23.11
Weight Tare, g	14.08	14.19	14.14
Weight Moisture, g	2.20	2.08	2.359
Weight Dry Soil, g	9.35	8.33	8.971
Moisture, %	23.5	25.0	26.3
Number of Blows	34	24	16

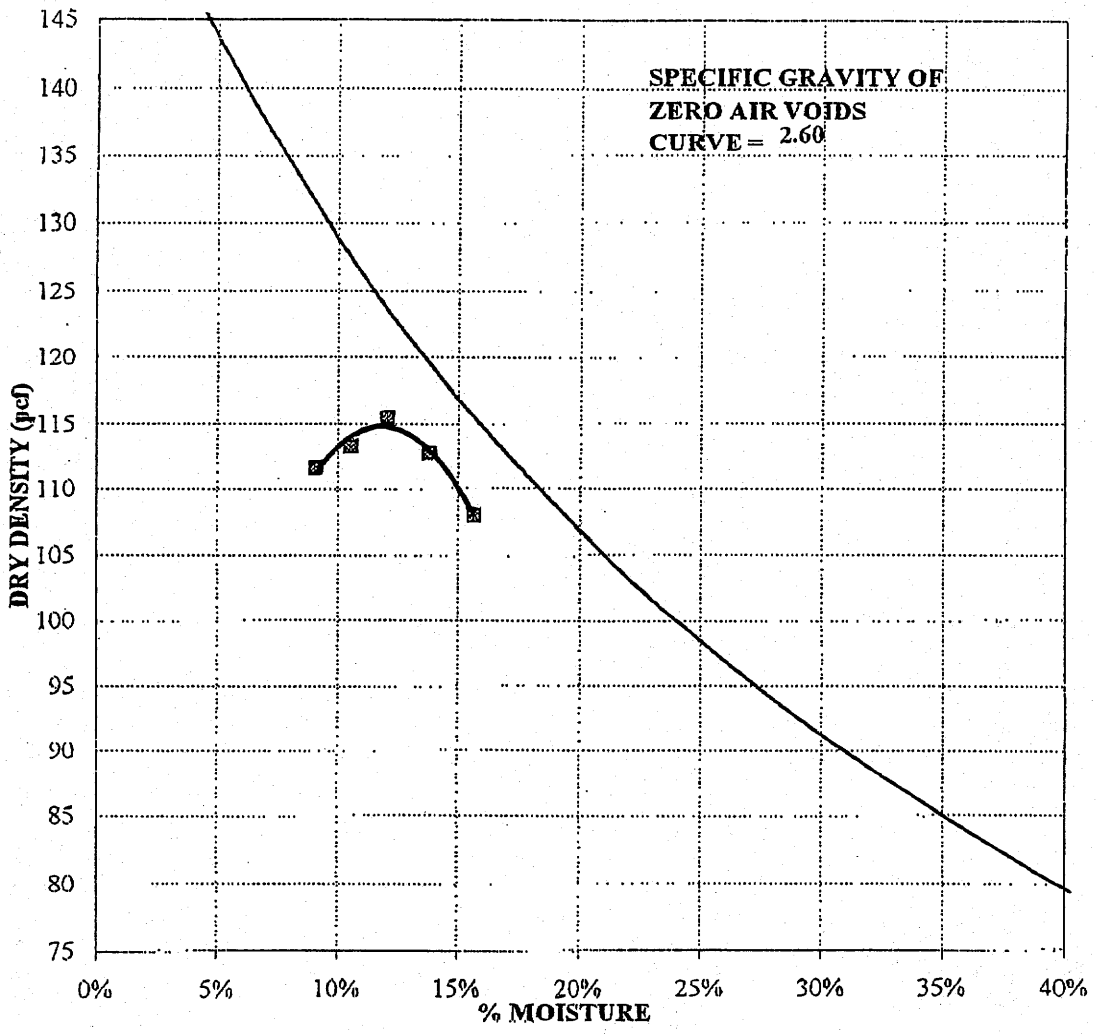


LIQUID LIMIT: 25
PLASTIC LIMIT: 20
PLASTICITY INDEX: 5

DATE: 22-Nov-99
TECH: CW
REVIEW: DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

MOISTURE-DENSITY CURVE
ASTM D 698, METHOD A



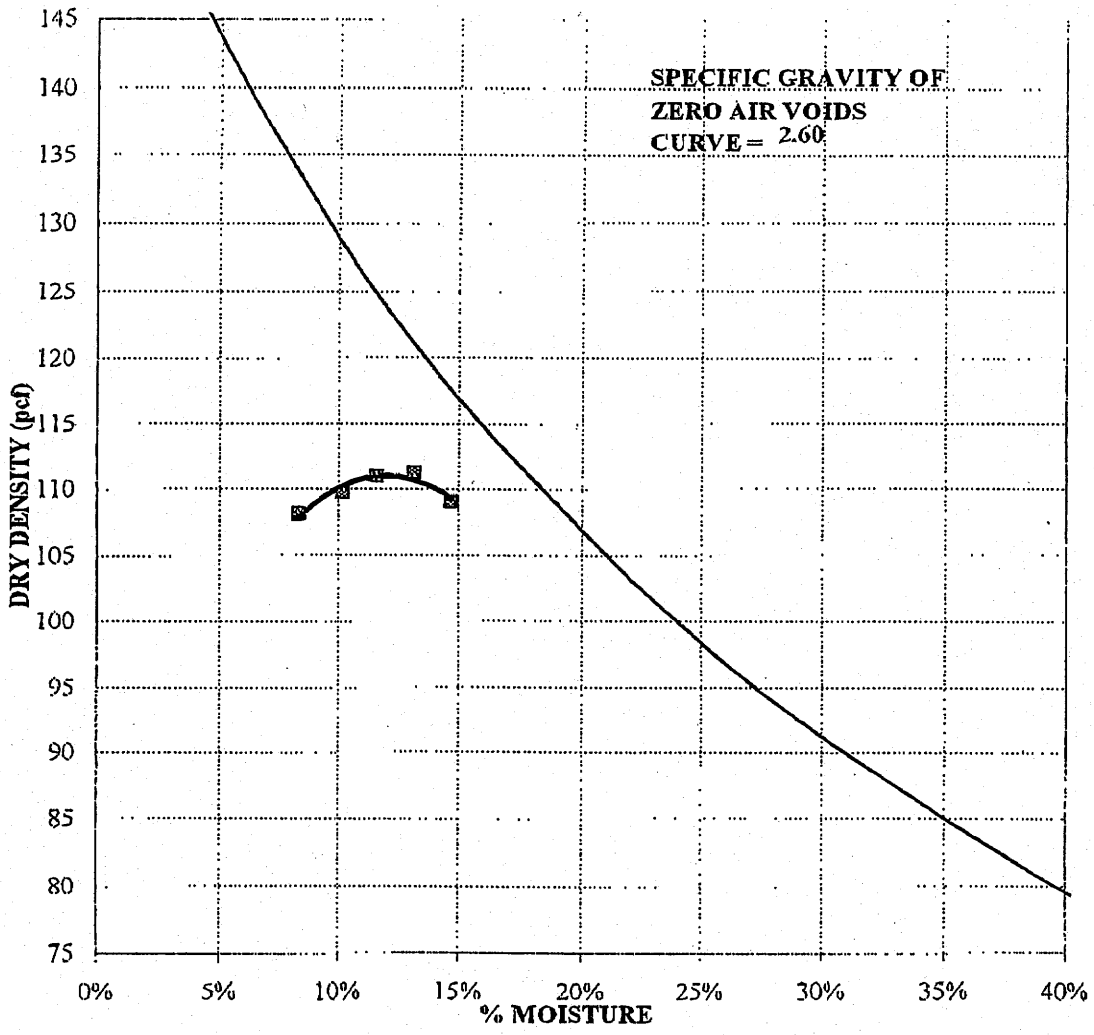
SAMPLE #:	TP6:200	MAXIMUM DRY DENSITY (pcf):	115.4
		OPTIMUM MOISTURE (%):	12.1
DESCRIPTION:	Fine to coarse SAND and silt (SM)	DELIVERED MOISTURE (%):	3.3
		LL: NP	
		PL: NP	
		PI: NP	
		DATE:	11/12/99
		TECH:	DMD
		REVIEW:	DMD

TERRAMATRIX/LAB TESTING/CO
953-2903

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

MOISTURE-DENSITY CURVE

ASTM D 698, METHOD A

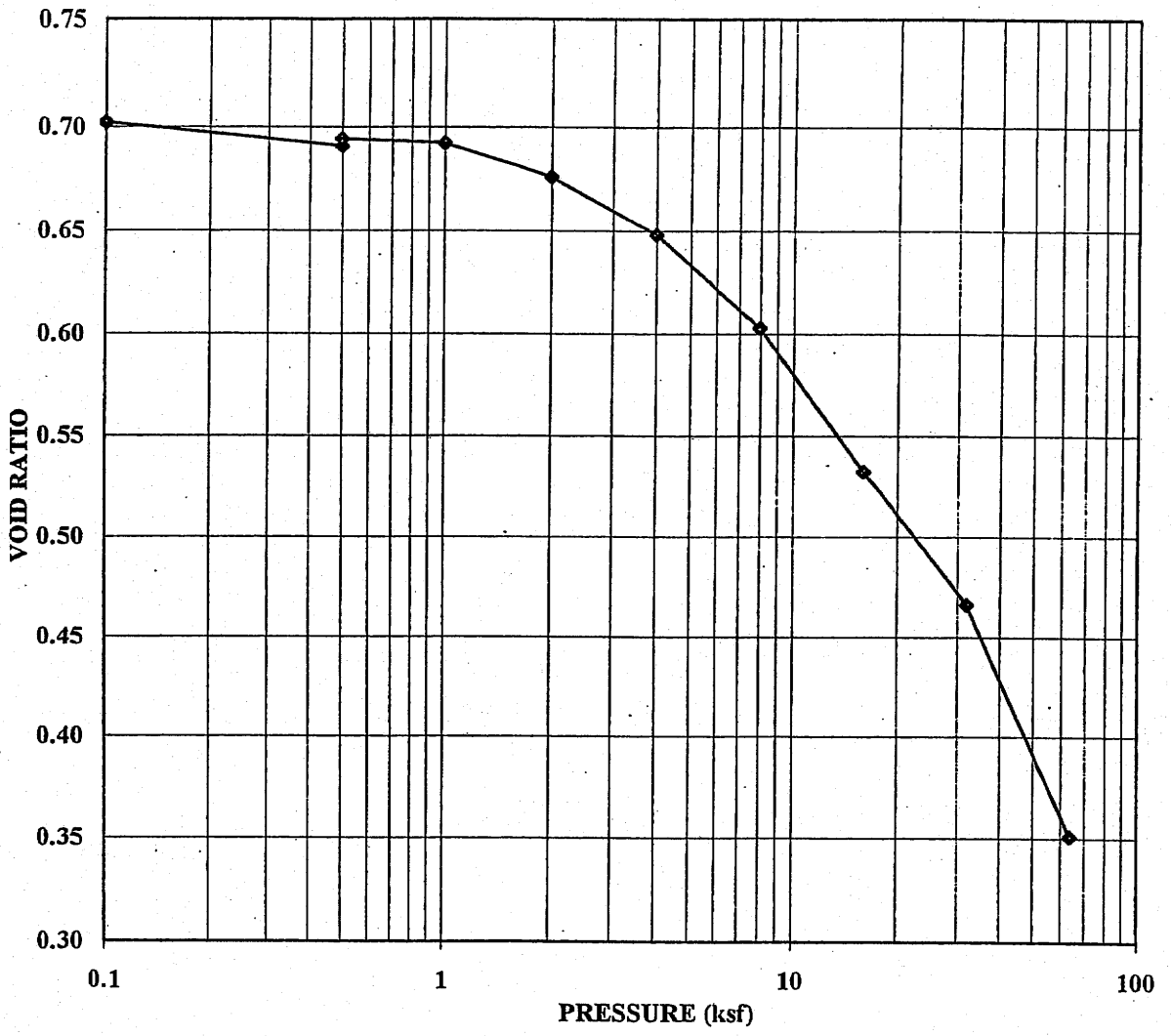


SAMPLE #:	TP5:280	MAXIMUM DRY DENSITY (pcf):	111.2
		OPTIMUM MOISTURE (%):	13.2
DESCRIPTION:	Fine to coarse SAND with some silt, trace fine gravel (SM)	DELIVERED MOISTURE (%):	3.3
		LL: NP	
		PL: NP	
		PI: NP	
		DATE:	11/12/99
		TECH:	DMD
		REVIEW:	DMD

TERRAMATRIX/LAB TESTING/CO
953-2903

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

ONE-DIMENSIONAL CONSOLIDATION



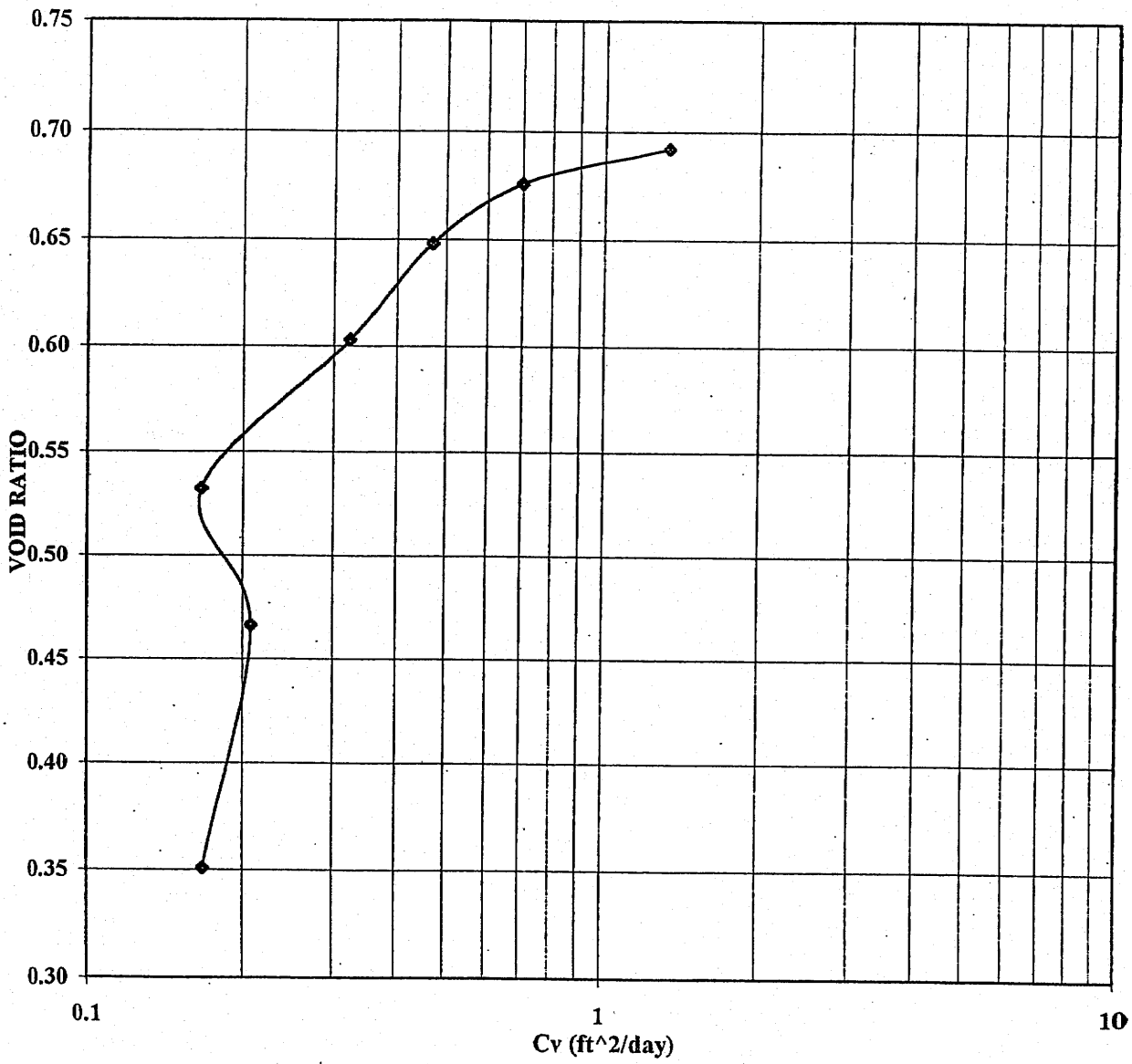
SAMPLE #:	PW-B1 22 ft
DESCRIPTION:	CLAY

TERRAMATRIX/LABTESTING/CO
953-2903

DATE	11/23/99
TECH	CW
REVIEW	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

ONE-DIMENSIONAL CONSOLIDATION



SAMPLE #:	PW-B1 22 ft
DESCRIPTION:	CLAY

TERRAMATRIX/LABTESTING/CO
953-2903

DATE	11/23/99
TECH	CW
REVIEW	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

ONE-DIMENSIONAL CONSOLIDATION

ASTM D 2435

TERRAMATRIX/LABTESTING/CO 953-2903	SAMPLE:	PW-B1 22 ft	DATE 11/23/99 TECH CW REVIEW DMD

SAMPLE DATA, GENERAL

height (in)	0.9900
diameter (in)	2.494
area (in^2)	4.884
volume (in^3)	4.836
specimen weight,wet (g)	156.99
specimen weight,dry (g)	125.73
water weight (g)	31.26

SAMPLE DATA, INITIAL

total height (in)	0.990
height of solids (in)	0.581
height of voids (in)	0.409
void ratio	0.703
dry density (pcf)	98.83
moist density (pcf)	123.68

SAMPLE DATA, FINAL

total height (in)	0.7733
height of solids (in)	0.581
height of voids (in)	0.192
void ratio	0.330
dry density (pcf)	126.80
moist density (pcf)	149.45

DESCRIPTION

CLAY

LL:	29
PL:	15
PI:	14
Gs:	2.70

MOISTURE CONTENT, INITIAL

tare #	X-33
wt soil&tare,moist	133.13
wt soil&tare,dry	113.25
wt tare	33.30
wt moisture	19.88
wt dry soil	79.95
% moisture	24.87%

MOISTURE CONTENT, FINAL

tare #	X-28
wt soil&tare,moist	172.69
wt soil&tare,dry	151.61
wt tare	33.56
wt moisture	21.08
wt dry soil	118.05
% moisture	17.86%

PRESSURE (ksf)	h100 Sample Height	D50 Sample Height	t50 TIME (min)	Sample Density (pcf)	VOID RATIO e	DRAINAGE PATH (DOUBLE DRAINAGE) H (in)	DRAINAGE PATH (DOUBLE DRAINAGE) H (cm)	DRAINAGE PATH (DOUBLE DRAINAGE) H^2 (in^2)	DRAINAGE PATH (DOUBLE DRAINAGE) H^2 (cm^2)	COEFFICIENT OF CONSOLIDATION Cv (cm^2/sec)	COEFFICIENT OF CONSOLIDATION (ft^2/day)	Cc
0.100	0.9884	-	-	99.0	0.702	-	-	-	-	-	-	
0.500	0.9819	-	-	99.6	0.691	-	-	-	-	-	-	
0.500	0.9840	-	-	99.4	0.694	-	-	-	-	-	-	
1.0	0.9827	0.9832	0.360	99.6	0.692	0.4916	1.2487	0.2417	1.5592	1.42E-02	1.33E+00	0.007
2.0	0.9730	0.9758	0.670	100.6	0.675	0.4879	1.2393	0.2380	1.5358	7.53E-03	7.02E-01	0.056
4.0	0.9571	0.9621	0.970	102.2	0.648	0.4811	1.2219	0.2314	1.4930	5.05E-03	4.72E-01	0.090
8.0	0.9309	0.9406	1.350	105.1	0.603	0.4703	1.1946	0.2212	1.4270	3.47E-03	3.24E-01	0.149
16.0	0.8899	0.9057	2.425	109.9	0.532	0.4529	1.1502	0.2051	1.3230	1.79E-03	1.67E-01	0.236
32.0	0.8516	0.8664	1.780	114.9	0.466	0.4332	1.1003	0.1877	1.2107	2.23E-03	2.08E-01	0.219
64.0	0.7845	0.8142	1.945	124.7	0.351	0.4071	1.0340	0.1657	1.0692	1.80E-03	1.68E-01	0.382

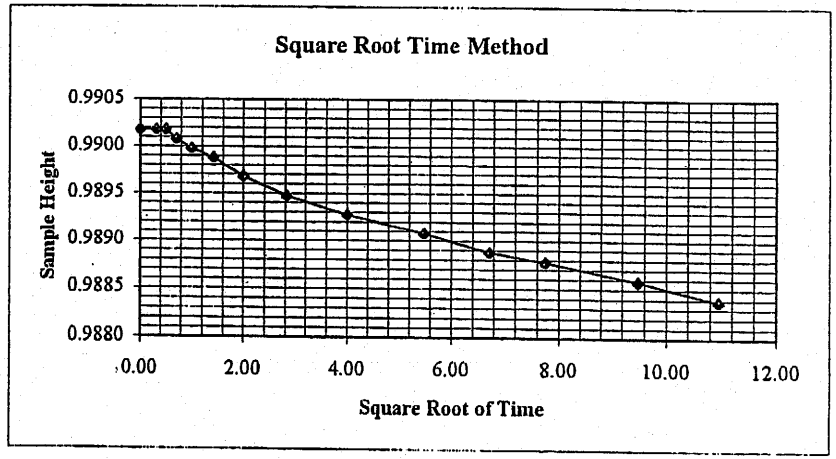
GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

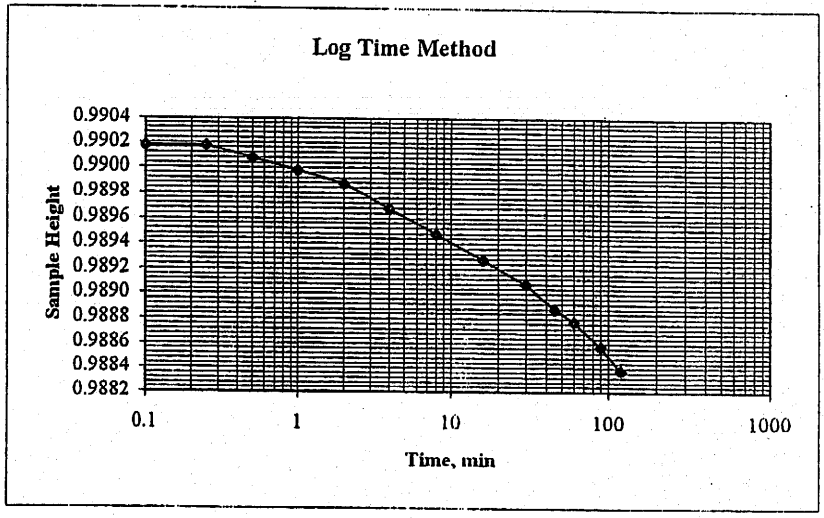
.1 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number = 3
Stress = 0.1 ksf
Load = 95 g
Condition: dry
Initial Sample Height = 0.9900

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/4/99 9:45	0	0.00	0.1027	0.9900	0.9902
	0.1	0.32	0.1027	0.9900	0.9902
	0.25	0.50	0.1027	0.9900	0.9902
	0.5	0.71	0.1028	0.9899	0.9901
	1	1.00	0.1029	0.9898	0.9900
	2	1.41	0.1030	0.9897	0.9899
	4	2.00	0.1032	0.9895	0.9897
	8	2.83	0.1034	0.9893	0.9895
	16	4.00	0.1036	0.9891	0.9893
	30	5.48	0.1038	0.9889	0.9891
	45	6.71	0.1040	0.9887	0.9889
	60	7.75	0.1041	0.9886	0.9888
	90	9.49	0.1043	0.9884	0.9886
	120	10.95	0.1045	0.9882	0.9884



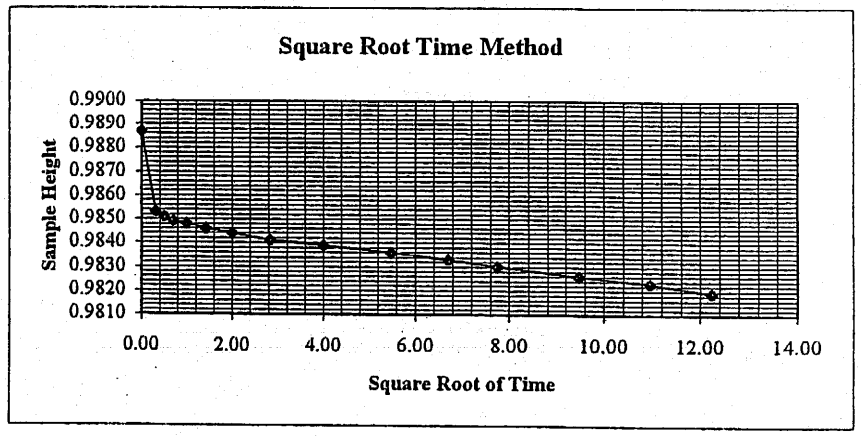


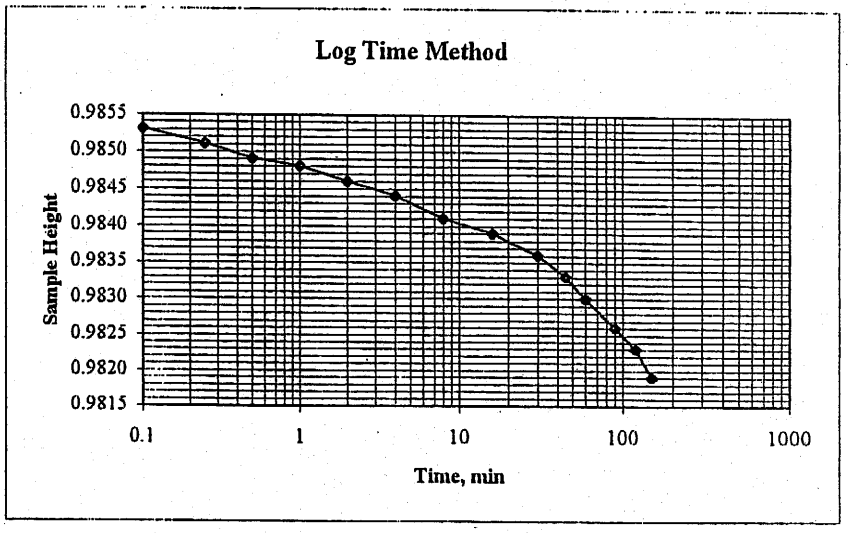
.5 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number =	3	
Stress =	0.5	ksf
Load =	656	g
Condition:	dry	
Initial Sample Height =	0.9884	

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/4/99 11:50	0	0.00	0.1045	0.9884	0.9887
	0.1	0.32	0.1079	0.9850	0.9853
	0.25	0.50	0.1081	0.9848	0.9851
	0.5	0.71	0.1083	0.9846	0.9849
	1	1.00	0.1084	0.9845	0.9848
	2	1.41	0.1086	0.9843	0.9846
	4	2.00	0.1088	0.9841	0.9844
	8	2.83	0.1091	0.9838	0.9841
	16	4.00	0.1093	0.9836	0.9839
	30	5.48	0.1096	0.9833	0.9836
	45	6.71	0.1099	0.9830	0.9833
	60	7.75	0.1102	0.9827	0.9830
	90	9.49	0.1106	0.9823	0.9826
	120	10.95	0.1109	0.9820	0.9823
	150	12.25	0.1113	0.9816	0.9819



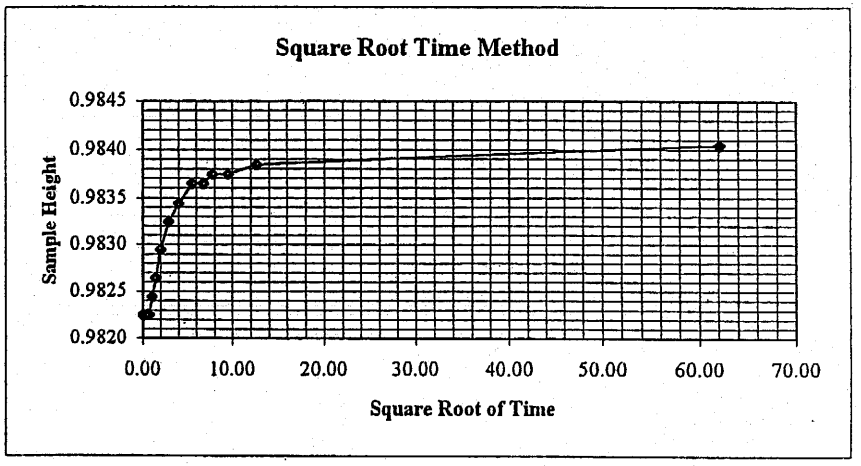


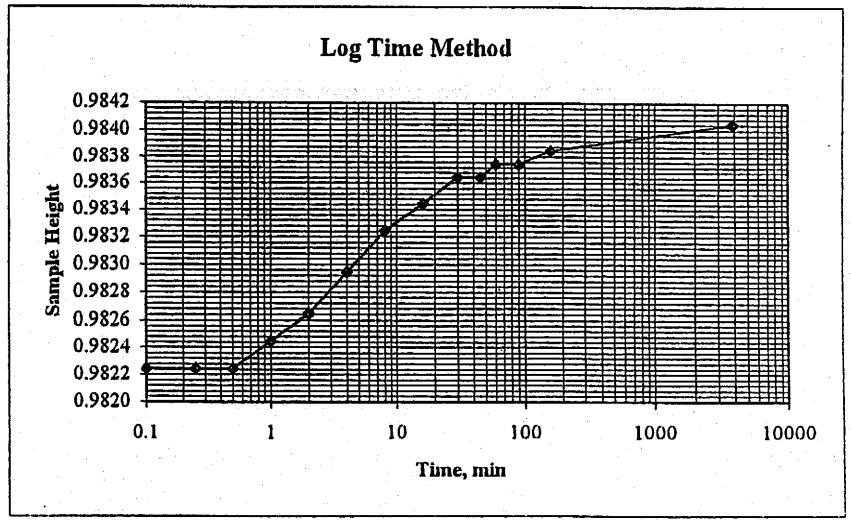
.5 wet ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number =	3	
Stress =	0.5	ksf
Load =	656	g
Condition:	wet	
Initial Sample Height =	0.9819	

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/4/99 14:20	0	0.00	0.1113	0.9819	0.9822
	0.1	0.32	0.1113	0.9819	0.9822
	0.25	0.50	0.1113	0.9819	0.9822
	0.5	0.71	0.1113	0.9819	0.9822
	1	1.00	0.1111	0.9821	0.9824
	2	1.41	0.1109	0.9823	0.9826
	4	2.00	0.1106	0.9826	0.9829
	8	2.83	0.1103	0.9829	0.9832
	16	4.00	0.1101	0.9831	0.9834
	30	5.48	0.1099	0.9833	0.9836
	45	6.71	0.1099	0.9833	0.9836
	60	7.75	0.1098	0.9834	0.9837
	90	9.49	0.1098	0.9834	0.9837
	160	12.65	0.1097	0.9835	0.9838
11/8/99 8:15	3855	62.09	0.1095	0.9837	0.9840



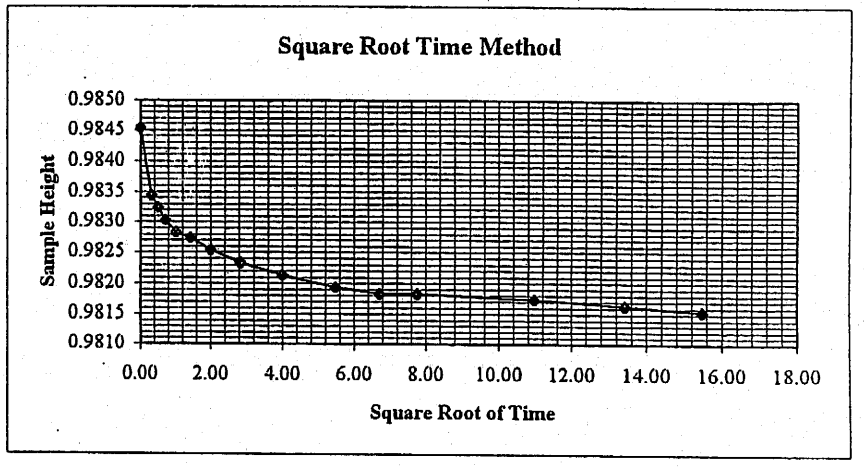


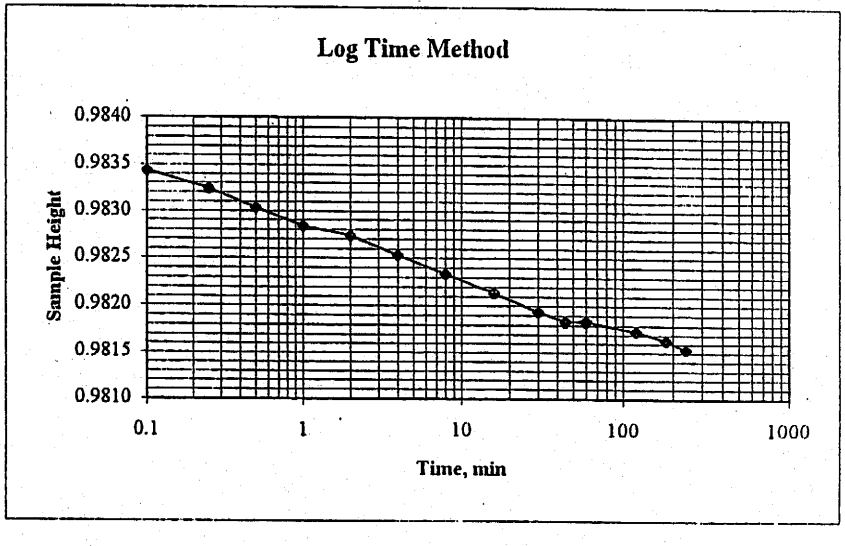
1 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number =	3	
Stress =	1	ksf
Load =	1356	g
Condition:	wet	
Initial Sample Height =	0.9840	

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/8/99 8:15	0	0.00	0.1095	0.9840	0.9845
	0.1	0.32	0.1106	0.9829	0.9834
	0.25	0.50	0.1108	0.9827	0.9832
	0.5	0.71	0.1110	0.9825	0.9830
	1	1.00	0.1112	0.9823	0.9828
	2	1.41	0.1113	0.9822	0.9827
	4	2.00	0.1115	0.9820	0.9825
	8	2.83	0.1117	0.9818	0.9823
	16	4.00	0.1119	0.9816	0.9821
	30	5.48	0.1121	0.9814	0.9819
	45	6.71	0.1122	0.9813	0.9818
	60	7.75	0.1122	0.9813	0.9818
	120	10.95	0.1123	0.9812	0.9817
	180	13.42	0.1124	0.9811	0.9816
	240	15.49	0.1125	0.9810	0.9815



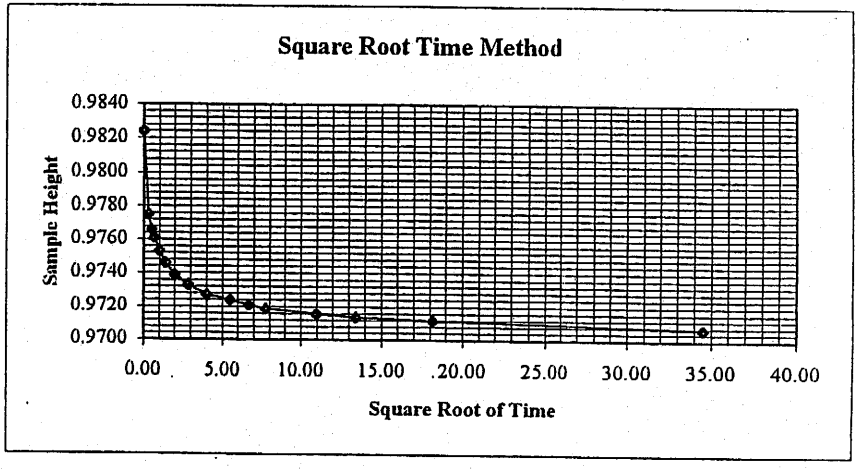


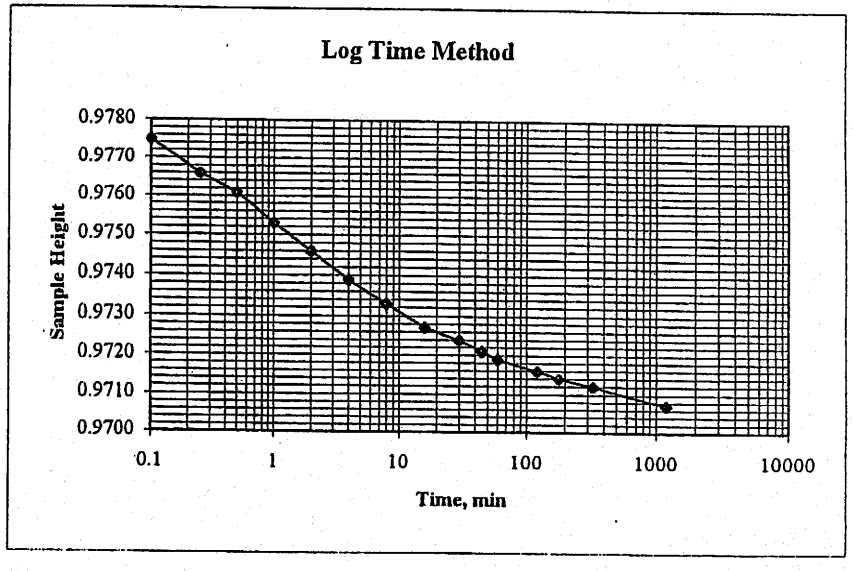
2 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number =	3	
Stress =	2	ksf
Load =	2757	g
Condition:	wet	
Initial Sample Height =	0.9815	

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/8/99 12:20	0	0.00	0.1125	0.9815	0.9824
	0.1	0.32	0.1174	0.9766	0.9775
	0.25	0.50	0.1183	0.9757	0.9766
	0.5	0.71	0.1188	0.9752	0.9761
	1	1.00	0.1196	0.9744	0.9753
	2	1.41	0.1203	0.9737	0.9746
	4	2.00	0.1210	0.9730	0.9739
	8	2.83	0.1216	0.9724	0.9733
	16	4.00	0.1222	0.9718	0.9727
	30	5.48	0.1225	0.9715	0.9724
	45	6.71	0.1228	0.9712	0.9721
	60	7.75	0.1230	0.9710	0.9719
	120	10.95	0.1233	0.9707	0.9716
	180	13.42	0.1235	0.9705	0.9714
	330	18.17	0.1237	0.9703	0.9712
11/9/99 8:10	1190	34.50	0.1242	0.9698	0.9707



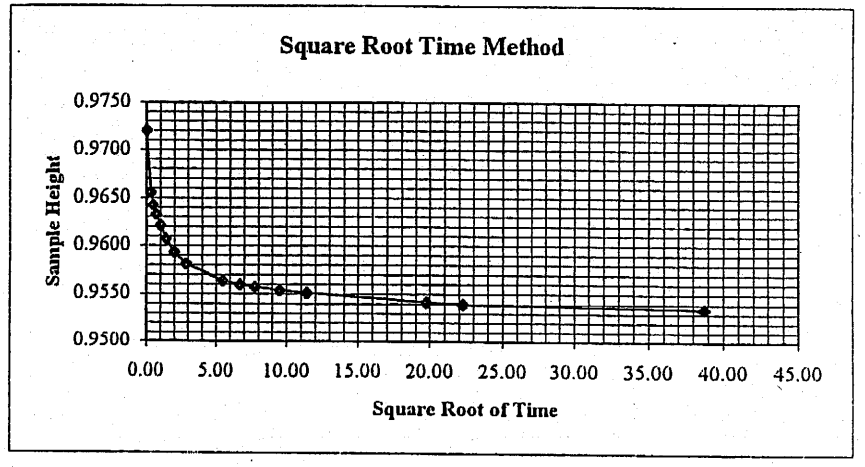


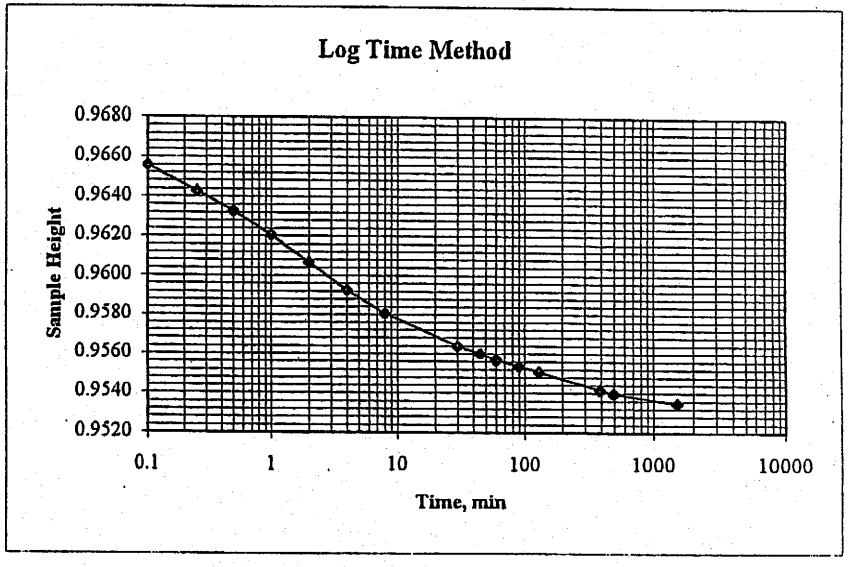
4 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number =	3	
Stress =	4	ksf
Load =	5559	g
Condition:	wet	
Initial Sample Height =	0.9707	

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/9/99 8:30	0	0.00	0.1242	0.9707	0.9721
	0.1	0.32	0.1307	0.9642	0.9656
	0.25	0.50	0.1320	0.9629	0.9643
	0.5	0.71	0.1330	0.9619	0.9633
	1	1.00	0.1342	0.9607	0.9621
	2	1.41	0.1356	0.9593	0.9607
	4	2.00	0.1370	0.9579	0.9593
	8	2.83	0.1382	0.9567	0.9581
	30	5.48	0.1399	0.9550	0.9564
	45	6.71	0.1403	0.9546	0.9560
	60	7.75	0.1406	0.9543	0.9557
	90	9.49	0.1409	0.9540	0.9554
	130	11.40	0.1412	0.9537	0.9551
	390	19.75	0.1421	0.9528	0.9542
	495	22.25	0.1423	0.9526	0.9540
11/10/99 9:30	1500	38.73	0.1428	0.9521	0.9535



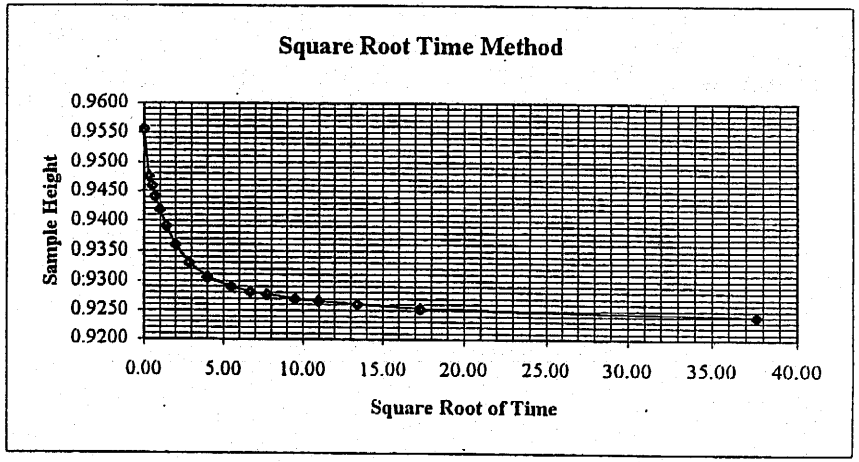


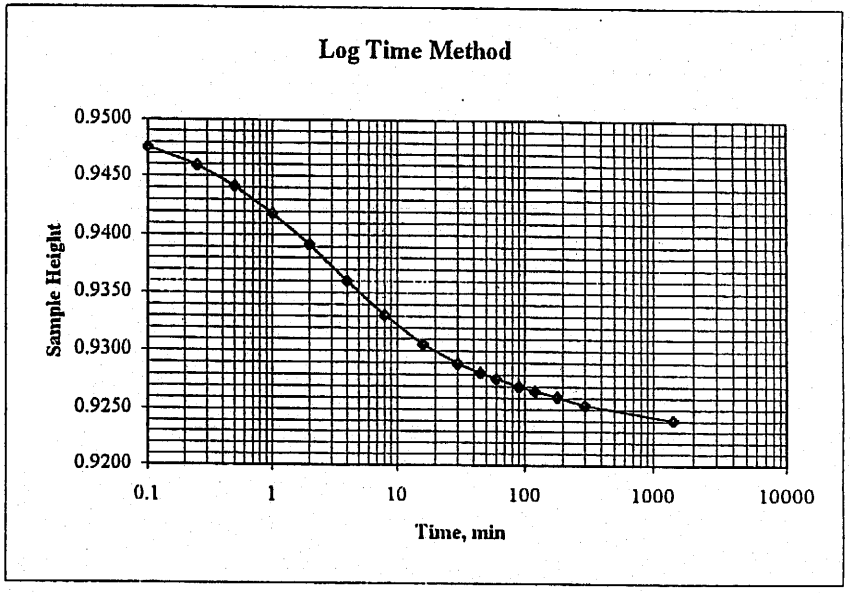
8 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number = 3
Stress = 8 ksf
Load = 11164 g
Condition: wet
Initial Sample Height = 0.9535

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/10/99 9:55	0	0.00	0.1428	0.9535	0.9556
	0.1	0.32	0.1508	0.9455	0.9476
	0.25	0.50	0.1524	0.9439	0.9460
	0.5	0.71	0.1542	0.9421	0.9442
	1	1.00	0.1565	0.9398	0.9419
	2	1.41	0.1592	0.9371	0.9392
	4	2.00	0.1623	0.9340	0.9361
	8	2.83	0.1653	0.9310	0.9331
	16	4.00	0.1678	0.9285	0.9306
	30	5.48	0.1694	0.9269	0.9290
	45	6.71	0.1702	0.9261	0.9282
	60	7.75	0.1707	0.9256	0.9277
	90	9.49	0.1714	0.9249	0.9270
	120	10.95	0.1718	0.9245	0.9266
	180	13.42	0.1723	0.9240	0.9261
	300	17.32	0.1730	0.9233	0.9254
11/11/99 9:30	1415	37.62	0.1743	0.9220	0.9241



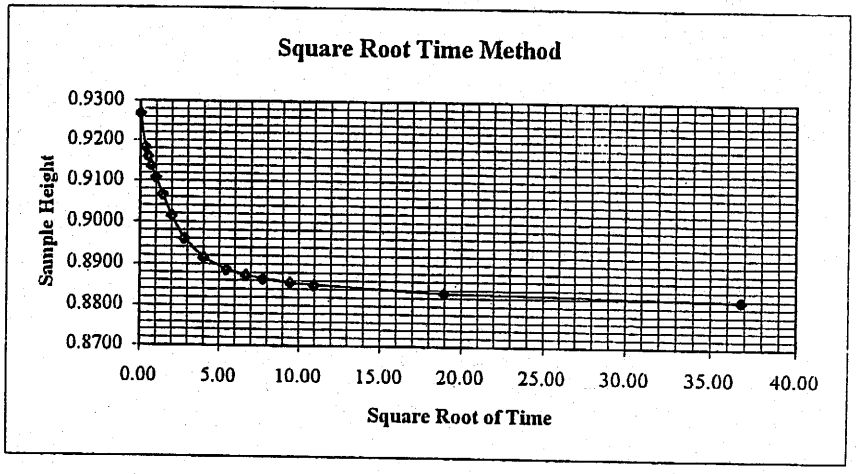


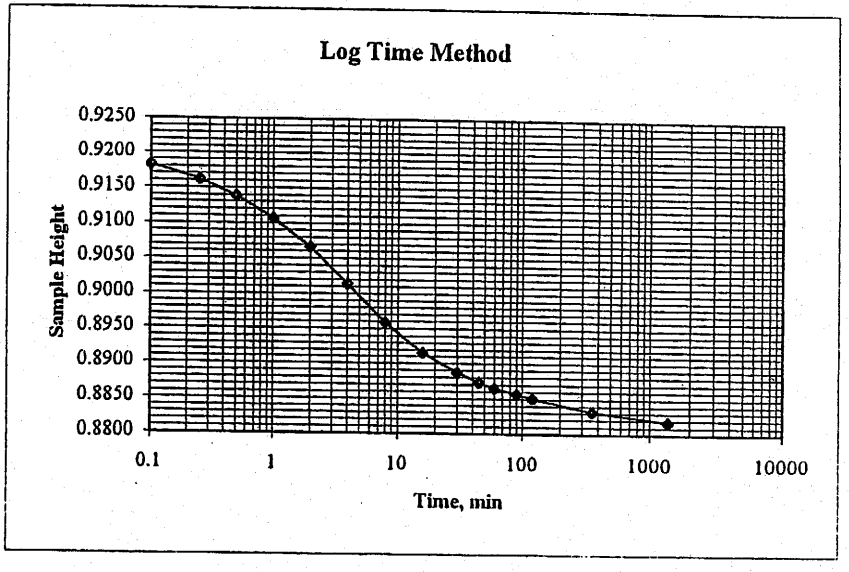
16 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number =	3	
Stress =	16	ksf
Load =	22372	g
Condition:	wet	
Initial Sample Height =	0.9241	

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/11/99 9:40	0	0.00	0.1743	0.9241	0.9269
	0.1	0.32	0.1829	0.9155	0.9183
	0.25	0.50	0.1850	0.9134	0.9162
	0.5	0.71	0.1873	0.9111	0.9139
	1	1.00	0.1904	0.9080	0.9108
	2	1.41	0.1945	0.9039	0.9067
	4	2.00	0.1997	0.8987	0.9015
	8	2.83	0.2052	0.8932	0.8960
	16	4.00	0.2096	0.8888	0.8916
	30	5.48	0.2124	0.8860	0.8888
	45	6.71	0.2138	0.8846	0.8874
	60	7.75	0.2146	0.8838	0.8866
	90	9.49	0.2155	0.8829	0.8857
	120	10.95	0.2161	0.8823	0.8851
	360	18.97	0.2179	0.8805	0.8833
11/12/99 8:15	1355	36.81	0.2193	0.8791	0.8819



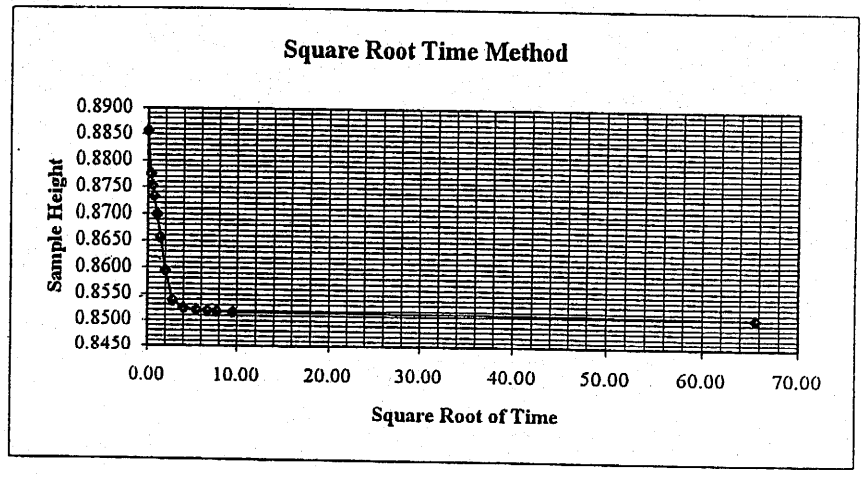


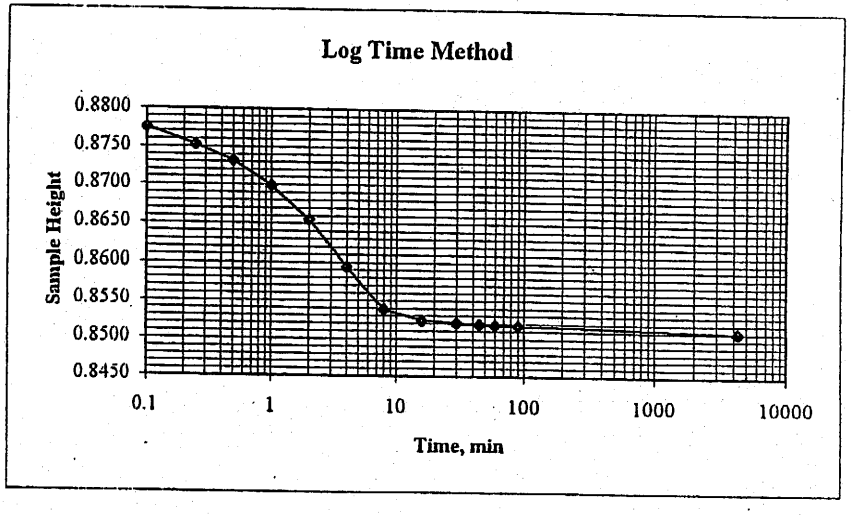
32 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number =	3	
Stress =	32	ksf
Load =	44789	g
Condition:	wet	
Initial Sample Height =	0.8819	

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/12/99 8:20	0	0.00	0.2193	0.8819	0.8858
	0.1	0.32	0.2275	0.8737	0.8776
	0.25	0.50	0.2297	0.8715	0.8754
	0.5	0.71	0.2318	0.8694	0.8733
	1	1.00	0.2351	0.8661	0.8700
	2	1.41	0.2395	0.8617	0.8656
	4	2.00	0.2456	0.8556	0.8595
	8	2.83	0.2512	0.8500	0.8539
	16	4.00	0.2526	0.8486	0.8525
	30	5.48	0.2530	0.8482	0.8521
	45	6.71	0.2531	0.8481	0.8520
	60	7.75	0.2532	0.8480	0.8519
	90	9.49	0.2533	0.8479	0.8518
11/15/99 8:00	4300	65.57	0.2540	0.8472	0.8511



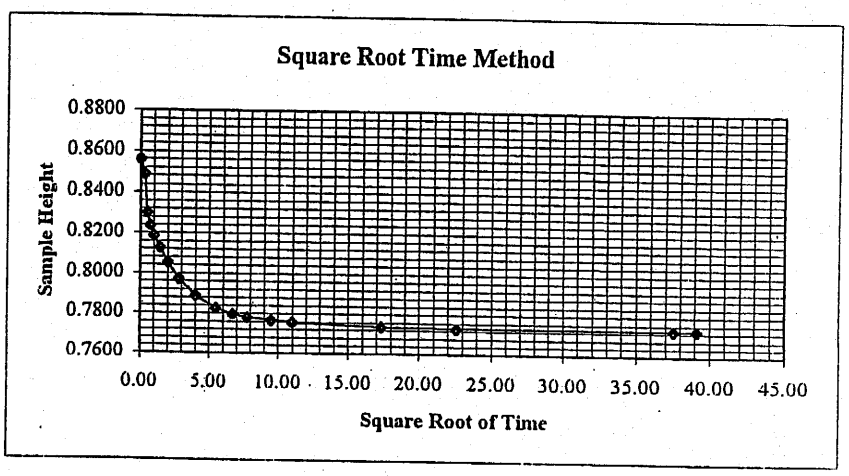


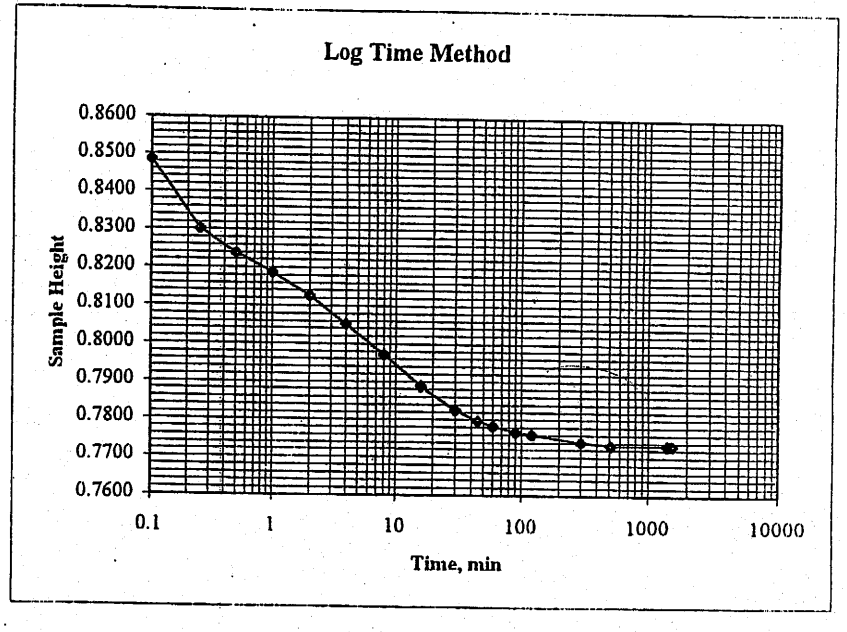
64 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number = 3
Stress = 64 ksf
Load = 89623 g
Condition: wet
Initial Sample Height = 0.8511

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/15/99 9:00	0	0.00	0.2540	0.8511	0.8561
	0.1	0.32	0.2615	0.8436	0.8486
	0.25	0.50	0.2798	0.8253	0.8303
	0.5	0.71	0.2863	0.8188	0.8238
	1	1.00	0.2913	0.8138	0.8188
	2	1.41	0.2974	0.8077	0.8127
	4	2.00	0.3049	0.8002	0.8052
	8	2.83	0.3128	0.7923	0.7973
	16	4.00	0.3212	0.7839	0.7889
	30	5.48	0.3275	0.7776	0.7826
	45	6.71	0.3303	0.7748	0.7798
	60	7.75	0.3318	0.7733	0.7783
	90	9.49	0.3333	0.7718	0.7768
	120	10.95	0.3340	0.7711	0.7761
	300	17.32	0.3359	0.7692	0.7742
	510	22.58	0.3368	0.7683	0.7733
11/16/99 8:30	1410	37.55	0.3368	0.7683	0.7733
	1530	39.12	0.3368	0.7683	0.7733

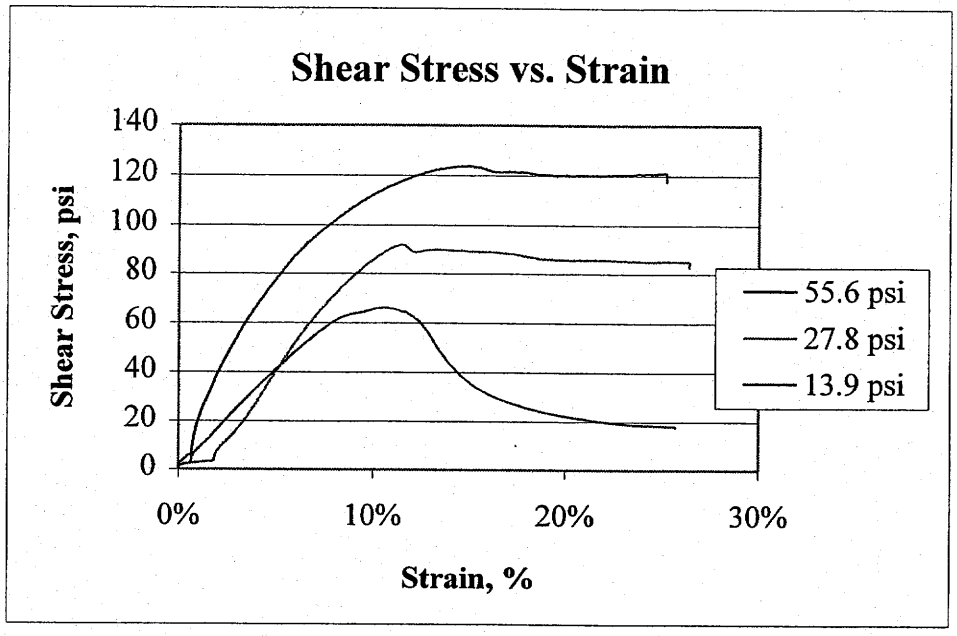


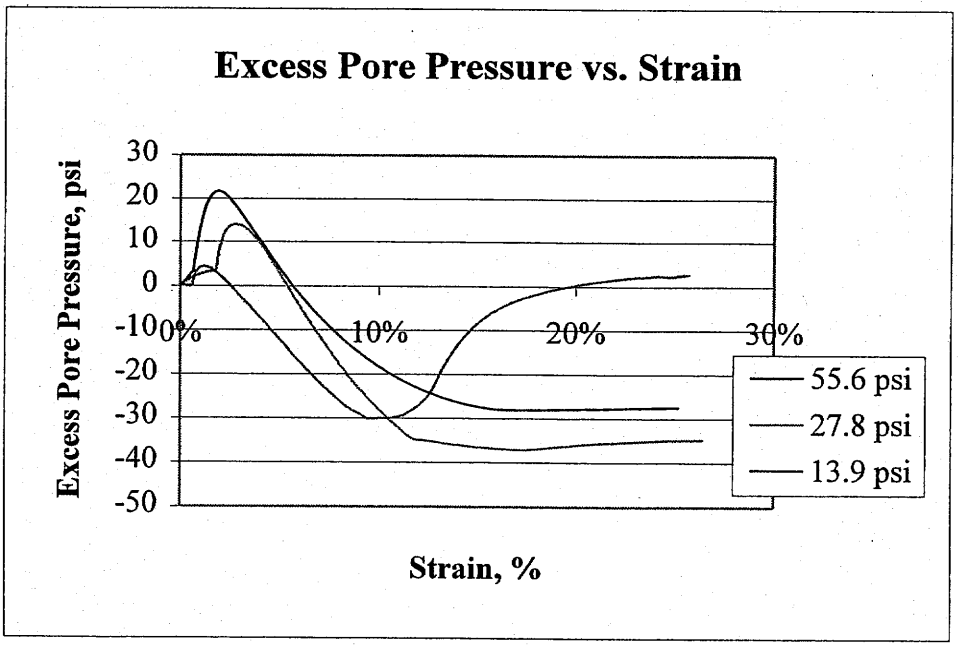


Sample # =	TP6-200		Sample # =	TP6-200		Sample # =	TP6-200	
Point # =	A		Point # =	B		Point # =	C	
	Initial			**Initial**			**Initial**	
Length =	14.73	cm	Length =	14.53	cm	Length =	14.73	cm
Diameter =	7.27	cm	Diameter =	7.30	cm	Diameter =	7.30	cm
Wet Weight =	1195.50	g	Wet Weight =	1196.30	g	Wet Weight =	1197.30	g
Area =	41.5	sq.cm	Area =	41.9	sq.cm	Area =	41.9	sq.cm
Sample Area =	6.43	sq. in.	Sample Area =	6.49	sq. in.	Sample Area =	6.49	sq. in.
Volume =	611.4	cc	Volume =	608.1	cc	Volume =	616.5	cc
Moisture Content =	10.4%		Moisture Content =	10.4%		Moisture Content =	10.4%	
Specific Gravity =	2.7		Specific Gravity =	2.7		Specific Gravity =	2.7	
Dry Weight of Solids =	1082.88	g	Dry Weight of Solids =	1083.61	g	Dry Weight of Solids =	1084.51	g
Wet Density =	1.96	g/cc	Wet Density =	1.97	g/cc	Wet Density =	1.94	g/cc
Dry Density =	1.77	g/cc	Dry Density =	1.78	g/cc	Dry Density =	1.76	g/cc
Wet Density =	122.0	pcf	Wet Density =	122.8	pcf	Wet Density =	121.2	pcf
Dry Density =	110.5	pcf	Dry Density =	111.2	pcf	Dry Density =	109.8	pcf
Cell Pressure =	100	psi	Cell Pressure =	100	psi	Cell Pressure =	100	psi
Back Pressure =	44.4	psi	Back Pressure =	72.2	psi	Back Pressure =	86.1	psi
Confining Pressure =	55.6	psi	Confining Pressure =	27.8	psi	Confining Pressure =	13.9	psi

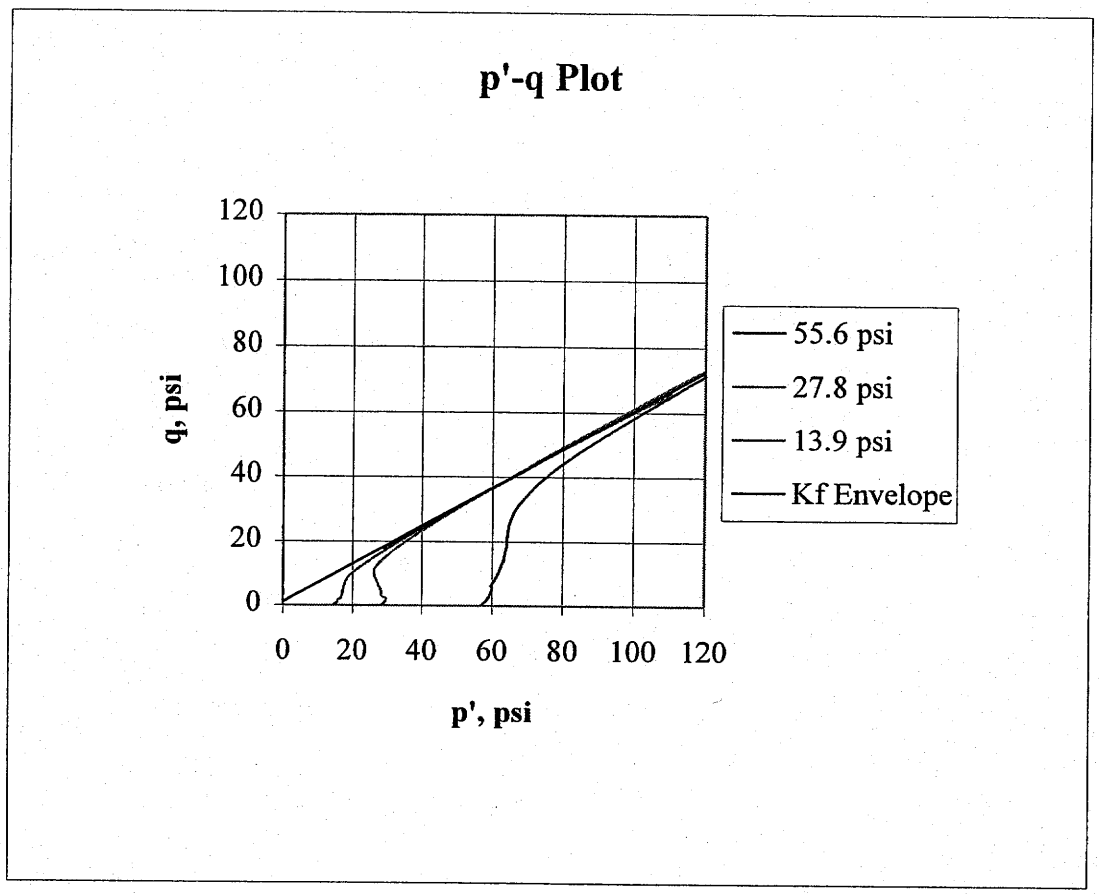
Notes:

Golder Associates, Inc. **Denver, Colorado**			**Title:** **TRIAXIAL SHEAR TEST REPORT** **SAMPLE DATA AND CALCULATIONS**		
Job Short Title: **Terramatrix/Lab Testing/CO**					
Sample No. **TP6-200**	**Depth** **95% Comp**	**Reviewed:**	**Date:** Jan. 2000	**Job Number:** 003-2111	**Figure:** 1





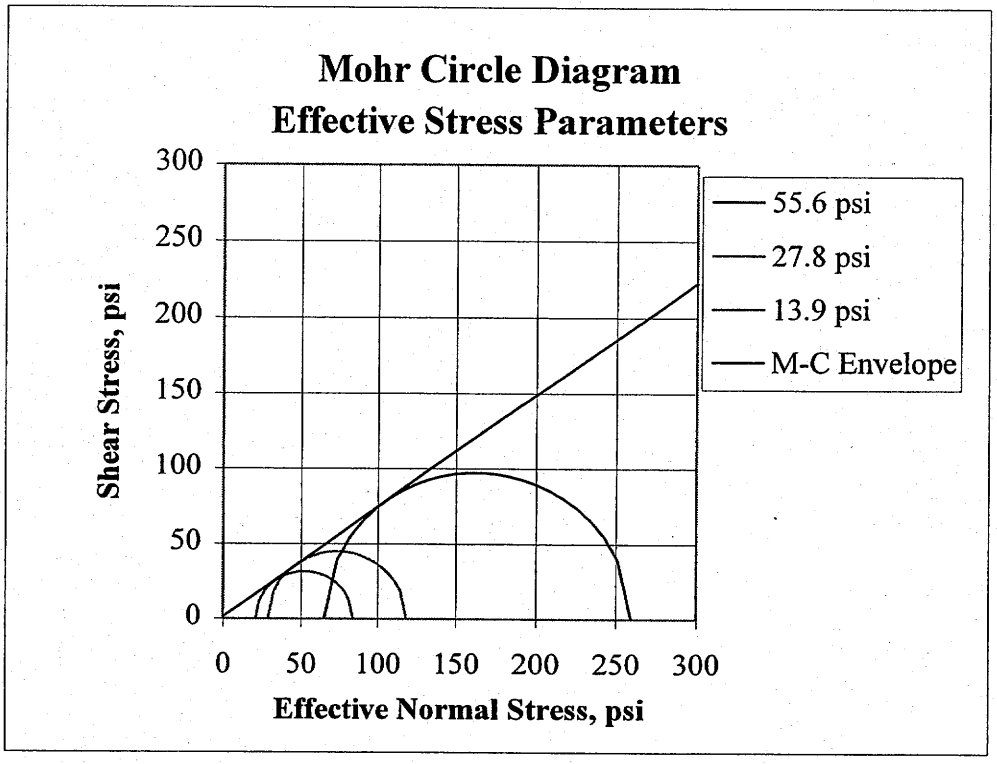
Golder Associates, Inc. **Denver, Colorado**			**Title:** **CU TRIAXIAL SHEAR DATA** **STRESS AND Δ PORE PRESSURE PLOTS**		
Job Short Title: **Terramatrix/Lab Testing/CO**					
Sample No. TP6-200	Depth 95% Comp	Reviewed:	**Date:** Jan. 2000	**Job Number:** 003-2111	**Figure:** 2



Stress Path Parameters

ψ' = 30.7 degrees
a' = 1.0 psi

Golder Associates, Inc. Denver, Colorado			**Title:** CU TRIAXIAL SHEAR DATA STRESS PATH PLOT		
Job Short Title: Terramatrix/Lab Testing/CO					
Sample No. TP6-200	Depth 95% Comp	Reviewed:	**Date:** Jan. 2000	**Job Number:** 003-2111	**Figure:** 3



Mohr-Coulomb Parameters

$\phi' =$ 36.4 degrees
$c' =$ 1.3 psi

Golder Associates, Inc. **Denver, Colorado**			**Title:** **CU TRIAXIAL SHEAR DATA** **MOHR CIRCLE DIAGRAM**		
Job Short Title: **Terramatrix/Lab Testing/CO**					
Sample No. TP6-200	Depth 95% Comp	Reviewed:	**Date:** Jan. 2000	**Job Number:** 003-2111	**Figure:** 4

Triaxial Consolidated Undrained Lab Data

From: GOLDER ASSOCIATES INC.

Project: **Terramatrix/Lab Testing/CO**

Project Number: **003-2111**

Sample Number	TP6-200
Depth	95% Comp
Effective Stress Analysis	

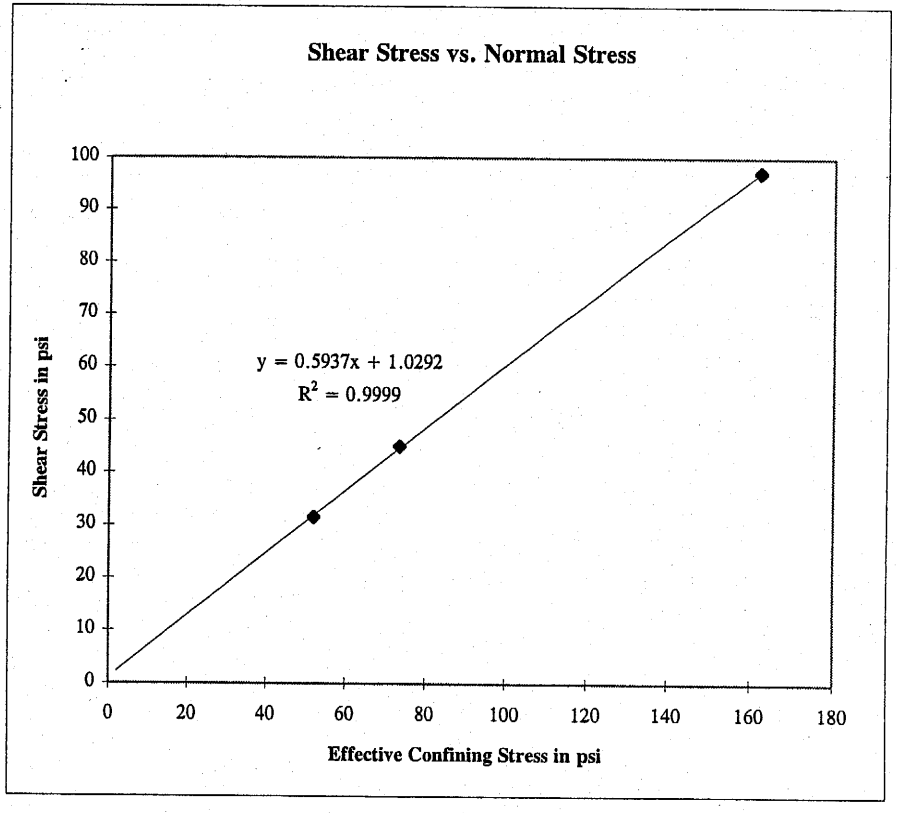
Point Number	P' (psi)	Q (psi)
A	162	97
B	73	45
C	52	32

Slope = 0.5937

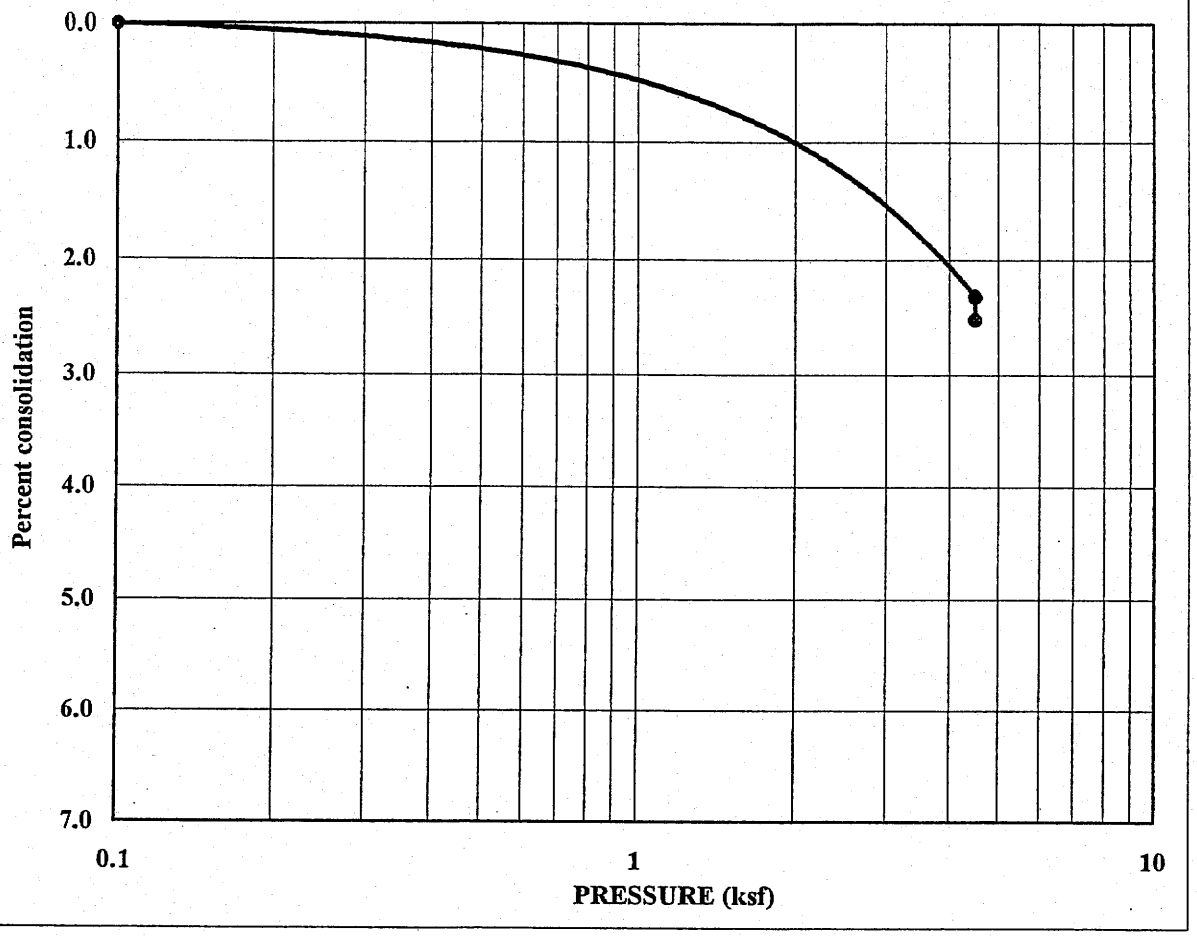
Intercept= 1.0292

ϕ' = 36.4 degrees

c' = 1.3 psi



ONE-DIMENSIONAL SHRINK SWELL



SAMPLE #:	**PW-B13 10'-12'**
DESCRIPTION:	**Sandy clay**

DATE	1/28/00
TECH	CW
REVIEW	DMD

MONTGOMERY WATSON/LAB TESTING/CO
003-2111-1

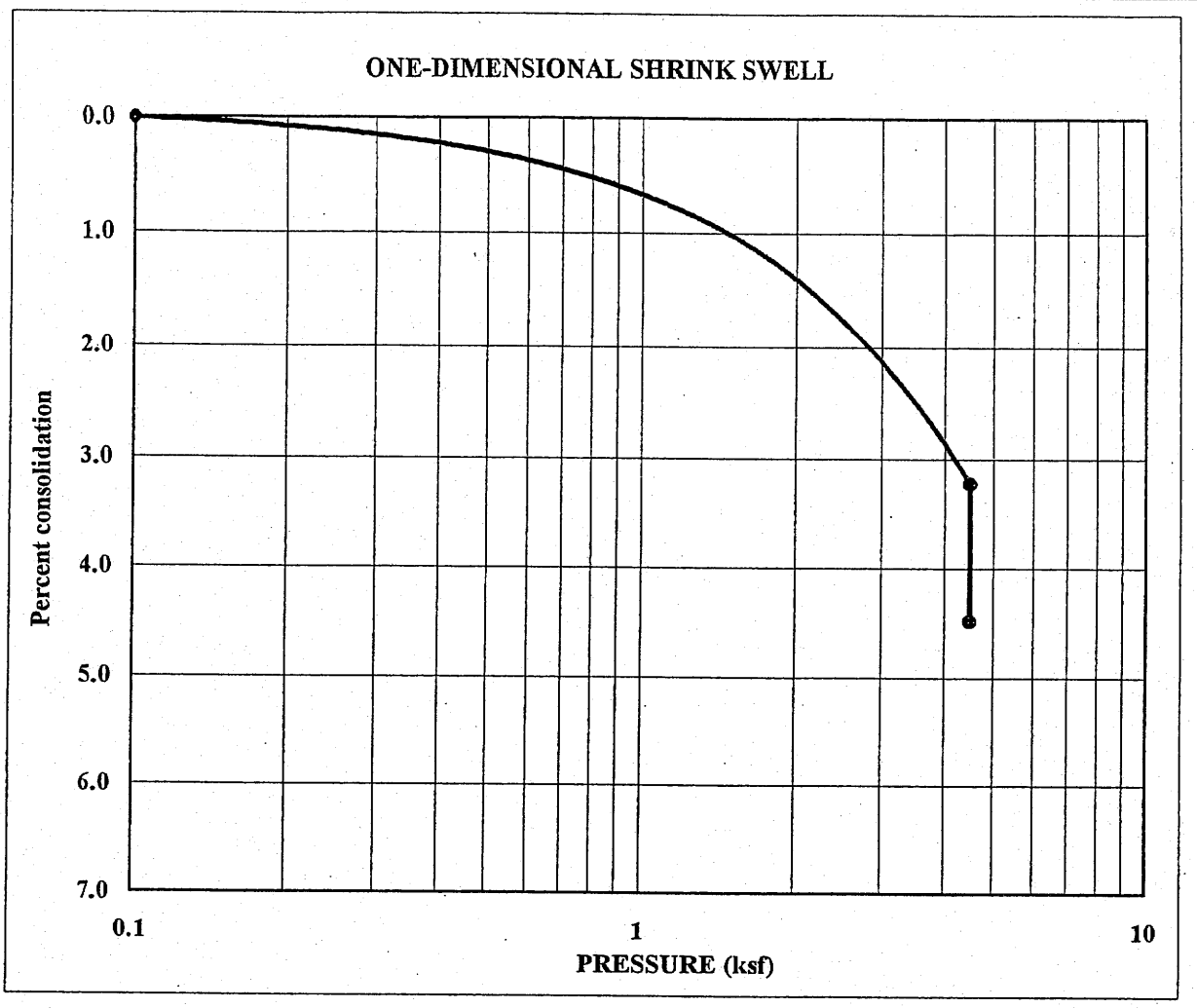
GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

Denver Swell Test Data

003-2111-1
MONTGOMERY WATSON/LAB TESTING/CO
PW-B13
10'-12'

Load (ksf)	Percent Swell/Consolidation	Dial Reading	Load Arm Deflection	Corrected Dial Reading
0.10	0.000	0.08	0.0000	0.0848
4.50	2.320	0.10	0.0015	0.1022
4.50	2.520	0.10	0.0015	0.1037
				0.0000
				0.0000
				0.0000
				0.0000

Moisture Content		Set Up Parameters	
Initial		Console Number =	2
Tare Number	M6	Initial Sample Height (cm)=	1.91
Tare Weight	27.94	Sample Diameter (cm)=	6.35
Wet Weight + Tare	94.89	Sample Mass (wet) =	104.81
Dry Weight + Tare	93.34	Sample Length(in) =	0.75
Dry Weight of Soil	65.40	"0" Dial Reading =	0.08
Moisture Content	2.4	Weight of Dry Soil (g) =	102.38
Final		Sample Volume (cm^3)=	60.49
Tare Number	X12	Unit Dry Weight (lb/ft^3) =	105.67
Tare Weight	33.56		
Wet Weight + Tare	151.31		
Dry Weight + Tare	128.69	Date Tested	1/27/00
Dry Weight of Soil	95.13	Technician	CVV
Moisture Content	23.8	Review	DMD



SAMPLE #:	**PW-B13 10'-12'**
DESCRIPTION:	**Fine to medium silty sand**

MONTGOMERY WATSON/LAB TESTING/CO
003-2111-1

DATE	1/27/00
TECH	CW
REVIEW	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

Denver Swell Test Data

003-2111-1
MONTGOMERY WATSON/LAB TESTING/CO
PW-B13
10'-12'

Load (ksf)	Percent Swell/Consolidation	Dial Reading	Load Arm Deflection	Corrected Dial Reading
0.10	0.000	0.08	0.0000	0.0762
4.50	3.227	0.10	0.0015	0.1004
4.50	4.480	0.11	0.0015	0.1098
				0.0000
				0.0000
				0.0000
				0.0000

Moisture Content	
Initial	
Tare Number	M9
Tare Weight	26.41
Wet Weight + Tare	104.61
Dry Weight + Tare	100.81
Dry Weight of Soil	74.40
Moisture Content	5.1
Final	
Tare Number	X35
Tare Weight	33.05
Wet Weight + Tare	141.19
Dry Weight + Tare	119.71
Dry Weight of Soil	86.66
Moisture Content	24.8

Set Up Parameters	
Console Number =	3
Initial Sample Height (cm)=	1.91
Sample Diameter (cm)=	6.35
Sample Mass (wet) =	95.54
Sample Length(in) =	0.75
"0" Dial Reading =	0.08
Weight of Dry Soil (g) =	90.90
Sample Volume (cm^3)=	60.49
Unit Dry Weight (lb/ft^3) =	93.82
Date Tested	1/27/03
Technician	CVV
Review	DMD

CONSTANT HEAD PERMEABILITY
(RIGID-WALL PERM)

JOB NUMBER: 953-2903
JOB NAME: MONTGOMERY WATSON/LAB TESTING/CO
BORING NUMBER:
SAMPLE NUMBER: TP-6:200
SAMPLE DEPTH:

TECHNICIAN: PLB
REVIEWED BY: DMD
DATE TESTED: 12/7/99

MOISTURE CONTENT (INITIAL)

TARE:	7B
WET WEIGHT & TARE, g:	101.73
DRY WEIGHT & TARE, g:	95.30
TARE WEIGHT, g:	24.65
MOISTURE, %:	9.1

MOISTURE CONTENT (FINAL)

TARE:	22B
WET WEIGHT & TARE, g:	212.78
DRY WEIGHT & TARE, g:	176.68
TARE WEIGHT, g:	24.77
MOISTURE, %:	23.8

REMOLD DATA

DIAMETER, cm:	10.15
LENGTH, cm:	11.65
WEIGHT OF MOLD & WET SAMPLE, g:	5808.00
WEIGHT OF MOLD, g:	4203.20
WET WEIGHT OF SAMPLE, g:	1604.80
DRY WEIGHT OF SAMPLE, g:	1470.9
SAMPLE AREA, cm^2:	80.98
SAMPLE VOLUME, cm^3:	943.42
WET DENSITY, pcf:	106.2
DRY DENSITY, pcf:	97.3

DATE	TIME (sec)	VOLUME (ml)	Q (ml/sec)	HEAD (cm)	TEMP. (°C)	TEMP. FACTOR	K (cm/sec)
12/7/99	300	19.01	0.1	16	26.2	0.86583	4.93E-04
	300	18.73	0.1	16	26.2	0.86583	4.86E-04
	300	22.13	0.1	16	26.2	0.86583	5.74E-04
	300	11.89	0.0	10	20.9	0.97841	5.58E-04
	300	12.11	0.0	10	20.9	0.97841	5.68E-04
	300	11.13	0.0	10	20.8	0.98076	5.23E-04
						AVERAGE:	5.3E-04

K = (ml/sec x Length) / (Head x Area)

MONTGOMERY WATSON/LAB TESTING/CO

003-2111-1

TABLE 1

SUMMARY OF RIGID-WALL PERMEABILITY TEST RESULTS

SAMPLE TYPE	SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE LENGTH (in)	SAMPLE DIAMETER (in)	SAMPLE DRY DENSITY (pcf)	INITIAL MOISTURE (%)	AVERAGE PERMEABILITY (cm/sec)
	N6/J19 COMP		10.28	10.00	112.9	8.4	$5.5X10^{-3}$

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

FROM : GOLDER ASSOCIATES PHONE NO. : 13039690468 Feb. 03 2000 01:30PM P1

PINHOLE DISPERSION TEST ASTM 4647

Project name: MONTGOMERY WATSON
Project number: 003-2111-1
Sample number: TP6-200
Compaction characteristics: 109.6 PCF/ 95%
Distilled water used: Yes X No

Date: February 3, 2000
Technician: DMD
Moisture content: 11.6
Curing time: 24 hours

CLOCK TIME	HEAD	FLOW ML	FLOW S	FLOW RATE ML/S	TURBIDITY FROM SIDE: DARK	SLIGHTLY DARK	BARELY VISIBLE	COMPLETELY CLEAR	REMARKS
1115	2	18.95	60	0.32			X		Test not applicable to soils with less than 12%
	2	19.33	60	0.32			X		finer than 0.005mm and with a plasticity index
	2	19.16	60	0.32			X		less than or equal to 4.
	2	18.94	60	0.32			X		Such soils generally have low resistance to
1128	7	38.62	60	0.64			X		erosion regardless of dispersive characteristics.
	7	38.34	60	0.64			X		Hole was observed to be several mm in diameter
	7	37.40	60	0.62			X		at the effluent end. Sample collapsed during
	7	37.27	60	0.62			X		disassembly.
	7	37.41	60	0.62			X		
1139	15	61.74	60	1.03		X			
	15	61.34	60	1.02		X			
	15	61.09	60	1.02		X			
	15	62.26	60	1.04		X			
	15	63.78	60	1.06		X			

Test evaluation method: B

Result: SLIGHTLY DISPERSIVE

Post-it® Fax Note 7671 | Date 2/3/00 | # of pages ▶ 1
To JORGE TRANCOSO | From DAVE DIX
Co./Dept. MONTGOMERY W. | Co. GOLDER
Phone # | Phone #
Fax # | Fax #

POINT LOAD TEST DATA SHEET

~~Asarco Ray Mine - Mineral Creek Project~~ PEABODY WESTERN
~~1166077~~ 1342052

Montgomery Watson Mining Group

By: BSJ
Date: 01/14/2000

DDH	DEPTH ~~(m)~~ FT	LENGTH (cm)	DIAM. (cm)	RX TYPE 2	FAILURE LOAD (kN) 1	COMPRESS. STRGTH. (MPa)	FAIL.TYPE 3
PWBS	40'	6.86	4.67	SILTSTONE	0.2		S
PWBS	41'	6.71	4.65	SILTSTONE	0.15		S
PWBS	42'	9.73	4.71	SILTSTONE	0.9		S
PWBS	42'	11.77	4.72	SILTSTONE	3.9		S
PWBS	43'	16.51	4.74	SILTSTONE	3.75		S
PWBS	43'	19.87	4.71	SILTSTONE	2.1		S
PWBS	44'	16.19	4.73	SILTSTONE	1.0		S
PWBS	45'	8.71	4.72	SILTSTONE	4.8		S
PWBS	46'	20.96	4.74	SILTSTONE	9.5		S
PWBS	47'	24.77	4.74	SILTSTONE	3.4		S
PW-B-1	66'	12.35	4.71	SANDSTONE	3.2		S
PWB1	67'	23.81	4.69	SANDSTONE	4.9		S
PWB1	68'	41.91	4.71	SANDSTONE	3.3		S
PW B1	69'	21.75	4.70	SANDSTONE	4.0		S
PWB1	70'	14.11	4.73	SILT/SANDSTONE	0.55		S
PWB1	71'	15.31	4.76	SANDSTONE	3.45		S
PWB1	72	9.97	4.71	SILT/SANDSTONE	1.35		S
PWB1	73	12.31	4.72	SILT/SANDSTONE	1.5		S
PWB1	74	16.51	4.72	SILT/SANDSTONE	1.65		S
PWB1	75	13.62	4.75	SILT/SANDSTONE	1.8		S
PWBS	58'	5.84	4.51	CLAYSTONE	0.4		S
PWBS	59'	5.70	4.58	CLAYSTONE	0.3		S
PWBS	60'	5.05	4.60	CLAYSTONE	0.55		S
PWBS	61'	6.75	4.61	CLAYSTONE	0.60		S
PWBS	62'	8.45	4.54	CLAYSTONE	0.1		S
PWBS	62'	2.62	4.63	CLAYSTONE	0.6		S
PWBS	63'	5.24	4.60	CLAYSTONE	0.8		S
PWBS	64'	6.0	4.71	CLAYSTONE	0.3		S
PWBS	121'	6.17	4.92	CLAYSTONE	0.2		F/S
PWBS	55'	6.32	4.81	CLAYSTONE	0.5		S

1 Loading Orientation - Parallel or Perpendicular to Weakness Plane(s)
3 F = Fracture Failure, S = Substance Failure, F/S = Combination (record % that is intact)
2 ROCK TYPE: 1 Conglomerate
2 Dacite Tuff

c:\sjh\asarco\PLTRESLT.WB2

POINT LOAD TEST DATA SHEET

~~Asarco Ray Mine - Mineral Creek Project~~ PEABODY WESTERN
~~1166077~~ 1342052

Montgomery Watson Mining Group

By: BSJ
Date: 01/14/2000

DDH	DEPTH ~~(m)~~ FT	LENGTH (cm)	DIAM. (cm)	RX TYPE [2]	FAILURE LOAD (kN)[1]	COMPRESS. STRGTH. (MPa)	FAIL.TYPE [3]
PWBS	48	5.46	4.71	SHALE/COAL	0.6		S
PWBS	48	5.29	4.74	SILTSTONE	2.7	INVALID TEST	S
PWBS	48	4.72	4.69	SHALE/COAL	0.15		S

[1] Loading Orientation - Parallel or Perpendicular to Weakness Plane(s)
[3] F = Fracture Failure, S = Substance Failure, F/S = Combination (record % that is intact)
[2] ROCK TYPE: 1 Conglomerate
2 Dacite Tuff

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Appendix D

Geotechnical Calculations

CALCULATION REVIEW COVER SHEET

MONTGOMERY WATSON

SHEET 1 OF 1

PROJECT TITLE:	J7JR MSHA DAM
PROJECT NO:	1342052.01180100
CALCULATION TITLE:	Geotechnical Calculations

	NAME	DATE
PREPARED BY:	Craig Burger	
CHECKED BY:	Jorge C. Troncoso	4/3/2000
REVIEWED BY:		

REVISIONS				
DATE	**PURPOSE**	**PREPARED BY**	**CHECKED BY**	**REVIEWED BY**

Appendix D

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Appendix D.1

Estimation of Soil Parameters

MONTGOMERY WATSON
Mining Group

Project Name: Peabody Western J 7 Jr
Project Number: 1342052.01480100 Sheet: 1 of 1
Prepared By: Craig Burger Date: 2/15/00
Checked By: Date:

Estimation of Soil Parameters

Purpose: Estimate the density, friction angle, and secant Youngs modulus for the soils encountered in the boring logs.

Assumptions: The applied correlations are valid for the soils encountered.

Calculations:

γ_{wet} and Φ are from table 3-4 pg 163 (Bowles) (attached) approximately $\Phi = 28° + 15° D_r$ ($\pm 2°$)

The correction for SPT values with depth: (pg 158 Bowles)

$$N'_{70} = C_N N_m n_1 n_2 n_3 n_4$$

where

$$C_N = \sqrt{\frac{95.76\ kPa}{p'_o}}$$ where p'_o is in kPa

$n_1 = n_2 = n_3 = n_4 = 1.0$

E_s: $E_s = 300 (N_{55} + 6)$ for silts, sandy silt or clayey silt

E_s in kPa

convert to N_{70} $55 N_{55} = 70 N_{70}$ $N_{55} = \frac{70}{55} N_{70}$

$1\ ksf = 47.9\ kPa$

so:

$$E_s = \frac{300\ kPa}{47.9\ kPa/ksf} \left(\frac{70}{55} N_{70} + 6 \right)$$

$$E_s\ (ksf) = 8 N_{70} + 7.64$$

Results: See following spreadsheet

References: "Foundation Analysis and Design, 5th Edition" Bowles, J.E. (1996) McGraw-Hill, New York, 1175 pp.

Estimated Soil Parameters for Alluvial Soils near J7Jr Sediment Control Dam

Boring	Depth (ft)	ϕ	γ_d (pcf)	E_s (ksf)
PW-B1	5	33	115	120
PW-B2	10	33	115	150
PW-B3	5	33	115	110
	20	33	120	400
PW-B4	5	33	120	380
PW-B5	10	33	120	380
PW-B7	5	31	105	64
	10	33	115	120
	15	33	120	240
	20	33	115	200
	25	33	120	330
	30	33	115	250
PW-B8	5	31	105	55
	10	33	115	110
	15	33	115	160
	20	33	120	300
	25	31	110	150
	30	31	110	160
	35	29	105	125
	40	29	95	50
PW-B10	20	29	95	40
PW-B12	5	33	120	220
	10	33	120	-
	15	33	120	300
	20	33	115	240
	25	33	120	360
PW-B13	5	33	120	140
	15	33	120	280
PW-B14	5	31	115	110
	15	33	120	310
	20	31	115	215
	25	31	105	125
PW-B15	25	31	115	240

Average Values:	32	114	201

TABLE 3-4
Empirical values for ϕ, D_r, and unit weight of granular soils based on the SPT at about 6 m depth and normally consolidated [approximately, $\phi = 28° + 15°D_r$ (±2°)]

Description	Very loose	Loose	Medium	Dense	Very dense
Relative density D_r	0	0.15	0.35	0.65	0.85
SPT N'_{70}: fine	1–2	3–6	7–15	16–30	?
medium	2–3	4–7	8–20	21–40	> 40
coarse	3–6	5–9	10–25	26–45	> 45
ϕ: fine	26–28	28–30	30–34	33–38	
medium	27–28	30–32	32–36	36–42	< 50
coarse	28–30	30–34	33–40	40–50	
γ_{wet}, kN/m³	11–16*	14–18	17–20	17–22	20–23

* Excavated soil or material dumped from a truck has a unit weight of 11 to 14 kN/m³ and must be quite dense to weigh much over 21 kN/m³. No existing soil has a $D_r = 0.00$ nor a value of 1.00. Common ranges are from 0.3 to 0.7.

The following are several SPT N-value correlations for angle of friction ϕ. The top two of Eq. (3-5) are from Shioi and Fukui (1982), who obtained them from the Japanese Railway Standards:

$$\begin{aligned} \phi &= \sqrt{18N'_{70}} + 15 \\ \phi &= 0.36N_{70} + 27 \\ \phi &= 4.5N_{70} + 20 \text{ (in general)} \end{aligned} \tag{3-5}$$

The top equation of this set is for roads and bridges, and the second is for buildings (refer also to Table 3-4).

A relationship for N and D_r was proposed indirectly by Meyerhof (1957) as

$$\frac{N}{D_r^2} = A + Bp_o \tag{3-5a}$$

For this equation Skempton (1986), using a database of five different soils, found that A and B are site-dependent with a range in A of 15 to about 54 and in B from 0.306 to 0.204 (using the N'_{70} base). This spread is such that using average values for A and B is somewhat risky; however, using averages we obtain

$$\frac{N'_{70}}{D_r^2} = 32 + 0.288p'_o \tag{3-5b}$$

with p'_o in kPa. For an average unit weight γ of 16 to 17 kN/m³ and a depth of about 6 m one obtains $N'_{70}/D_r^2 \approx 60$, which was also used as a guide in designating the N values for normally consolidated sands of Table 3-4. For overconsolidated sands (OCR > 1), Skempton (1986) suggested the following adjustment:

$$\frac{N'_{70}}{D_r^2} = A + BC_{OCR}p'_o \tag{3-5c}$$

Appendix D.2

Settlement Calculations

MONTGOMERY WATSON
Mining Group

Project Name: _____
Project Number: _____ Sheet: 1 of 2
Prepared By: Craig Burger Date: 1/26/00
Checked By: _____ Date: _____

Purpose: Calculate the settlement that will occur at dam JTJR for the portion founded above clay layers that have the potential to consolidate and determine the portion of this settlement that will occur before the completion of construction.

Method: Consolidation theory.

Assumptions: The clay layers will settle according to consolidation theory.
The physical parameters of the soil are constant and described by the consolidation test performed on a sample from boring PW-B1 at a depth of 22 ft.
The clays are normally consolidated (conservative).
Two clay layers exist at depths of 30 ft and 45 ft and both are drained from the top and bottom.
The dam will be 25 ft high at the portion founded above the clay layers.
The dam will be constructed in 120 days.

Calculations:

Soil parameters:

$\gamma_d = 115.4$ pcf, $w = 12.1\%$

$\gamma_w = 115.4\text{ pcf}(1+.21) = \gamma_w = 129.4\text{ pcf}$

soil saturated at approximately $w = 25\%$

$\gamma_{sat} = 115.4\text{ pcf}(1.25) = \gamma_{sat} = 144\text{ pcf}$

$\gamma_{boy} = \gamma_{sat} - \gamma_{wat} = 144 - 62.4 = \gamma_{boy} = 82$ pcf

top of dam +25 ft

existing ground surface 0 ft

groundwater −25 ft

clay layer (1) −30 ft to −35 ft

clay layer (2) −45 ft to −55 ft

Initial stress in clay layer (1)

$\bar{\sigma}_o = 25\text{ ft}(129.4\text{ pcf}) + 7.5\text{ ft}(82\text{ pcf})$

$\bar{\sigma}_o = 3850\text{ pcf} = 3.85\text{ ksf}$

initial void ratio: $e_o = 0.7$
and coefficient of consolidation, $c_v = 0.2\text{ ft}^2/\text{day}$

layer (2)

$\bar{\sigma}_o = 25\text{ ft}(129.4\text{ pcf}) + 25\text{ ft}(82\text{ pcf})$

$\bar{\sigma}_o = 5285\text{ pcf} = 5.29\text{ ksf}$

and $e_o = 0.7$, $c_v = 0.2\text{ ft}^2/\text{day}$

from consolidation data: $C_c = \frac{0.6 - 0.3}{\log(100/10)} = C_c = 0.3$

$C_r = \frac{0.70 - 0.656}{\log(10/1)} = C_r = 0.044$

Consolidation settlement:

total load from construction: $\Delta\bar{\sigma}_v = 25\,ft\,(129.4\,pcf) = \Delta\bar{\sigma}_v = 3.24\,ksf$

$\bar{\sigma}_f = \bar{\sigma}_o + \Delta\bar{\sigma}_v$

to be conservative: assume normally consolidated and use $C_c = 0.3$

layer ①

$S = \frac{H}{1+e_o}\left(C_c \log \frac{\bar{\sigma}_f}{\bar{\sigma}_o}\right)$ $\quad \bar{\sigma}_f = 3.85\,ksf + 3.24\,ksf$

$\bar{\sigma}_f = 7.09\,ksf$

$= \frac{5\,ft}{1+0.7}\left(0.3 \log \frac{7.09\,ksf}{3.85\,ksf}\right)$

total settlement in layer ① $S = 0.26\,ft = 3.1\,inches$

layer ②

$S = \frac{H}{1+e_o}\left(C_c \log \frac{\bar{\sigma}_f}{\bar{\sigma}_o}\right)$ $\quad \bar{\sigma}_f = \bar{\sigma}_o + \Delta\bar{\sigma} = 5.29\,ksf + 3.24\,ksf$

$\bar{\sigma}_f = 8.53\,ksf$

$= \frac{10\,ft}{1+0.7}\left(0.3 \log \frac{8.53}{5.29}\right)$

total settlement in layer ② $S = 0.37\,ft = 4.4\,inches$

Total Settlement at end of consolidation settlement:

8 inches

Time Varying Load Consolidation
method on pg 414, Lambe & Whitman 3rd

120 days to build, layers are double drained, H = ½ of thickness

at 120 days $T_{con} = \frac{C_v t}{2H^2}$

layer ① $T_{con} = \frac{(0.2\,ft^2/day)(120\,days)}{2(2.5\,ft)^2} = 1.9$ from Fig 27.3 Lambe & Whitman, $U = 95\%$

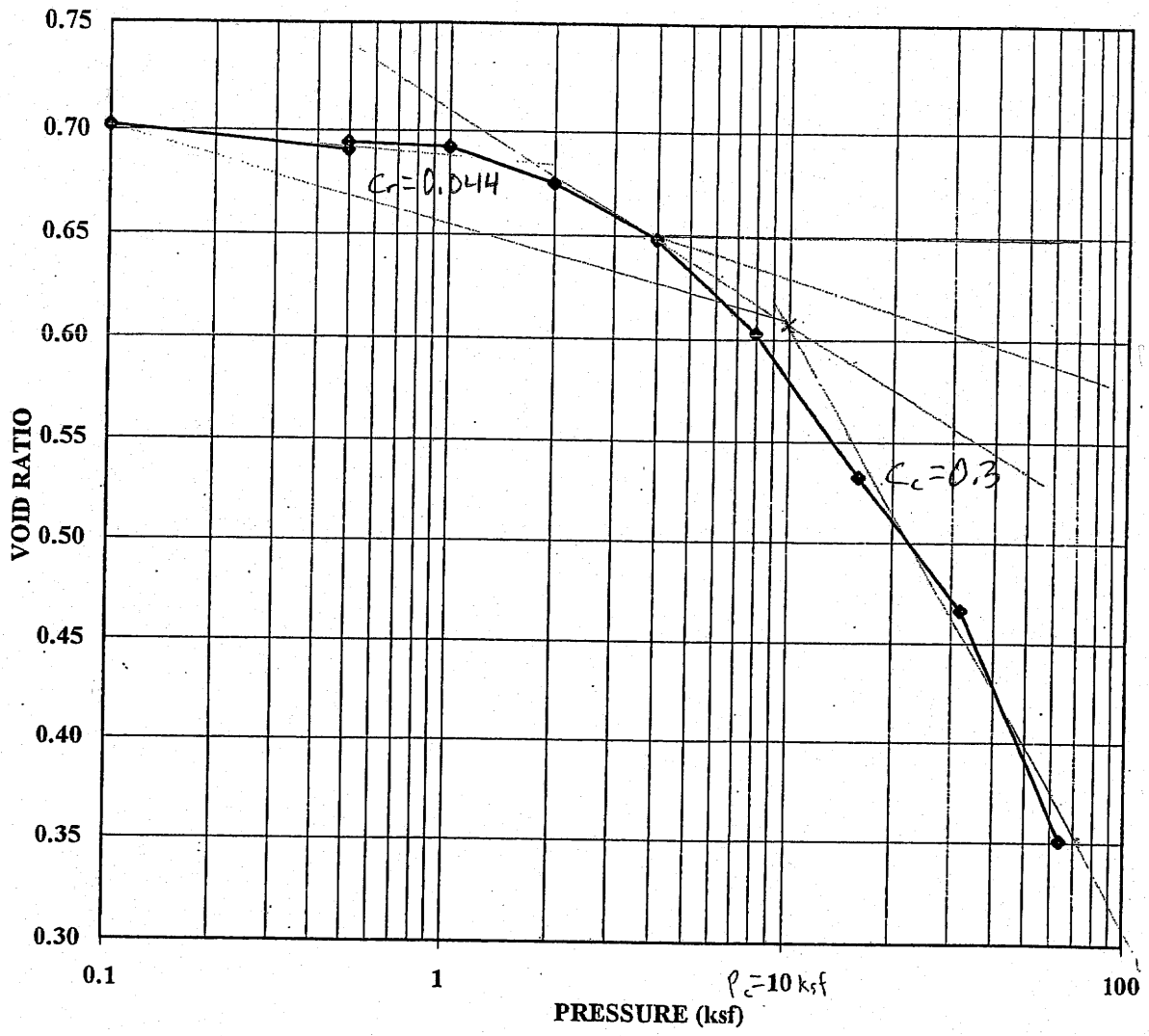
layer ② $T_{con} = \frac{(0.2\,ft^2/day)(120\,days)}{2(5\,ft)^2} = 0.5$ $U = 77\%$

total settlement after 120 days

$S_t = US = 0.95(3\,inches) + 0.77(4.4\,inches) = 6.2\,inches$

Remaining Settlement after construction: 8 inches - 6.2 inches = 1.8 inches

ONE-DIMENSIONAL CONSOLIDATION



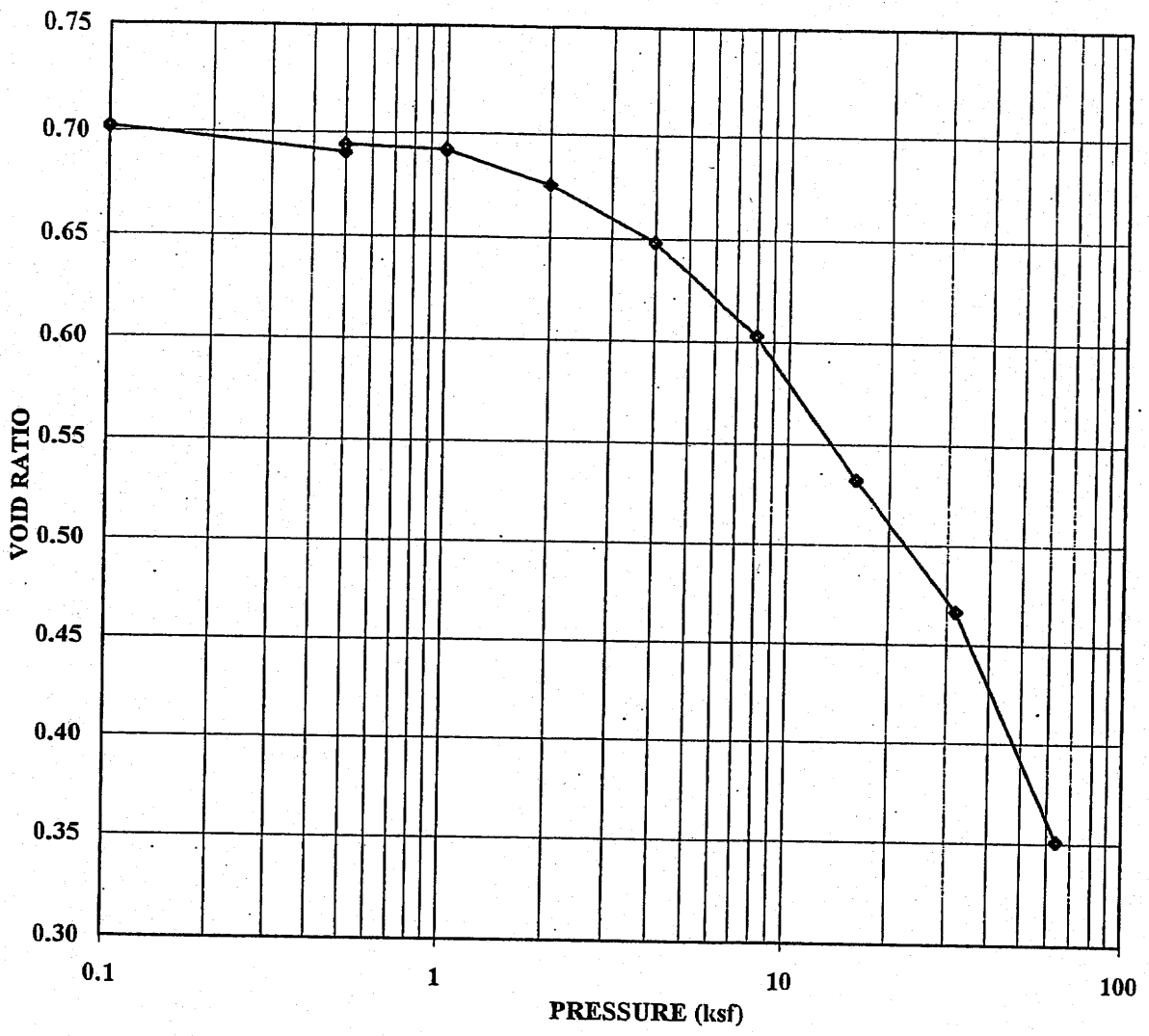
SAMPLE #:	**PW-B1** **22 ft**
DESCRIPTION:	CLAY

TERRAMATRIX/LABTESTING/CO
953-2903

DATE	11/23/99
TECH	CW
REVIEW	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

ONE-DIMENSIONAL CONSOLIDATION



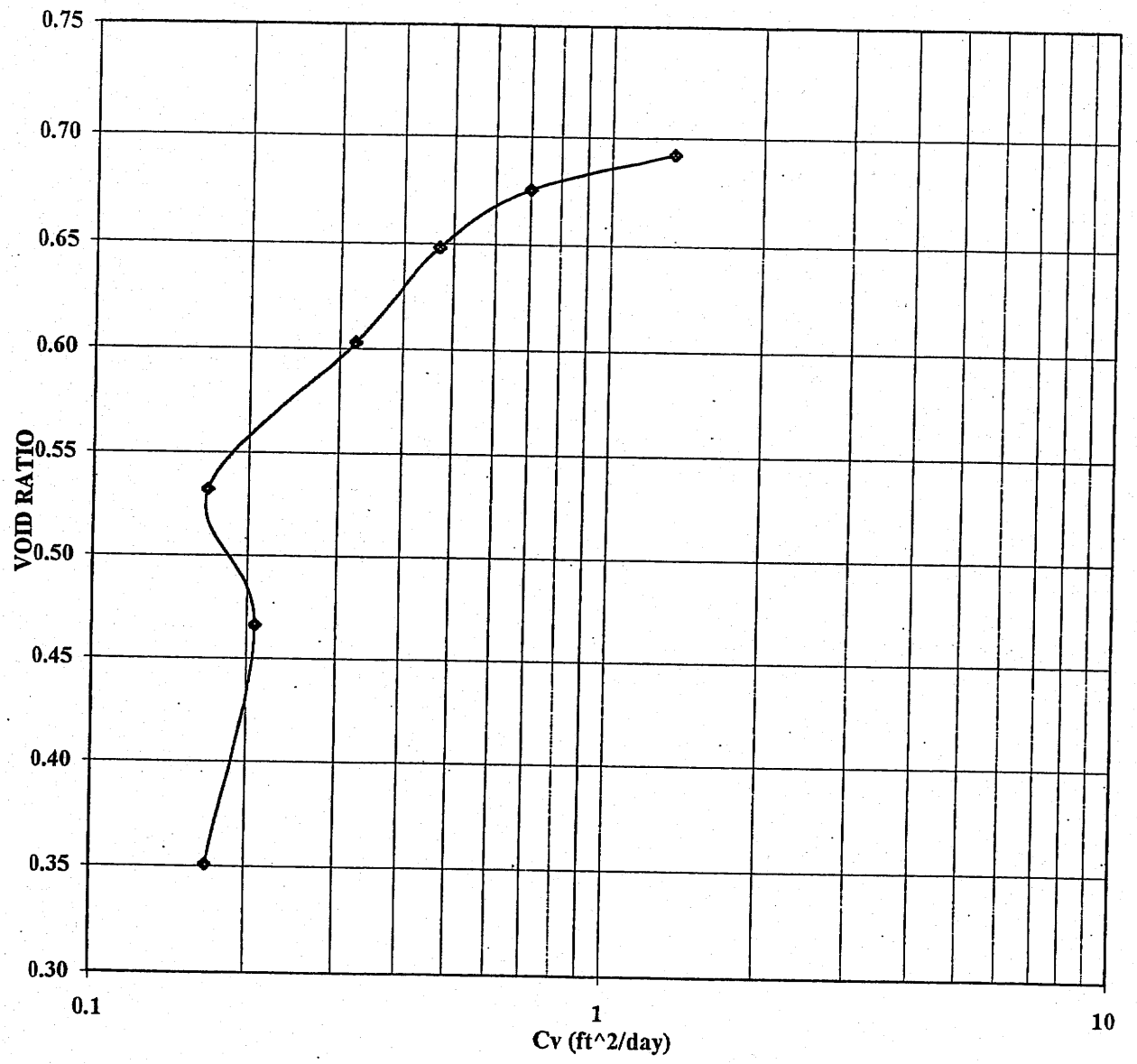
SAMPLE #:	PW-B1 22 ft
DESCRIPTION:	CLAY

TERRAMATRIX/LABTESTING/CO
953-2903

DATE	11/23/95
TECH	CW
REVIEW	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

ONE-DIMENSIONAL CONSOLIDATION



SAMPLE #:	PW-B1 22 ft
DESCRIPTION:	CLAY

TERRAMATRIX/LABTESTING/CO
953-2903

DATE	11/23/99
TECH	CW
REVIEW	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

ONE-DIMENSIONAL CONSOLIDATION

ASTM D 2435

TERRAMATRIX/LABTESTING/CO 953-2903	SAMPLE:	PW-B1 22 ft	DATE 11/23/99 TECH CW REVIEW DMD

SAMPLE DATA, GENERAL

height (in)	0.9900
diameter (in)	2.494
area (in^2)	4.884
volume (in^3)	4.836
specimen weight,wet (g)	156.99
specimen weight,dry (g)	125.73
water weight (g)	31.26

SAMPLE DATA, INITIAL

total height (in)	0.990
height of solids (in)	0.581
height of voids (in)	0.409
void ratio	0.703
dry density (pcf)	98.83
moist density (pcf)	123.68

SAMPLE DATA, FINAL

total height (in)	0.7733
height of solids (in)	0.581
height of voids (in)	0.192
void ratio	0.330
dry density (pcf)	126.80
moist density (pcf)	149.45

DESCRIPTION

CLAY

LL:	29
PL:	15
PI:	14
Gs:	2.70

MOISTURE CONTENT, INITIAL

tare #	X-33
wt soil&tare,moist	133.13
wt soil&tare,dry	113.25
wt tare	33.30
wt moisture	19.88
wt dry soil	79.95
% moisture	24.87%

MOISTURE CONTENT, FINAL

tare #	X-28
wt soil&tare,moist	172.69
wt soil&tare,dry	151.61
wt tare	33.56
wt moisture	21.08
wt dry soil	118.05
% moisture	17.86%

PRESSURE (ksf)	h100 Sample Height	D50 Sample Height	t50 TIME (min)	Sample Density (pcf)	VOID RATIO e	DRAINAGE PATH (DOUBLE DRAINAGE) H (in)	DRAINAGE PATH (DOUBLE DRAINAGE) H (cm)	DRAINAGE PATH (DOUBLE DRAINAGE) H^2 (in^2)	DRAINAGE PATH (DOUBLE DRAINAGE) H^2 (cm^2)	COEFFICIENT OF CONSOLIDATION Cv (cm^2/sec)	COEFFICIENT OF CONSOLIDATION (ft^2/day)	Cc
0.100	0.9884	-	-	99.0	0.702	-	-	-	-	-	-	
0.500	0.9819	-	-	99.6	0.691	-	-	-	-	-	-	
0.500	0.9840	-	-	99.4	0.694	-	-	-	-	-	-	
1.0	0.9827	0.9832	0.360	99.6	0.692	0.4916	1.2487	0.2417	1.5592	1.42E-02	1.33E+00	0.007
2.0	0.9730	0.9758	0.670	100.6	0.675	0.4879	1.2393	0.2380	1.5358	7.53E-03	7.02E-01	0.056
4.0	0.9571	0.9621	0.970	102.2	0.648	0.4811	1.2219	0.2314	1.4930	5.05E-03	4.72E-01	0.090
8.0	0.9309	0.9406	1.350	105.1	0.603	0.4703	1.1946	0.2212	1.4270	3.47E-03	3.24E-01	0.149
16.0	0.8899	0.9057	2.425	109.9	0.532	0.4529	1.1502	0.2051	1.3230	1.79E-03	1.67E-01	0.236
32.0	0.8516	0.8664	1.780	114.9	0.466	0.4332	1.1003	0.1877	1.2107	2.23E-03	2.08E-01	0.219
64.0	0.7845	0.8142	1.945	124.7	0.351	0.4071	1.0340	0.1657	1.0692	1.80E-03	1.68E-01	0.382

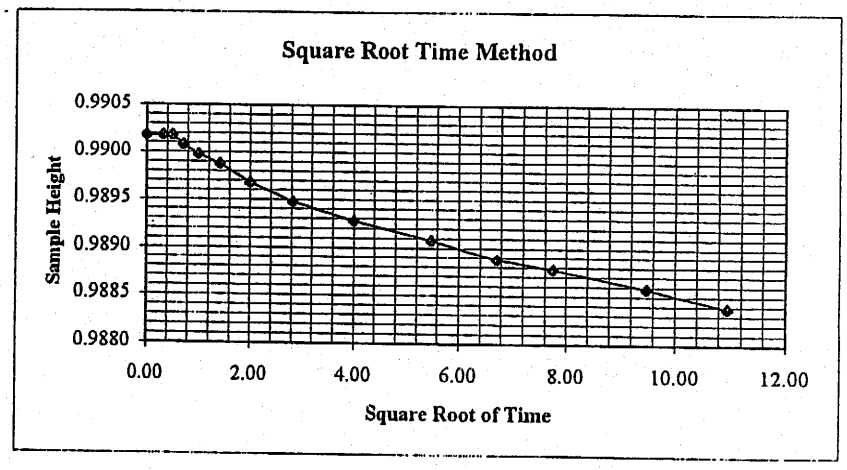
GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

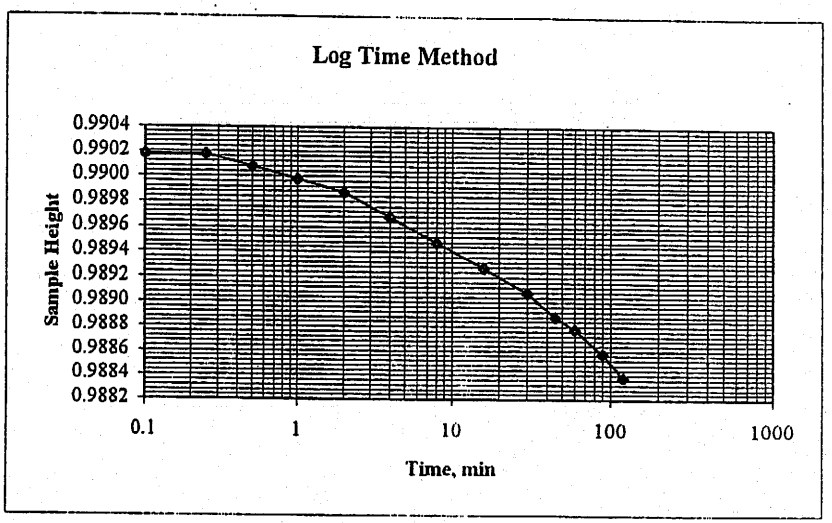
.1 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number = 3
Stress = 0.1 ksf
Load = 95 g
Condition: dry
Initial Sample Height = 0.9900

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/4/99 9:45	0	0.00	0.1027	0.9900	0.9902
	0.1	0.32	0.1027	0.9900	0.9902
	0.25	0.50	0.1027	0.9900	0.9902
	0.5	0.71	0.1028	0.9899	0.9901
	1	1.00	0.1029	0.9898	0.9900
	2	1.41	0.1030	0.9897	0.9899
	4	2.00	0.1032	0.9895	0.9897
	8	2.83	0.1034	0.9893	0.9895
	16	4.00	0.1036	0.9891	0.9893
	30	5.48	0.1038	0.9889	0.9891
	45	6.71	0.1040	0.9887	0.9889
	60	7.75	0.1041	0.9886	0.9888
	90	9.49	0.1043	0.9884	0.9886
	120	10.95	0.1045	0.9882	0.9884



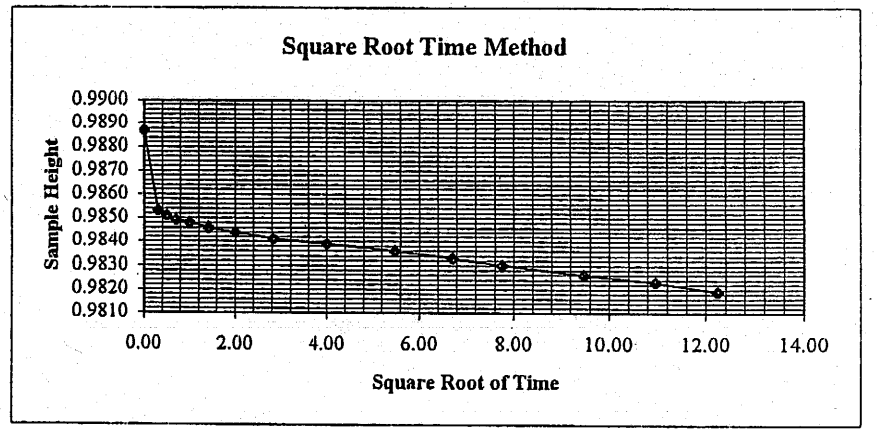


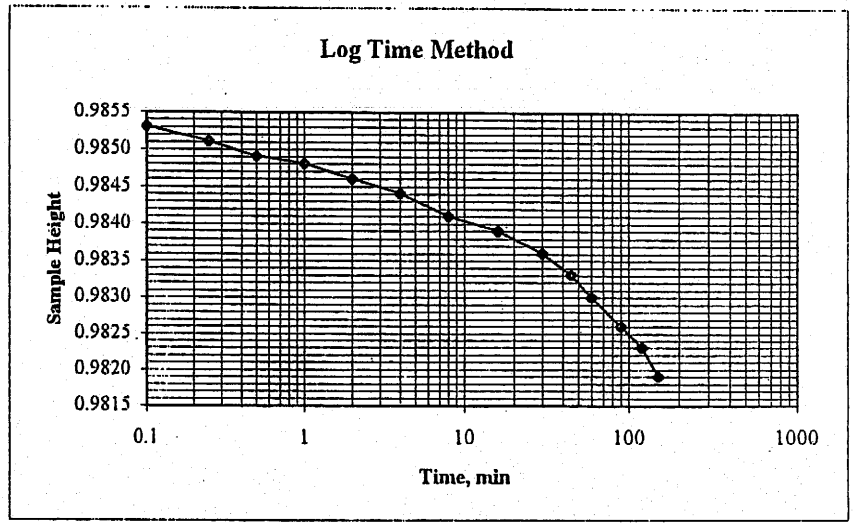
.5 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number = 3
Stress = 0.5 ksf
Load = 656 g
Condition: dry
Initial Sample Height = 0.9884

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/4/99 11:50	0	0.00	0.1045	0.9884	0.9887
	0.1	0.32	0.1079	0.9850	0.9853
	0.25	0.50	0.1081	0.9848	0.9851
	0.5	0.71	0.1083	0.9846	0.9849
	1	1.00	0.1084	0.9845	0.9848
	2	1.41	0.1086	0.9843	0.9846
	4	2.00	0.1088	0.9841	0.9844
	8	2.83	0.1091	0.9838	0.9841
	16	4.00	0.1093	0.9836	0.9839
	30	5.48	0.1096	0.9833	0.9836
	45	6.71	0.1099	0.9830	0.9833
	60	7.75	0.1102	0.9827	0.9830
	90	9.49	0.1106	0.9823	0.9826
	120	10.95	0.1109	0.9820	0.9823
	150	12.25	0.1113	0.9816	0.9819



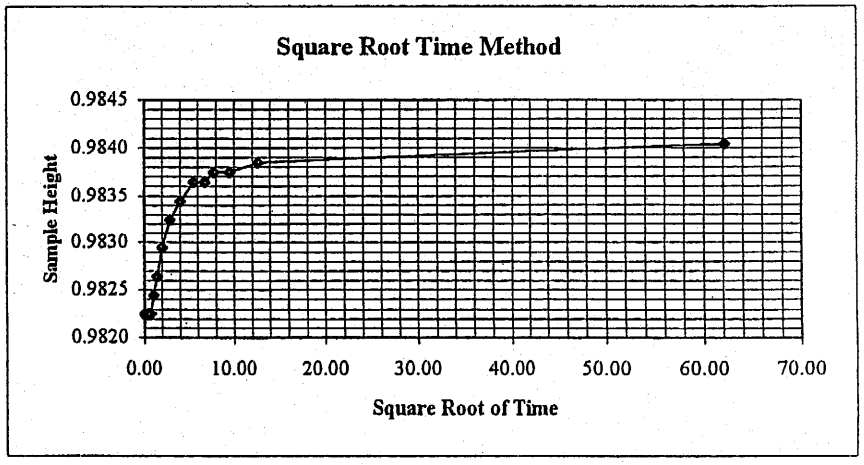


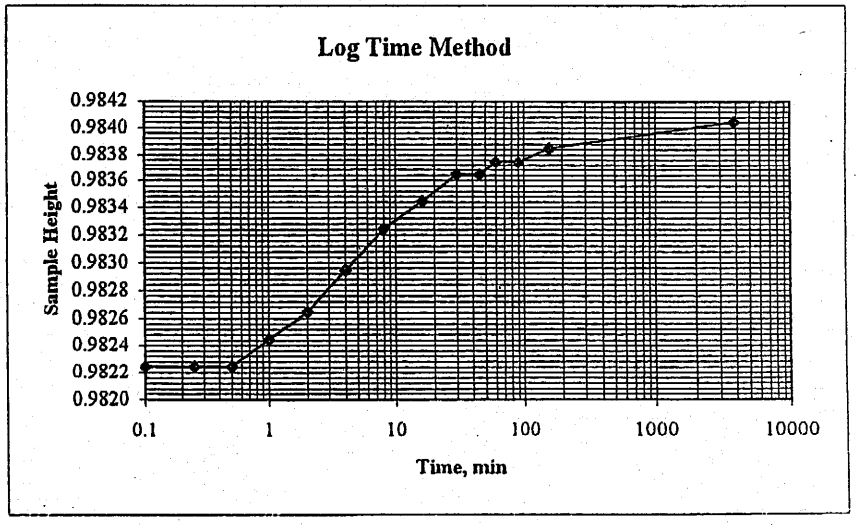
.5 wet ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number =	3	
Stress =	0.5	ksf
Load =	656	g
Condition:	wet	
Initial Sample Height =	0.9819	

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/4/99 14:20	0	0.00	0.1113	0.9819	0.9822
	0.1	0.32	0.1113	0.9819	0.9822
	0.25	0.50	0.1113	0.9819	0.9822
	0.5	0.71	0.1113	0.9819	0.9822
	1	1.00	0.1111	0.9821	0.9824
	2	1.41	0.1109	0.9823	0.9826
	4	2.00	0.1106	0.9826	0.9829
	8	2.83	0.1103	0.9829	0.9832
	16	4.00	0.1101	0.9831	0.9834
	30	5.48	0.1099	0.9833	0.9836
	45	6.71	0.1099	0.9833	0.9836
	60	7.75	0.1098	0.9834	0.9837
	90	9.49	0.1098	0.9834	0.9837
	160	12.65	0.1097	0.9835	0.9838
11/8/99 8:15	3855	62.09	0.1095	0.9837	0.9840



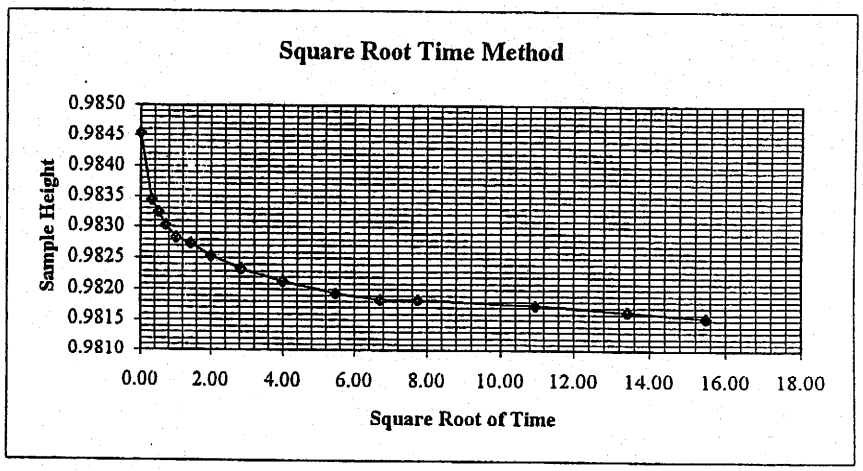


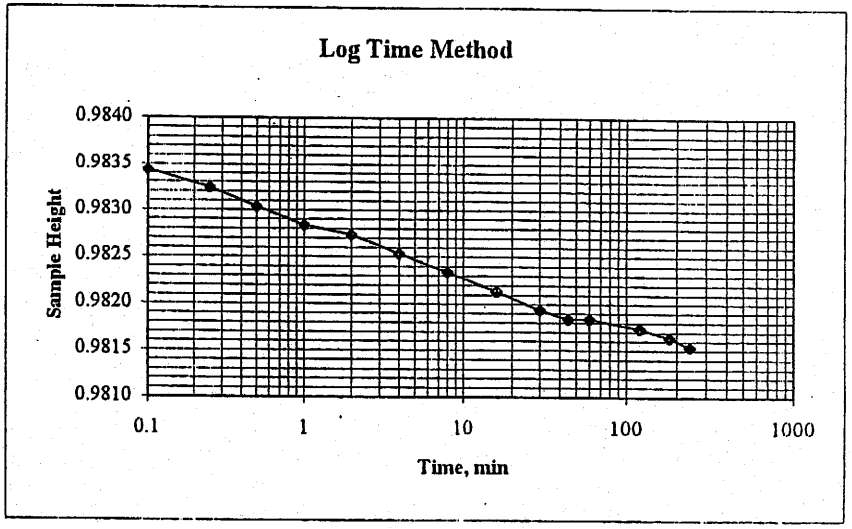
1 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number =	3	
Stress =	1	ksf
Load =	1356	g
Condition:	wet	
Initial Sample Height =	0.9840	

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/8/99 8:15	0	0.00	0.1095	0.9840	0.9845
	0.1	0.32	0.1106	0.9829	0.9834
	0.25	0.50	0.1108	0.9827	0.9832
	0.5	0.71	0.1110	0.9825	0.9830
	1	1.00	0.1112	0.9823	0.9828
	2	1.41	0.1113	0.9822	0.9827
	4	2.00	0.1115	0.9820	0.9825
	8	2.83	0.1117	0.9818	0.9823
	16	4.00	0.1119	0.9816	0.9821
	30	5.48	0.1121	0.9814	0.9819
	45	6.71	0.1122	0.9813	0.9818
	60	7.75	0.1122	0.9813	0.9818
	120	10.95	0.1123	0.9812	0.9817
	180	13.42	0.1124	0.9811	0.9816
	240	15.49	0.1125	0.9810	0.9815



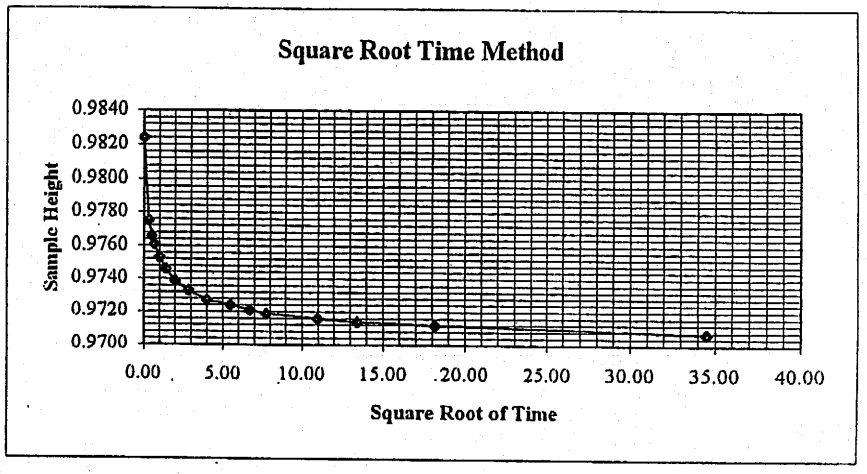


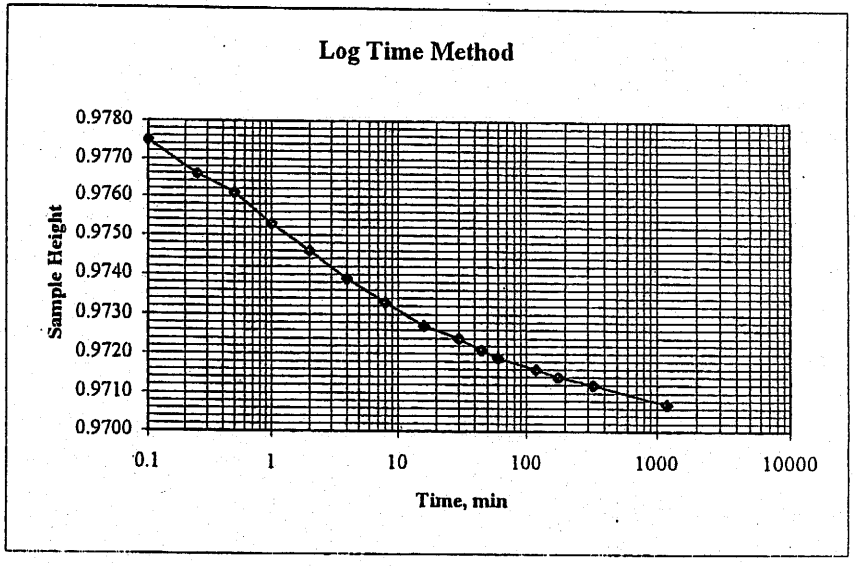
2 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number =	3	
Stress =	2	ksf
Load =	2757	g
Condition:	wet	
Initial Sample Height =	0.9815	

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/8/99 12:20	0	0.00	0.1125	0.9815	0.9824
	0.1	0.32	0.1174	0.9766	0.9775
	0.25	0.50	0.1183	0.9757	0.9766
	0.5	0.71	0.1188	0.9752	0.9761
	1	1.00	0.1196	0.9744	0.9753
	2	1.41	0.1203	0.9737	0.9746
	4	2.00	0.1210	0.9730	0.9739
	8	2.83	0.1216	0.9724	0.9733
	16	4.00	0.1222	0.9718	0.9727
	30	5.48	0.1225	0.9715	0.9724
	45	6.71	0.1228	0.9712	0.9721
	60	7.75	0.1230	0.9710	0.9719
	120	10.95	0.1233	0.9707	0.9716
	180	13.42	0.1235	0.9705	0.9714
	330	18.17	0.1237	0.9703	0.9712
11/9/99 8:10	1190	34.50	0.1242	0.9698	0.9707



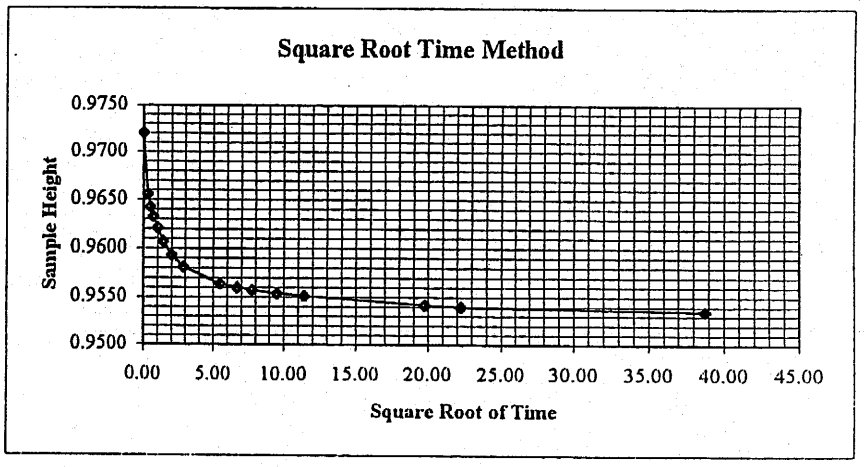


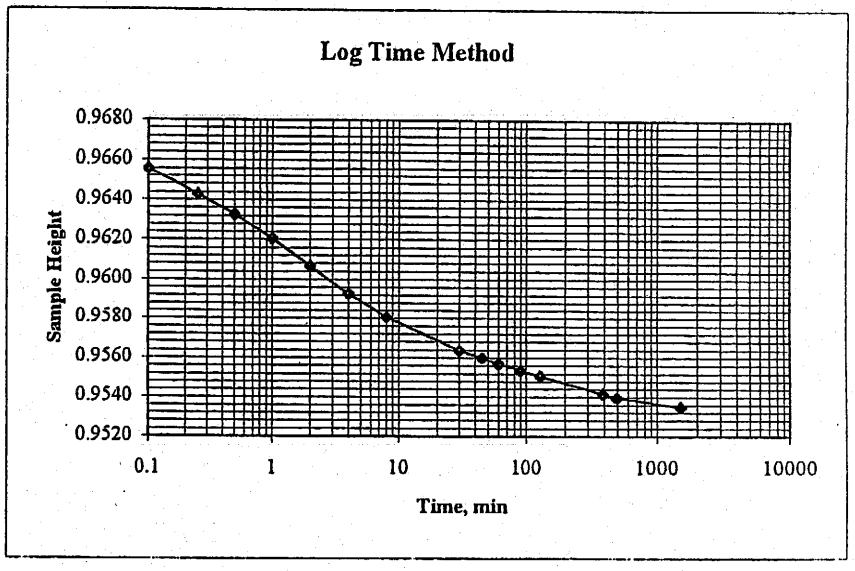
4 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number =	3	
Stress =	4	ksf
Load =	5559	g
Condition:	wet	
Initial Sample Height =	0.9707	

Time	Elapsed Time minutes	Sq Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/9/99 8:30	0	0.00	0.1242	0.9707	0.9721
	0.1	0.32	0.1307	0.9642	0.9656
	0.25	0.50	0.1320	0.9629	0.9643
	0.5	0.71	0.1330	0.9619	0.9633
	1	1.00	0.1342	0.9607	0.9621
	2	1.41	0.1356	0.9593	0.9607
	4	2.00	0.1370	0.9579	0.9593
	8	2.83	0.1382	0.9567	0.9581
	30	5.48	0.1399	0.9550	0.9564
	45	6.71	0.1403	0.9546	0.9560
	60	7.75	0.1406	0.9543	0.9557
	90	9.49	0.1409	0.9540	0.9554
	130	11.40	0.1412	0.9537	0.9551
	390	19.75	0.1421	0.9528	0.9542
	495	22.25	0.1423	0.9526	0.9540
11/10/99 9:30	1500	38.73	0.1428	0.9521	0.9535



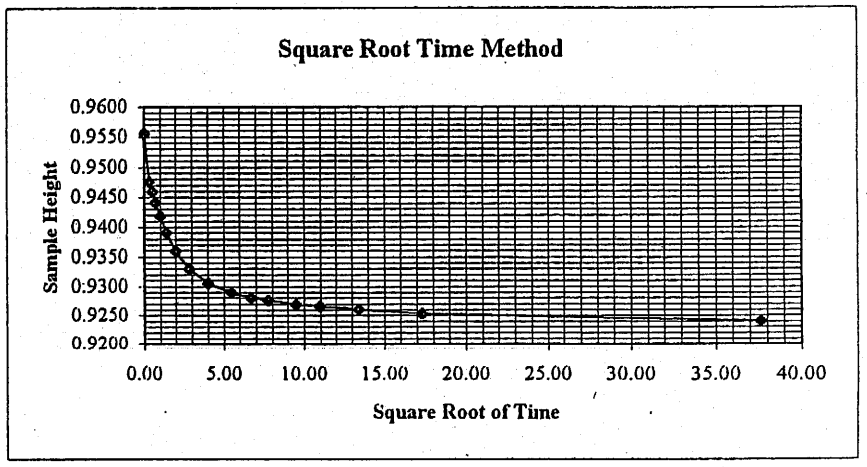


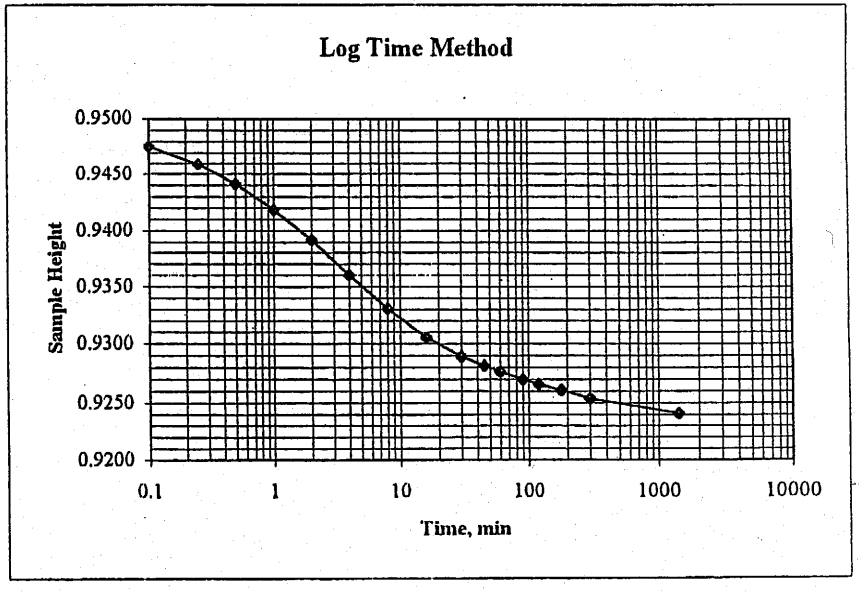
8 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number = 3
Stress = 8 ksf
Load = 11164 g
Condition: wet
Initial Sample Height = 0.9535

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/10/99 9:55	0	0.00	0.1428	0.9535	0.9556
	0.1	0.32	0.1508	0.9455	0.9476
	0.25	0.50	0.1524	0.9439	0.9460
	0.5	0.71	0.1542	0.9421	0.9442
	1	1.00	0.1565	0.9398	0.9419
	2	1.41	0.1592	0.9371	0.9392
	4	2.00	0.1623	0.9340	0.9361
	8	2.83	0.1653	0.9310	0.9331
	16	4.00	0.1678	0.9285	0.9306
	30	5.48	0.1694	0.9269	0.9290
	45	6.71	0.1702	0.9261	0.9282
	60	7.75	0.1707	0.9256	0.9277
	90	9.49	0.1714	0.9249	0.9270
	120	10.95	0.1718	0.9245	0.9266
	180	13.42	0.1723	0.9240	0.9261
	300	17.32	0.1730	0.9233	0.9254
11/11/99 9:30	1415	37.62	0.1743	0.9220	0.9241



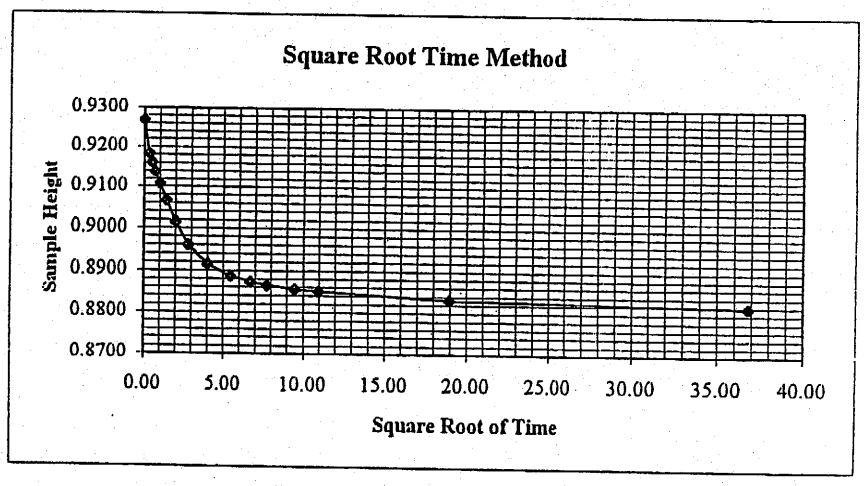


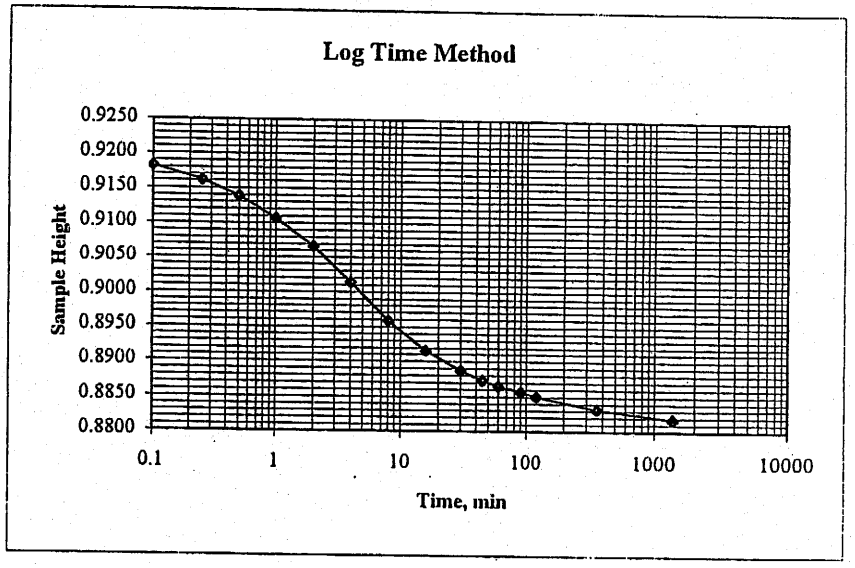
16 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number =	3	
Stress =	16	ksf
Load =	22372	g
Condition:	wet	
Initial Sample Height =	0.9241	

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/11/99 9:40	0	0.00	0.1743	0.9241	0.9269
	0.1	0.32	0.1829	0.9155	0.9183
	0.25	0.50	0.1850	0.9134	0.9162
	0.5	0.71	0.1873	0.9111	0.9139
	1	1.00	0.1904	0.9080	0.9108
	2	1.41	0.1945	0.9039	0.9067
	4	2.00	0.1997	0.8987	0.9015
	8	2.83	0.2052	0.8932	0.8960
	16	4.00	0.2096	0.8888	0.8916
	30	5.48	0.2124	0.8860	0.8888
	45	6.71	0.2138	0.8846	0.8874
	60	7.75	0.2146	0.8838	0.8866
	90	9.49	0.2155	0.8829	0.8857
	120	10.95	0.2161	0.8823	0.8851
	360	18.97	0.2179	0.8805	0.8833
11/12/99 8:15	1355	36.81	0.2193	0.8791	0.8819



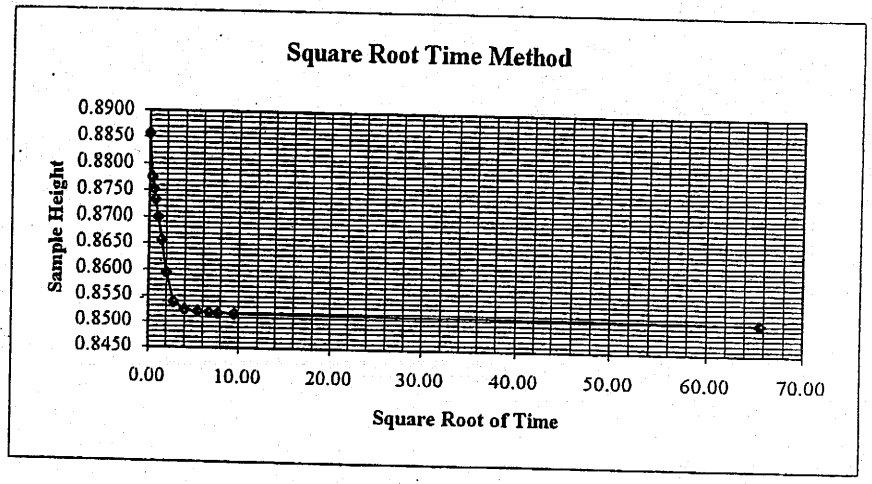


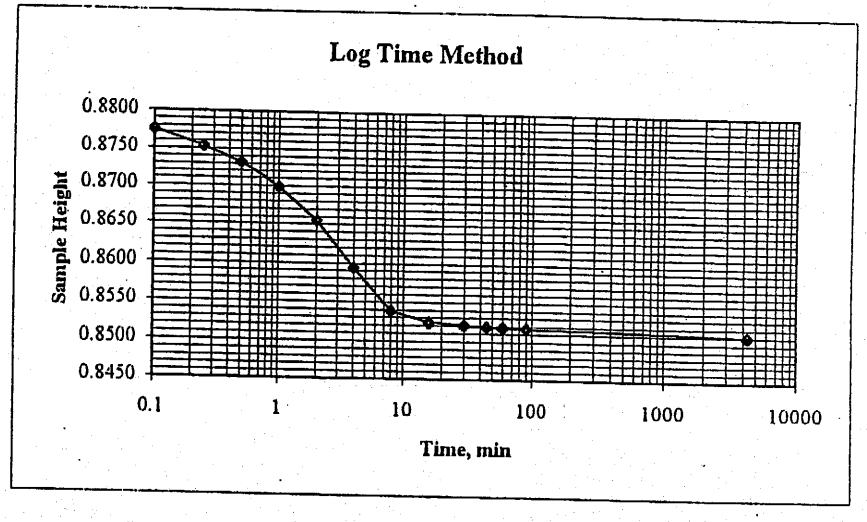
32 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number =	3	
Stress =	32	ksf
Load =	44789	g
Condition:	wet	
Initial Sample Height =	0.8819	

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/12/99 8:20	0	0.00	0.2193	0.8819	0.8858
	0.1	0.32	0.2275	0.8737	0.8776
	0.25	0.50	0.2297	0.8715	0.8754
	0.5	0.71	0.2318	0.8694	0.8733
	1	1.00	0.2351	0.8661	0.8700
	2	1.41	0.2395	0.8617	0.8656
	4	2.00	0.2456	0.8556	0.8595
	8	2.83	0.2512	0.8500	0.8539
	16	4.00	0.2526	0.8486	0.8525
	30	5.48	0.2530	0.8482	0.8521
	45	6.71	0.2531	0.8481	0.8520
	60	7.75	0.2532	0.8480	0.8519
	90	9.49	0.2533	0.8479	0.8518
11/15/99 8:00	4300	65.57	0.2540	0.8472	0.8511



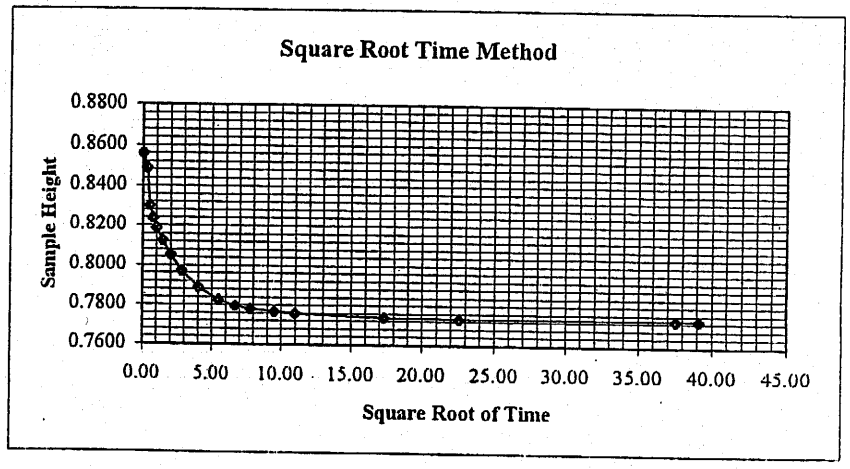


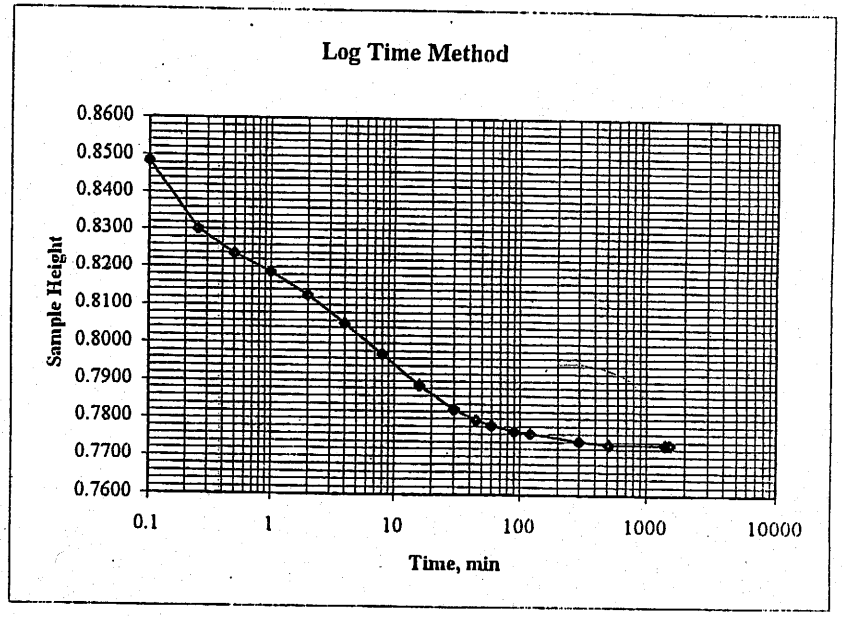
64 ksf

Project Name:	TERRAMATRIX/LABTESTING/CO
Project Number:	953-2903
Sample Number:	PW-B1
Depth:	22'

Frame Number =	3	
Stress =	64	ksf
Load =	89623	g
Condition:	wet	
Initial Sample Height =	0.8511	

Time	Elapsed Time minutes	Sq. Root of Time	Dial Reading inches	Sample Height inches	Corrected Height inches
11/15/99 9:00	0	0.00	0.2540	0.8511	0.8561
	0.1	0.32	0.2615	0.8436	0.8486
	0.25	0.50	0.2798	0.8253	0.8303
	0.5	0.71	0.2863	0.8188	0.8238
	1	1.00	0.2913	0.8138	0.8188
	2	1.41	0.2974	0.8077	0.8127
	4	2.00	0.3049	0.8002	0.8052
	8	2.83	0.3128	0.7923	0.7973
	16	4.00	0.3212	0.7839	0.7889
	30	5.48	0.3275	0.7776	0.7826
	45	6.71	0.3303	0.7748	0.7798
	60	7.75	0.3318	0.7733	0.7783
	90	9.49	0.3333	0.7718	0.7768
	120	10.95	0.3340	0.7711	0.7761
	300	17.32	0.3359	0.7692	0.7742
	510	22.58	0.3368	0.7683	0.7733
11/16/99 8:30	1410	37.55	0.3368	0.7683	0.7733
	1530	39.12	0.3368	0.7683	0.7733





Appendix D.3

Rock Strength Calculations

MONTGOMERY WATSON
Mining Group

Project Name: Peabody Western J 7 Jr
Project Number: 1342052.01180100 Sheet: 1 of 1
Prepared By: Craig Burger Date: 1/30/00
Checked By: Date:

Point Load Test

Purpose: Calculate the unconfined compressive strength (UCS) and Tangent Young's Modulus (E_t) for rock core samples.

Method: following Johnson & DeGraff (1988) pg. 148 for UCS and pg 150 for E_t

Assumptions:

Calculations: See attached spreadsheet

example/check: PW-B5 at 40'

$$I_s = P/d^2 = \frac{0.2\,kN}{(4.57\,cm)^2}\left(\frac{1m}{100cm}\right)^2 = 95.76\,kPa$$

$UCS = k I_s$ from fig 4.18 $k = 22$

$UCS = 22 \times 95.76\,kPa$ $UCS = 2{,}107\,kPa = 2.1\,MPa$

linear relationship for k: $k = 0.158\,d + 15$
d = core diameter in mm

Tangent Young's Modulus

Fig 4.20 pg 150 Johnson & DeGraff

$$E_t\,(MPa) = (0.588\,I_s + 0.084) \times 10^4 = 1403\,MPa$$

Comparisons of UCS and E_t:

table 4.2 pg 130 Johnson & DeGraff

	UCS range	UCS avg.	E_t (MPa)	average
Sandstone:	10-235.2 MPa	90.1 MPa	1900-39,700	15,300
Mudstone (shale)		50 MPa	7500-21,900	13,700

References: "Principles of Engineering Geology", Johnson, R.B. and DeGraff, J.V. (1988) John Wiley and Sons, New York, 497pp.

Point Load Test Results Peabody Western Sediment Control Dam

DDH	Depth (ft)	Length (cm)	Diameter (cm)	RX Type	Failure Load (kN)	Failure Type	Point Load Index, Is (MPa)	conversion factor, k	Unconfined Compressive Strength (MPa)	Tangent Elastic Modulus, Et (MPa)
PW-B1	66	12.35	4.71	Sandstone	5.20	S	2.34	22.4	52.6	14623
PW-B1	67	23.81	4.69	Sandstone	4.90	S	2.23	22.4	49.9	13939
PW-B1	68	41.91	4.71	Sandstone	3.30	S	1.49	22.4	33.4	9587
PW-B1	69	31.75	4.70	Sandstone	4.00	S	1.81	22.4	40.6	11487
PW-B1	70	14.11	4.73	Silt/Sandstone	0.55	S	0.25	22.5	5.5	2285
PW-B1	71	15.31	4.76	Sandstone	3.45	S	1.52	22.5	34.3	9793
PW-B1	72	9.97	4.71	Silt/Sandstone	1.35	S	0.61	22.4	13.7	4418
PW-B1	73	12.31	4.77	Silt/Sandstone	1.50	S	0.66	22.5	14.9	4716
PW-B1	74	16.51	4.72	Silt/Sandstone	1.65	S	0.74	22.5	16.6	5195
PW-B1	75	13.62	4.75	Silt/Sandstone	2.80	S	1.24	22.5	27.9	8137
PW-B5	40	6.86	4.57	Siltstone	0.20	S	0.10	22.2	2.1	1403
PW-B5	41	6.71	4.65	Siltstone	0.15	S	0.07	22.3	1.6	1248
PW-B5	42	9.93	4.71	Siltstone	0.90	S	0.41	22.4	9.1	3225
PW-B5	42	11.77	4.72	Siltstone	3.90	S	1.75	22.5	39.3	11133
PW-B5	43	16.51	4.74	Siltstone	3.75	S	1.67	22.5	37.5	10654
PW-B5	43	19.87	4.71	Siltstone	2.10	S	0.95	22.4	21.2	6406
PW-B5	44	16.19	4.73	Siltstone	1.00	S	0.45	22.5	10.0	3468
PW-B5	45	8.71	4.72	Siltstone	4.80	S	2.15	22.5	48.4	13509
PW-B5	46	20.96	4.74	Siltstone	9.50	S	4.23	22.5	95.1	25702
PW-B5	47	24.77	4.74	Siltstone	3.40	S	1.51	22.5	34.0	9738
PW-B5	48	5.46	4.71	Shale/Coal	0.60	S	0.27	22.4	6.1	2430
PW-B5	48	4.72	4.69	Shale/Coal	0.15	S	0.07	22.4	1.5	1241
PW-B5	58	6.32	4.81	Claystone	0.50	S	0.22	22.6	4.9	2111
PW-B5	58	5.84	4.51	Claystone	0.40	S	0.20	22.1	4.4	1996
PW-B5	59	5.70	4.58	Claystone	0.30	S	0.14	22.2	3.2	1681
PW-B5	60	5.05	4.60	Claystone	0.55	S	0.26	22.3	5.8	2368
PW-B5	61	6.75	4.61	Claystone	0.60	S	0.28	22.3	6.3	2500
PW-B5	62	8.45	4.54	Claystone	0.10	S	0.05	22.2	1.1	1125
PW-B5	62	8.62	4.63	Claystone	0.60	S	0.28	22.3	6.2	2486
PW-B5	62	5.17	4.92	Claystone	0.20	F/S	0.08	22.8	1.9	1326
PW-B5	63	5.24	4.60	Claystone	0.80	S	0.38	22.3	8.4	3063
PW-B5	64	5.00	4.71	Claystone	0.30	S	0.14	22.4	3.0	1635

Average Value for:

	Is (Mpa)
Sandstone	1.29
Siltstone	1.33
Claystone	0.20
Shale/Coal	0.17

UCS (Mpa)	Et (Mpa)
28.9	8418
29.8	8649
4.5	2029
3.8	1836

Typical Range of Values (from Johnson and DeGraff):

	UCS (Mpa)	average	Et (Mpa)	average
Sandstone	10-235	90	1900-39,200	15,300
Mudstone/shale	34-231	50/103	7500-21,900	13,700

POINT LOAD TEST DATA SHEET

~~Asarco Ray Mine - Mineral Creek Project~~ PEABODY WESTERN
~~1166077~~ 1342052

Montgomery Watson Mining Group

By: BSJ
Date: 01/14/2000

DDH	DEPTH (m) FT	LENGTH (cm)	DIAM. (cm)	RX TYPE 2	FAILURE LOAD (kN) 1	COMPRESS. STRGTH. (MPa)	FAIL.TYPE 3
PWBS	40'	6.86	4.57	SILTSTONE	0.2		S
PWBS	41'	6.71	4.65	SILTSTONE	0.15		S
PWBS	42'	9.93	4.71	SILTSTONE	0.9		S
PWBS	42'	11.77	4.72	SILTSTONE	3.9		S
PWBS	43'	16.51	4.74	SILTSTONE	3.75		S
PWBS	43'	19.87	4.71	SILTSTONE	2.1		S
PWBS	44'	16.19	4.73	SILTSTONE	1.0		S
PWBS	45'	8.71	4.72	SILTSTONE	4.8		S
PWBS	46'	20.96	4.74	SILTSTONE	9.5		S
PWBS	47'	14.77	4.74	SILTSTONE	3.4		S
PWBS1	66'	12.35	4.71	SANDSTONE	5.2		
PWBS1	67'	23.81	4.69	SANDSTONE	4.9		S
PWBS1	68'	41.91	4.71	SANDSTONE	3.3		S
PWBS1	69'	21.75	4.70	SANDSTONE	4.0		S
PWBS1	70'	14.11	4.73	SILT/SANDSTONE	0.55		S
PWBS1	71'	15.31	4.76	SANDSTONE	3.45		S
PWBS1	72	9.97	4.71	SILT/SANDSTONE	1.35		S
PWBS1	73	12.31	4.72	SILT/SANDSTONE	1.5		S
PWBS1	74	16.51	4.72	SILT/SANDSTONE	1.65		S
PWBS1	75	13.62	4.75	SILT/SANDSTONE	2.8		S
PWBS	58'	5.84	4.51	CLAYSTONE	0.4		S
PWBS	59'	5.70	4.58	CLAYSTONE	0.3		S
PWBS	60'	5.05	4.60	CLAYSTONE	0.55		S
PWBS	61'	6.75	4.61	CLAYSTONE	0.60		S
PWBS	62'	8.45	4.54	CLAYSTONE	0.1		S
PWBS	62'	2.62	4.63	CLAYSTONE	0.5		S
PWBS	63'	5.24	4.60	CLAYSTONE	0.8		S
PWBS	64'	5.0	4.71	CLAYSTONE	0.3		S
PWBS	121	5.17	4.92	CLAYSTONE	0.2		F/S
PWBS	65'	1.32	4.81	CLAYSTONE	0.5		S

1 Loading Orientation - Parallel or Perpendicular to Weakness Plane(s)
3 F = Fracture Failure, S = Substance Failure, F/S = Combination (record % that is intact)
2 ROCK TYPE: 1 Conglomerate
2 Dacite Tuff

c:\sjh\asarco\PLTRESLT.WB2

POINT LOAD TEST DATA SHEET

~~Asarco Ray Mine - Mineral Creek Project~~ PEABODY WESTERN
~~116607Z~~ 1342052

Montgomery Watson Mining Group

By: BSJ
Date: 01/14/2K

DDH	DEPTH ~~(m)~~ FT	LENGTH (cm)	DIAM. (cm)	RX TYPE [2]	FAILURE LOAD (kN)[1]	COMPRESS. STRGTH. (MPa)	FAIL.TYPE [3]
PWBS	48	5.46	4.71	SHALE/COAL	0.6		S
PWBS	48	5.29	4.74	SILTSTONE	2.7	INVALID TEST	S
PWBS	48	4.72	4.69	SHALE/COAL	0.15		S

[1] Loading Orientation - Parallel or Perpendicular to Weakness Plane(s)
[3] F = Fracture Failure, S = Substance Failure, F/S = Combination (record % that is intact)
[2] ROCK TYPE: 1 Conglomerate
2 Dacite Tuff

c:\pl\asarco\PLTRESLT.WB2

Appendix D.4

Seepage Analysis

MONTGOMERY WATSON
Mining Group

Project Name: Peabody Western JTJr
Project Number: 1342052.0180100 Sheet: 1 of 1
Prepared By: Craig Burger Date: 2/15/00
Checked By: Date:

Seepage Analysis

Purpose: Model the flow of water through dam JTJr to determine long term stability of the dam and parameters for design of the drainage system.

Method: Geoslope's SEEP/W seepage analysis program.

Assumptions: The measured permeability of the dam material, $k = 6 \times 10^{-4}$ cm/sec, is representative.

The permeability of the toe and blanket drain material (Scoria) of $k = 5 \times 10^{-3}$ cm/sec is representative.

The toe and blanket drain are protected by an appropriate filter material to ensure that piping does not occur in the dam material and that a reduction of permeability due to plugging of the blanket drain does not occur.

The location of the water level corresponds to the maximum expected elevation (6713 ft).

Calculations: The permeabilities of the materials are:

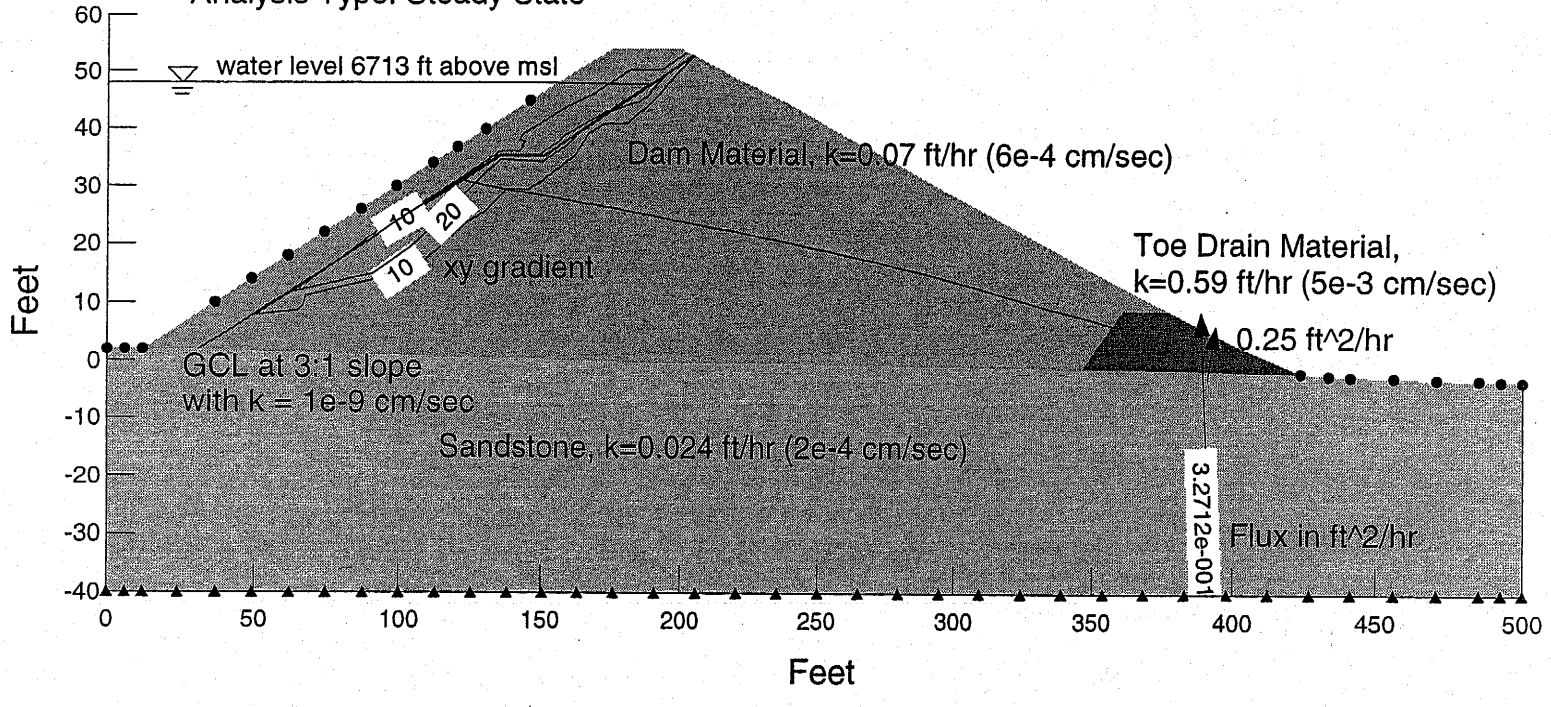
Material	Permeability (cm/sec)	Obtained from
Dam Material	6×10^{-4}	Lab test
GCL	1×10^{-9}	Product literature
Drain (Scoria)	5×10^{-3}	Lab test
Sandstone	2×10^{-4}	Packer tests
Clay	1×10^{-6}	Assumed
Native Sand	1×10^{-3}	Assumed

Results: Two sections are considered: The standard section founded on sandstone with a 54 ft height and the section founded on native silty sand and clay with a 29 ft height.

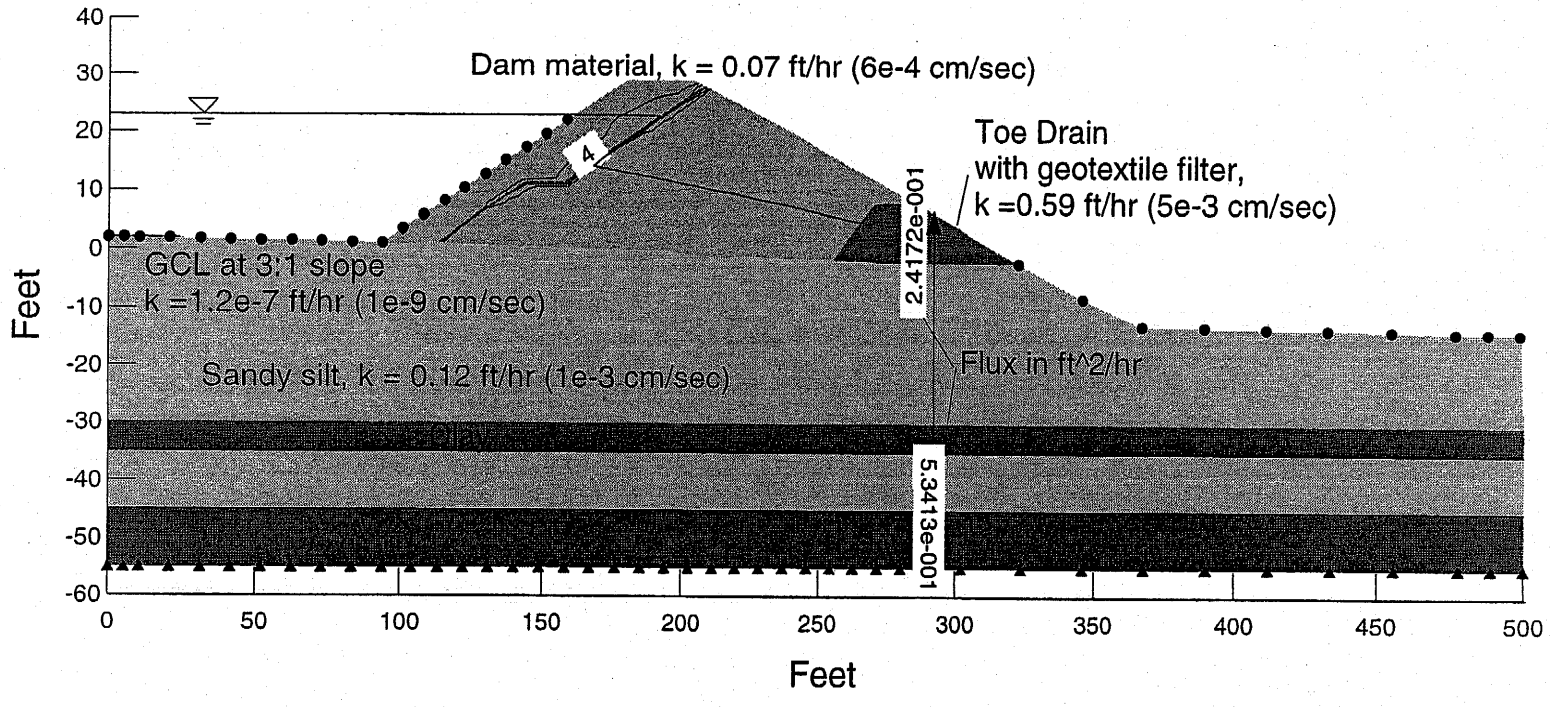
The total flux through the standard section is: 0.33 ft²/hr
and the flux through the drain: 0.25 ft²/hr
The total flux through the section on soil is: 0.53 ft²/hr
and the flux through the drain is: 0.24 ft²/hr

References: "SEEP/W User's Guide" (1995), Geoslope International Ltd. Calgary, Canada

Description: Peabody Western Sediment Control Dam
Comments: Seepage through Earth Dam GCL
File Name: J7JRseepstandardsection.sep
Last Saved Date: 3/28/00
Analysis Type: Steady-State



Description: Peabody Western Sediment Control Dam
Comments: Seepage through Earth Dam with Blanket Drain and GCL
File Name: J7JRsoilgcl.sep
Last Saved Date: 3/28/00
Analysis Type: Steady-State



CONSTANT HEAD PERMEABILITY
(RIGID-WALL PERM)

JOB NUMBER: 953-2903
JOB NAME: MONTGOMERY WATSON/LAB TESTING/CO
BORING NUMBER:
SAMPLE NUMBER: TP-6:200
SAMPLE DEPTH:

TECHNICIAN: PLB
REVIEWED BY: DMD
DATE TESTED: 12/7/99

MOISTURE CONTENT (INITIAL)

TARE:	7B
WET WEIGHT & TARE, g:	101.73
DRY WEIGHT & TARE, g:	95.30
TARE WEIGHT, g:	24.65
MOISTURE, %:	9.1

MOISTURE CONTENT (FINAL)

TARE:	22B
WET WEIGHT & TARE, g:	212.78
DRY WEIGHT & TARE, g:	176.68
TARE WEIGHT, g:	24.77
MOISTURE, %:	23.8

REMOLD DATA

DIAMETER, cm:	10.15
LENGTH, cm:	11.65
WEIGHT OF MOLD & WET SAMPLE, g:	5808.00
WEIGHT OF MOLD, g:	4203.20
WET WEIGHT OF SAMPLE, g:	1604.80
DRY WEIGHT OF SAMPLE, g:	1470.9
SAMPLE AREA, cm²:	80.98
SAMPLE VOLUME, cm³:	943.42
WET DENSITY, pcf:	106.2
DRY DENSITY, pcf:	97.3

DATE	TIME (sec)	VOLUME (ml)	Q (ml/sec)	HEAD (cm)	TEMP. (°C)	TEMP. FACTOR	K (cm/sec)
12/7/99	300	19.01	0.1	16	26.2	0.86583	4.93E-04
	300	18.73	0.1	16	26.2	0.86583	4.86E-04
	300	22.13	0.1	16	26.2	0.86583	5.74E-04
	300	11.89	0.0	10	20.9	0.97841	5.58E-04
	300	12.11	0.0	10	20.9	0.97841	5.68E-04
	300	11.13	0.0	10	20.8	0.98076	5.23E-04
						AVERAGE:	5.3E-04

K = (ml/sec x Length) / (Head x Area)

MONTGOMERY WATSON/LAB TESTING/CO

003-2111-1

TABLE 1

SUMMARY OF RIGID-WALL PERMEABILITY TEST RESULTS

SAMPLE TYPE	SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE LENGTH (in)	SAMPLE DIAMETER (in)	SAMPLE DRY DENSITY (pcf)	INITIAL MOISTURE (%)	AVERAGE PERMEABILITY (cm/sec)
	N6/J19 COMP		10.28	10.00	112.9	8.4	$5.5X10^{-3}$

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

Appendix D.5

Slope Stability Analysis

MONTGOMERY WATSON
Mining Group

Project Name: Peabody Western J7Jr
Project Number: 1342052.01180100 Sheet: 1 of 3
Prepared By: Craig Burger Date: 2/14/00
Checked By: Date:

Purpose: Calculate the factor of safety for the upstream and downstream slopes of J7Jr.

Method: Geoslope's Slope/W slope stability analysis program solving Bishop's method for circular failure surfaces and the Morgenstern-Price method for block failure surfaces.

Assumptions: The soil sample from TP-2:600 (borrow area) used for triaxial testing is representative of the embankment fill material.

The strength of the Scoria material used for the toe and blanket drain is $\phi' = 39°$, based on an average particle diameter of 7mm and Figure 11.12 from Lambe and Whitman, 1969. Figure 11.12 and particle size analysis for the Scoria are attached. The saturated unit weight of this material is assumed to be $\gamma_{sat} = 138$ pcf.

Calculations:

Soil Properties

Material	γ_{sat} (pcf)	γ_{wet} (pcf)	ϕ'	c' (psf)	ϕ	c (psf)	
Structural embankment fill	138	122	36.4	0	36	0	
GCL or Geotextile interface	130	–	25	0	25	0	From parameters given by manufacturer.
GCL interior plane	130	–	–	–	0	336	
Native SM/ML	138	–	31	0	31	0	See Appendix D.1, Estimation of Soil Properties
Native Clay	125	–	–	–	0	$S_u/\sigma = 0.27$	
Sedimentary Rock	140	–	0	10,000	0	10,000	See Appendix D.2 Rock Strength Calculations

Total Stress Parameter Calculations; for Rapid Drawdown
Calculations for S_u/σ ratio of the native clay:

at 22 ft: $S_u = 5.09\ psi = 733\ psf$, use 700 psf.

$\gamma_s = 120\ pcf$, $\sigma = \gamma_s h = (120\ pcf)(22\ ft) = 2640\ psf$

$$S_u/\sigma = \frac{700\ psf}{2640\ psf} = \frac{S_u}{\sigma} = 0.27$$

The strength as a function of depth model for rapid drawdown in the embankment fill: use the effective stress parameters because the total stress parameters from testing are higher.
$\gamma_{sat} = 138\ pcf$ $\phi = 36°$ $c = 187\ psf$ h = depth

$$\tau = c + \sigma \tan\phi = 187\ psf + h \cdot 138\ pcf \tan 36°$$

$$\tau = 187\ psf + 100 \cdot h$$

for the GCL interior plane assume $c = 336\ psf$.
(see attached calculation)

The following conditions were analyzed:

Foundation	Slope	Condition	Description
Sedimentary Rock	Upstream	Static	reservoir full at 6713'
		Pseudo-Static	reservoir full, acceleration of 0.04g during operation
		Rapid drawdown	- reservoir level drops rapidly during operation
		During Construction	- Soil Compactor of 7100 psf on bench, GCL interface is weak surface
	Downstream	Static	reservoir full at 6713'
		Pseudostatic	reservoir full, 0.1g event (life of structure)
Alluvial Soil	Downstream	Static	reservoir full at 6713'
		Pseudo-static	reservoir full 0.1g event
	Upstream	N/A	Upstream conditions on rock are conservative due to greater height of dam

MONTGOMERY WATSON
Mining Group

Project Name: Peabody Western J7Jr
Project Number: 1342052.01180100 Sheet: 1 of 1
Prepared By: Craig Burger Date: 3/9/00
Checked By: Date:

Purpose: Calculate the total stress cohesion for the interior plane of the GCL.

Assumptions: Interior plane friction angle for the GCL is 25° in an undrained (total stress) test, as specified.
soil: $\gamma_w = 120$ pcf

Calculations: Construction drawings call for at least 6 feet of overburden on the GCL.

$$\sigma = (120\text{ pcf})(6\text{ ft}) = 720\text{ psf}$$

$$\tau = c + \sigma \tan\phi = 720\text{ psf} \tan(25°)$$

$$\tau = 336\text{ psf}$$

The section founded on sedimentary rock has a crest elevation of 6719', a maximum water level in the reservoir of 6713', with the base of the centerline of the dam at 6665' resulting in a dam height of 54 ft. The downstream slope is 4h:1v and the upstream slope is 3h:1v.

The section founded on alluvial soil has the same elevations for the crest and gel bench but the base of the centerline is at 6685 ft resulting in a height of 34 ft.

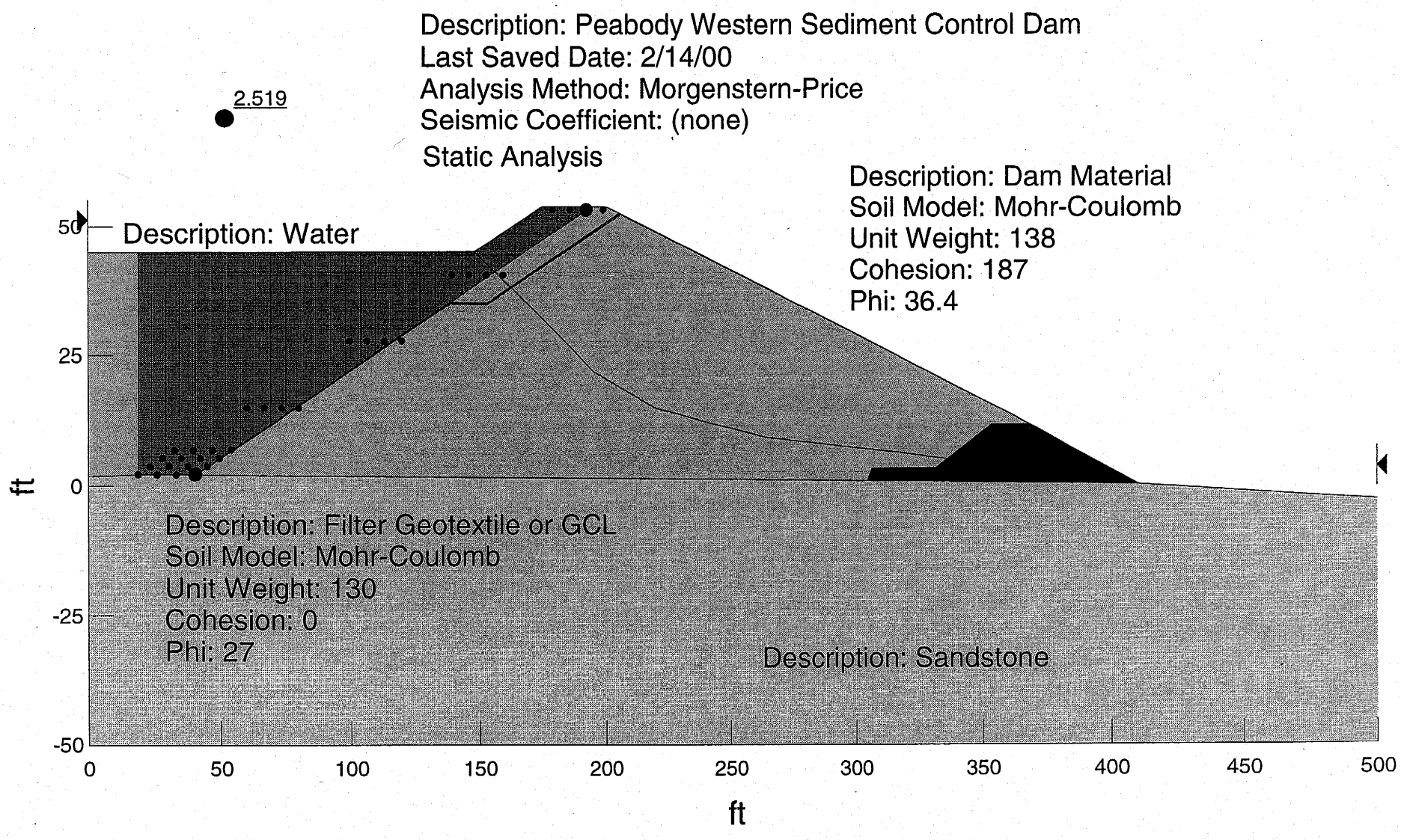
The results of the conditions analyzed are shown below.

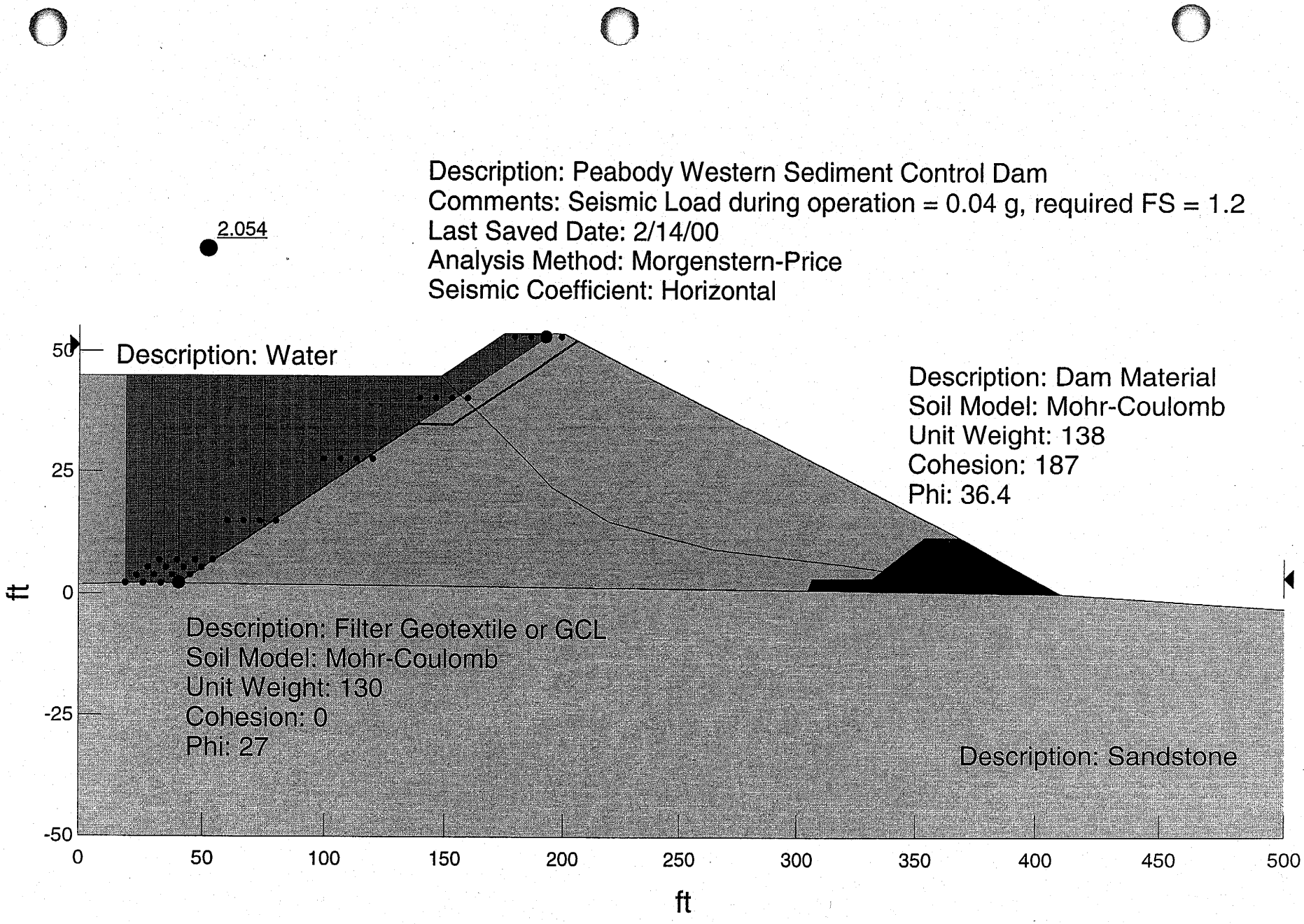
Foundation	Slope	Condition	Factor of Safety
Sedimentary Rock	Upstream	Static	2.519
		Pseudo-Static	2.054
		Rapid Drawdown	2.350
		During Construction	2.499
	Downstream	Static	3.112
		Pseudostatic	2.152
Alluvial Soil	Downstream	Static	1.579
		Pseudostatic	1.216

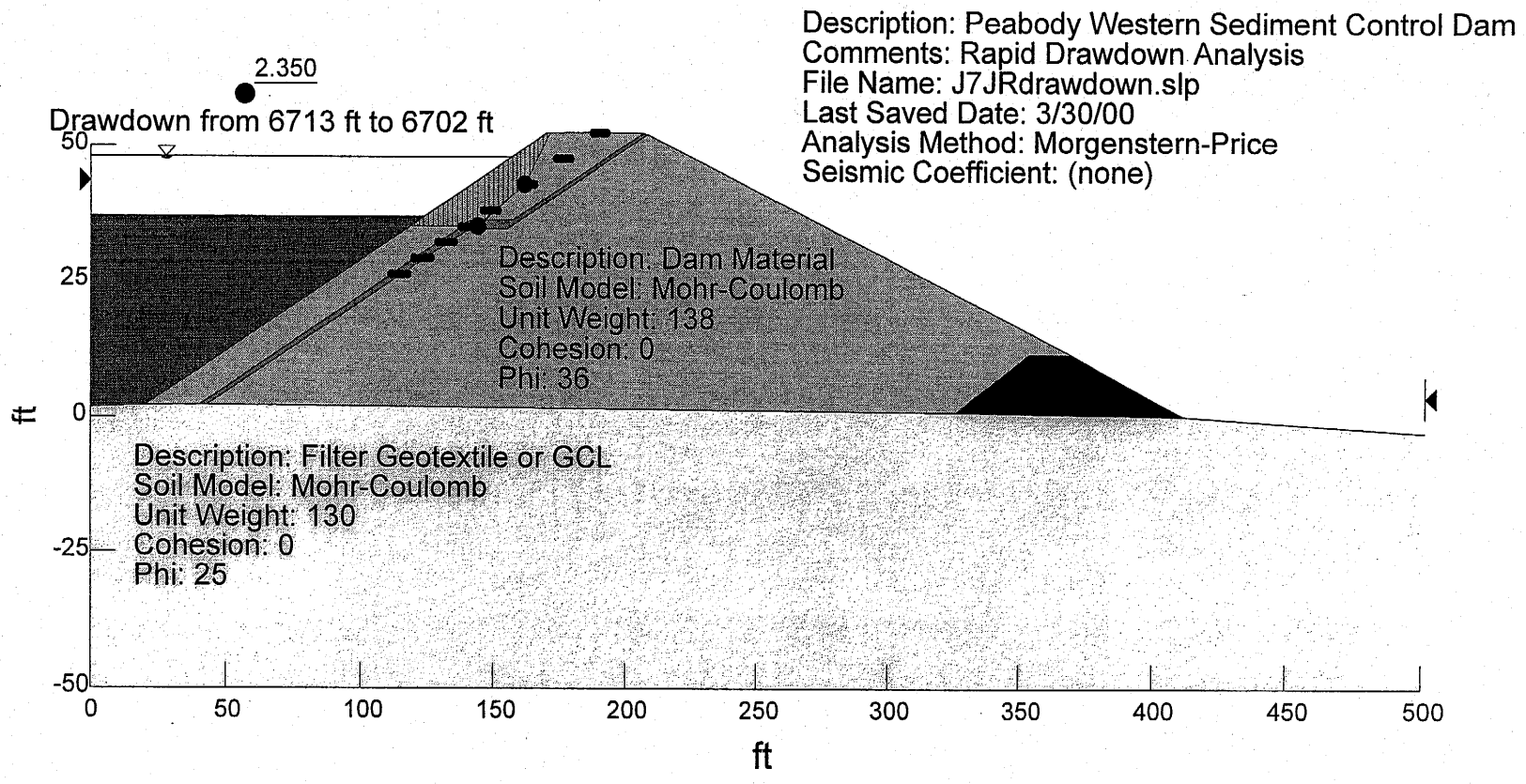
References:

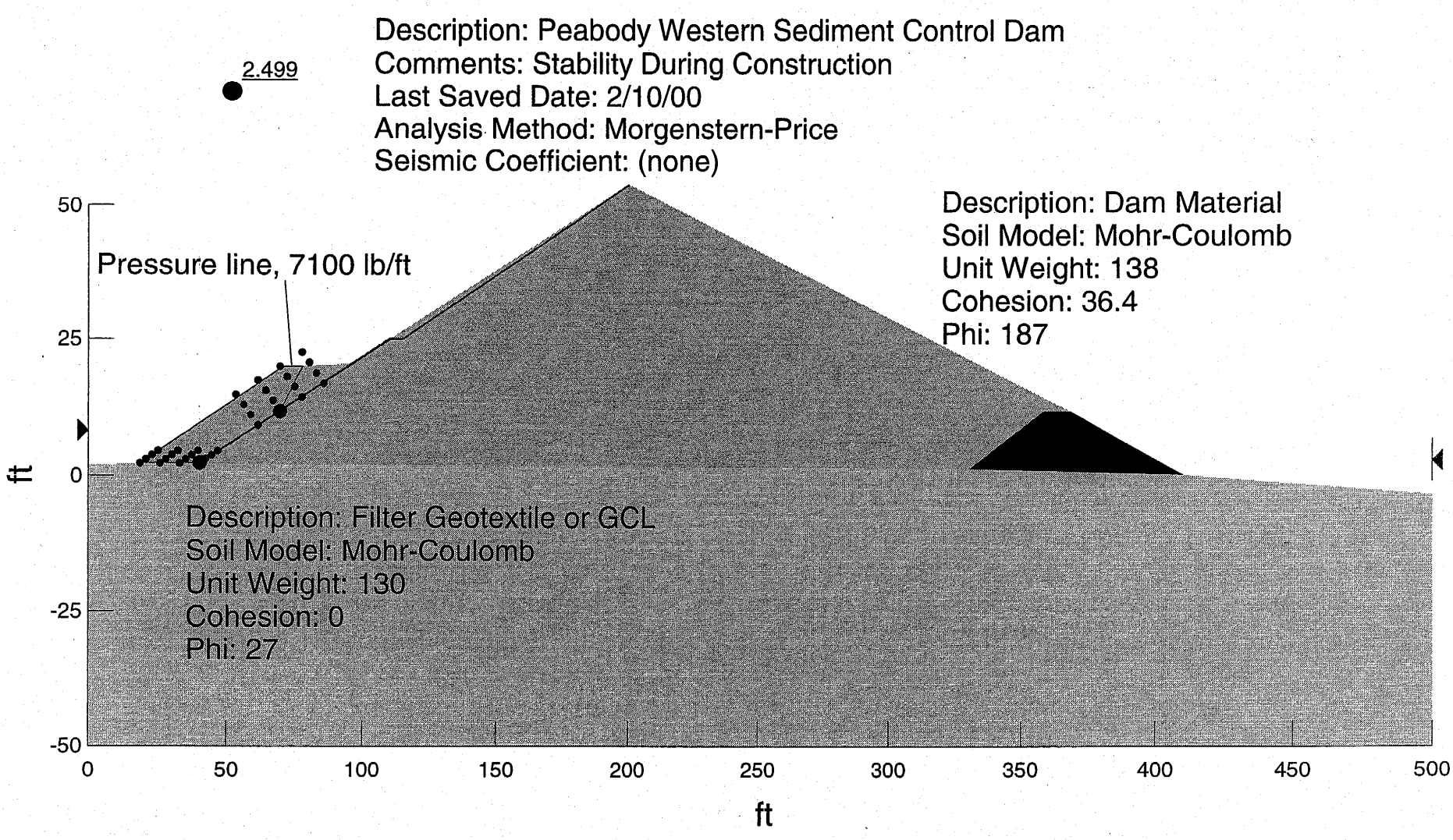
"Soil Mechanics", Lambe, T.W. and Whitman, R.V. (1969) John Wiley and Sons, Inc., New York, 553 pp.

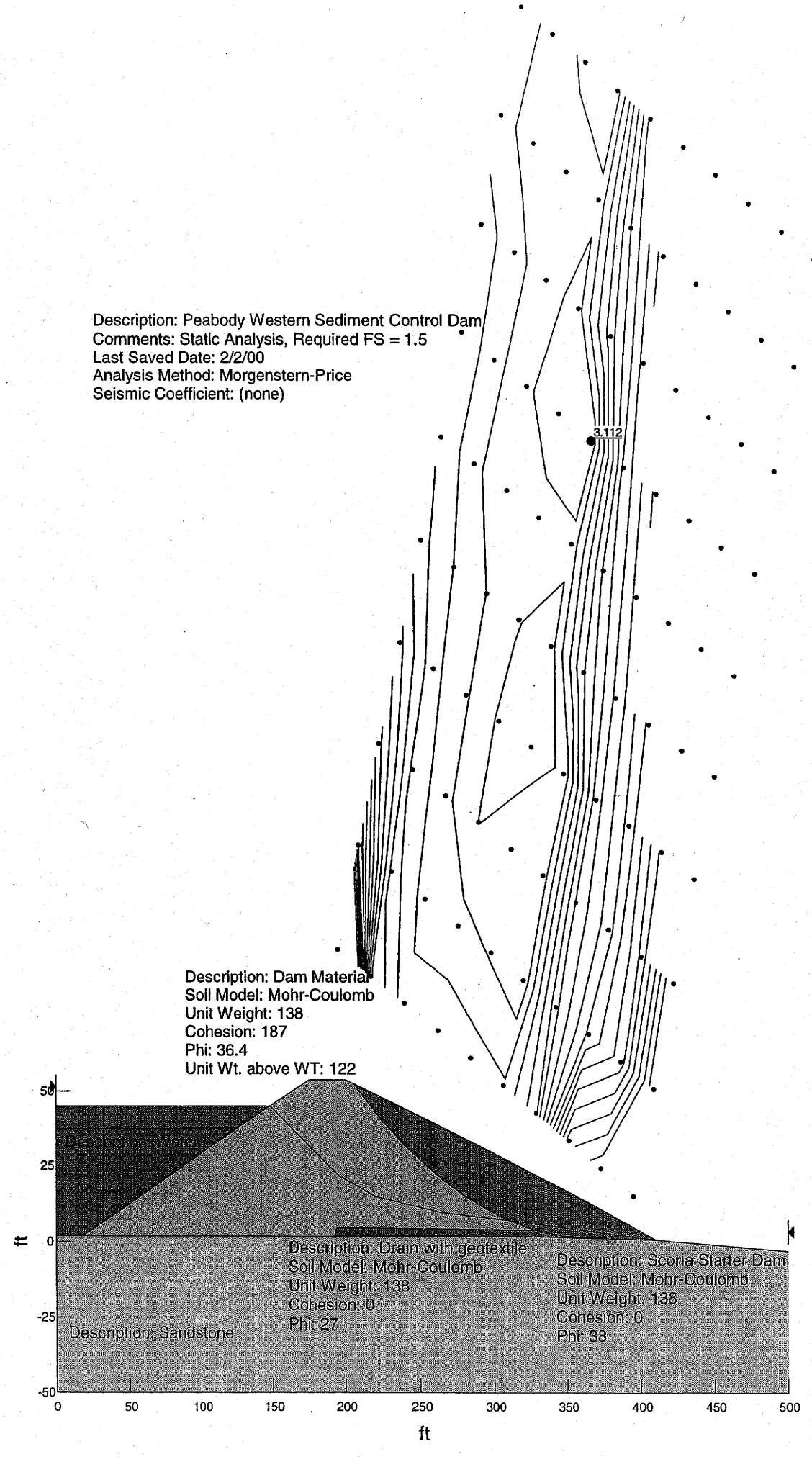
"Slope/W Users Manual," Geoslope International Ltd. (1995) Calgary, Canada.

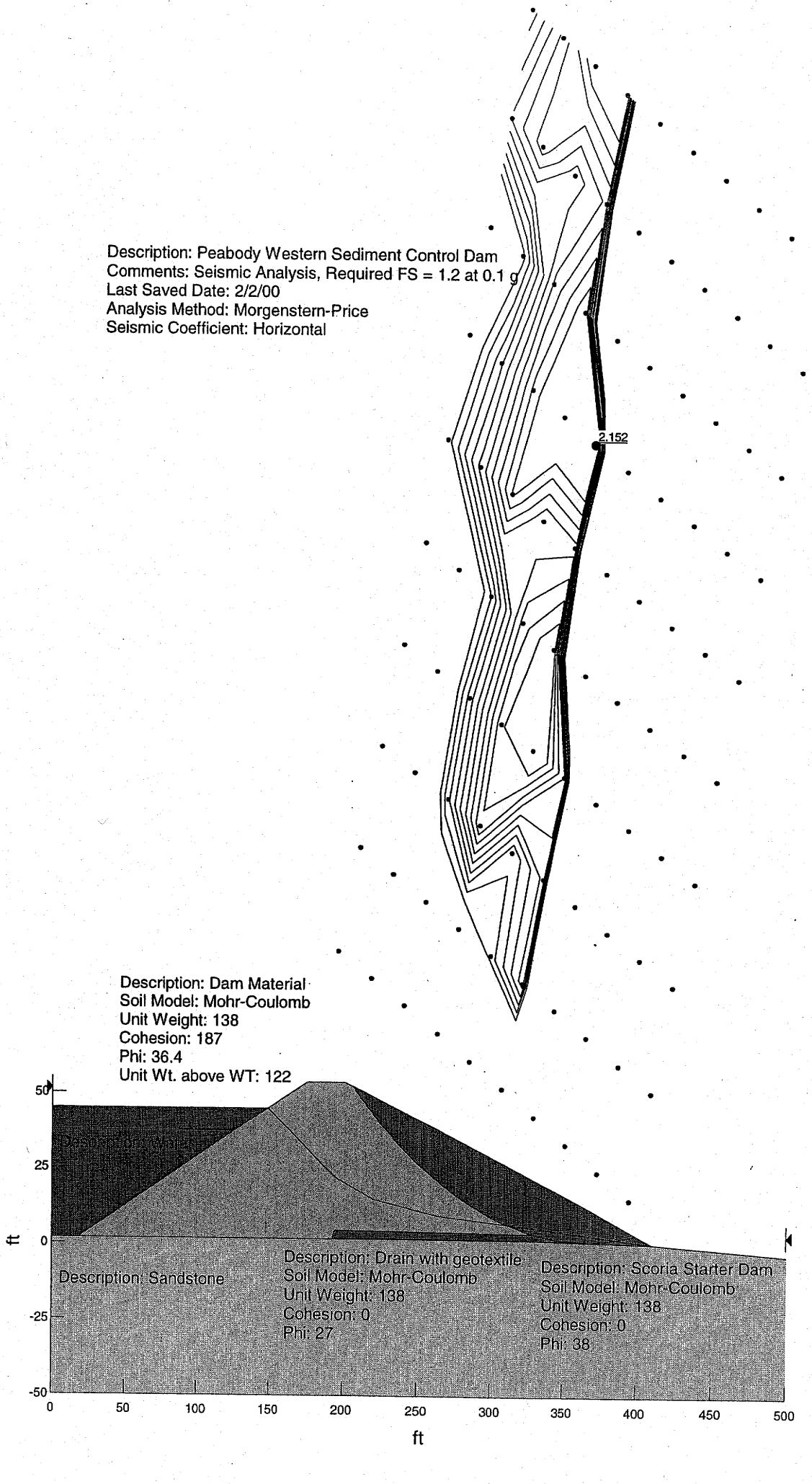

Description: Peabody Western Sediment Control Dam
Last Saved Date: 2/14/00
Analysis Method: Morgenstern-Price
Seismic Coefficient: (none)
Static Analysis
2.519
Description: Dam Material
Soil Model: Mohr-Coulomb
Unit Weight: 138
Cohesion: 187
Phi: 36.4
Description: Water
Description: Filter Geotextile or GCL
Soil Model: Mohr-Coulomb
Unit Weight: 130
Cohesion: 0
Phi: 27
Description: Sandstone
ft
50
25
0
-25
-50
0
50
100
150
200
250
300
350
400
450
500
ft


Description: Peabody Western Sediment Control Dam
Comments: Seismic Load during operation = 0.04 g, required FS = 1.2
Last Saved Date: 2/14/00
Analysis Method: Morgenstern-Price
Seismic Coefficient: Horizontal
2.054
Description: Water
Description: Dam Material
Soil Model: Mohr-Coulomb
Unit Weight: 138
Cohesion: 187
Phi: 36.4
Description: Filter Geotextile or GCL
Soil Model: Mohr-Coulomb
Unit Weight: 130
Cohesion: 0
Phi: 27
Description: Sandstone
ft
50
25
0
-25
-50
0
50
100
150
200
250
300
350
400
450
500
ft

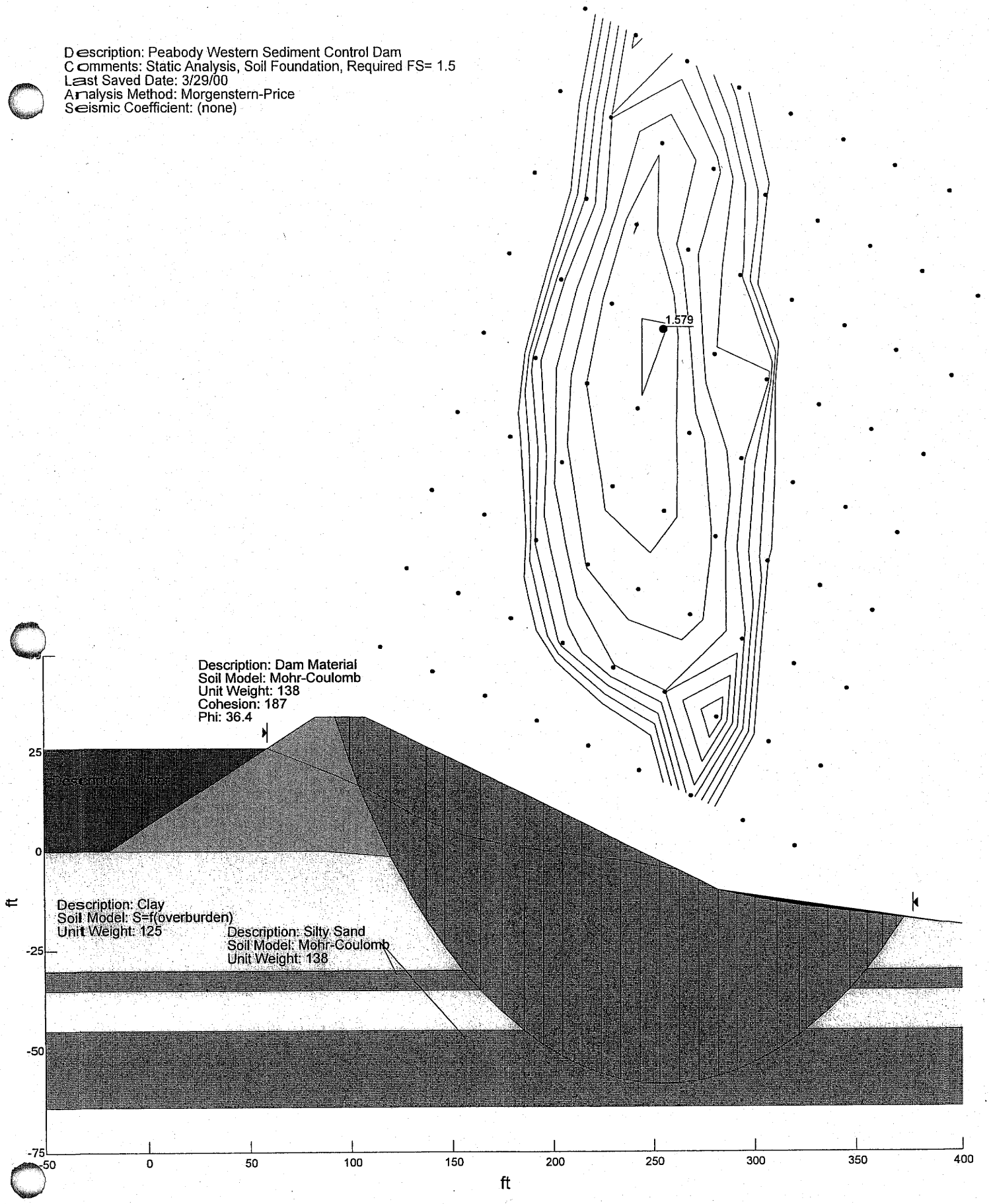

Description: Peabody Western Sediment Control Dam
Comments: Rapid Drawdown Analysis
File Name: J7JRdrawdown.slp
Last Saved Date: 3/30/00
Analysis Method: Morgenstern-Price
Seismic Coefficient: (none)
2.350
Drawdown from 6713 ft to 6702 ft
Description: Dam Material
Soil Model: Mohr-Coulomb
Unit Weight: 138
Cohesion: 0
Phi: 36
Description: Filter Geotextile or GCL
Soil Model: Mohr-Coulomb
Unit Weight: 130
Cohesion: 0
Phi: 25
50
25
0
-25
-50
ft
0
50
100
150
200
250
300
350
400
450
500
ft

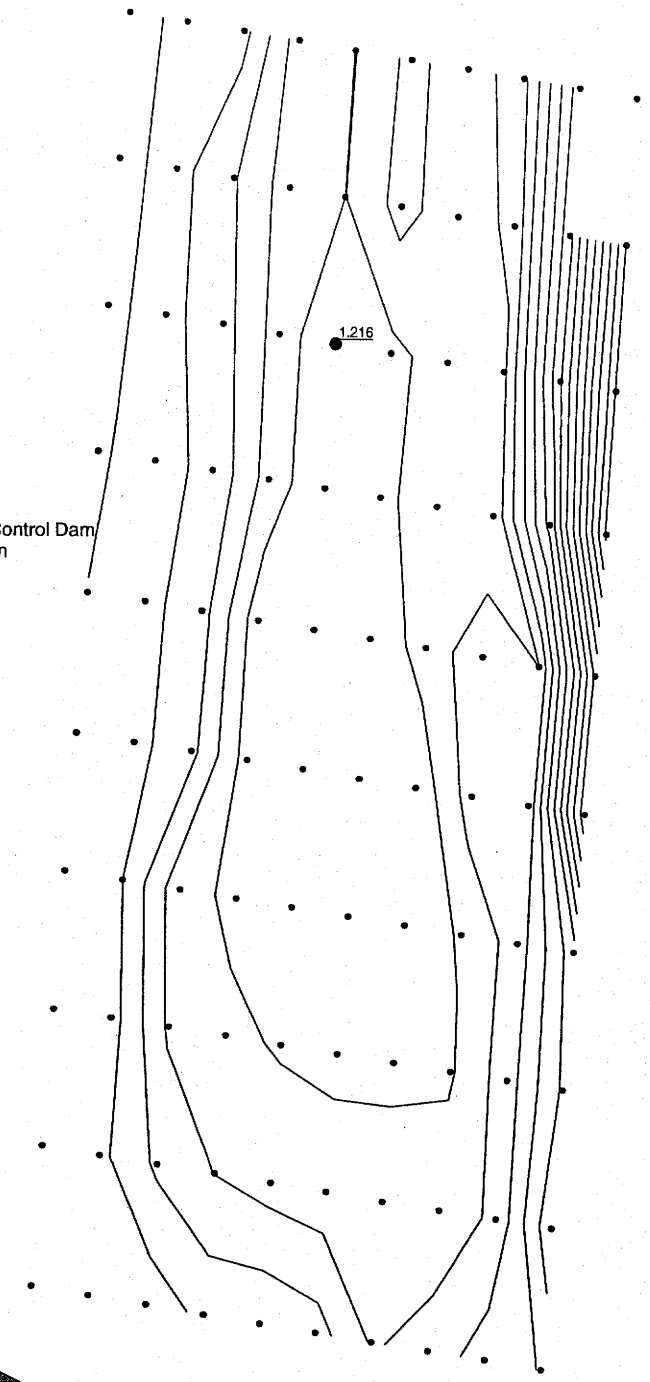

Description: Peabody Western Sediment Control Dam
Comments: Stability During Construction
Last Saved Date: 2/10/00
Analysis Method: Morgenstern-Price
Seismic Coefficient: (none)
2.499
Description: Dam Material
Soil Model: Mohr-Coulomb
Unit Weight: 138
Cohesion: 36.4
Phi: 187
Pressure line, 7100 lb/ft
Description: Filter Geotextile or GCL
Soil Model: Mohr-Coulomb
Unit Weight: 130
Cohesion: 0
Phi: 27
50
25
0
-25
-50
ft
0
50
100
150
200
250
300
350
400
450
500
ft


Description: Peabody Western Sediment Control Dam
Comments: Static Analysis, Required FS = 1.5
Last Saved Date: 2/2/00
Analysis Method: Morgenstern-Price
Seismic Coefficient: (none)
3.112
Description: Dam Material
Soil Model: Mohr-Coulomb
Unit Weight: 138
Cohesion: 187
Phi: 36.4
Unit Wt. above WT: 122
Description: Drain with geotextile
Soil Model: Mohr-Coulomb
Unit Weight: 138
Cohesion: 0
Phi: 27
Description: Scoria Starter Dam
Soil Model: Mohr-Coulomb
Unit Weight: 138
Cohesion: 0
Phi: 38
Description: Sandstone
50
25
0
-25
-50
ft
0
50
100
150
200
250
300
350
400
450
500
ft

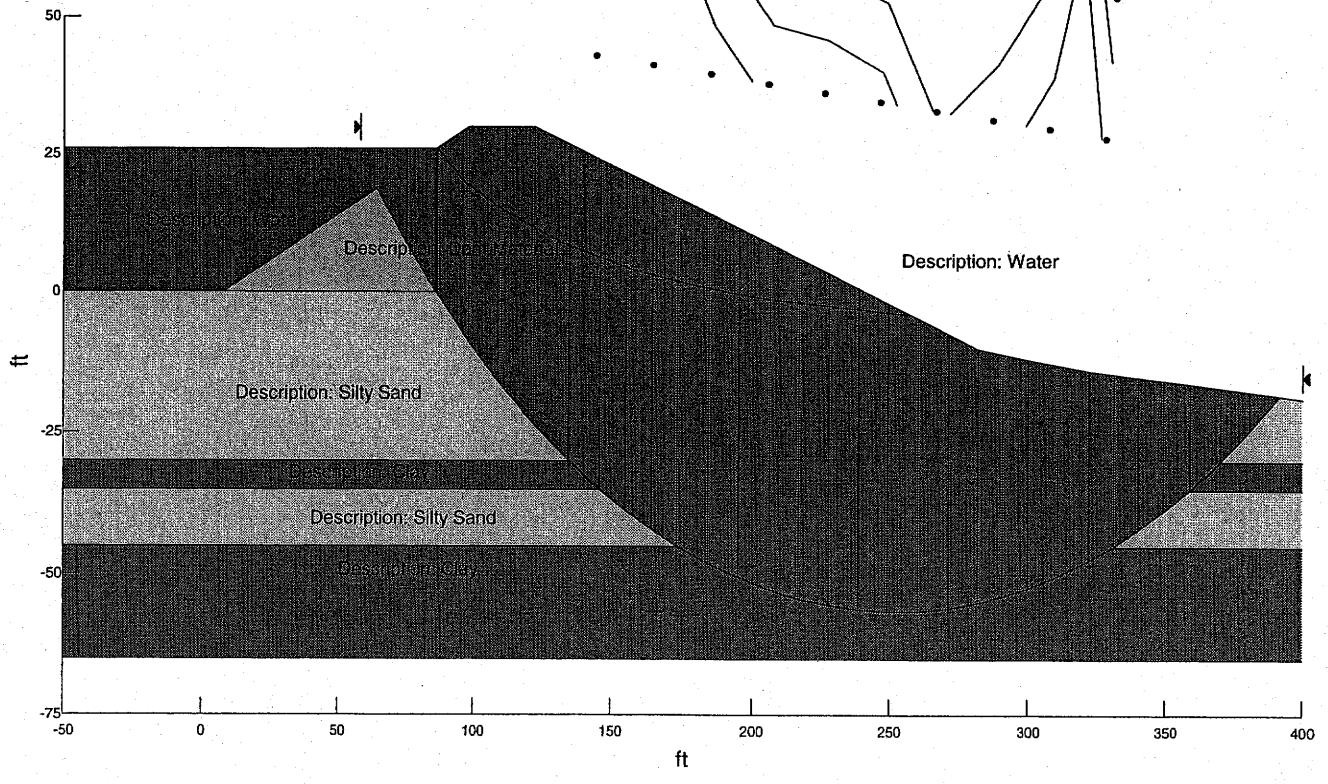

Description: Peabody Western Sediment Control Dam
Comments: Seismic Analysis, Required FS = 1.2 at 0.1 g
Last Saved Date: 2/2/00
Analysis Method: Morgenstern-Price
Seismic Coefficient: Horizontal
2.152
Description: Dam Material
Soil Model: Mohr-Coulomb
Unit Weight: 138
Cohesion: 187
Phi: 36.4
Unit Wt. above WT: 122
Description: Sandstone
Description: Drain with geotextile
Soil Model: Mohr-Coulomb
Unit Weight: 138
Cohesion: 0
Phi: 27
Description: Scoria Starter Dam
Soil Model: Mohr-Coulomb
Unit Weight: 138
Cohesion: 0
Phi: 38
50
25
0
-25
-50
ft
0
50
100
150
200
250
300
350
400
450
500
ft

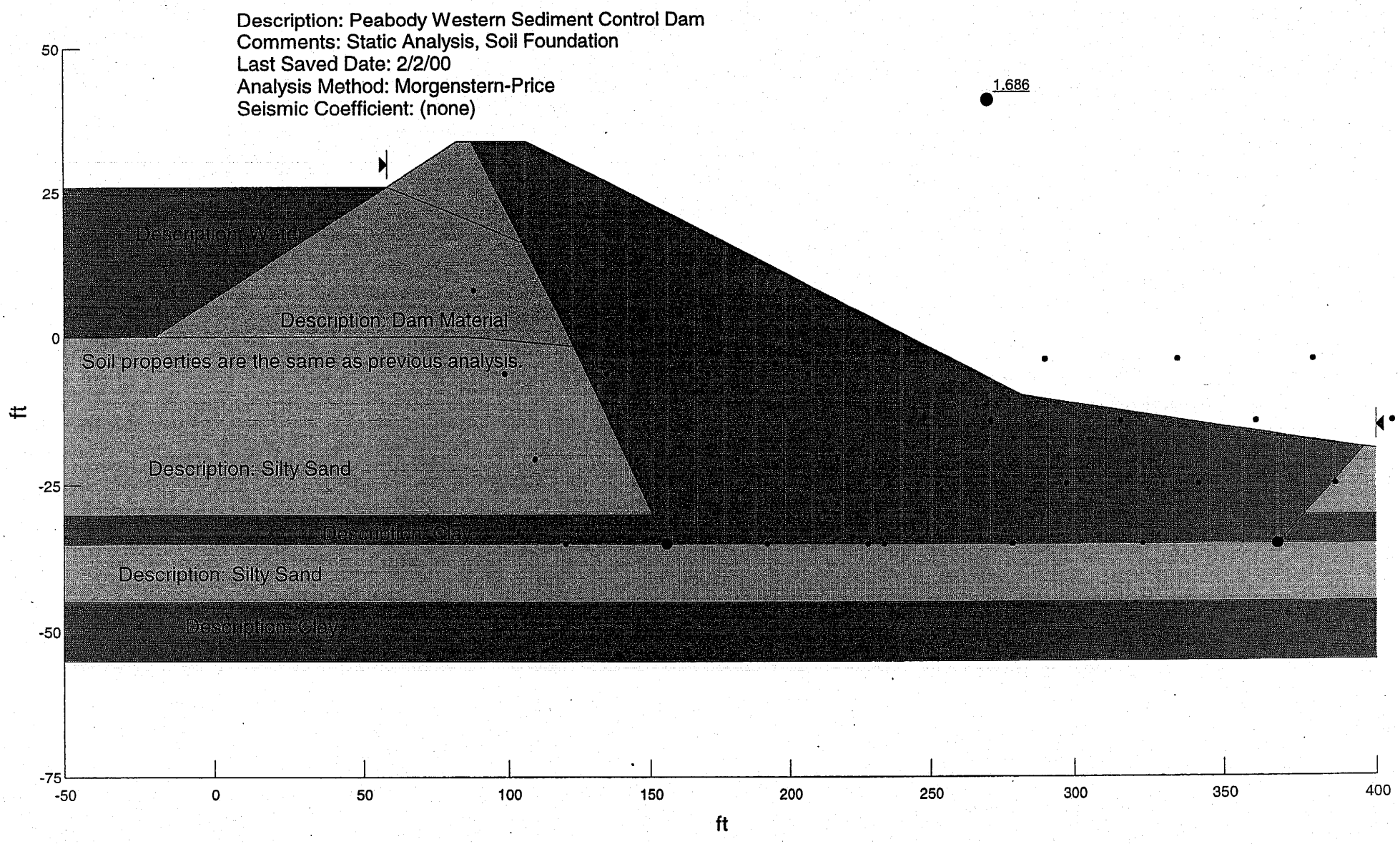
Description: Peabody Western Sediment Control Dam
Comments: Static Analysis, Soil Foundation, Required FS= 1.5
Last Saved Date: 3/29/00
Analysis Method: Morgenstern-Price
Seismic Coefficient: (none)





Description: Peabody Western Sediment Control Dam
Comments: Static Analysis, Soil Foundation
Last Saved Date: 3/29/00
Analysis Method: Morgenstern-Price
Seismic Coefficient: Horizontal




Description: Peabody Western Sediment Control Dam
Comments: Static Analysis, Soil Foundation
Last Saved Date: 2/2/00
Analysis Method: Morgenstern-Price
Seismic Coefficient: (none)
1.686
Description: Water
Description: Dam Material
Soil properties are the same as previous analysis.
Description: Silty Sand
Description: Clay
Description: Silty Sand
Description: Clay
50
25
0
-25
-50
-75
ft
-50
0
50
100
150
200
250
300
350
400
ft

From: "Soil Mechanics" Lambe and Whitman, 1969

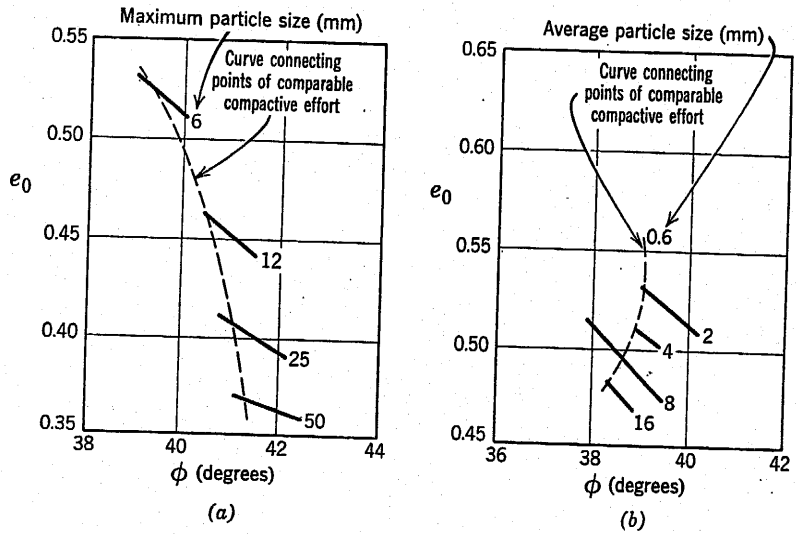


Fig. 11.12 Effect of particle size and gradation on friction angle. (*a*) Soils with same minimum particle size (0.5 mm). (*b*) Soils with same uniformity coefficient. Data from Leslie (1963).

particle size increases the load per particle, and hence crushing begins at a smaller confining stress. Spurred by the increasing popularity of rockfill dams, several laboratories have constructed triaxial testing systems which can accommodate specimens as large as 12 in. in diameter. An apparatus that can test specimens 3.7 ft in diameter and 8.2 ft long has been constructed in Mexico (Marsal, 1963).

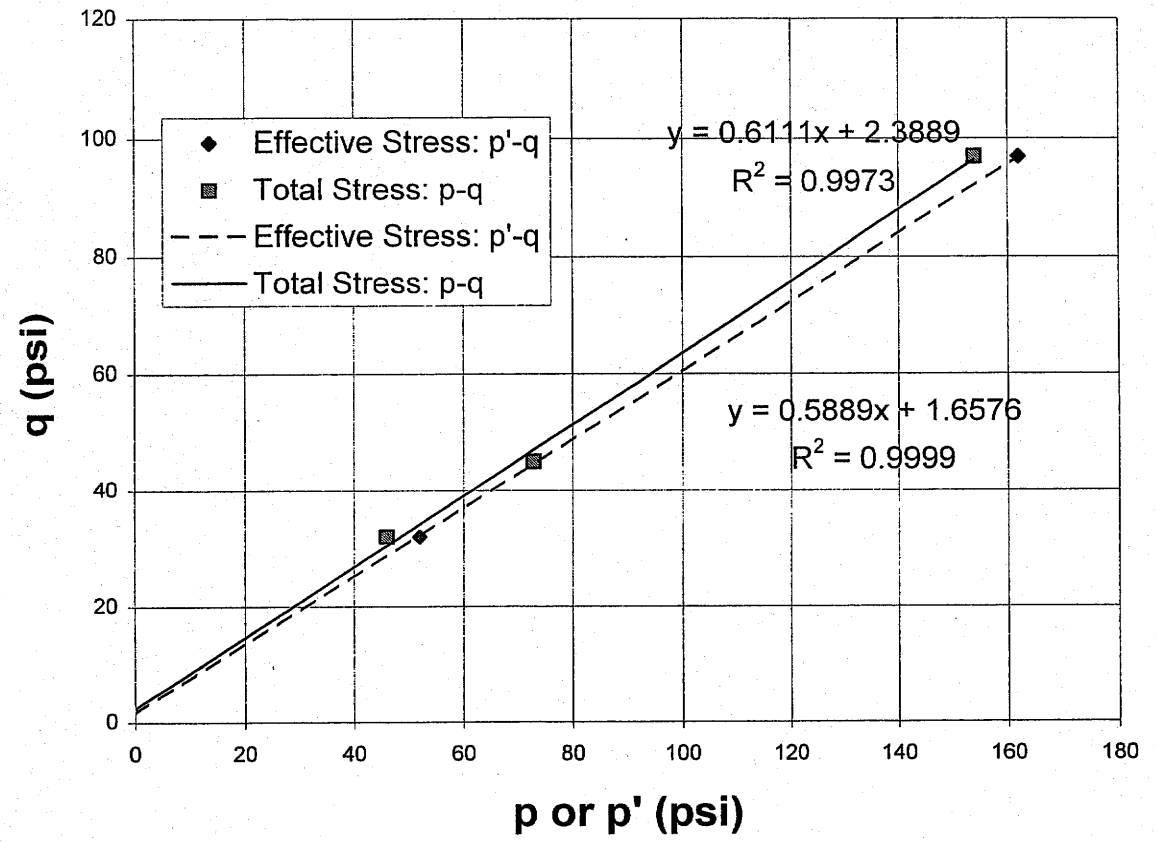
Grading of the Sand

Figure 11.12*a* shows data for four soils all having the same minimum particle size but different maximum

If these particles are numerous enough so that they interlock with each other, it is important that these large particles be present in the test specimen. However, if these larger particles are just embedded in a matrix of much smaller particles so that the shearing takes place through the matrix, then the large particles can safely be omitted from the specimen. Unfortunately, the profession still is lacking definitive guides as to what constitutes a satisfactory test upon a gravelly soil.

A well-graded soil experiences less breakdown than a uniform soil of the same particle size, since in a well-

CU Triaxial Shear Data Stress Path Plot



Point Number	p	p'	q
A	46	52	32
B	73	73	45
C	154	162	97

$\sin\phi = \tan\alpha$ and $c = a/\cos\phi$

Total Stress Parameters:

$p = (\sigma_1 + \sigma_3)/2$ $q = (\sigma_1 - \sigma_3)/2$

slope =	0.611	intercept =	2.389
α =	31.4	a:	2.4
ϕ =	37.7	c (psi)=	3.0

Effective Stress Parameters:

$p' = (\sigma_1' + \sigma_3')/2$ $q = (\sigma_1 - \sigma_3)/2$

slope =	0.589	intercept =	1.658
α' =	30.5	a':	1.7
ϕ' =	36.1	c' (psi)=	2.1

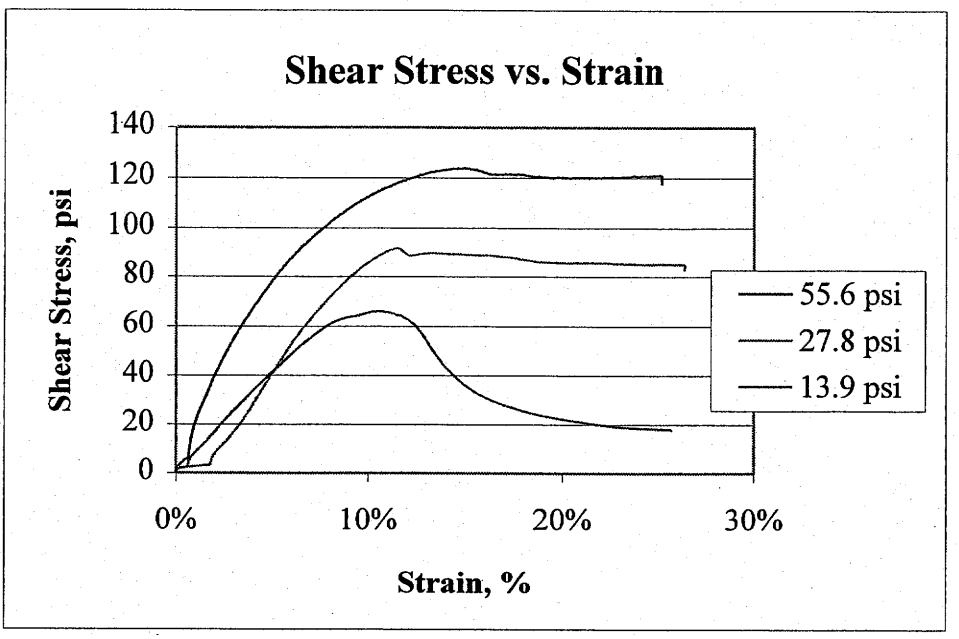
Golder Lab Results:

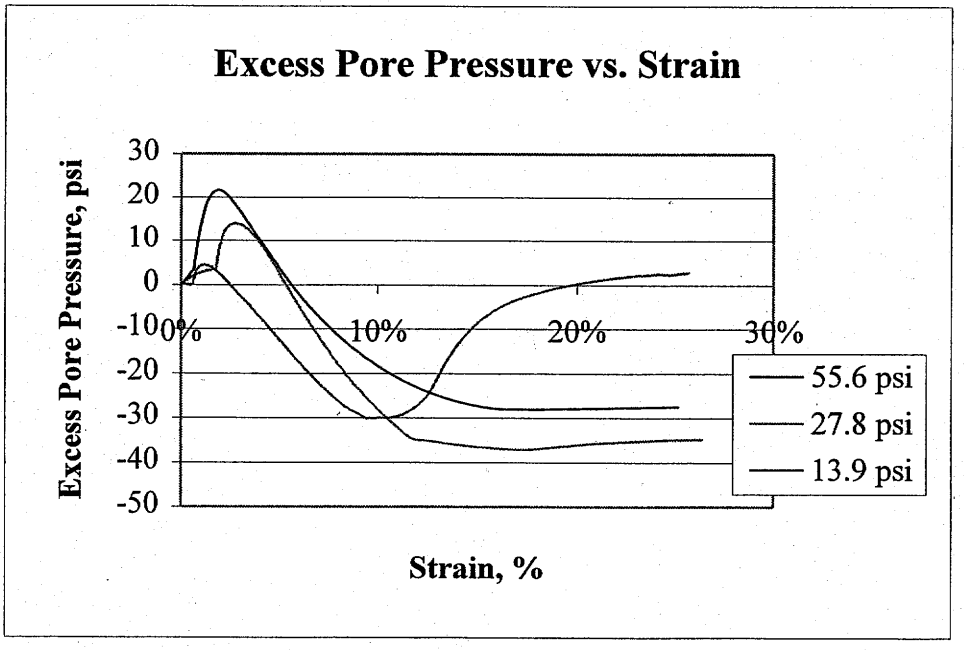
ϕ =	38.1	c (psi)=	2.2
ϕ' =	36.4	c' (psi)=	1.3

Sample # =	TP6-200		Sample # =	TP6-200		Sample # =	TP6-200	
Point # =	A		Point # =	B		Point # =	C	
	Initial			**Initial**			**Initial**	
Length =	14.73	cm	Length =	14.53	cm	Length =	14.73	cm
Diameter =	7.27	cm	Diameter =	7.30	cm	Diameter =	7.30	cm
Wet Weight =	1195.50	g	Wet Weight =	1196.30	g	Wet Weight =	1197.30	g
Area =	41.5	sq.cm	Area =	41.9	sq.cm	Area =	41.9	sq.cm
Sample Area =	6.43	sq. in.	Sample Area =	6.49	sq. in.	Sample Area =	6.49	sq. in.
Volume =	611.4	cc	Volume =	608.1	cc	Volume =	616.5	cc
Moisture Content =	10.4%		Moisture Content =	10.4%		Moisture Content =	10.4%	
Specific Gravity =	2.7		Specific Gravity =	2.7		Specific Gravity =	2.7	
Dry Weight of Solids =	1082.88	g	Dry Weight of Solids =	1083.61	g	Dry Weight of Solids =	1084.51	g
Wet Density =	1.96	g/cc	Wet Density =	1.97	g/cc	Wet Density =	1.94	g/cc
Dry Density =	1.77	g/cc	Dry Density =	1.78	g/cc	Dry Density =	1.76	g/cc
Wet Density =	122.0	pcf	Wet Density =	122.8	pcf	Wet Density =	121.2	pcf
Dry Density =	110.5	pcf	Dry Density =	111.2	pcf	Dry Density =	109.8	pcf
Cell Pressure =	100	psi	Cell Pressure =	100	psi	Cell Pressure =	100	psi
Back Pressure =	44.4	psi	Back Pressure =	72.2	psi	Back Pressure =	86.1	psi
Confining Pressure =	55.6	psi	Confining Pressure =	27.8	psi	Confining Pressure =	13.9	psi

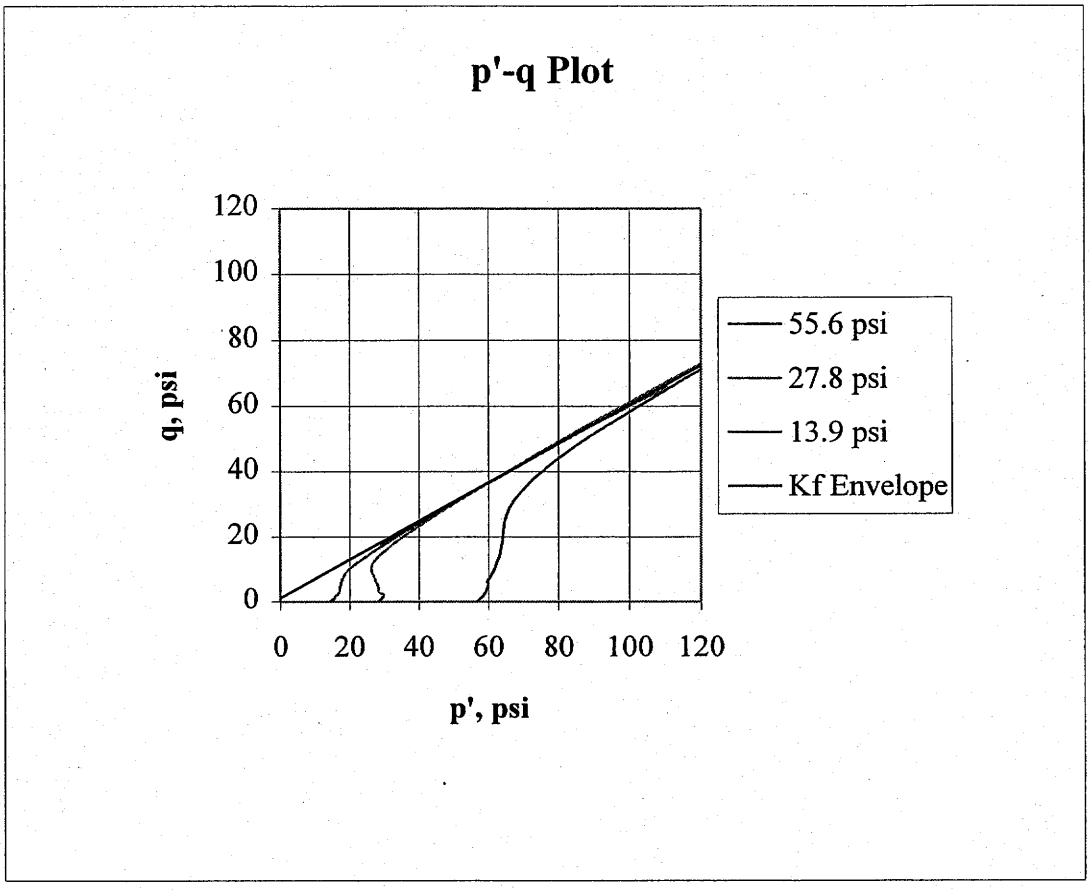
Notes:

Golder Associates, Inc. **Denver, Colorado**			**Title:** **TRIAXIAL SHEAR TEST REPORT** **SAMPLE DATA AND CALCULATIONS**		
Job Short Title: **Terramatrix/Lab Testing/CO**					
Sample No. **TP6-200**	**Depth** **95% Comp**	**Reviewed:**	**Date:** Jan. 2000	**Job Number:** 003-2111	**Figure:** 1





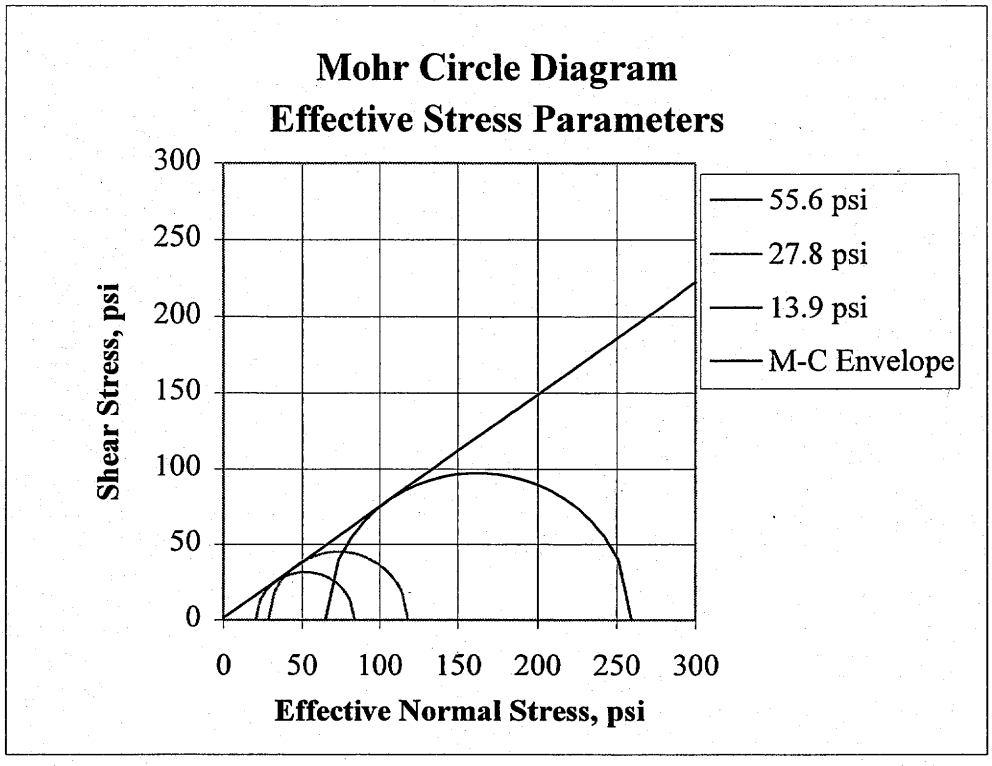
Golder Associates, Inc. **Denver, Colorado**			**Title:** **CU TRIAXIAL SHEAR DATA** **STRESS AND Δ PORE PRESSURE PLOTS**		
Job Short Title: **Terramatrix/Lab Testing/CO**					
Sample No. TP6-200	Depth 95% Comp	Reviewed:	**Date:** Jan. 2000	**Job Number:** 003-2111	**Figure:** 2



Stress Path Parameters

ψ' = 30.7 degrees
a' = 1.0 psi

Golder Associates, Inc. Denver, Colorado			**Title:** CU TRIAXIAL SHEAR DATA STRESS PATH PLOT		
Job Short Title: Terramatrix/Lab Testing/CO					
Sample No.	Depth	Reviewed:	**Date:**	**Job Number:**	**Figure:** 3
TP6-200	95% Comp		Jan. 2000	003-2111	



Mohr-Coulomb Parameters

$\phi' =$ 36.4 degrees
$c' =$ 1.3 psi

Golder Associates, Inc. **Denver, Colorado**			**Title:** **CU TRIAXIAL SHEAR DATA** **MOHR CIRCLE DIAGRAM**		
Job Short Title: **Terramatrix/Lab Testing/CO**					
Sample No. TP6-200	Depth 95% Comp	Reviewed:	**Date:** Jan. 2000	**Job Number:** 003-2111	**Figure:** 4

Triaxial Consolidated Undrained Lab Data

From: GOLDER ASSOCIATES INC.

Project: **Terramatrix/Lab Testing/CO**

Project Number: **003-2111**

Sample Number	TP6-200
Depth	95% Comp
Effective Stress Analysis	

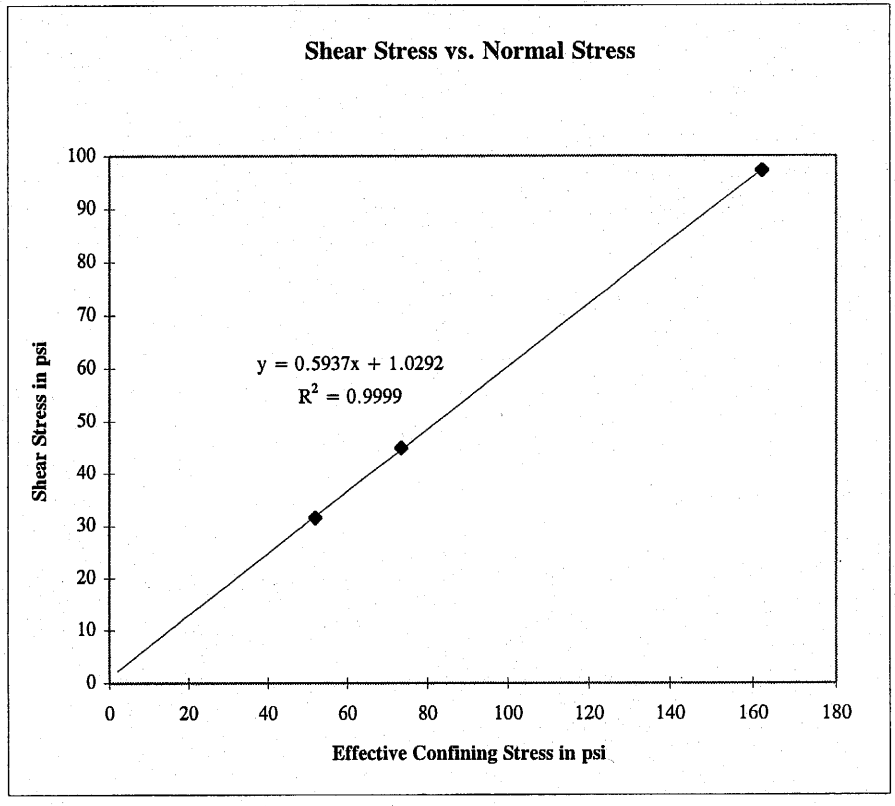
Point Number	P' (psi)	Q (psi)
A	162	97
B	73	45
C	52	32

Slope = 0.5937

Intercept= 1.0292

ϕ' = 36.4 degrees

c' = 1.3 psi



Triaxial Consolidated Undrained Lab Data

From: GOLDER ASSOCIATES INC.

Project: **Terramatrix/Lab Testing/CO**

Project Number: **003-2111**

Sample Number	TP6-200
Depth	95% Comp
Total Stress Analysis	

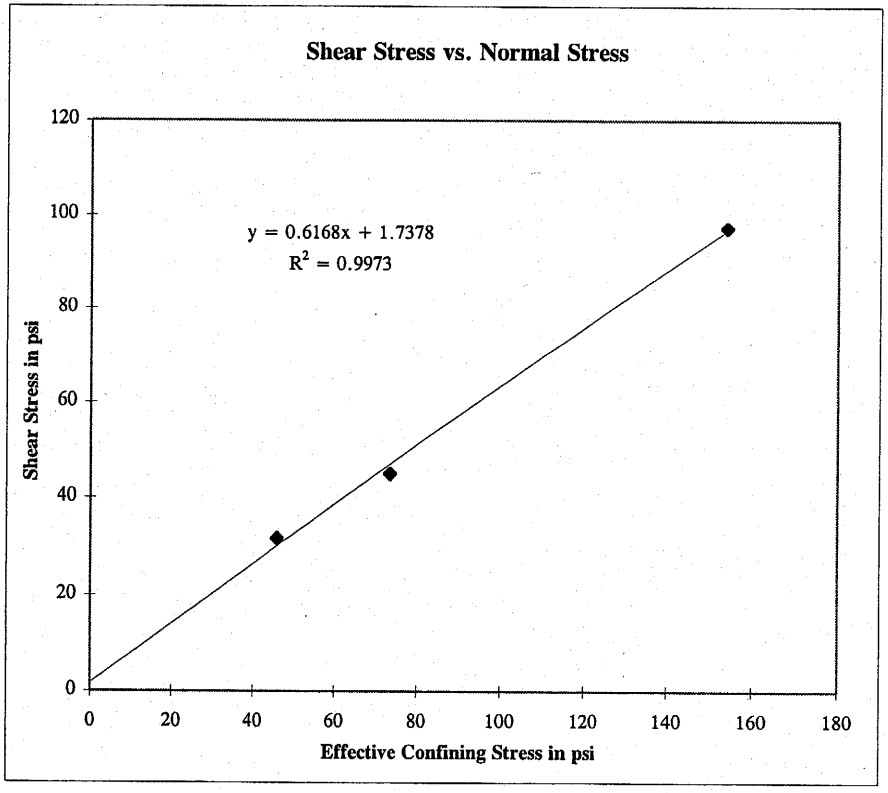
Point Number	P-Uo (psi)	Q (psi)
A	154	97
B	73	45
C	46	32

Slope = 0.6168

Intercept= 1.7378

ϕ = 38.1 degrees

c = 2.2 psi



PARTICLE-SIZE ANALYSIS OF SOILS

ASTM C 117, C 136, D 421, D 422, D 1140, D 2216, D 2217

TERRAMATRIX/LAB TESTING/CO 953-2903	SAMPLE #: N6 SCORIA DEPTH (ft):

MOISTURE CONTENT (As tested)

Tare	9A
Weight Wet Soil & Tare, g	292.97
Weight Dry Soil & Tare, g	285.19
Weight Tare, g	33.93
Weight Water, g	7.78
Weight Dry Soil, g	251.26
Moisture, %	**3.10%**

#200 WASH (Percent Fines)

Tare	-
Weight Soil & Tare Before Wash, g	-
Weight Soil & Tare After Wash, g	-
Weight Tare, g	-
Weight Fines Lost, g	-
Weight Dry Soil, g	20,724.68
Fines Lost, %	-

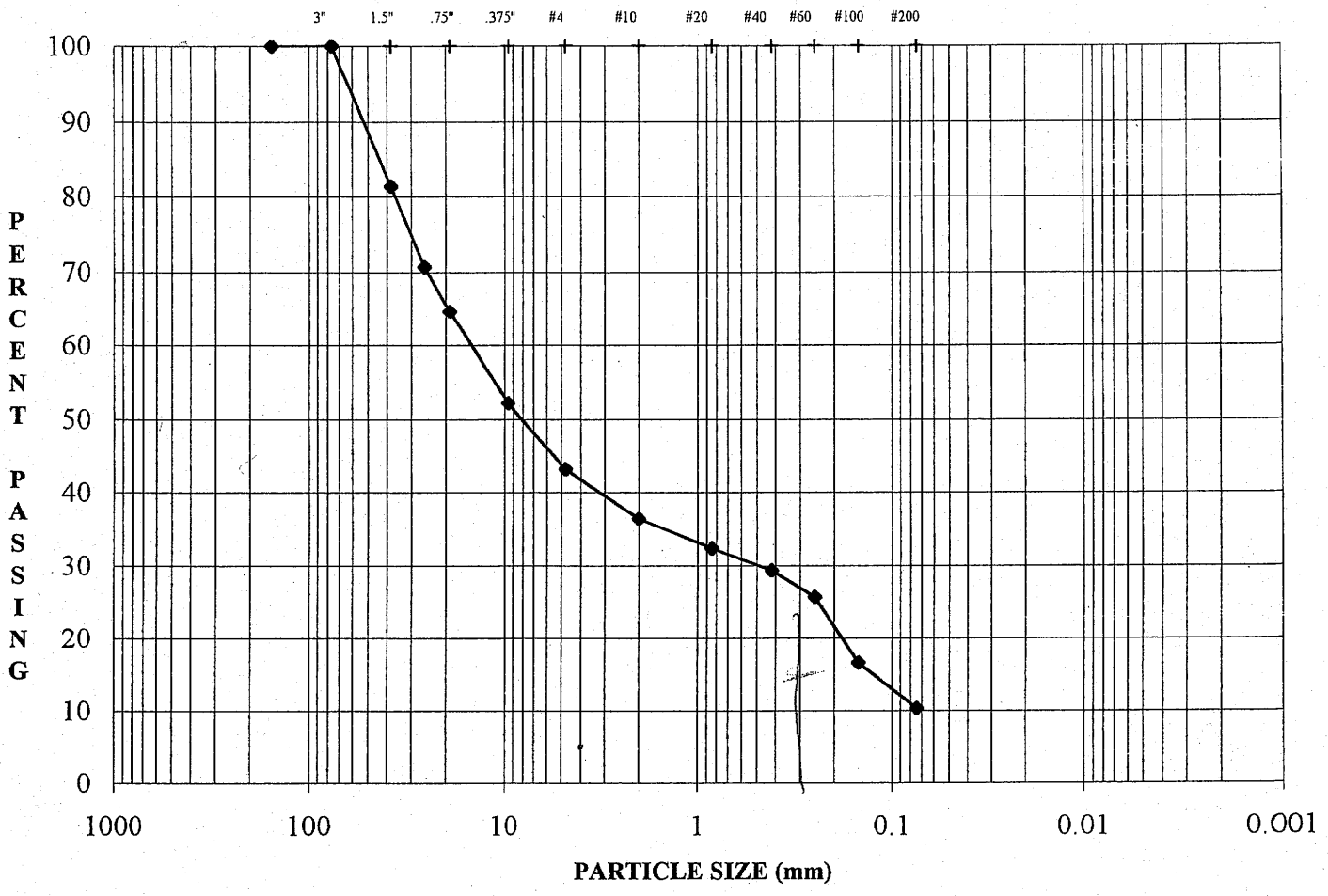
	SIEVE	Wt. Ret.	% Ret.	% Pass.	SIEVE
	6.000"	0.00	0.00%	**100.00%**	6.000"
Coarse Gravel	3.000"	0.00	0.00%	**100.00%**	3.000" Coarse Gravel
	1.500"	3,855.40	18.60%	**81.40%**	1.500"
	1.000"	6,078.30	29.33%	**70.67%**	1.000"
Fine Gravel	0.750"	7,313.00	35.29%	**64.71%**	0.750" Fine Gravel
	0.375"	9,911.30	47.82%	**52.18%**	0.375"
Coarse Sand	#4	11,781.50	56.85%	**43.15%**	#4 Coarse Sand
Medium Sand	#10	13,185.34	63.62%	**36.38%**	#10 Medium Sand
	#20	14,037.18	67.73%	**32.27%**	#20
Fine Sand	#40	14,648.16	70.68%	**29.32%**	#40 Fine Sand
	#60	15,409.06	74.35%	**25.65%**	#60
	#100	17,292.60	83.44%	**16.56%**	#100
	#200	18,596.01	89.73%	**10.27%**	#200
Fines	PAN	20,724.68	0.00%	**100.00%**	PAN Fines

% C GRVL:	**35.3%**	
% F GRVL:	**21.6%**	56.8%
% C SAND:	**6.8%**	
% M SAND:	**7.1%**	
% F SAND:	**19.0%**	32.9%
% FINES:	**10.3%**	
% TOTAL:	**100.0%**	

Wet Color:	**Fine to coarse GRAVEL**
Description:	**and fine to coarse sand, little silt (GP-GM)**
LL:	**NP**
PL:	**NP**
PI:	**NP**
Gs:	**Gs**
DATE:	08-Nov-99
TECH:	MJK
REVIEW:	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE-SIZE DISTRIBUTION ASTM D 421 AND D 422
US STANDARD SIEVE OPENING SIZES



	Coarse	Fine	Cor	Med	Fine	Silt or Clay Size
COBBLES	GRAVEL		SAND			FINES

SAMPLE #:	N6 SCORIA	MC (As tested):	3.1%
DEPTH (ft):		LL:	NP
		PL:	NP
DESCRIPTION:	Fine to coarse GRAVEL and fine to coarse sand, little silt (GP-GM)	PI:	NP
		Gs:	Gs

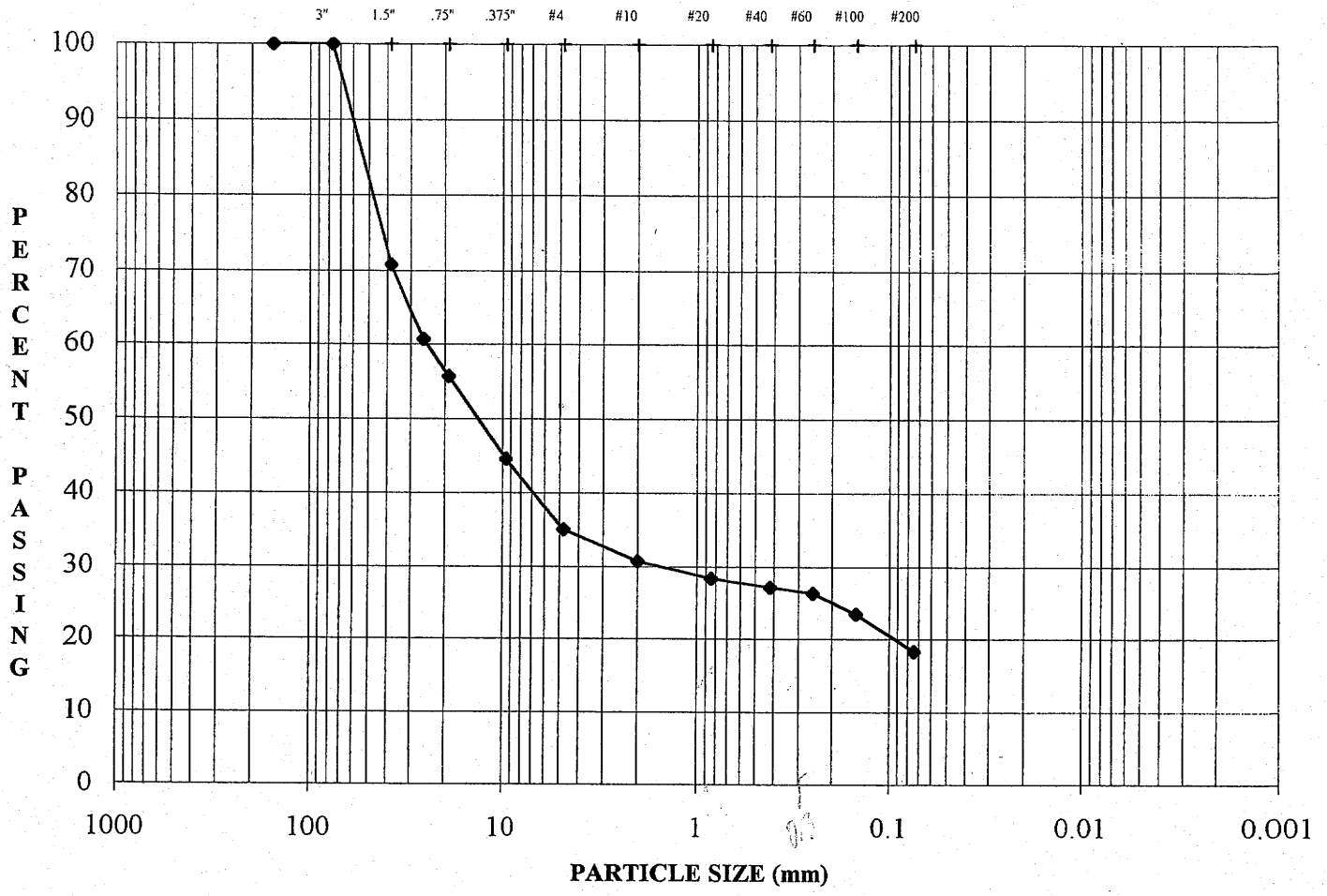
TERRAMATRIX/LAB TESTING/CO
953-2903

08-Nov-99
MJK
DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

$C_u = \frac{15}{0.08} = 190$

PARTICLE-SIZE DISTRIBUTION ASTM D 421 AND D 422
US STANDARD SIEVE OPENING SIZES



COBBLES	Coarse	Fine	Cor	Med	Fine	Silt or Clay Size
	GRAVEL		SAND			FINES

SAMPLE #:	**J19 SCORIA**	**MC (As tested):**	**4.3%**
DEPTH (ft):		**LL:**	**NP**
		PL:	**NP**
DESCRIPTION:	**Fine to coarse GRAVEL with some fine to coarse sand, some silt (GM)**	**PI:**	**NP**
		Gs:	**Gs**

TERRAMATRIX/LAB TESTING/CO
953-2903

08-Nov-99
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GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM C 117, C 136, D 421, D 422, D 1140, D 2216, D 2217

TERRAMATRIX/LAB TESTING/CO 953-2903	SAMPLE #: J19 SCORIA DEPTH (ft):

MOISTURE CONTENT (As tested)

Tare	6A
Weight Wet Soil & Tare, g	326.19
Weight Dry Soil & Tare, g	314.00
Weight Tare, g	31.91
Weight Water, g	12.19
Weight Dry Soil, g	282.09
Moisture, %	**4.32%**

#200 WASH (Percent Fines)

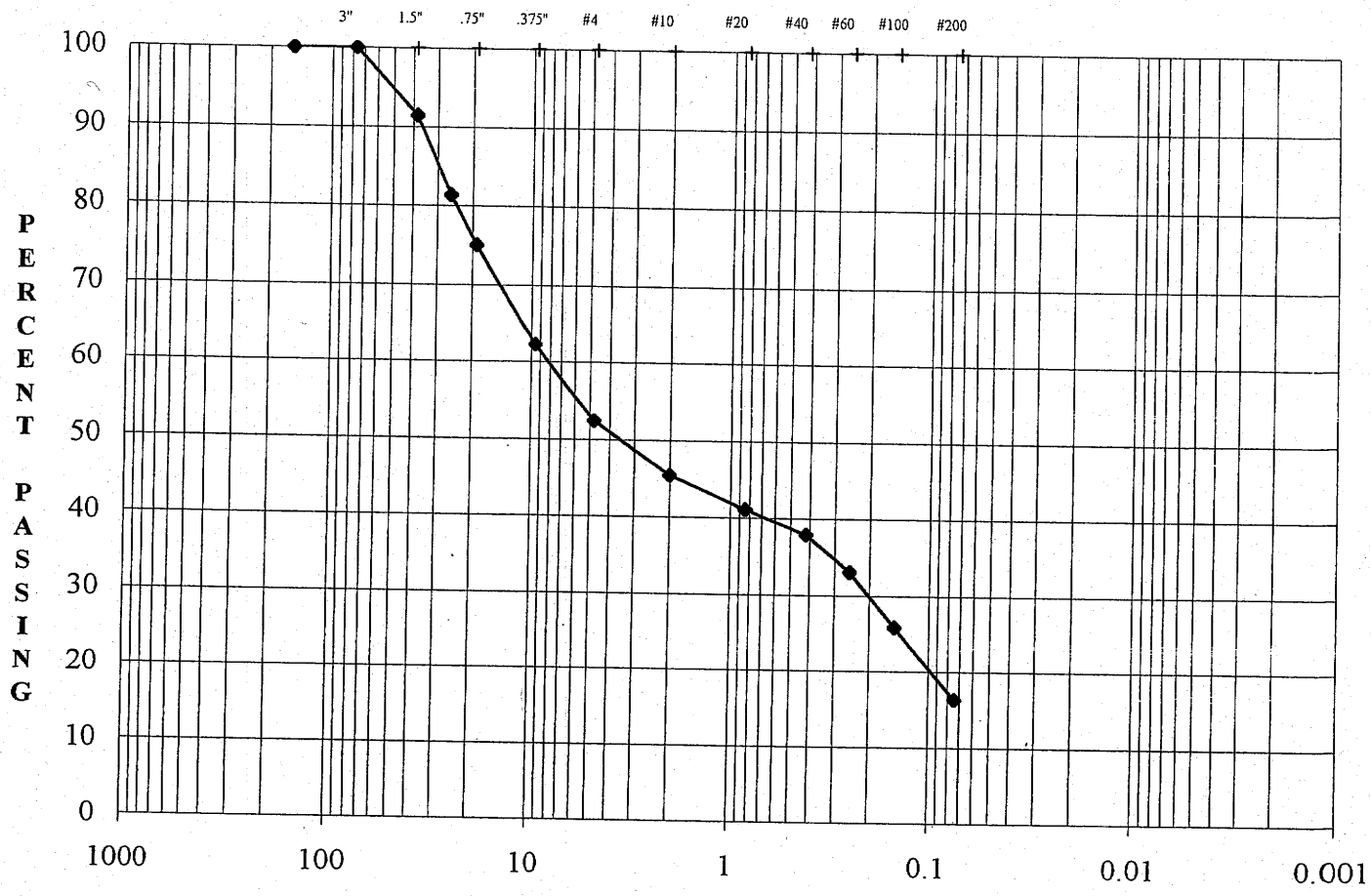
Tare	-
Weight Soil & Tare Before Wash, g	-
Weight Soil & Tare After Wash, g	-
Weight Tare, g	-
Weight Fines Lost, g	-
Weight Dry Soil, g	22,577.46
Fines Lost, %	-

	SIEVE	Wt. Ret.	% Ret.	% Pass.	SIEVE	
	6.000"	0.00	0.00%	**100.00%**	6.000"	
Coarse Gravel	3.000"	0.00	0.00%	**100.00%**	3.000"	Coarse Gravel
	1.500"	6,597.60	29.22%	**70.78%**	1.500"	
	1.000"	8,879.50	39.33%	**60.67%**	1.000"	
Fine Gravel	0.750"	10,005.40	44.32%	**55.68%**	0.750"	Fine Gravel
	0.375"	12,521.50	55.46%	**44.54%**	0.375"	
Coarse Sand	#4	14,678.40	65.01%	**34.99%**	#4	Coarse Sand
Medium Sand	#10	15,651.84	69.33%	**30.67%**	#10	Medium Sand
	#20	16,172.27	71.63%	**28.37%**	#20	
Fine Sand	#40	16,448.08	72.85%	**27.15%**	#40	Fine Sand
	#60	16,641.20	73.71%	**26.29%**	#60	
	#100	17,281.97	76.55%	**23.45%**	#100	
	#200	18,444.27	81.69%	**18.31%**	#200	
Fines	PAN	22,577.46	0.00%	**100.00%**	PAN	Fines

% C GRVL:	**44.3%**		Wet Color:	**Fine to coarse GRAVEL**	
% F GRVL:	**20.7%**	65.0%	Description:	**with some fine to coarse sand,**	
% C SAND:	**4.3%**			**some silt (GM)**	
% M SAND:	**3.5%**		LL:	**NP**	
% F SAND:	**8.8%**	16.7%	PL:	**NP**	DATE: 08-Nov-99
% FINES:	**18.3%**		PI:	**NP**	TECH: MJK
% TOTAL:	**100.0%**		Gs:	**Gs**	REVIEW: DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE-SIZE DISTRIBUTION ASTM D 421 AND D 422
US STANDARD SIEVE OPENING SIZES



COBBLES	Coarse	Fine	Cor	Med	Fine	Silt or Clay Size
	GRAVEL		SAND			FINES

SAMPLE #:	J21 SCORIA
DEPTH (ft):	
DESCRIPTION:	Fine to coarse SAND and fine to coarse gravel, some silt (SM)

MC (As tested):	5.4%
LL:	NP
PL:	NP
PI:	NP
Gs:	Gs

TERRAMATRIX/LAB TESTING/CO
953-2903

08-Nov-99
MJK
DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

$D_{15} = 0.07mm$

$C_u = \frac{D_{60}}{D_{10}} =$

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM C 117, C 136, D 421, D 422, D 1140, D 2216, D 2217

TERRAMATRIX/LAB TESTING/CO 953-2903	SAMPLE #: J21 SCORIA DEPTH (ft):

MOISTURE CONTENT (As tested)

Tare	X28
Weight Wet Soil & Tare, g	291.04
Weight Dry Soil & Tare, g	277.85
Weight Tare, g	33.56
Weight Water, g	13.19
Weight Dry Soil, g	244.29
Moisture, %	**5.40%**

#200 WASH (Percent Fines)

Tare	-
Weight Soil & Tare Before Wash, g	-
Weight Soil & Tare After Wash, g	-
Weight Tare, g	-
Weight Fines Lost, g	-
Weight Dry Soil, g	20,955.38
Fines Lost, %	-

	SIEVE	Wt. Ret.	% Ret.	% Pass.	SIEVE	
	6.000"	0.00	0.00%	**100.00%**	6.000"	
Coarse Gravel	3.000"	0.00	0.00%	**100.00%**	3.000"	Coarse Gravel
	1.500"	1,794.70	8.56%	**91.44%**	1.500"	
	1.000"	3,896.60	18.59%	**81.41%**	1.000"	
Fine Gravel	0.750"	5,232.30	24.97%	**75.03%**	0.750"	Fine Gravel
	0.375"	7,906.20	37.73%	**62.27%**	0.375"	
Coarse Sand	#4	9,972.20	47.59%	**52.41%**	#4	Coarse Sand
Medium Sand	#10	11,437.84	54.58%	**45.42%**	#10	Medium Sand
	#20	12,359.60	58.98%	**41.02%**	#20	
Fine Sand	#40	13,018.80	62.13%	**37.87%**	#40	Fine Sand
	#60	14,036.36	66.98%	**33.02%**	#60	
	#100	15,542.72	74.17%	**25.83%**	#100	
	#200	17,535.92	83.68%	**16.32%**	#200	
Fines	PAN	20,955.38	0.00%	**100.00%**	PAN	Fines

% C GRVL:	**25.0%**		Wet Color:	**Fine to coarse SAND**	
% F GRVL:	**22.6%**	47.6%	Description:	**and fine to coarse gravel,**	
% C SAND:	**7.0%**			**some silt (SM)**	
% M SAND:	**7.5%**		LL:	**NP**	
% F SAND:	**21.6%**	36.1%	PL:	**NP**	DATE: 08-Nov-99
% FINES:	**16.3%**		PI:	**NP**	TECH: MJK
% TOTAL:	**100.0%**		Gs:	**Gs**	REVIEW: DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

Appendix D.6

Filter Criteria and Drainage Calculations

MONTGOMERY WATSON
Mining Group

Project Name: Peabody Western JTJK
Project Number: 1342052.01180100 Sheet: 1 of 1
Prepared By: Craig Berger Date: 11/28/00
Checked By: Date:

Geotextile Filter Fabric for contact with embankment fill.

According to "Designing with Geosynthetics" by Koerner

O_{95} is defined as the 95% opening size of the geosynthetic, tested by the apparent opening size (AOS) test

criteria: $O_{95} < 0.59$mm (for $\leq 50\%$ passing #200 sieve)

and according to Carroll $O_{95}/d_{85} \leq 2$

$O_{95} \leq 2 d_{85}$

$\leq 2(0.22\text{mm})$

so $O_{95} \leq 0.44$mm for geotextile used as a filter fabric.

The associated AOS value for the geotextile should be:

> 50

References: "Designing with Geosynthetics", Koerner, Robert M. (1994) Prentice Hall, Englewood Cliffs, New Jersey, 783pp.

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM C 117, C 136, D 421, D 422, D 1140, D 2216, D 2217

MONTGOMERY WATSON/LAB TESTING/CO 953-2903	SAMPLE #: TP-6:200 DEPTH (FT):

MOISTURE CONTENT (As tested)

Tare	M53
Weight Wet Soil & Tare, g	464.29
Weight Dry Soil & Tare, g	452.88
Weight Tare, g	103.01
Weight Water, g	11.41
Weight Dry Soil, g	349.87
Moisture, %	**3.26%**

#200 WASH (Percent Fines)

Tare	58
Weight Soil & Tare Before Wash, g	747.19
Weight Soil & Tare After Wash, g	577.30
Weight Tare, g	157.61
Weight Fines Lost, g	151.27
Weight Dry Soil, g	570.96
Fines Lost, %	**26.49%**

	SIEVE	Wt. Ret.	% Ret.	% Pass.	SIEVE	
	6.000"	0.00	0.00%	**100.00%**	6.000"	
Coarse Gravel	3.000"	0.00	0.00%	**100.00%**	3.000"	Coarse Gravel
	1.500"	0.00	0.00%	**100.00%**	1.500"	
	1.000"	0.00	0.00%	**100.00%**	1.000"	
Fine Gravel	0.750"	0.00	0.00%	**100.00%**	0.750"	Fine Gravel
	0.375"	0.00	0.00%	**100.00%**	0.375"	
Coarse Sand	#4	0.15	0.03%	**99.97%**	#4	Coarse Sand
Medium Sand	#10	1.26	0.22%	**99.78%**	#10	Medium Sand
	#20	2.60	0.46%	**99.54%**	#20	
Fine Sand	#40	7.87	1.38%	**98.62%**	#40	Fine Sand
	#60	42.75	7.49%	**92.51%**	#60	
	#100	189.61	33.21%	**66.79%**	#100	
	#200	378.52	66.30%	**33.70%**	#200	
Fines	PAN	420.14	0.00%	**100.00%**	PAN	Fines

% C GRVL:	**0.0%**	
% F GRVL:	**0.0%**	0.0%
% C SAND:	**0.2%**	
% M SAND:	**1.2%**	
% F SAND:	**64.9%**	66.3%
% FINES:	**33.7%**	
% TOTAL:	**100.0%**	

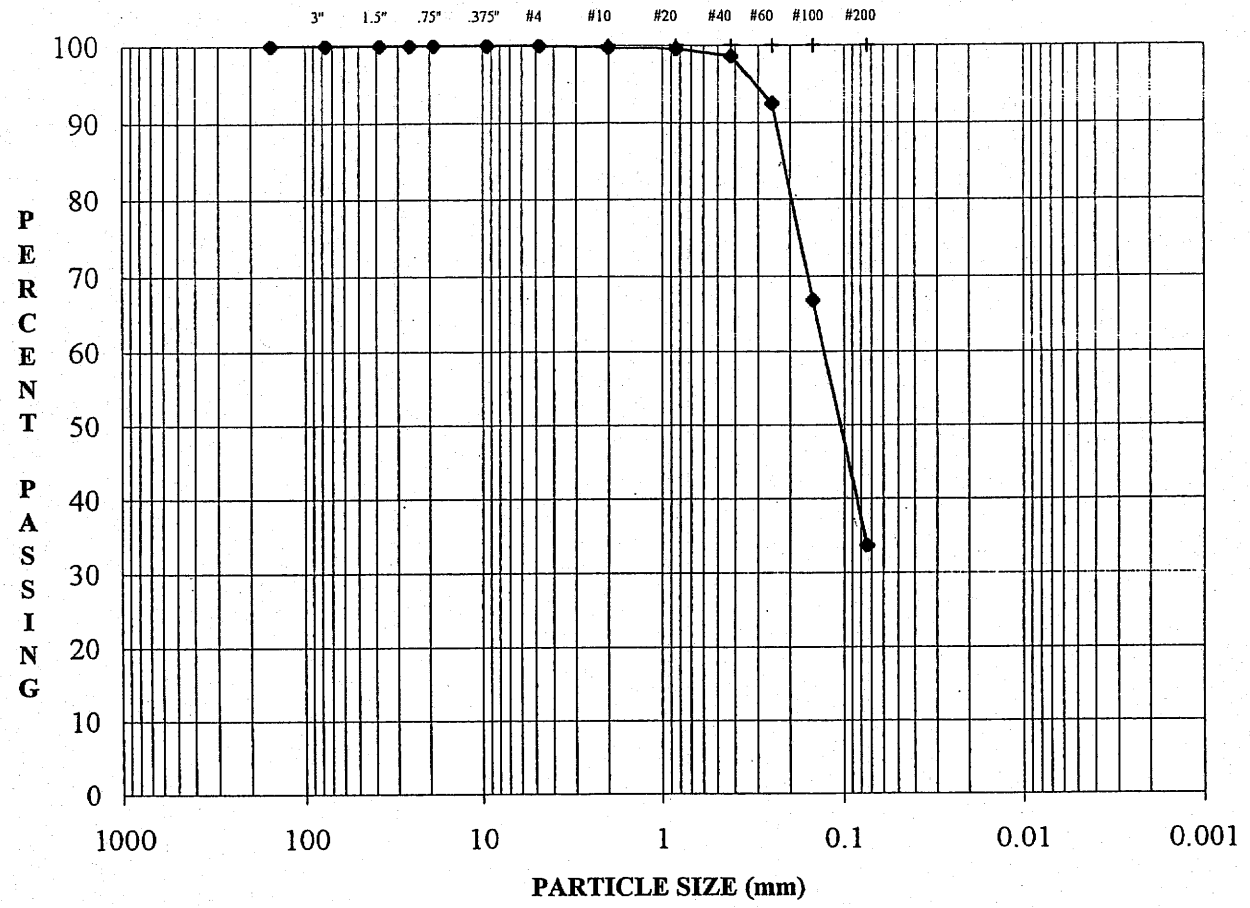
Wet Color: **Fine to coarse SAND**
Description: **and silt (SM)**

LL:	**NP**
PL:	**NP**
PI:	**NP**
Gs:	**2.60**

DATE:	03-Nov-99
TECH:	CW
REVIEW:	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE-SIZE DISTRIBUTION ASTM D 421 AND D 422
US STANDARD SIEVE OPENING SIZES



COBBLES	Coarse	Fine	Cor	Med	Fine	Silt or Clay Size
	GRAVEL		SAND			FINES

SAMPLE #:	TP-6:200
DEPTH (ft):	
DESCRIPTION:	Fine to coarse SAND and silt (SM)

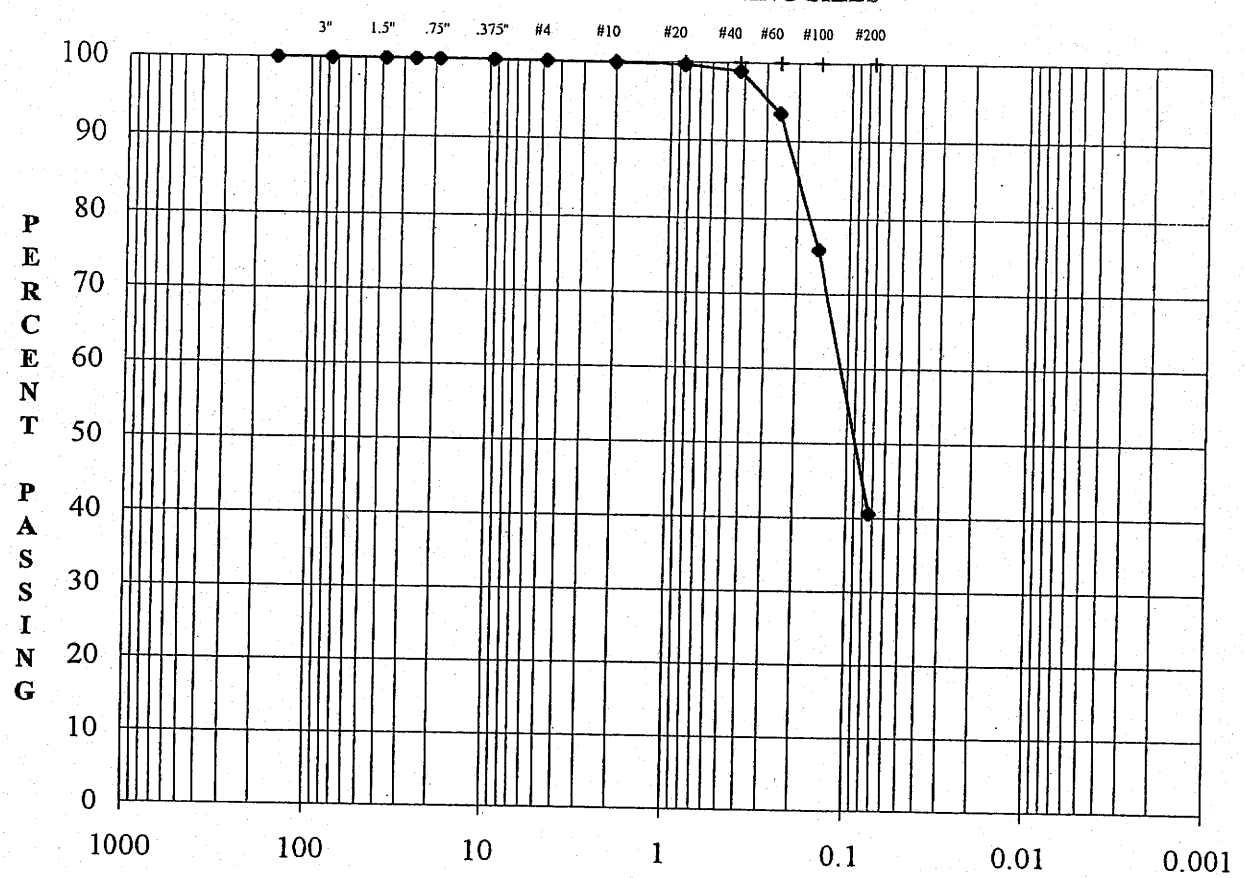
MC (As tested):	3.3%
LL:	NP
PL:	NP
PI:	NP
Gs:	2.60

MONTGOMERY WATSON/LAB TESTING/CO
953-2903

DATE:	03-Nov-99
TECH:	CW
REVIEW:	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE-SIZE DISTRIBUTION ASTM D 421 AND D 422
US STANDARD SIEVE OPENING SIZES



COBBLES	Coarse	Fine	Cor	Med	Fine	Silt or Clay Size
	GRAVEL		SAND			FINES

SAMPLE #:	TP-7:280
DEPTH (ft):	
DESCRIPTION:	Fine to coarse SAND and silt, trace fine gravel (SM)

MC (As tested):	2.9%
LL:	NP
PL:	NP
PI:	NP
Gs:	Gs

MONTGOMERY WATSON/LAB TESTING/CO
953-2903

DATE:	03-Nov-99
TECH:	CW
REVIEW:	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM C 117, C 136, D 421, D 422, D 1140, D 2216, D 2217

MONTGOMERY WATSON/LAB TESTING/CO **953-2903**	**SAMPLE #:** TP-7:280 **DEPTH (FT):**

MOISTURE CONTENT (As tested)

Tare	CW
Weight Wet Soil & Tare, g	435.80
Weight Dry Soil & Tare, g	426.33
Weight Tare, g	100.83
Weight Water, g	9.47
Weight Dry Soil, g	325.50
Moisture, %	**2.91%**

#200 WASH (Percent Fines)

Tare	O69
Weight Soil & Tare Before Wash, g	574.56
Weight Soil & Tare After Wash, g	433.96
Weight Tare, g	155.45
Weight Fines Lost, g	128.75
Weight Dry Soil, g	407.26
Fines Lost, %	**31.61%**

	SIEVE	Wt. Ret.	% Ret.	% Pass.	SIEVE	
	6.000"	0.00	0.00%	**100.00%**	6.000"	
Coarse Gravel	3.000"	0.00	0.00%	**100.00%**	3.000"	Coarse Gravel
	1.500"	0.00	0.00%	**100.00%**	1.500"	
	1.000"	0.00	0.00%	**100.00%**	1.000"	
Fine Gravel	0.750"	0.00	0.00%	**100.00%**	0.750"	Fine Gravel
	0.375"	0.00	0.00%	**100.00%**	0.375"	
Coarse Sand	#4	0.31	0.08%	**99.92%**	#4	Coarse Sand
Medium Sand	#10	0.74	0.18%	**99.82%**	#10	Medium Sand
	#20	1.50	0.37%	**99.63%**	#20	
Fine Sand	#40	4.53	1.11%	**98.89%**	#40	Fine Sand
	#60	26.34	6.47%	**93.53%**	#60	
	#100	98.66	24.23%	**75.77%**	#100	
	#200	242.09	59.44%	**40.56%**	#200	
Fines	PAN	278.70	0.00%	**100.00%**	PAN	Fines

% C GRVL:	**0.0%**	
% F GRVL:	**0.1%**	0.1%
% C SAND:	**0.1%**	
% M SAND:	**0.9%**	
% F SAND:	**58.3%**	59.4%
% FINES:	**40.6%**	
% TOTAL:	**100.0%**	

Wet Color:	**Fine to coarse SAND**
Description:	**and silt,**
	trace fine gravel (SM)
LL:	**NP**
PL:	**NP**
PI:	**NP**
Gs:	**Gs**

DATE:	03-Nov-99
TECH:	CW
REVIEW:	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM C 117, C 136, D 421, D 422, D 1140, D 2216, D 2217

MONTGOMERY WATSON/LAB TESTING/CO **953-2903**	**SAMPLE #:** TP-5:280 **DEPTH (FT):**

MOISTURE CONTENT (As tested)

Tare	QT
Weight Wet Soil & Tare, g	448.23
Weight Dry Soil & Tare, g	440.11
Weight Tare, g	103.70
Weight Water, g	8.12
Weight Dry Soil, g	336.41
Moisture, %	**2.41%**

#200 WASH (Percent Fines)

Tare	ABC4
Weight Soil & Tare Before Wash, g	754.91
Weight Soil & Tare After Wash, g	648.61
Weight Tare, g	157.14
Weight Fines Lost, g	92.21
Weight Dry Soil, g	583.68
Fines Lost, %	**15.80%**

	SIEVE	Wt. Ret.	% Ret.	% Pass.	SIEVE
	6.000"	0.00	0.00%	**100.00%**	6.000"
Coarse Gravel	3.000"	0.00	0.00%	**100.00%**	3.000" Coarse Gravel
	1.500"	0.00	0.00%	**100.00%**	1.500"
	1.000"	0.00	0.00%	**100.00%**	1.000"
Fine Gravel	0.750"	0.00	0.00%	**100.00%**	0.750" Fine Gravel
	0.375"	18.64	3.19%	**96.81%**	0.375"
Coarse Sand	#4	22.43	3.84%	**96.16%**	#4 Coarse Sand
Medium Sand	#10	26.76	4.58%	**95.42%**	#10 Medium Sand
	#20	34.60	5.93%	**94.07%**	#20
Fine Sand	#40	61.98	10.62%	**89.38%**	#40 Fine Sand
	#60	176.46	30.23%	**69.77%**	#60
	#100	372.43	63.81%	**36.19%**	#100
	#200	482.66	82.69%	**17.31%**	#200
Fines	PAN	492.32	0.00%	**100.00%**	PAN Fines

% C GRVL:	**0.0%**	
% F GRVL:	**3.8%**	3.8%
% C SAND:	**0.7%**	
% M SAND:	**6.0%**	
% F SAND:	**72.1%**	78.8%
% FINES:	**17.3%**	
% TOTAL:	**100.0%**	

Wet Color: **Fine to coarse SAND**

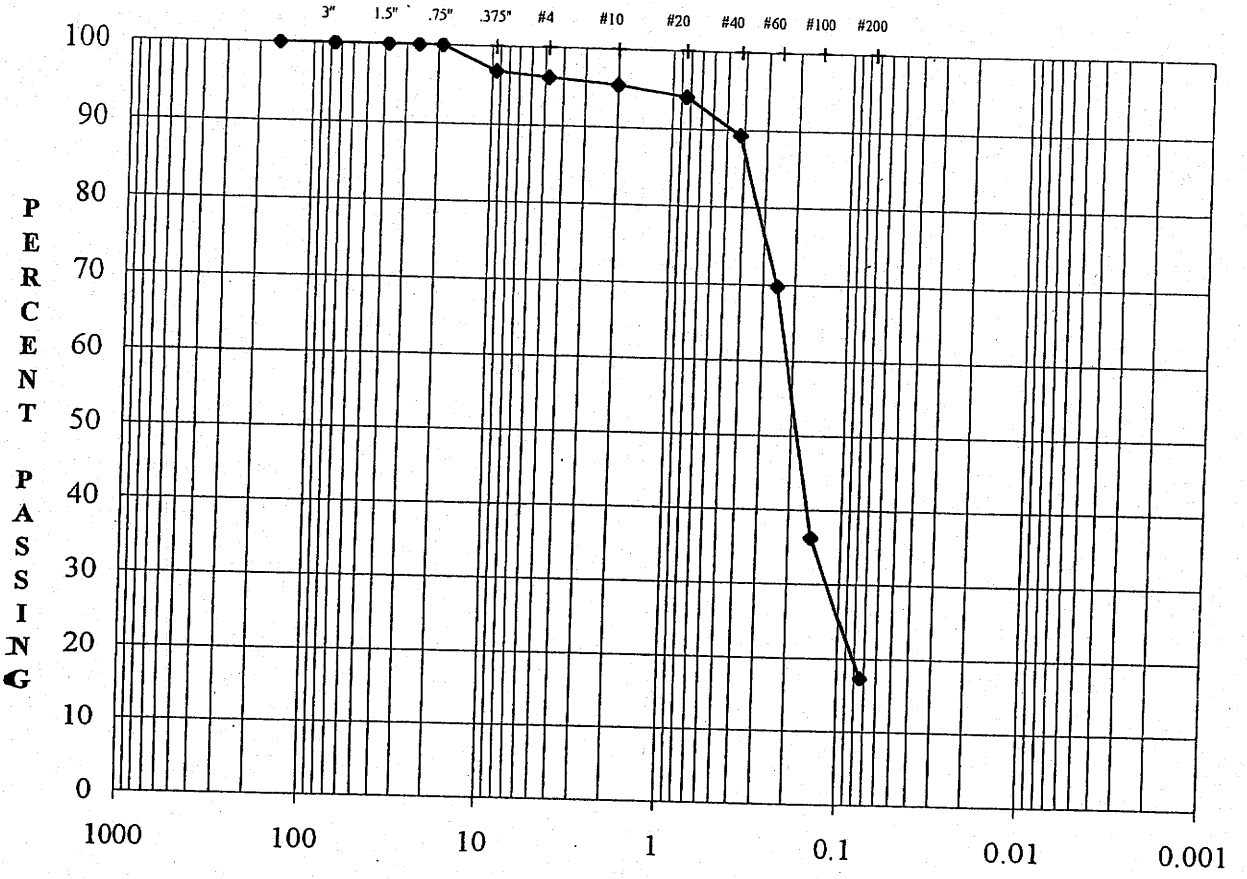
Description: **with some silt, trace fine gravel (SM)**

LL:	**NP**
PL:	**NP**
PI:	**NP**
Gs:	**Gs**

DATE:	03-Nov-99
TECH:	CW
REVIEW:	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

PARTICLE-SIZE DISTRIBUTION ASTM D 421 AND D 422
US STANDARD SIEVE OPENING SIZES



COBBLES	Coarse	Fine	Cor	Med	Fine	Silt or Clay Size
	GRAVEL		SAND			FINES

SAMPLE #:	TP-5:280
DEPTH (ft):	
DESCRIPTION:	Fine to coarse SAND with some silt, trace fine gravel (SM)

MC (As tested):	2.4%
LL:	NP
PL:	NP
PI:	NP
Gs:	Gs

MONTGOMERY WATSON/LAB TESTING/CO
953-2903

DATE:	03-Nov-99
TECH:	CW
REVIEW:	DMD

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

Appendix D.7

Upstream Slope Protection

MONTGOMERY WATSON
Mining Group

Project Name: Peabody Western JTJR
Project Number: 134205 2-01180100 Sheet: 1 of 2
Prepared By: Craig Burger Date: 1/31/00
Checked By: Date:

Upstream Slope Protection

Purpose: Develop specifications for riprap protection of the upstream slope and an associated filter material to prevent erosion of the slope.

Assumptions: Maximum wave height is less than 2 ft, based on a fetch of 2800 Ft (0.53 miles).

Calculations: From Design of Small Dams, 1987 pg 731

minimum riprap size: D_{50} = 10 inches
minimum riprap thickness: = 12 inches
maximum riprap size: $D_{max} = 2 \cdot D_{50}$ = 20 inches

Weight Specifications:
Maximum: 500 lb
30 to 40%: from 250 to 500 lbs
60 to 70%: from 15 to 250 lbs
0 to 10%: less than 15 lbs

Size Specifications for riprap from "Embankment Details" by John Nelson (attached)

diameter	minimum % passing	maximum percent passing
20 inches	100	100
10 inches	0	50
#4 sieve	0	5

To make filter criteria calculations, estimate that d_{15} = 4 inch
In addition to meeting filter criteria with dam material, 0.88mm > D_{15} > 0.3mm
filter thickness between 9 and 30 inches

$\frac{D_{15}\ \text{riprap}}{D_{85}\ \text{filter}} < 10$ so D_{85} filter > $\frac{D_{15}\ \text{riprap}}{10}$ > $\frac{4\ \text{inch}}{10}$

from "Embankment Details" D_{85} filter > 0.4 inch = 10.2 mm

Specifications for filter beneath riprap,

U.S. Sieve #	minimum % passing	maximum % passing
#4	15	40
#20	15	30
#50	0	15
#200	0	5

or Geotextile with $AOS \geq 70$ (Construction Guide)

MONTGOMERY WATSON
Mining Group

Project Name: Peabody Western JTJP
Project Number: 1342052 - 011300
Prepared By: Craig Burger
Checked By:
Sheet: 2 of 2
Date: 11/31/02
Date:

Design for equivalent geotextile
Table 2.3 on 101 and Table 2.7 pg 131
From Christopher/Holtz (85) for pulsating cyclic flows (wave action or rapid drawdown)

$d_{85-soil} = 0.22mm$ (fine material)

from Calhoun ('72) for woven geotextiles with ≤ 50% passing #200
$O_{95}/d_{85} \leq 1$, $O_{95} \leq 0.22mm$.

specify AOS ≥ #70 (0.21mm)

Tear Resistance of Geotextile after Koerner '94
pg. 168
- Riprap placement maximum riprap diameter = 20"
maximum height of fall = 3 ft
minimum placed by bulldozer
use FS = 2 for installation damage.

$T_{all} = T_{req'd} \times FS/RF$

from Fig 2.31 and 2.32: RF = 20 based on $S_u = 2.2$ psi
$T_{req'd} = 900$ ft-lb

$T_{all} = 900 \times 2/20 =$ $T_{all} = 90$ ft-lbs: required impact strength of geotext.

Specifications for Geotextile for Riprap Interface:

AOS ≥ 70 and minimum impact strength: 90 ft-lbs

References: "Designing with Geosynthetics" Koerner, R.M. (1994). Prentice Hall, Englewood Cliffs, New Jersey, 783 pp.

"Design of Small Dams" Bureau of Reclamation (1987) United States Government Printing Office, Denver, CO 860 pp.

Slope Protection

Rock - Dumped rock is a better wave dissipator than hand placed rock.

Concrete - Monolithic slabs are better than individual panels

Design of rock riprap

* Individual rocks must not be displaced by waves.

* Riprap must be underlain by filter material so that underlying material will not be washed out between riprap.

less stringent than normal filter criteria

$$(D_{15})_{riprap} / (D_{85})_{filter} < 10$$

Thickness of filter is not critical. Usually 9 to 30 in. is good.

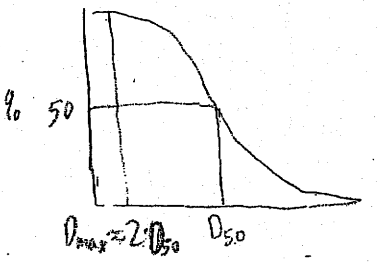
• all layers in contact must meet filter criteria

* To estimate rock size see Table 6-9, p.263. or,

nominal thickness

criterion - singular
criteria - plural

Max. wave ht. (ft)	D_{50} min. (in)	Thickness* (in)
0 - 2	10	12
2 - 4	12	18
4 - 6	15	24
6 - 8	18	30
8 - 10	21	36



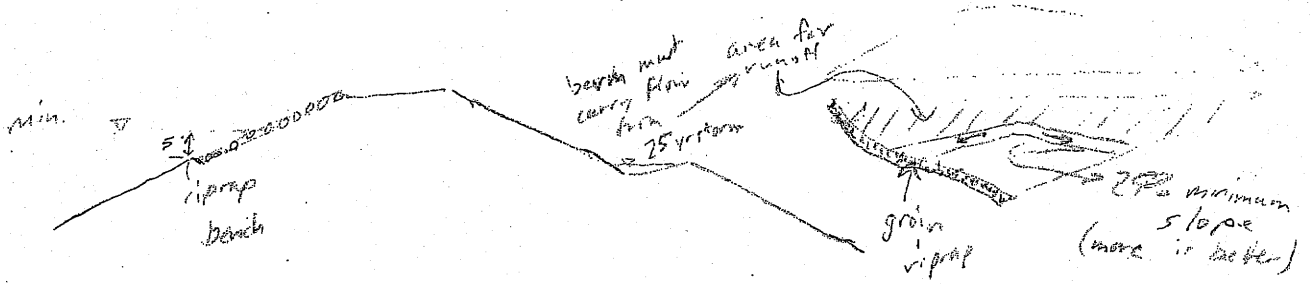
Minimum Slope Coverage

* Place riprap to depth at least 5 ft below min pool elev. (upstream)

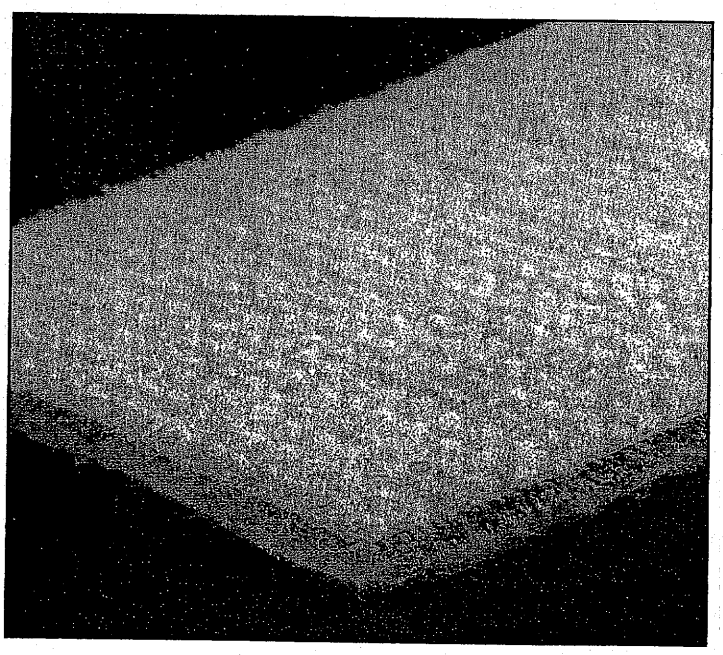
* In flood control structures where max pool is only for a short duration, rip rap may be reduced somewhat.

Berms

* Place horizontal berms at bottom and at steps up dam face to provide equipment access and to prevent undermining of riprap.



RECOMMENDED SPECIFICATIONS



Bentofix™ GEOSYNTHETIC CLAY LINER

NSC

National Seal Company

Bentofix™ GEOSYNTHETIC CLAY LINER
Recommended Specifications

1.0 These specifications describe Bentofix Geosynthetic Clay Liner (GCL), a bentonite geotextile composite that is needlepunched to provide high shear resistance and durability. The supply and installation of these materials shall be in strict accordance with these specifications and contract drawings.

2.0 Description

2.01 The top and bottom layers of the GCL shall be geotextiles. At least one layer will be a nonwoven needlepunched geotextile.

2.02 The primary constituent of the GCL shall be a natural sodium montmorillonite clay, called bentonite, placed on the carrier layer geotextile at a minimum rate of 1 lb/sf.

2.03 The nonwoven geotextile shall be needle punched through the bentonite into the carrier geotextile, effectively attaching the top geotextile to the bottom geotextile, encapsulating the bentonite.

3.0 Manufacturer Quality Assurance/Quality Control

3.01 Each geotextile layer shall be Quality Control tested during the manufacturing process to ensure they meet material specifications. The geotextile manufacturer shall perform the following tests at least once every 60,000 square feet (ft^2), and certify conformance with the following:

mass per unit area	trapezoid tear strength
thickness	burst strength
tensile strength	

3.02 The bentonite shall be tested at a frequency correlating to one test per 50,000 square feet (ft^2) of finished GCL, to ensure conformance with:

moisture content	fluid loss
water absorption capacity	montmorillonite content (methylene blue test)
swell index	

3.03 Additionally, the bentonite producer will provide certifications for the following properties:

moisture content	montmorrillonite content (XRD test)
water absorption	fluid loss
bulk density	

3.04 The GCL finished product will be tested at a frequency of one test every 3,000 sf for:

overall thickness	mass per unit area

every 10,000 ft^2 for:

moisture content	grab tensile strength
peel strength	puncture strength

and every 100,000 ft^2 for:

hydraulic conductivity

3.05 The GCL shall be continually bonded and reinforced by needle-punching.

3.06 No separation of geotextile components shall occur if the liner is cut, punctured, torn or hydrated.

3.07 The roll shall be marked with a continuous "match line" at each edge to ensure that the minimum recommended overlap is maintained during installation.

3.08 The GCL shall pass over bright back-lighting prior to roll-up so that consistency of the bentonite layer within the GCL can be visually inspected.

3.09 Needle detecting devices and magnets will scan the entire width of the roll prior to roll-up to ensure no broken needles are present in the final product.

3.10 The GCL shall be Bentofix™ supplied by National Seal Company, Aurora, Illinois or approved equal.

3.11 The GCL shall conform to the following specifications.

PROPERTY	TEST	STANDARD	UNITS	*VALUE*
Physical				
-Mass Per Unit Area	ASTM D3776	typical	lb/ft² (g/m²)	1.10 (5390)
-Thickness	ASTM D1777	typical	in (mm)	0.24 (6.0)
-Moisture Content	ASTM D4643	maximum	%	10
Mechanical				
-Grab Tensile[1]	ASTM D4632	typical	lb (N)	120 (530)
-Puncture	ASTM D4833	typical	lb (N)	170 (750)
-Friction Angle[2]	ASTM D5321	typical	degrees	25
-Peel Strength	ASTM D4632	typical	lb (N)	5 (22)
Hydraulic				
-Water Permeability[3]	GRI GCL-2	maximum	cm/s	1×10^{-9}
COMPONENT	**TEST**	**STANDARD**	**UNITS**	***VALUE***
Carrier Geotextile				woven
-Mass Per Unit Area	ASTM D3776	minimum	oz/yd² (g/m²)	3.25 (110)
Cover Geotextile				nonwoven
-Mass Per Unit Area	ASTM D3776	minimum	oz/yd² (g/m²)	7.25 (250)
Sodium Bentonite				
-Mass Per Unit Area		minimum	lb/ft² (g/m²)	1.0 (4900)
-Montmorillonite	XRD-Method	minimum	%	90
Content	Methylene-Blue	minimum	%	70
-Moisture Content	ASTM D4643	maximum	%	10
-Swell Index	USP NF XVII	minimum	ml	25
-Water Absorption	Enslin-Neff	minimum	%	600
DIMENSION		**STANDARD**	**UNITS**	***VALUE***
-Width × Length[4]		nominal	ft (m)	15.2 × 100 (4.6 × 30.5)
-Area per Roll		minimum	ft² (m²)	1520 (140)
-Packaged Weight		typical	lb (kg)	1740 (790)

NOTES:
[1]Typical tensile values given for weakest principle direction.
[2]Samples hydrated under an initial normal stress of 7.5 psi (50 kPa) and sheared internally.
[3]Water permeability values given correspond to effective stress of 10 psi (67 kPa).
[4]Nominal roll dimensions exclusive of protective edge area.

4.0 Manufacturers Statement

4.01 The manufacturer shall submit, upon request, certificates indicating that the material meets the above specification, supported by quality control test results.

4.02 The GCL shall be supplied in rolls, clearly labeled with the following information:

Manufacturer's Name	Typical Roll Weight
Product Name	Typical Roll Dimensions
Roll Number	Lot Number

5.0 Shipping, Handling and Storage

5.01 The GCL shall be wrapped in plastic to protect it from ultraviolet light and to ensure the product stays dry during shipment and prior to use.

5.02 The GCL material shall be shipped and stored by appropriate means so that no damage is caused to the material. Material shall be stored in a secure area to protect against standing water, precipitation, contamination, theft, and vandalism.

5.03 Rolls shall be lifted by inserting a steel bar, capable of supporting the full weight of the roll, through the center core.

6.0 Installation

6.01 The Earthwork Contractor shall be responsible for preparing and maintaining the subgrade and anchor trenches in a condition suitable for the laying of the GCL.

6.02 The method and equipment used to deploy the GCL shall not damage the adjacent geosynthetics or the supporting subgrade surface.

6.03 Adequate temporary loading such as sandbags or tires shall be provided to prevent GCL uplift due to strong winds.

6.04 All wrinkles shall be pulled out and overlaps shall be free of obstructions, debris and rocks.

6.05 Seams shall be a simple overlap unless the expected normal load that will be applied to the liner and the intended function determine the need for the addition of granular bentonite.

6.06 Overlap seams shall be placed so that the edge of the upper panel aligns with the matchline on the lower panel.

6.07 The GCL shall be secured in an anchor trench at the top of the slope as per the contract drawings.

6.08 Material will be deployed from the high elevation to the low elevation to protect against the adverse effect of precipitation during deployment. Panels shall be shingled in a down slope direction.

6.09 All seams shall be parallel with the direction of the slope. Horizontal seams shall not be allowed on slopes unless approved by the engineer.

6.10 In general, the GCL installation shall halt during any form of precipitation and exposed GCL shall be covered in a timely manner.

6.11 Only as much of the GCL should be deployed in a given day as can be covered during that day either by a geomembrane or confining soil layer.

6.12 Repairs will be made by placing a patch of the same material over the damaged area extending at least one foot (12 inches) beyond the damaged area in every direction.

7.0 Specific Applications

7.01 Additional details may be required for specific applications. Contact National Seal Company for more detailed information.

The information contained herein has been compiled by National Seal Company and is, to the best of our knowledge, true and accurate. All suggestions and recommendations are offered without guarantee. Final determination of suitability for use based on any information provided, is the sole responsibility of the user. There is no implied or expressed warranty of merchantability or fitness of the product for the contemplated use.

National Seal Company

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TC Mirafi

Comparison Chart
Mirafi 160N

Product Type: Nonwoven
Application(s): Separation/Stabilization/Filtration/Drainage/Erosion Control

Property	Test Method	Units	**Mirafi 160N**	Amoco 4551	Carthage Mills FX-60HS	Linq 150EX	Synthetic Industries Geotex 601	TNS R060	Webtec TerraTex N06
Grab Tensile	ASTM D 4632	lbf	**160**	160	160	165	160	160	165
Elongation	ASTM D 4632	%	**50**	50	50	50	50	50	50
Mullen Burst	ASTM D 3786	psi	**325**	315	280	310	280	315	325
Puncture	ASTM D 4833	lbf	**95**	90	85	85	85	90	95
Trapezoid Tear	ASTM D 4533	lbf	**60**	65	60	65	60	65	65
Permittivity	ASTM D 4491	sec^{-1}	**1.40**	1.50	1.30	1.10	1.30	1.60	1.50
Flow Rate	ASTM D 4491	$gal/min/ft^2$	**110**	110	110	NP	110	110	100
AOS	ASTM D 4751	US Sieve	**70**	100	70	80	70	80	80
Polymer	--	--	**PP**	PP	PP	PP	PP	PP	PP

NOTE: Chart for comparison purposes only. All "Equivalents" should be determined by the Engineer. All data taken from GFR "1999 Specifier's Guide"
NOTE: PP = Polypropylene
PET = Polyester
NP = Not Published
N/A = No product information available

TC Mirafi *TECHNICAL DATA SHEET*

Mirafi 160N

Mirafi 160N is a nonwoven geotextile composed of polypropylene fibers, which are formed into a stable network such that the fibers retain their relative position. 160N is inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value	
			MD	CD
Grab Tensile Strength	ASTM D 4632	kN (lbs)	0.71 (160)	0.71 (160)
Grab Tensile Elongation	ASTM D 4632	%	50	50
Trapezoid Tear Strength	ASTM D 4533	kN (lbs)	0.27 (60)	0.27 (60)
Mullen Burst Strength	ASTM D 3786	kPa (psi)	2239 (325)	
Puncture Strength	ASTM D 4833	kN (lbs)	0.42 (95)	
Apparent Opening Size (AOS)	ASTM D 4751	mm (U.S. Sieve)	0.212 (70)	
Permittivity	ASTM D 4491	sec^{-1}	1.4	
Permeability	ASTM D 4491	cm/sec	0.28	
Flow Rate	ASTM D 4491	$l/min/m^2$ ($gal/min/ft^2$)	4477 (110)	
UV Resistance (at 500 hours)	ASTM D 4355	% strength retained	70	

Physical Properties	Test Method	Unit	Typical Value
Weight	ASTM D 5261	g/m^2 (oz/yd^2)	217 (6.4)
Thickness	ASTM D 5199	mm (mils)	1.9 (75)
Roll Dimensions (width x length)	--	m (ft)	4.5 x 91 (15 x 300)
Roll Area	--	m^2 (yd^2)	418 (500)
Estimated Roll Weight	--	kg (lb)	103 (227)

DISCLAIMER: TC Mirafi warrants our products to be free from defects in material and workmanship when delivered to TC Mirafi's customers and that our products meet our published specifications. Contact your local TC Mirafi Representative for detailed product specification and warranty information.

Appendix E

Hydrololgy, Sedimentology and Hydraulics Calculations

CALCULATION COVER SHEET

MONTGOMERY WATSON

SHEET 1 OF 1

PROJECT TITLE:	J7-Jr MSHA DAM – HYDROLOGY
PROJECT NO:	1342052.01180100
CALCULATION TITLE:	Appendix E, Hydrology, Sedimentology and Hydraulics

	NAME	DATE
PREPARED BY:	Daniel Tecca	April 1, 2000
CHECKED BY:	T Leidich	April 2, 2000
REVIEWED BY:		

REVISIONS				
DATE	**PURPOSE**	**PREPARED BY**	**CHECKED BY**	**REVIEWED BY**

APPENDIX E

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APPENDIX E.1

Hydrology Calculations

PEABODY WESTERN COAL COMPANY
CALCULATED HYDROLOGIC DATA

PROJECT: J7 Area

STRUCTURE: POND J7-Jr

TIME OF CONCENTRATION:

Start Elevation (ft) =	7125
End Elevation (ft) =	6650
Elevation Difference, E (ft) =	475
Watercourse Length (ft) =	19486
Watercourse Length, L (mi) =	3.691
Tc = (11.9L^3/E)^0.385 =	1.093 hours

ROUTING PARAMETERS:

Between structure routing parameters were calculated using the SCS Upland Method in SEDCAD4. Input and output parameters are shown on the SEDCAD4 printouts in Appendices C.

SCS CURVE NUMBER:

Cover Type	Soil Group	Curve Number	Area (acres)	CN*Area
Pinyon Juniper	B	65	42.8	2782
Pinyon Juniper	C	78	306.4	23899.2
Pinyon Juniper	D	83	77.7	6449.1
Sagebrush	B	60	67.9	4074
Sagebrush	C	73	116.7	8519.1
Sagebrush	D	79	67.8	5356.2
Sage/Grass	B	60	1.2	72
Sage/Grass	D	79	2.7	213.3
Disturbed - Topsoil Stripped/Pit		90	221	19890
Disturbed - Spoil		86	677	58222
Reclaimed	C	81	2379.1	192707.1
TOTAL:			3960.3	322184

Weighted CN = Total CN*Area/ Total Area = 81

DRAINAGE BASIN AREA:

3960.3 Acres

APPENDIX E.2

Sediment Yield Calculations

PEABODY WESTERN COAL COMPANY
CALCULATED SEDIMENT YIELD DATA

PROJECT: J7-Jr Pond

SOIL ERODIBILITY FACTOR:

Soil Type	Erodibility Factor, K	Area (acres)	K*Area
1B	0.15	0.3	0.05
3BC	0.16	16.3	2.61
11	0.46	26.5	12.19
11B	0.46	1.6	0.74
12	0.38	1.3	0.49
16C	0.05	1.8	0.09
16E	0.05	6.5	0.33
25	0.19	131.6	25.00
26	0.31	423.1	131.16
27	0.36	74.2	26.71
34-spoil	0.12	677	81.24
35-TS/Pit	0.22	221	48.62
35-Reclaimed	0.38	2379.1	904.06
TOTAL:		3960.3	1233.28

Weighted K = Total K*Area/ Total Area = 0.31

SLOPE FACTOR:

Length (ft)	Elevation Change (ft)	Slope (%)	m	Slope Angle (deg)	LS Factor
600	50	8.3%	0.5	4.8	2.66
360	70	19.4%	0.6	11.0	7.07
660	80	12.1%	0.6	6.9	5.72
440	80	18.2%	0.6	10.3	7.39
300	50	16.7%	0.6	9.5	5.30
440	90	20.5%	0.6	11.6	8.45
660	70	10.6%	0.6	6.1	4.78
300	40	13.3%	0.6	7.6	4.03
860	50	5.8%	0.5	3.3	2.26
800	30	3.8%	0.4	2.1	1.14
680	50	7.4%	0.5	4.2	2.52
960	70	7.3%	0.5	4.2	2.97
400	35	8.8%	0.5	5.0	2.28
640	35	5.5%	0.5	3.1	1.84
600	50	8.3%	0.5	4.8	2.66
580	70	12.1%	0.6	6.9	5.26
610	50	8.2%	0.5	4.7	2.64
580	120	20.7%	0.6	11.7	10.10
480	70	14.6%	0.6	8.3	5.98
300	80	26.7%	0.6	14.9	8.97
340	50	14.7%	0.6	8.4	4.91
520	130	25.0%	0.6	14.0	11.65
420	80	19.0%	0.6	10.8	7.58
860	140	16.3%	0.6	9.2	9.69
380	140	36.8%	0.6	20.2	14.33
340	60	17.6%	0.6	10.0	6.11
300	130	43.3%	0.6	23.4	14.48

CALCULATED SEDIMENT YIELD DATA (cont)

Average LS = 6.03

The LS Factor was calculated by:

LS = (Slope Length/72.6)^m(10.8*sin(slope angle) + 0.03) for Slopes < 9%*

LS = (Slope Length/72.6)^m(16.8*sin(slope angle) - 0.5) for Slopes > 9%*

Where:

Slope < 3%	*m = 0.3*
Slope = 4%	*m = 0.4*
5% > Slope < 10%	*m = 0.5*
Slope > 10%	*m = 0.6*

COVER AND PRACTICE FACTORS:

Cover Type	Cover (%)	Canopy (%)	Area (acres)	Cover Factor, C	C*Area	Practice Factor, P	P*Area
Pinyon Juniper	40%	25%	426.9	0.22	93.92	1.00	426.90
Sagebrush/Grass	40%	25%	256.3	0.20	51.26	1.00	256.30
Spoil	0%	0%	677	1.00	677.00	0.80	541.60
Topsoil/Pit	0%	0%	221	1.00	221.00	1.00	221.00
Reclaimed	40%	0%	2379.1	0.15	356.87	0.40	951.64
TOTAL:			3960.3		1400.04		2397.44

Weighted C = Total C*Area/ Total Area = 0.354

Weighted P = Total P*Area/ Total Area = 0.605

RAINFALL FACTOR:

R = 40

PEABODY WESTERN COAL COMPANY
CALCULATED SEDIMENT YIELD

PROJECT: J7-Jr POND

The following spreadsheet calculates the predicted sediment yield for the project area. The gross sediment yie is determined according to the Revised Universal Soil Loss Equation.

PARAMETER DESCRIPTION	VALUE	
Annual Rainfall Factor	40.00	
Soil Erodibility Factor	0.31	
Length Slope Factor	6.03	
Cover Factor	0.35	
Practice Factor	0.61	
Gross Annual Sediment Yield	16.07	tons/acre/year
Sediment Density	94.00	pcf
Gross Annual Sediment Yield	0.0079	acre-feet/acre/year
Sediment Delivery Ratio	80%	
Estimated Annual Sediment Yield	0.0063	acre-feet/acre/year
Watershed Area	3960.3	acres
Watershed Annual Sediment Yield	24.87	acre-feet/year
Number of years	1	years
Calculated Sediment Volume	24.87	acre-feet

APPENDIX E.3

SEDCAD4 (input and output) 10-year, 24-hour Storm Event

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PEABODY WESTERN KAYENTA MINE MSHA POND J7-Jr

10-year, 24-hour

DJK

Montgomery Watson
165 S. Union Blvd.
Suite 410
Lakewood, Co. 80228

Phone: 303 763-5140

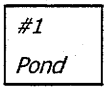
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	2.100 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	End	0.000	0.000	Pond J7-Jr



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	In	3,960.300	3,960.300	1,105.87	220.74
	Out			0.00	0.00

Structure Detail:

Structure #1 (Pond)

Pond J7-Jr

Pond Inputs:

Initial Pool Elev:	6,702.00
Initial Pool:	0.00 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
6,710.00	44.00	3.00:1	3.00:1	70.00

Pond Results:

Peak Elevation:	6,708.79
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)
6,670.00	0.610	0.000	0.000	
6,670.50	0.698	0.327	0.000	
6,671.00	0.793	0.699	0.000	
6,671.50	0.893	1.120	0.000	
6,672.00	0.999	1.593	0.000	
6,672.50	1.111	2.120	0.000	
6,673.00	1.229	2.705	0.000	
6,673.50	1.353	3.350	0.000	
6,674.00	1.483	4.058	0.000	
6,674.50	1.618	4.833	0.000	
6,675.00	1.760	5.678	0.000	
6,675.50	1.979	6.612	0.000	
6,676.00	2.210	7.659	0.000	
6,676.50	2.454	8.824	0.000	
6,677.00	2.711	10.115	0.000	
6,677.50	2.980	11.538	0.000	
6,678.00	3.263	13.098	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
6,678.50	3.558	14.803	0.000	
6,679.00	3.866	16.658	0.000	
6,679.50	4.187	18.671	0.000	
6,680.00	4.520	20.847	0.000	
6,680.50	4.700	23.152	0.000	
6,681.00	4.884	25.548	0.000	
6,681.50	5.071	28.037	0.000	
6,682.00	5.262	30.620	0.000	
6,682.50	5.456	33.299	0.000	
6,683.00	5.654	36.077	0.000	
6,683.50	5.855	38.954	0.000	
6,684.00	6.060	41.932	0.000	
6,684.50	6.268	45.014	0.000	
6,685.00	6.480	48.201	0.000	
6,685.50	6.884	51.542	0.000	
6,686.00	7.299	55.087	0.000	
6,686.50	7.727	58.843	0.000	
6,687.00	8.167	62.816	0.000	
6,687.50	8.618	67.011	0.000	
6,688.00	9.083	71.436	0.000	
6,688.50	9.559	76.095	0.000	
6,689.00	10.047	80.996	0.000	
6,689.50	10.548	86.145	0.000	
6,690.00	11.060	91.546	0.000	
6,690.50	11.496	97.185	0.000	
6,691.00	11.941	103.044	0.000	
6,691.50	12.394	109.127	0.000	
6,692.00	12.855	115.439	0.000	
6,692.50	13.325	121.984	0.000	
6,693.00	13.803	128.765	0.000	
6,693.50	14.290	135.788	0.000	
6,694.00	14.785	143.056	0.000	
6,694.50	15.288	150.574	0.000	
6,695.00	15.800	158.346	0.000	
6,695.50	16.456	166.409	0.000	
6,696.00	17.124	174.804	0.000	
6,696.50	17.806	183.536	0.000	
6,697.00	18.501	192.612	0.000	
6,697.50	19.209	202.039	0.000	
6,698.00	19.931	211.823	0.000	
6,698.50	20.666	221.972	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
6,699.00	21.414	232.491	0.000		
6,699.50	22.176	243.388	0.000		
6,700.00	22.950	254.669	0.000		
6,700.50	23.572	266.299	0.000		
6,701.00	24.202	278.242	0.000		
6,701.50	24.840	290.502	0.000		
6,702.00	25.487	303.083	0.000		
6,702.50	26.141	315.990	0.000		
6,703.00	26.805	329.226	0.000		
6,703.50	27.476	342.796	0.000		
6,704.00	28.156	356.704	0.000		
6,704.50	28.844	370.953	0.000		
6,705.00	29.540	385.549	0.000		
6,705.50	30.405	400.534	0.000		
6,706.00	31.281	415.955	0.000		
6,706.50	32.170	431.817	0.000		
6,707.00	33.071	448.127	0.000		
6,707.50	33.984	464.890	0.000		
6,708.00	34.911	482.114	0.000		
6,708.50	35.850	499.803	0.000		
6,708.79	36.403	510.316	0.000	0.00	Peak Stage
6,709.00	36.801	517.966	0.000		
6,709.50	37.765	536.606	0.000		
6,710.00	38.740	555.732	0.000		Spillway #1
6,710.50	39.784	575.362	67.981		
6,711.00	40.841	595.518	135.962		
6,711.50	41.913	616.206	302.329		
6,712.00	42.998	637.433	493.585		
6,712.50	44.097	659.207	717.604		
6,713.00	45.210	681.533	992.277		
6,713.50	46.337	704.419	1,305.805		
6,714.00	47.477	727.872	1,665.923		
6,714.50	48.632	751.899	2,032.517		
6,715.00	49.800	776.506	2,444.368		
6,715.50	50.377	801.550	2,888.012		
6,716.00	50.958	826.884	3,363.224		
6,716.50	51.541	852.508	3,869.878		
6,717.00	52.128	878.426	4,407.921		
6,717.50	52.719	904.637	4,977.361		
6,718.00	53.313	931.145	5,578.250		
6,718.50	53.910	957.951	6,165.379		

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
6,719.00	54.510	985.055	6,779.881	

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	3,960.300	1.093	0.000	0.000	81.000	F	1,105.87	220.738
	$\sum$	**3,960.300**						**1,105.87**	**220.738**

APPENDIX E.4

SEDCAD4 (input and output) ½ 6-hour PMP Storm Event

And

General 6-hour Storm Event Calculation

PEABODY WESTERN
KAYENTA MINE
MSHA POND J7-Jr

100-year, 6-hour

spillway @ 6710'

DJK

Montgomery Watson
165 S. Union Blvd.
Suite 410
Lakewood, Co. 80228

Phone: 303 763-5140

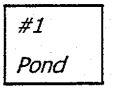
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 6 hr
Rainfall Depth:	2.400 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	End	0.000	0.000	Pond J7-Jr



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	In	3,960.300	3,960.300	2,024.26	287.71
	Out			881.52	287.72

Structure Detail:

Structure #1 (Pond)

Pond J7-Jr

Pond Inputs:

Initial Pool Elev:	6,710.00
Initial Pool:	555.77 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
6,710.00	44.00	3.00:1	3.00:1	70.00

Pond Results:

Peak Elevation:	6,712.78
Dewater Time:	0.32 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)
6,670.00	0.610	0.000	0.000	
6,671.00	0.793	0.700	0.000	
6,672.00	0.999	1.594	0.000	
6,673.00	1.229	2.706	0.000	
6,674.00	1.483	4.061	0.000	
6,675.00	1.760	5.681	0.000	
6,676.00	2.212	7.662	0.000	
6,677.00	2.712	10.120	0.000	
6,678.00	3.264	13.104	0.000	
6,679.00	3.868	16.666	0.000	
6,680.00	4.520	20.856	0.000	
6,681.00	4.884	25.557	0.000	
6,682.00	5.262	30.629	0.000	
6,683.00	5.654	36.086	0.000	
6,684.00	6.060	41.943	0.000	
6,685.00	6.480	48.212	0.000	
6,686.00	7.301	55.098	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
6,687.00	8.167	62.828	0.000		
6,688.00	9.083	71.450	0.000		
6,689.00	10.049	81.012	0.000		
6,690.00	11.060	91.562	0.000		
6,691.00	11.942	103.060	0.000		
6,692.00	12.856	115.457	0.000		
6,693.00	13.804	128.784	0.000		
6,694.00	14.786	143.076	0.000		
6,695.00	15.800	158.366	0.000		
6,696.00	17.126	174.825	0.000		
6,697.00	18.502	192.634	0.000		
6,698.00	19.932	211.847	0.000		
6,699.00	21.416	232.516	0.000		
6,700.00	22.950	254.695	0.000		
6,701.00	24.203	278.269	0.000		
6,702.00	25.487	303.111	0.000		
6,703.00	26.805	329.255	0.000		
6,704.00	28.157	356.733	0.000		
6,705.00	29.540	385.579	0.000		
6,706.00	31.283	415.986	0.000		
6,707.00	33.072	448.160	0.000		
6,708.00	34.912	482.148	0.000		
6,709.00	36.803	518.001	0.000		
6,710.00	38.740	555.768	0.000		Spillway #1
6,711.00	40.844	595.555	135.962	3.54*	
6,712.00	42.999	637.472	493.585	2.20	
6,712.78	44.726	671.778	881.516	2.00	Peak Stage
6,713.00	45.211	681.573	992.277		
6,714.00	47.480	727.914	1,665.923		
6,715.00	49.800	776.549	2,444.368		
6,716.00	50.958	826.926	3,363.224		
6,717.00	52.128	878.468	4,407.921		
6,718.00	53.313	931.188	5,578.250		
6,719.00	54.510	985.098	6,779.881		

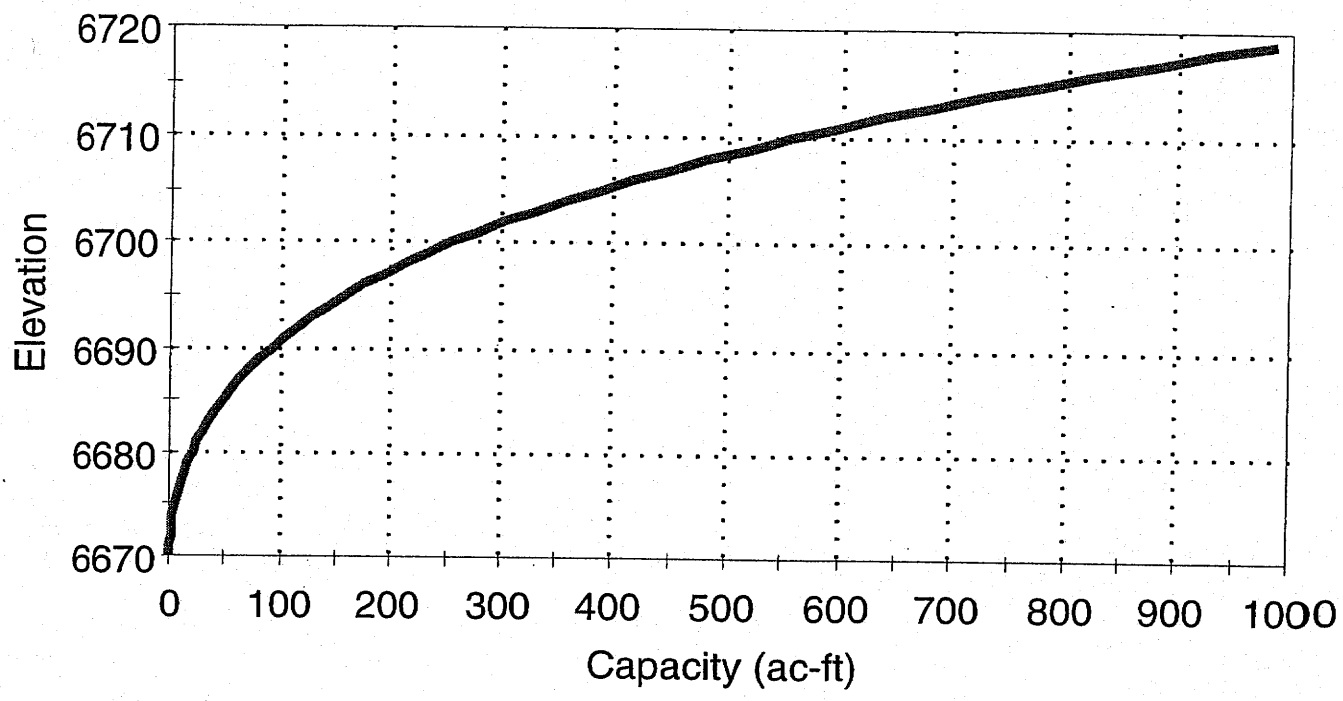
**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,670.00	0.000	0.000
6,671.00	0.000	0.000
6,672.00	0.000	0.000
6,673.00	0.000	0.000
6,674.00	0.000	0.000
6,675.00	0.000	0.000
6,676.00	0.000	0.000
6,677.00	0.000	0.000
6,678.00	0.000	0.000
6,679.00	0.000	0.000
6,680.00	0.000	0.000
6,681.00	0.000	0.000
6,682.00	0.000	0.000
6,683.00	0.000	0.000
6,684.00	0.000	0.000
6,685.00	0.000	0.000
6,686.00	0.000	0.000
6,687.00	0.000	0.000
6,688.00	0.000	0.000
6,689.00	0.000	0.000
6,690.00	0.000	0.000
6,691.00	0.000	0.000
6,692.00	0.000	0.000
6,693.00	0.000	0.000
6,694.00	0.000	0.000
6,695.00	0.000	0.000
6,696.00	0.000	0.000
6,697.00	0.000	0.000
6,698.00	0.000	0.000
6,699.00	0.000	0.000
6,700.00	0.000	0.000
6,701.00	0.000	0.000
6,702.00	0.000	0.000
6,703.00	0.000	0.000
6,704.00	0.000	0.000
6,705.00	0.000	0.000
6,706.00	0.000	0.000
6,707.00	0.000	0.000
6,708.00	0.000	0.000
6,709.00	0.000	0.000

Elevation	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,710.00	0.000	0.000
6,711.00	135.962	135.962
6,712.00	493.585	493.585
6,713.00	992.277	992.277
6,714.00	1,665.923	1,665.923
6,715.00	2,444.368	2,444.368
6,716.00	3,363.224	3,363.224
6,717.00	4,407.921	4,407.921
6,718.00	5,578.250	5,578.250
6,719.00	6,779.881	6,779.881

J7Jr STAGE / STORAGE GRAPH



PEABODY WESTERN
KAYENTA MINE
MSHA POND J7-Jr

1/2 General 6-hour PMP

Water Level @ 6710'

Em. Spillway Invert

DJK

Montgomery Watson
165 South Union Blvd.
Suite 410
Lakewood, Co. 80228

Phone: 303 763-5140

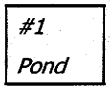
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100000000 yr - 6 hr
Rainfall Depth:	2.980 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	End	0.000	0.000	Pond J7-Jr



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	In	3,960.300	3,960.300	3,085.37	428.42
	Out			1,522.62	428.43

Structure Detail:

Structure #1 (Pond)

Pond J7-Jr

Pond Inputs:

Initial Pool Elev:	6,710.00
Initial Pool:	555.77 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
6,710.00	44.00	3.00:1	3.00:1	70.00

Pond Results:

Peak Elevation:	6,713.79
Dewater Time:	0.35 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)
6,670.00	0.610	0.000	0.000	
6,671.00	0.793	0.700	0.000	
6,672.00	0.999	1.594	0.000	
6,673.00	1.229	2.706	0.000	
6,674.00	1.483	4.061	0.000	
6,675.00	1.760	5.681	0.000	
6,676.00	2.212	7.662	0.000	
6,677.00	2.712	10.120	0.000	
6,678.00	3.264	13.104	0.000	
6,679.00	3.868	16.666	0.000	
6,680.00	4.520	20.856	0.000	
6,681.00	4.884	25.557	0.000	
6,682.00	5.262	30.629	0.000	
6,683.00	5.654	36.086	0.000	
6,684.00	6.060	41.943	0.000	
6,685.00	6.480	48.212	0.000	
6,686.00	7.301	55.098	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
6,687.00	8.167	62.828	0.000		
6,688.00	9.083	71.450	0.000		
6,689.00	10.049	81.012	0.000		
6,690.00	11.060	91.562	0.000		
6,691.00	11.942	103.060	0.000		
6,692.00	12.856	115.457	0.000		
6,693.00	13.804	128.784	0.000		
6,694.00	14.786	143.076	0.000		
6,695.00	15.800	158.366	0.000		
6,696.00	17.126	174.825	0.000		
6,697.00	18.502	192.634	0.000		
6,698.00	19.932	211.847	0.000		
6,699.00	21.416	232.516	0.000		
6,700.00	22.950	254.695	0.000		
6,701.00	24.203	278.269	0.000		
6,702.00	25.487	303.111	0.000		
6,703.00	26.805	329.255	0.000		
6,704.00	28.157	356.733	0.000		
6,705.00	29.540	385.579	0.000		
6,706.00	31.283	415.986	0.000		
6,707.00	33.072	448.160	0.000		
6,708.00	34.912	482.148	0.000		
6,709.00	36.803	518.001	0.000		
6,710.00	38.740	555.768	0.000		Spillway #1
6,711.00	40.844	595.555	135.962	3.54*	
6,712.00	42.999	637.472	493.585	2.00	
6,713.00	45.211	681.573	992.277	1.45	
6,713.79	47.003	718.055	1,522.615	1.35	Peak Stage
6,714.00	47.480	727.914	1,665.923		
6,715.00	49.800	776.549	2,444.368		
6,716.00	50.958	826.926	3,363.224		
6,717.00	52.128	878.468	4,407.921		
6,718.00	53.313	931.188	5,578.250		
6,719.00	54.510	985.098	6,779.881		

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,670.00	0.000	0.000
6,671.00	0.000	0.000
6,672.00	0.000	0.000
6,673.00	0.000	0.000
6,674.00	0.000	0.000
6,675.00	0.000	0.000
6,676.00	0.000	0.000
6,677.00	0.000	0.000
6,678.00	0.000	0.000
6,679.00	0.000	0.000
6,680.00	0.000	0.000
6,681.00	0.000	0.000
6,682.00	0.000	0.000
6,683.00	0.000	0.000
6,684.00	0.000	0.000
6,685.00	0.000	0.000
6,686.00	0.000	0.000
6,687.00	0.000	0.000
6,688.00	0.000	0.000
6,689.00	0.000	0.000
6,690.00	0.000	0.000
6,691.00	0.000	0.000
6,692.00	0.000	0.000
6,693.00	0.000	0.000
6,694.00	0.000	0.000
6,695.00	0.000	0.000
6,696.00	0.000	0.000
6,697.00	0.000	0.000
6,698.00	0.000	0.000
6,699.00	0.000	0.000
6,700.00	0.000	0.000
6,701.00	0.000	0.000
6,702.00	0.000	0.000
6,703.00	0.000	0.000
6,704.00	0.000	0.000
6,705.00	0.000	0.000
6,706.00	0.000	0.000
6,707.00	0.000	0.000
6,708.00	0.000	0.000
6,709.00	0.000	0.000

Elevation	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,710.00	0.000	0.000
6,711.00	135.962	135.962
6,712.00	493.585	493.585
6,713.00	992.277	992.277
6,714.00	1,665.923	1,665.923
6,715.00	2,444.368	2,444.368
6,716.00	3,363.224	3,363.224
6,717.00	4,407.921	4,407.921
6,718.00	5,578.250	5,578.250
6,719.00	6,779.881	6,779.881

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	3,960.300	1.093	0.000	0.000	81.000	F	3,085.37	428.416
	$\sum$	**3,960.300**						**3,085.37**	**428.416**

Table 6.1.--General-storm PMP computations for the Colorado River and Great basin

Drainage Red Peak Valley Wash 110° 19' 52" Area 6.2 (mi²) (km²)

Latitude 36°26'13", Longitude ___ of basin center

Month August

Step	Duration (hrs) (6) 12 18 24 48 72
A. Convergence PMP	
1. Drainage average value from one of figures 2.5 to 2.16	12.5 (in.) (mm)
2. Reduction for barrier-elevation [fig. 2.18]	45 %
3. Barrier-elevation reduced PMP [step 1 X step 2]	5.625 (in.) (mm)
4. Durational variation [figs. 2.25 to 2.27 and table 2.7].	72 ___ ___ ___ ___ ___ %
5. Convergence PMP for indicated durations [steps 3 X 4]	4.05 ___ ___ ___ ___ ___ (in.) (mm)
6. Incremental 10 mi² (26 km²) PMP [successive subtraction in step 5] Fig. 4.9	4.05 ___ ___ ___ ___ ___ (in.) (mm)
7. Areal reduction [select from figs. 2.28 and 2.29]	100 ___ ___ ___ ___ ___ %
8. Areally reduced PMP [step 6 X step 7]	4.05 ___ ___ ___ ___ ___ (in.) (mm)
9. Drainage average PMP [accumulated values of step 8]	4.05 ___ ___ ___ ___ ___ (in.) (mm)
B. Orographic PMP	
1. Drainage average orographic index from figure 3.11a to d.	(revised) 5.8 (in.) (mm)
2. Areal reduction [figure 3.20]	100%
3. Adjustment for month [one of figs. 3.12 to 3.17]	100%
4. Areally and seasonally adjusted PMP [steps 1 X 2 X 3]	5.8 (in.) (mm)
5. Durational variation [table ~~3.8~~ 3.9]	33 ___ ___ ___ ___ ___ %
6. Orographic PMP for given durations [steps 4 X 5]	1.91 ___ ___ ___ ___ ___ (in.) (mm)
C. Total PMP	
1. Add steps A9 and B6	5.96 ___ ___ ___ ___ ___ (in.) (mm)
2. PMP for other durations from ~~smooth curve~~ fitted to plot of computed data.	
3. Comparison with local-storm PMP (see sec. 6.3).	

General PMP = 5.96 in

½ General PMP = 2.98 in

APPENDIX E.5

SEDCAD4 De-watering Time Calculations

DECANT PIPE DEWATERING TIME SUMMARY

ELEVATION	HOURS	DAYS	CUMULATIVE DAYS
6710 to 6709	21.30	0.9	0.9
6709 to 6708	21.06	0.9	1.8
6708 to 6707	21.68	0.9	2.7
6707 to 6706	23.17	1.0	3.7
6706 to 6705	25.70	1.1	4.8
6705 to 6704	30.97	1.3	6.1
6704 to 6703	48.41	2.0	8.1
6703 to 6702	191.53	8.0	16.1

Note: Dewatering hours from SEDCAD4 output file (file #J7Jr100-6DecantBREV1).

PEABODY WESTERN
KAYENTA MINE
MSHA POND J7-Jr
Dewatering Time

Decant Pipe Inlet @ 6702'

Straight Pipe @ 3.5% Slope

DJK

Montgomery Watson
165 S. Union Blvd.
Suite 410
Lakewood, Colorado 80228

Phone: 303 763-5140

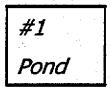
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10000000 yr - 6 hr
Rainfall Depth:	2.980 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	End	0.000	0.000	Pond J7-Jr



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	In	3,960.300	3,960.300	3,085.37	428.42
	Out			459.48	223.46

Structure Detail:

Structure #1 (Pond)

Pond J7-Jr

Pond Inputs:

Initial Pool Elev:	6,702.00
Initial Pool:	303.08 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
6,710.00	44.00	3.00:1	3.00:1	70.00

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev	Entrance Loss Coefficient	Tailwater Depth (ft)
18.00	200.00	3.50	0.0140	6,702.00	0.50	0.00

Pond Results:

Peak Elevation:	6,711.85
Dewater Time:	16.38 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)
6,670.00	0.610	0.000	0.000	
6,670.50	0.698	0.327	0.000	
6,671.00	0.793	0.699	0.000	
6,671.50	0.893	1.120	0.000	
6,672.00	0.999	1.593	0.000	
6,672.50	1.111	2.120	0.000	
6,673.00	1.229	2.705	0.000	
6,673.50	1.353	3.350	0.000	
6,674.00	1.483	4.058	0.000	
6,674.50	1.618	4.833	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
6,675.00	1.760	5.678	0.000	
6,675.50	1.979	6.612	0.000	
6,676.00	2.210	7.659	0.000	
6,676.50	2.454	8.824	0.000	
6,677.00	2.711	10.115	0.000	
6,677.50	2.980	11.538	0.000	
6,678.00	3.263	13.098	0.000	
6,678.50	3.558	14.803	0.000	
6,679.00	3.866	16.658	0.000	
6,679.50	4.187	18.671	0.000	
6,680.00	4.520	20.847	0.000	
6,680.50	4.700	23.152	0.000	
6,681.00	4.884	25.548	0.000	
6,681.50	5.071	28.037	0.000	
6,682.00	5.262	30.620	0.000	
6,682.50	5.456	33.299	0.000	
6,683.00	5.654	36.077	0.000	
6,683.50	5.855	38.954	0.000	
6,684.00	6.060	41.932	0.000	
6,684.50	6.268	45.014	0.000	
6,685.00	6.480	48.201	0.000	
6,685.50	6.884	51.542	0.000	
6,686.00	7.299	55.087	0.000	
6,686.50	7.727	58.843	0.000	
6,687.00	8.167	62.816	0.000	
6,687.50	8.618	67.011	0.000	
6,688.00	9.083	71.436	0.000	
6,688.50	9.559	76.095	0.000	
6,689.00	10.047	80.996	0.000	
6,689.50	10.548	86.145	0.000	
6,690.00	11.060	91.546	0.000	
6,690.50	11.496	97.185	0.000	
6,691.00	11.941	103.044	0.000	
6,691.50	12.394	109.127	0.000	
6,692.00	12.855	115.439	0.000	
6,692.50	13.325	121.984	0.000	
6,693.00	13.803	128.765	0.000	
6,693.50	14.290	135.788	0.000	
6,694.00	14.785	143.056	0.000	
6,694.50	15.288	150.574	0.000	
6,695.00	15.800	158.346	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
6,695.50	16.456	166.409	0.000		
6,696.00	17.124	174.804	0.000		
6,696.50	17.806	183.536	0.000		
6,697.00	18.501	192.612	0.000		
6,697.50	19.209	202.039	0.000		
6,698.00	19.931	211.823	0.000		
6,698.50	20.666	221.972	0.000		
6,699.00	21.414	232.491	0.000		
6,699.50	22.176	243.388	0.000		
6,700.00	22.950	254.669	0.000		
6,700.50	23.572	266.299	0.000		
6,701.00	24.202	278.242	0.000		
6,701.50	24.840	290.502	0.000		
6,702.00	25.487	303.083	0.000		Spillway #2
6,702.50	26.141	315.990	1.111	140.55*	
6,703.00	26.805	329.226	3.142	50.98*	
6,703.50	27.476	342.796	5.774	28.44*	
6,704.00	28.156	356.704	8.425	19.97*	
6,704.50	28.844	370.953	10.472	16.46*	
6,705.00	29.540	385.549	12.173	14.51*	
6,705.50	30.405	400.534	13.675	13.26*	
6,706.00	31.281	415.955	15.003	12.44*	
6,706.50	32.170	431.817	16.242	11.82*	
6,707.00	33.071	448.127	17.381	11.35*	
6,707.50	33.984	464.890	18.479	10.98*	
6,708.00	34.911	482.114	19.477	10.70*	
6,708.50	35.850	499.803	20.463	10.46*	
6,709.00	36.801	517.966	20.982	10.60	
6,709.50	37.765	536.606	21.425	10.65	
6,710.00	38.740	555.732	21.868	10.65	Spillway #1
6,710.50	39.784	575.362	90.292	4.95	
6,711.00	40.841	595.518	158.691	2.00	
6,711.50	41.913	616.206	325.430	1.25	
6,711.85	42.674	631.055	459.481	1.10	Peak Stage
6,712.00	42.998	637.433	517.058		
6,712.50	44.097	659.207	741.448		
6,713.00	45.210	681.533	1,016.493		
6,713.50	46.337	704.419	1,330.392		
6,714.00	47.477	727.872	1,690.854		
6,714.50	48.632	751.899	2,057.792		
6,715.00	49.800	776.506	2,469.985		

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
6,715.50	50.377	801.550	2,913.972	
6,716.00	50.958	826.884	3,389.527	
6,716.50	51.541	852.508	3,896.520	
6,717.00	52.128	878.426	4,434.881	
6,717.50	52.719	904.637	5,004.639	
6,718.00	53.313	931.145	5,605.846	
6,718.50	53.910	957.951	6,193.293	
6,719.00	54.510	985.055	6,808.113	

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation	Emergency Spillway (cfs)	Straight Pipe (cfs)	Combined Total Discharge (cfs)
6,670.00	0.000	0.000	0.000
6,670.50	0.000	0.000	0.000
6,671.00	0.000	0.000	0.000
6,671.50	0.000	0.000	0.000
6,672.00	0.000	0.000	0.000
6,672.50	0.000	0.000	0.000
6,673.00	0.000	0.000	0.000
6,673.50	0.000	0.000	0.000
6,674.00	0.000	0.000	0.000
6,674.50	0.000	0.000	0.000
6,675.00	0.000	0.000	0.000
6,675.50	0.000	0.000	0.000
6,676.00	0.000	0.000	0.000
6,676.50	0.000	0.000	0.000
6,677.00	0.000	0.000	0.000
6,677.50	0.000	0.000	0.000
6,678.00	0.000	0.000	0.000
6,678.50	0.000	0.000	0.000
6,679.00	0.000	0.000	0.000
6,679.50	0.000	0.000	0.000
6,680.00	0.000	0.000	0.000
6,680.50	0.000	0.000	0.000
6,681.00	0.000	0.000	0.000
6,681.50	0.000	0.000	0.000
6,682.00	0.000	0.000	0.000

Elevation	Emergency Spillway (cfs)	Straight Pipe (cfs)	Combined Total Discharge (cfs)
6,682.50	0.000	0.000	0.000
6,683.00	0.000	0.000	0.000
6,683.50	0.000	0.000	0.000
6,684.00	0.000	0.000	0.000
6,684.50	0.000	0.000	0.000
6,685.00	0.000	0.000	0.000
6,685.50	0.000	0.000	0.000
6,686.00	0.000	0.000	0.000
6,686.50	0.000	0.000	0.000
6,687.00	0.000	0.000	0.000
6,687.50	0.000	0.000	0.000
6,688.00	0.000	0.000	0.000
6,688.50	0.000	0.000	0.000
6,689.00	0.000	0.000	0.000
6,689.50	0.000	0.000	0.000
6,690.00	0.000	0.000	0.000
6,690.50	0.000	0.000	0.000
6,691.00	0.000	0.000	0.000
6,691.50	0.000	0.000	0.000
6,692.00	0.000	0.000	0.000
6,692.50	0.000	0.000	0.000
6,693.00	0.000	0.000	0.000
6,693.50	0.000	0.000	0.000
6,694.00	0.000	0.000	0.000
6,694.50	0.000	0.000	0.000
6,695.00	0.000	0.000	0.000
6,695.50	0.000	0.000	0.000
6,696.00	0.000	0.000	0.000
6,696.50	0.000	0.000	0.000
6,697.00	0.000	0.000	0.000
6,697.50	0.000	0.000	0.000
6,698.00	0.000	0.000	0.000
6,698.50	0.000	0.000	0.000
6,699.00	0.000	0.000	0.000
6,699.50	0.000	0.000	0.000
6,700.00	0.000	0.000	0.000
6,700.50	0.000	0.000	0.000
6,701.00	0.000	0.000	0.000
6,701.50	0.000	0.000	0.000
6,702.00	0.000	0.000	0.000

Elevation	Emergency Spillway (cfs)	Straight Pipe (cfs)	Combined Total Discharge (cfs)
6,702.50	0.000	(3)>1.111	1.111
6,703.00	0.000	(3)>3.142	3.142
6,703.50	0.000	(3)>5.774	5.774
6,704.00	0.000	(5)>8.425	8.425
6,704.50	0.000	(5)>10.472	10.472
6,705.00	0.000	(5)>12.173	12.173
6,705.50	0.000	(5)>13.675	13.675
6,706.00	0.000	(5)>15.003	15.003
6,706.50	0.000	(5)>16.242	16.242
6,707.00	0.000	(5)>17.381	17.381
6,707.50	0.000	(5)>18.479	18.479
6,708.00	0.000	(5)>19.477	19.477
6,708.50	0.000	(5)>20.463	20.463
6,709.00	0.000	(5)>20.982	20.982
6,709.50	0.000	(5)>21.425	21.425
6,710.00	0.000	(6)>21.868	21.868
6,710.50	67.981	(6)>22.310	90.292
6,711.00	135.962	(6)>22.729	158.691
6,711.50	302.329	(6)>23.101	325.430
6,712.00	493.585	(6)>23.472	517.058
6,712.50	717.604	(6)>23.844	741.448
6,713.00	992.277	(6)>24.216	1,016.493
6,713.50	1,305.805	(6)>24.588	1,330.392
6,714.00	1,665.923	(6)>24.932	1,690.854
6,714.50	2,032.517	(6)>25.274	2,057.792
6,715.00	2,444.368	(6)>25.617	2,469.985
6,715.50	2,888.012	(6)>25.960	2,913.972
6,716.00	3,363.224	(6)>26.303	3,389.527
6,716.50	3,869.878	(6)>26.642	3,896.520
6,717.00	4,407.921	(6)>26.960	4,434.881
6,717.50	4,977.361	(6)>27.278	5,004.639
6,718.00	5,578.250	(6)>27.596	5,605.846
6,718.50	6,165.379	(6)>27.914	6,193.293
6,719.00	6,779.881	(6)>28.232	6,808.113

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	3,960.300	1.093	0.000	0.000	81.000	F	3,085.37	428.416
	Σ	**3,960.300**						**3,085.37**	**428.416**

APPENDIX E.6

SEDCAD4 (input and output) 100-year, 6-hour Storm Event W/ Water Level set at Elevation 6702' (Decant Pipe Invert)

Copyright 1998 Pamela J. Schwab

PEABODY WESTERN KAYENTA MINE MSHA POND J7-Jr

100-year, 6-hour

Water level @ 6702'

DJK

Montgomery Watson
165 S. Union Blvd.
Suite 410
Lakewood, Co. 80228

Phone: 303 763-5140

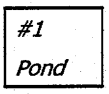
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 6 hr
Rainfall Depth:	2.400 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	End	0.000	0.000	Pond J7-Jr



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	In	3,960.300	3,960.300	3,085.37	428.42
	Out			458.87	209.24

Structure Detail:

Structure #1 (Pond)

Pond J7-Jr

Pond Inputs:

Initial Pool Elev:	6,702.00
Initial Pool:	303.08 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
6,710.00	44.00	3.00:1	3.00:1	70.00

Straight Pipe

Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev	Entrance Loss Coefficient	Tailwater Depth (ft)
18.00	200.00	3.50	0.0190	6,702.00	0.50	0.00

Pond Results:

Peak Elevation:	6,711.86
Dewater Time:	17.20 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)
6,670.00	0.610	0.000	0.000	
6,670.50	0.698	0.327	0.000	
6,671.00	0.793	0.699	0.000	
6,671.50	0.893	1.120	0.000	
6,672.00	0.999	1.593	0.000	
6,672.50	1.111	2.120	0.000	
6,673.00	1.229	2.705	0.000	
6,673.50	1.353	3.350	0.000	
6,674.00	1.483	4.058	0.000	
6,674.50	1.618	4.833	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
6,675.00	1.760	5.678	0.000	
6,675.50	1.979	6.612	0.000	
6,676.00	2.210	7.659	0.000	
6,676.50	2.454	8.824	0.000	
6,677.00	2.711	10.115	0.000	
6,677.50	2.980	11.538	0.000	
6,678.00	3.263	13.098	0.000	
6,678.50	3.558	14.803	0.000	
6,679.00	3.866	16.658	0.000	
6,679.50	4.187	18.671	0.000	
6,680.00	4.520	20.847	0.000	
6,680.50	4.700	23.152	0.000	
6,681.00	4.884	25.548	0.000	
6,681.50	5.071	28.037	0.000	
6,682.00	5.262	30.620	0.000	
6,682.50	5.456	33.299	0.000	
6,683.00	5.654	36.077	0.000	
6,683.50	5.855	38.954	0.000	
6,684.00	6.060	41.932	0.000	
6,684.50	6.268	45.014	0.000	
6,685.00	6.480	48.201	0.000	
6,685.50	6.884	51.542	0.000	
6,686.00	7.299	55.087	0.000	
6,686.50	7.727	58.843	0.000	
6,687.00	8.167	62.816	0.000	
6,687.50	8.618	67.011	0.000	
6,688.00	9.083	71.436	0.000	
6,688.50	9.559	76.095	0.000	
6,689.00	10.047	80.996	0.000	
6,689.50	10.548	86.145	0.000	
6,690.00	11.060	91.546	0.000	
6,690.50	11.496	97.185	0.000	
6,691.00	11.941	103.044	0.000	
6,691.50	12.394	109.127	0.000	
6,692.00	12.855	115.439	0.000	
6,692.50	13.325	121.984	0.000	
6,693.00	13.803	128.765	0.000	
6,693.50	14.290	135.788	0.000	
6,694.00	14.785	143.056	0.000	
6,694.50	15.288	150.574	0.000	
6,695.00	15.800	158.346	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
6,699.00	21.414	232.491	0.000		
6,699.50	22.176	243.388	0.000		
6,700.00	22.950	254.669	0.000		
6,700.50	23.572	266.299	0.000		
6,701.00	24.202	278.242	0.000		
6,701.50	24.840	290.502	0.000		
6,702.00	25.487	303.083	0.000		
6,702.50	26.141	315.990	0.000		
6,703.00	26.805	329.226	0.000		
6,703.50	27.476	342.796	0.000		
6,704.00	28.156	356.704	0.000		
6,704.50	28.844	370.953	0.000		
6,705.00	29.540	385.549	0.000		
6,705.50	30.405	400.534	0.000		
6,706.00	31.281	415.955	0.000		
6,706.50	32.170	431.817	0.000		
6,707.00	33.071	448.127	0.000		
6,707.50	33.984	464.890	0.000		
6,708.00	34.911	482.114	0.000		
6,708.50	35.850	499.803	0.000		
6,709.00	36.801	517.966	0.000		
6,709.50	37.765	536.606	0.000		
6,710.00	38.740	555.732	0.000		Spillway #1
6,710.32	39.424	568.352	43.702	42.55	Peak Stage
6,710.50	39.784	575.362	67.981		
6,711.00	40.841	595.518	135.962		
6,711.50	41.913	616.206	302.329		
6,712.00	42.998	637.433	493.585		
6,712.50	44.097	659.207	717.604		
6,713.00	45.210	681.533	992.277		
6,713.50	46.337	704.419	1,305.805		
6,714.00	47.477	727.872	1,665.923		
6,714.50	48.632	751.899	2,032.517		
6,715.00	49.800	776.506	2,444.368		
6,715.50	50.377	801.550	2,888.012		
6,716.00	50.958	826.884	3,363.224		
6,716.50	51.541	852.508	3,869.878		
6,717.00	52.128	878.426	4,407.921		
6,717.50	52.719	904.637	4,977.361		
6,718.00	53.313	931.145	5,578.250		
6,718.50	53.910	957.951	6,165.379		

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
6,719.00	54.510	985.055	6,779.881	

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,670.00	0.000	0.000
6,670.50	0.000	0.000
6,671.00	0.000	0.000
6,671.50	0.000	0.000
6,672.00	0.000	0.000
6,672.50	0.000	0.000
6,673.00	0.000	0.000
6,673.50	0.000	0.000
6,674.00	0.000	0.000
6,674.50	0.000	0.000
6,675.00	0.000	0.000
6,675.50	0.000	0.000
6,676.00	0.000	0.000
6,676.50	0.000	0.000
6,677.00	0.000	0.000
6,677.50	0.000	0.000
6,678.00	0.000	0.000
6,678.50	0.000	0.000
6,679.00	0.000	0.000
6,679.50	0.000	0.000
6,680.00	0.000	0.000
6,680.50	0.000	0.000
6,681.00	0.000	0.000
6,681.50	0.000	0.000
6,682.00	0.000	0.000
6,682.50	0.000	0.000
6,683.00	0.000	0.000
6,683.50	0.000	0.000
6,684.00	0.000	0.000
6,684.50	0.000	0.000
6,685.00	0.000	0.000
6,685.50	0.000	0.000

Elevation	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,686.00	0.000	0.000
6,686.50	0.000	0.000
6,687.00	0.000	0.000
6,687.50	0.000	0.000
6,688.00	0.000	0.000
6,688.50	0.000	0.000
6,689.00	0.000	0.000
6,689.50	0.000	0.000
6,690.00	0.000	0.000
6,690.50	0.000	0.000
6,691.00	0.000	0.000
6,691.50	0.000	0.000
6,692.00	0.000	0.000
6,692.50	0.000	0.000
6,693.00	0.000	0.000
6,693.50	0.000	0.000
6,694.00	0.000	0.000
6,694.50	0.000	0.000
6,695.00	0.000	0.000
6,695.50	0.000	0.000
6,696.00	0.000	0.000
6,696.50	0.000	0.000
6,697.00	0.000	0.000
6,697.50	0.000	0.000
6,698.00	0.000	0.000
6,698.50	0.000	0.000
6,699.00	0.000	0.000
6,699.50	0.000	0.000
6,700.00	0.000	0.000
6,700.50	0.000	0.000
6,701.00	0.000	0.000
6,701.50	0.000	0.000
6,702.00	0.000	0.000
6,702.50	0.000	0.000
6,703.00	0.000	0.000
6,703.50	0.000	0.000
6,704.00	0.000	0.000
6,704.50	0.000	0.000
6,705.00	0.000	0.000
6,705.50	0.000	0.000

Elevation	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,706.00	0.000	0.000
6,706.50	0.000	0.000
6,707.00	0.000	0.000
6,707.50	0.000	0.000
6,708.00	0.000	0.000
6,708.50	0.000	0.000
6,709.00	0.000	0.000
6,709.50	0.000	0.000
6,710.00	0.000	0.000
6,710.50	67.981	67.981
6,711.00	135.962	135.962
6,711.50	302.329	302.329
6,712.00	493.585	493.585
6,712.50	717.604	717.604
6,713.00	992.277	992.277
6,713.50	1,305.805	1,305.805
6,714.00	1,665.923	1,665.923
6,714.50	2,032.517	2,032.517
6,715.00	2,444.368	2,444.368
6,715.50	2,888.012	2,888.012
6,716.00	3,363.224	3,363.224
6,716.50	3,869.878	3,869.878
6,717.00	4,407.921	4,407.921
6,717.50	4,977.361	4,977.361
6,718.00	5,578.250	5,578.250
6,718.50	6,165.379	6,165.379
6,719.00	6,779.881	6,779.881

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	3,960.300	1.093	0.000	0.000	81.000	F	2,024.26	287.712
	Σ	**3,960.300**						**2,024.26**	**287.712**

APPENDIX E.6

SEDCAD4 (input and output) ½ 6-hour PMP Storm Event

w/Water Level Set at Elevation 6702' (Decant Pipe Invert)

PEABODY WESTERN
KAYENTA MINE
MSHA POND J7-Jr

General 6-hour PMP

Water level @ 6702'

Decant Pipe Invert

DJK

Montgomery Watson
165 South Union Blvd.
Suite 410
Lakewood, Co. 80228

Phone: 303 763-5140

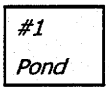
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100000000 yr - 6 hr
Rainfall Depth:	2.980 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	End	0.000	0.000	Pond J7-Jr



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	In	3,960.300	3,960.300	3,085.37	428.42
	Out			458.16	159.32

Structure Detail:

Structure #1 (Pond)

Pond J7-Jr

Pond Inputs:

Initial Pool Elev:	6,702.00
Initial Pool:	555.77 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
6,710.00	44.00	3.00:1	3.00:1	70.00

Pond Results:

Peak Elevation:	6,711.91
Dewater Time:	0.36 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)
6,670.00	0.610	0.000	0.000	
6,670.50	0.698	0.327	0.000	
6,671.00	0.793	0.699	0.000	
6,671.50	0.893	1.120	0.000	
6,672.00	0.999	1.593	0.000	
6,672.50	1.111	2.120	0.000	
6,673.00	1.229	2.705	0.000	
6,673.50	1.353	3.350	0.000	
6,674.00	1.483	4.058	0.000	
6,674.50	1.618	4.833	0.000	
6,675.00	1.760	5.678	0.000	
6,675.50	1.979	6.612	0.000	
6,676.00	2.210	7.659	0.000	
6,676.50	2.454	8.824	0.000	
6,677.00	2.711	10.115	0.000	
6,677.50	2.980	11.538	0.000	
6,678.00	3.263	13.098	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
6,678.50	3.558	14.803	0.000	
6,679.00	3.866	16.658	0.000	
6,679.50	4.187	18.671	0.000	
6,680.00	4.520	20.847	0.000	
6,680.50	4.700	23.152	0.000	
6,681.00	4.884	25.548	0.000	
6,681.50	5.071	28.037	0.000	
6,682.00	5.262	30.620	0.000	
6,682.50	5.456	33.299	0.000	
6,683.00	5.654	36.077	0.000	
6,683.50	5.855	38.954	0.000	
6,684.00	6.060	41.932	0.000	
6,684.50	6.268	45.014	0.000	
6,685.00	6.480	48.201	0.000	
6,685.50	6.884	51.542	0.000	
6,686.00	7.299	55.087	0.000	
6,686.50	7.727	58.843	0.000	
6,687.00	8.167	62.816	0.000	
6,687.50	8.618	67.011	0.000	
6,688.00	9.083	71.436	0.000	
6,688.50	9.559	76.095	0.000	
6,689.00	10.047	80.996	0.000	
6,689.50	10.548	86.145	0.000	
6,690.00	11.060	91.546	0.000	
6,690.50	11.496	97.185	0.000	
6,691.00	11.941	103.044	0.000	
6,691.50	12.394	109.127	0.000	
6,692.00	12.855	115.439	0.000	
6,692.50	13.325	121.984	0.000	
6,693.00	13.803	128.765	0.000	
6,693.50	14.290	135.788	0.000	
6,694.00	14.785	143.056	0.000	
6,694.50	15.288	150.574	0.000	
6,695.00	15.800	158.346	0.000	
6,695.50	16.456	166.409	0.000	
6,696.00	17.124	174.804	0.000	
6,696.50	17.806	183.536	0.000	
6,697.00	18.501	192.612	0.000	
6,697.50	19.209	202.039	0.000	
6,698.00	19.931	211.823	0.000	
6,698.50	20.666	221.972	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
6,699.00	21.414	232.491	0.000		
6,699.50	22.176	243.388	0.000		
6,700.00	22.950	254.669	0.000		
6,700.50	23.572	266.299	0.000		
6,701.00	24.202	278.242	0.000		
6,701.50	24.840	290.502	0.000		
6,702.00	25.487	303.083	0.000		
6,702.50	26.141	315.990	0.000		
6,703.00	26.805	329.226	0.000		
6,703.50	27.476	342.796	0.000		
6,704.00	28.156	356.704	0.000		
6,704.50	28.844	370.953	0.000		
6,705.00	29.540	385.549	0.000		
6,705.50	30.405	400.534	0.000		
6,706.00	31.281	415.955	0.000		
6,706.50	32.170	431.817	0.000		
6,707.00	33.071	448.127	0.000		
6,707.50	33.984	464.890	0.000		
6,708.00	34.911	482.114	0.000		
6,708.50	35.850	499.803	0.000		
6,709.00	36.801	517.966	0.000		
6,709.50	37.765	536.606	0.000		
6,710.00	38.740	555.732	0.000		Spillway #1
6,710.50	39.784	575.362	67.981	3.49*	
6,711.00	40.841	595.518	135.962	2.50	
6,711.50	41.913	616.206	302.329	1.30	
6,711.91	42.798	633.502	458.164	1.25	Peak Stage
6,712.00	42.998	637.433	493.585		
6,712.50	44.097	659.207	717.604		
6,713.00	45.210	681.533	992.277		
6,713.50	46.337	704.419	1,305.805		
6,714.00	47.477	727.872	1,665.923		
6,714.50	48.632	751.899	2,032.517		
6,715.00	49.800	776.506	2,444.368		
6,715.50	50.377	801.550	2,888.012		
6,716.00	50.958	826.884	3,363.224		
6,716.50	51.541	852.508	3,869.878		
6,717.00	52.128	878.426	4,407.921		
6,717.50	52.719	904.637	4,977.361		
6,718.00	53.313	931.145	5,578.250		
6,718.50	53.910	957.951	6,165.379		

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
6,719.00	54.510	985.055	6,779.881	

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,670.00	0.000	0.000
6,670.50	0.000	0.000
6,671.00	0.000	0.000
6,671.50	0.000	0.000
6,672.00	0.000	0.000
6,672.50	0.000	0.000
6,673.00	0.000	0.000
6,673.50	0.000	0.000
6,674.00	0.000	0.000
6,674.50	0.000	0.000
6,675.00	0.000	0.000
6,675.50	0.000	0.000
6,676.00	0.000	0.000
6,676.50	0.000	0.000
6,677.00	0.000	0.000
6,677.50	0.000	0.000
6,678.00	0.000	0.000
6,678.50	0.000	0.000
6,679.00	0.000	0.000
6,679.50	0.000	0.000
6,680.00	0.000	0.000
6,680.50	0.000	0.000
6,681.00	0.000	0.000
6,681.50	0.000	0.000
6,682.00	0.000	0.000
6,682.50	0.000	0.000
6,683.00	0.000	0.000
6,683.50	0.000	0.000
6,684.00	0.000	0.000
6,684.50	0.000	0.000
6,685.00	0.000	0.000
6,685.50	0.000	0.000

Elevation	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,686.00	0.000	0.000
6,686.50	0.000	0.000
6,687.00	0.000	0.000
6,687.50	0.000	0.000
6,688.00	0.000	0.000
6,688.50	0.000	0.000
6,689.00	0.000	0.000
6,689.50	0.000	0.000
6,690.00	0.000	0.000
6,690.50	0.000	0.000
6,691.00	0.000	0.000
6,691.50	0.000	0.000
6,692.00	0.000	0.000
6,692.50	0.000	0.000
6,693.00	0.000	0.000
6,693.50	0.000	0.000
6,694.00	0.000	0.000
6,694.50	0.000	0.000
6,695.00	0.000	0.000
6,695.50	0.000	0.000
6,696.00	0.000	0.000
6,696.50	0.000	0.000
6,697.00	0.000	0.000
6,697.50	0.000	0.000
6,698.00	0.000	0.000
6,698.50	0.000	0.000
6,699.00	0.000	0.000
6,699.50	0.000	0.000
6,700.00	0.000	0.000
6,700.50	0.000	0.000
6,701.00	0.000	0.000
6,701.50	0.000	0.000
6,702.00	0.000	0.000
6,702.50	0.000	0.000
6,703.00	0.000	0.000
6,703.50	0.000	0.000
6,704.00	0.000	0.000
6,704.50	0.000	0.000
6,705.00	0.000	0.000
6,705.50	0.000	0.000

Elevation	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,706.00	0.000	0.000
6,706.50	0.000	0.000
6,707.00	0.000	0.000
6,707.50	0.000	0.000
6,708.00	0.000	0.000
6,708.50	0.000	0.000
6,709.00	0.000	0.000
6,709.50	0.000	0.000
6,710.00	0.000	0.000
6,710.50	67.981	67.981
6,711.00	135.962	135.962
6,711.50	302.329	302.329
6,712.00	493.585	493.585
6,712.50	717.604	717.604
6,713.00	992.277	992.277
6,713.50	1,305.805	1,305.805
6,714.00	1,665.923	1,665.923
6,714.50	2,032.517	2,032.517
6,715.00	2,444.368	2,444.368
6,715.50	2,888.012	2,888.012
6,716.00	3,363.224	3,363.224
6,716.50	3,869.878	3,869.878
6,717.00	4,407.921	4,407.921
6,717.50	4,977.361	4,977.361
6,718.00	5,578.250	5,578.250
6,718.50	6,165.379	6,165.379
6,719.00	6,779.881	6,779.881

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	3,960.300	1.093	0.000	0.000	81.000	F	3,085.37	428.416
	$\sum$	**3,960.300**						**3,085.37**	**428.416**

APPENDIX E.7

Emergency Spillway Critical Slope Calculation

J7Jr Outflow Channel Critical Slope
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	Critical
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.059	
Channel Slope	0.120000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	70.00	ft
Discharge	1,523.00	cfs

Results		
Depth	1.71	ft
Flow Area	128.28	ft^2
Wetted Perimeter	80.80	ft
Top Width	80.25	ft
Critical Depth	2.37	ft
Critical Slope	0.039678	ft/ft
Velocity	11.87	ft/s
Velocity Head	2.19	ft
Specific Energy	3.90	ft
Froude Number	1.66	
Flow is supercritical.		

APPENDIX E.8

Emergency Spillway Outflow Channel Design

MSHA POND J7Jr SPILLWAY CRITICAL SLOPE
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	qq
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.011416	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	70.00	ft
Discharge	881.50	cfs

Results		
Depth	1.66	ft
Flow Area	124.53	ft^2
Wetted Perimeter	80.50	ft
Top Width	79.96	ft
Critical Depth	1.66	ft
Critical Slope	0.011416	ft/ft
Velocity	7.08	ft/s
Velocity Head	0.78	ft
Specific Energy	2.44	ft
Froude Number	1.00	
Flow is subcritical.		

J7Jr SPILLWAY OUTFLOW CHANNEL MIN. WIDTH=70', MAX. SLOPE=12%

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
70.00	3.0:1	3.0:1	12.0	1.00		

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	1,523.00 cfs	
Depth:	1.70 ft	2.70 ft
Top Width:	80.23 ft	86.23 ft
Velocity:	11.89 fps	
X-Section Area:	128.05 sq ft	
Hydraulic Radius:	1.585	
Froude Number:	1.66	
Manning's n:	0.0590	
Dmin:	7.00 in	
D50:	12.00 in	
Dmax:	18.00 in	

J7Jr SPILLWAY OUTFLOW CHANNEL MIN. WIDTH=70', MAX. SLOPE=12%

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
70.00	3.0:1	3.0:1	12.0	1.00		

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	458.00 cfs	
Depth:	0.79 ft	1.79 ft
Top Width:	74.75 ft	80.75 ft
Velocity:	7.99 fps	
X-Section Area:	57.32 sq ft	
Hydraulic Radius:	0.764	
Froude Number:	1.61	
Manning's n:	0.0540	
Dmin:	3.00 in	
D50:	6.00 in	
Dmax:	9.00 in	

PEABODY WESTERN
KAYENTA MINE
MSHA POND J7-Jr

General 6-hour PMP

Water level @ 6710'

DJK

Montgomery Watson
165 S. Union blvd.
Suite 410
Lakewood, Colorado 80228

Phone: 303 763-5140

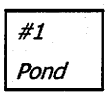
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10000000 yr - 6 hr
Rainfall Depth:	5.960 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	End	0.000	0.000	Pond J7-Jr



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	In	3,960.300	3,960.300	9,446.89	1,269.71
	Out			6,092.58	1,269.73

Structure Detail:

Structure #1 (Pond)

Pond J7-Jr

Pond Inputs:

Initial Pool Elev:	6,710.00
Initial Pool:	555.73 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
6,710.00	44.00	3.00:1	3.00:1	70.00

Pond Results:

Peak Elevation:	6,718.44
Dewater Time:	0.50 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)
6,670.00	0.610	0.000	0.000	
6,670.50	0.698	0.327	0.000	
6,671.00	0.793	0.699	0.000	
6,671.50	0.893	1.120	0.000	
6,672.00	0.999	1.593	0.000	
6,672.50	1.111	2.120	0.000	
6,673.00	1.229	2.705	0.000	
6,673.50	1.353	3.350	0.000	
6,674.00	1.483	4.058	0.000	
6,674.50	1.618	4.833	0.000	
6,675.00	1.760	5.678	0.000	
6,675.50	1.979	6.612	0.000	
6,676.00	2.210	7.659	0.000	
6,676.50	2.454	8.824	0.000	
6,677.00	2.711	10.115	0.000	
6,677.50	2.980	11.538	0.000	
6,678.00	3.263	13.098	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
6,678.50	3.558	14.803	0.000	
6,679.00	3.866	16.658	0.000	
6,679.50	4.187	18.671	0.000	
6,680.00	4.520	20.847	0.000	
6,680.50	4.700	23.152	0.000	
6,681.00	4.884	25.548	0.000	
6,681.50	5.071	28.037	0.000	
6,682.00	5.262	30.620	0.000	
6,682.50	5.456	33.299	0.000	
6,683.00	5.654	36.077	0.000	
6,683.50	5.855	38.954	0.000	
6,684.00	6.060	41.932	0.000	
6,684.50	6.268	45.014	0.000	
6,685.00	6.480	48.201	0.000	
6,685.50	6.884	51.542	0.000	
6,686.00	7.299	55.087	0.000	
6,686.50	7.727	58.843	0.000	
6,687.00	8.167	62.816	0.000	
6,687.50	8.618	67.011	0.000	
6,688.00	9.083	71.436	0.000	
6,688.50	9.559	76.095	0.000	
6,689.00	10.047	80.996	0.000	
6,689.50	10.548	86.145	0.000	
6,690.00	11.060	91.546	0.000	
6,690.50	11.496	97.185	0.000	
6,691.00	11.941	103.044	0.000	
6,691.50	12.394	109.127	0.000	
6,692.00	12.855	115.439	0.000	
6,692.50	13.325	121.984	0.000	
6,693.00	13.803	128.765	0.000	
6,693.50	14.290	135.788	0.000	
6,694.00	14.785	143.056	0.000	
6,694.50	15.288	150.574	0.000	
6,695.00	15.800	158.346	0.000	
6,695.50	16.456	166.409	0.000	
6,696.00	17.124	174.804	0.000	
6,696.50	17.806	183.536	0.000	
6,697.00	18.501	192.612	0.000	
6,697.50	19.209	202.039	0.000	
6,698.00	19.931	211.823	0.000	
6,698.50	20.666	221.972	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
6,699.00	21.414	232.491	0.000		
6,699.50	22.176	243.388	0.000		
6,700.00	22.950	254.669	0.000		
6,700.50	23.572	266.299	0.000		
6,701.00	24.202	278.242	0.000		
6,701.50	24.840	290.502	0.000		
6,702.00	25.487	303.083	0.000		
6,702.50	26.141	315.990	0.000		
6,703.00	26.805	329.226	0.000		
6,703.50	27.476	342.796	0.000		
6,704.00	28.156	356.704	0.000		
6,704.50	28.844	370.953	0.000		
6,705.00	29.540	385.549	0.000		
6,705.50	30.405	400.534	0.000		
6,706.00	31.281	415.955	0.000		
6,706.50	32.170	431.817	0.000		
6,707.00	33.071	448.127	0.000		
6,707.50	33.984	464.890	0.000		
6,708.00	34.911	482.114	0.000		
6,708.50	35.850	499.803	0.000		
6,709.00	36.801	517.966	0.000		
6,709.50	37.765	536.606	0.000		
6,710.00	38.740	555.732	0.000		Spillway #1
6,710.50	39.784	575.362	67.981	3.49*	
6,711.00	40.841	595.518	135.962	2.50	
6,711.50	41.913	616.206	302.329	1.20	
6,712.00	42.998	637.433	493.585	0.70	
6,712.50	44.097	659.207	717.604	0.50	
6,713.00	45.210	681.533	992.277	0.40	
6,713.50	46.337	704.419	1,305.805	0.35	
6,714.00	47.477	727.872	1,665.923	0.40	
6,714.50	48.632	751.899	2,032.517	0.35	
6,715.00	49.800	776.506	2,444.368	0.30	
6,715.50	50.377	801.550	2,888.012	0.30	
6,716.00	50.958	826.884	3,363.224	0.25	
6,716.50	51.541	852.508	3,869.878	0.25	
6,717.00	52.128	878.426	4,407.921	0.20	
6,717.50	52.719	904.637	4,977.361	0.25	
6,718.00	53.313	931.145	5,578.250	0.15	
6,718.44	53.836	954.627	6,092.579	0.30	Peak Stage
6,718.50	53.910	957.951	6,165.379		

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
6,719.00	54.510	985.055	6,779.881	

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

Detailed Discharge Table

Elevation	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,670.00	0.000	0.000
6,670.50	0.000	0.000
6,671.00	0.000	0.000
6,671.50	0.000	0.000
6,672.00	0.000	0.000
6,672.50	0.000	0.000
6,673.00	0.000	0.000
6,673.50	0.000	0.000
6,674.00	0.000	0.000
6,674.50	0.000	0.000
6,675.00	0.000	0.000
6,675.50	0.000	0.000
6,676.00	0.000	0.000
6,676.50	0.000	0.000
6,677.00	0.000	0.000
6,677.50	0.000	0.000
6,678.00	0.000	0.000
6,678.50	0.000	0.000
6,679.00	0.000	0.000
6,679.50	0.000	0.000
6,680.00	0.000	0.000
6,680.50	0.000	0.000
6,681.00	0.000	0.000
6,681.50	0.000	0.000
6,682.00	0.000	0.000
6,682.50	0.000	0.000
6,683.00	0.000	0.000
6,683.50	0.000	0.000
6,684.00	0.000	0.000
6,684.50	0.000	0.000
6,685.00	0.000	0.000
6,685.50	0.000	0.000

Elevation	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,686.00	0.000	0.000
6,686.50	0.000	0.000
6,687.00	0.000	0.000
6,687.50	0.000	0.000
6,688.00	0.000	0.000
6,688.50	0.000	0.000
6,689.00	0.000	0.000
6,689.50	0.000	0.000
6,690.00	0.000	0.000
6,690.50	0.000	0.000
6,691.00	0.000	0.000
6,691.50	0.000	0.000
6,692.00	0.000	0.000
6,692.50	0.000	0.000
6,693.00	0.000	0.000
6,693.50	0.000	0.000
6,694.00	0.000	0.000
6,694.50	0.000	0.000
6,695.00	0.000	0.000
6,695.50	0.000	0.000
6,696.00	0.000	0.000
6,696.50	0.000	0.000
6,697.00	0.000	0.000
6,697.50	0.000	0.000
6,698.00	0.000	0.000
6,698.50	0.000	0.000
6,699.00	0.000	0.000
6,699.50	0.000	0.000
6,700.00	0.000	0.000
6,700.50	0.000	0.000
6,701.00	0.000	0.000
6,701.50	0.000	0.000
6,702.00	0.000	0.000
6,702.50	0.000	0.000
6,703.00	0.000	0.000
6,703.50	0.000	0.000
6,704.00	0.000	0.000
6,704.50	0.000	0.000
6,705.00	0.000	0.000
6,705.50	0.000	0.000

Elevation	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,706.00	0.000	0.000
6,706.50	0.000	0.000
6,707.00	0.000	0.000
6,707.50	0.000	0.000
6,708.00	0.000	0.000
6,708.50	0.000	0.000
6,709.00	0.000	0.000
6,709.50	0.000	0.000
6,710.00	0.000	0.000
6,710.50	67.981	67.981
6,711.00	135.962	135.962
6,711.50	302.329	302.329
6,712.00	493.585	493.585
6,712.50	717.604	717.604
6,713.00	992.277	992.277
6,713.50	1,305.805	1,305.805
6,714.00	1,665.923	1,665.923
6,714.50	2,032.517	2,032.517
6,715.00	2,444.368	2,444.368
6,715.50	2,888.012	2,888.012
6,716.00	3,363.224	3,363.224
6,716.50	3,869.878	3,869.878
6,717.00	4,407.921	4,407.921
6,717.50	4,977.361	4,977.361
6,718.00	5,578.250	5,578.250
6,718.50	6,165.379	6,165.379
6,719.00	6,779.881	6,779.881

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	3,960.300	1.093	0.000	0.000	81.000	F	9,446.89	1,269.708
	$\sum$	**3,960.300**						**9,446.89**	**1,269.708**

APPENDIX E.9

Decant Pipe Flow Path Calculation Brief

Project Name: J7Jr MSHA Dam
Project Number: 1342052.01180100

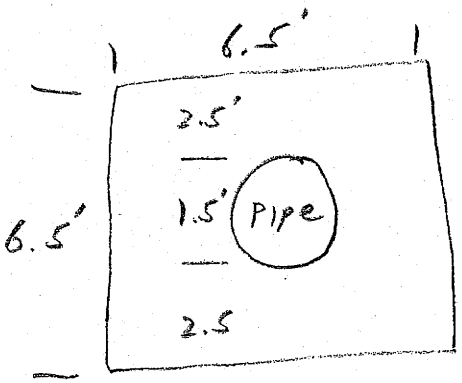
Prepared by: DJK Date: 3/23/00
Checked by: TEL Date: 3/23/00

Purpose: The purpose of this calculation brief is show that anti-seep collars placed on a decant pipe will increase the flow path along the pipe by 15% as recommended by the Natural Resources Conservation Service (NRCS). Peabody Western Coal Company (PWCC) plans to place a decant pipe through a sedimentation pond to control the water level of the pond. The inlet end of the pipe will be equipped with a gated valve or equivalent.

Methodology: It was conservatively assumed that as flow moved along the pipe it would contact the collar and then moved around the collar and back to the decant pipe. The distance around the collar was used to represent the increase in flow path. A trial and error method was used whereby collar dimensions and quantity were altered until the 15% increase in flow path was achieved. The sketch below shows the final dimensions and locations of the anti-seep collars.

Increased Flowpath Required

Pipe Length = 200'
15% increase required
0.15 x 200 = 30'



Flowpath Around Collar

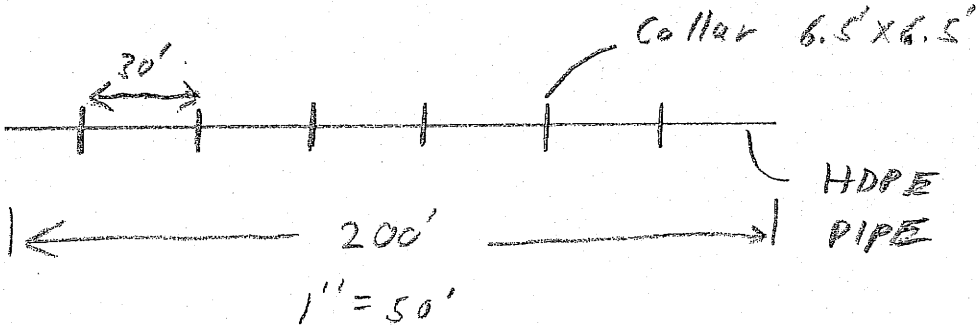
2.5' x 2 = 5.0'

Anti-Seep Collars Required

DISTANCE Required = 30'
@ 6.5' x 6.5' collar = 5' increase

30'/5' = 6 Collars

@ 30' centers

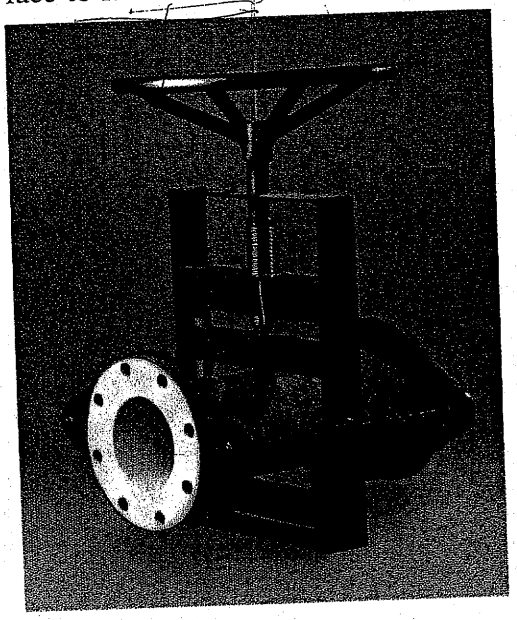


APPENDIX E.10

Red Valve and Hydro Gate Valves and Slide Gate Products

Series 70

- Lightweight open frame construction
- Valve position instantly visible
- Custom fabricated design can accomodate special face-to-face dimensions



Materials of Construction

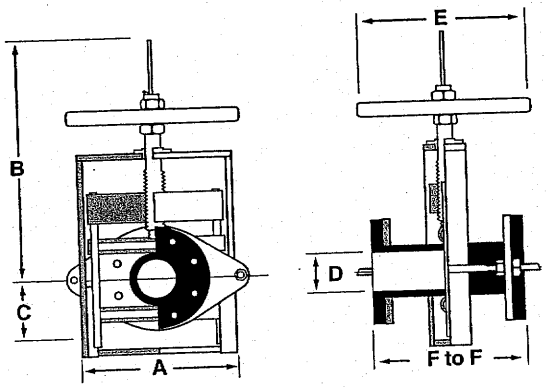
- Fabricated steel frame
- Sleeves available in Pure Gum Rubber, Neoprene, Hypalon, Chlorobutyl, Buna-N, Viton and EPDM
- ANSI Class 125/150 flanges or metric flanges

Our Series 70 Manual Pinch Valve is the counterpart to the unique Series 75 and has the same design features and advantages, but the heavy cast iron housing is eliminated and a strong fabricated steel body is in its place. The Series 70 is less costly, lighter, versatile, and can be used when the location of the valve is not exposed to attack from corrosives or other volatile material.

The Series 70 is available in the same sizes and dimensions as the Series 75. Special face-to-face dimensions are available.

The standard body material is fabricated carbon steel. Sleeve material include: Pure Gum Rubber, Neoprene, Buna-N, Butyl, Hypalon, EPDM, Viton.

Operation of the Series 70 is the same as the Series 75, utilizing double pinch bars to compress the flexible rubber sleeve from above and below, closing simultaneously on centerline when the handwheel is turned.

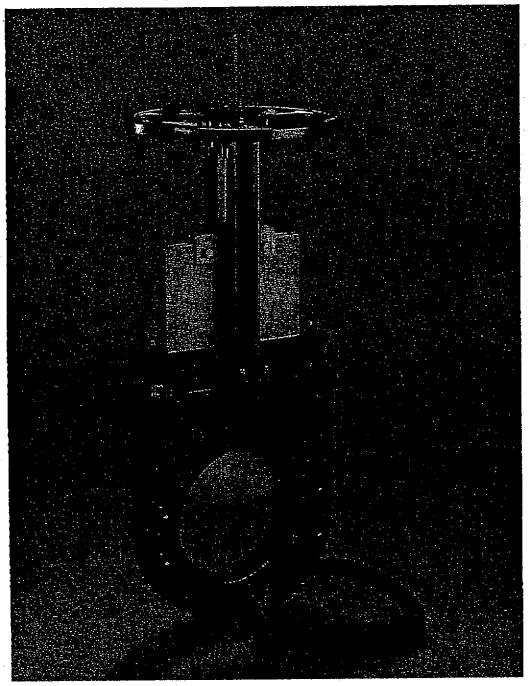


Dimensions Series 70

Valve Size D	Length F-to-F	Width A	Height B	Height C	Dia. E	Working Pressure (psi)	Valve Weight (lbs)
1"	5-1/2"	5-7/8"	10-1/2"	2-7/8"	6"	150	8
1-1/2"	6-1/2"	9"	12"	3-5/8"	6"	150	14
2"	7"	10-1/2"	15-3/4"	5-3/8"	8"	150	18
2-1/2"	7-1/2"	9-1/2"	16-1/4"	4-3/4"	12"	150	36
3"	8"	9-1/2"	16-1/4"	5"	12"	150	40
4"	9"	10-3/4"	17-1/2"	5-1/2"	12"	150	50
5"	10"	15-3/8"	24-1/2"	7-3/4"	24"	150	72
6"	10-1/2"	18-1/4"	24-1/4"	8-3/8"	* 24"	150	89
8"	16"	29-1/4"	34"	9-3/4"	* 24"	125	151
10"	20"	31-1/4"	37"	10"	* 24"	100	178
12"	24"	35"	38"	12"	* 24"	100	242
14"	28"	37"	36"	14-3/8"	* 24"	75	473
16"	32"	36-3/8"	40"	15-1/2"	* 24"	50	560
18"	36"	44"	43"	20-1/2"	* 24"	50	690
20"	40"	49-1/4"	45"	21"	* 24"	50	770
24"	48"	51"	51-1/2"	25"	* 30"	50	1,150
30"	60"	64"	54"	29"	*	50	1,770
36"	72"	77"	65"	35"	*	50	2,250
42"	84"	90"	76"	41"	*	50	3,175
48"	96"	101"	86"	46"	*	50	3,990

* Optional bevel gear operators normally required.

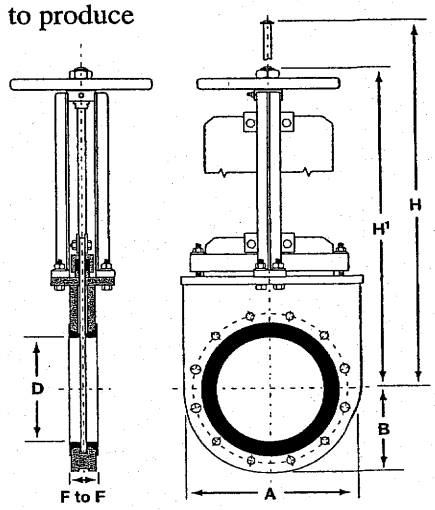
Handwheel Operated Flexgate



Red Valve's Flexgate is designed with a cast iron body, stainless steel gate, and two heavy duty elastomer cartridge slurry sleeves. The port is formed by two heavy duty cartridge elastomer slurry sleeve halves. The cartridge slurry sleeves are available in various elastomers for chemical compatibility and abrasion resistance. A flush area at the valve's base provides a cleanout port.

The Flexgate valve provides bi-directional shutoff. A heavy duty topworks is standard. The relatively simple design eliminates expensive overhauls, unscheduled shutdowns, and costly replacement parts –the only replacement parts are the slurry sleeves.

Flexgate Valves 3" - 12" are provided with standard handwheel mechanisms featuring cast handwheels, machined 303 stainless steel stems with yoke sleeves, and thrust washers designed to produce maximum thrust with minimum torque. Bevel gear actuators are recommended for Manual Flexgate valves 12" and larger. A bevel gear actuator is available to reduce rim pull and operate the valve. Chainwheel actuators and limit switches are also available.



Materials of Construction

- Cast Iron Body through 24"; Steel Plate 30" - 42" Optional 304SS or 316SS Body
- Gate ASTM A240 T–316 Optional 17-4Ph, Hastelloy C, or Teflon Coated 316 Stainless Steel
- Slurry Sleeves available in Pure Gum Rubber, EPDM, Viton, and Buna-N

Dimensions Flexgate

Valve Size	Width F to F	A	B	Height Close H1	Height Open H	Height Pneumatic Actuated Valve C	Stem Diameter	Gate Thickness	Maximum Working Pressure Gate Material 316SS	17-4 Ph
3"	2"	8"	3 7/8"	17 1/8"	20 3/8"	27 1/2"	3/4"	1/4"	150	150
4"	2"	9 1/4"	4 3/4"	18 1/4"	22 5/16"	29 1/2"	3/4"	1/4"	150	150
6"	2 1/4"	11 1/2"	5 7/8"	21 1/16"	27 3/16"	33 1/2"	1"	1/4"	150	150
8"	2 3/4"	14"	7"	26 9/16"	34 9/16"	38 5/8"	1"	1/2"	150	150
10"	2 3/4"	16 3/4"	8 3/8"	32 7/16"	43 5/8"	49 7/8"	1"	1/2"	150	150
12"	3"	20 1/8"	10 1/16"	37"	50 7/8"	55"	1"	1/2"	100	150
14"	3"	21 1/2"	11"	43 5/8"	57 1/8"	59"	1"	9/16"	100	150
16"	3 1/2"	24"	12 1/2"	47 1/2"	63"	63"	1 1/2"	5/8"	100	150
18"	3 1/2"	25 3/4"	13 1/4"	52 5/8"	70"	83 3/4"	1 1/2"	3/4"	100	150
20"	4 1/2"	28 1/2"	14 1/4"	59 1/2"	78 5/8"	–	1 1/2"	7/8"	100	150
24"	4 1/2"	33 1/2"	17"	67 1/2"	90 5/8"	–	1 3/4"	1"	100	150
30"	5"	38 3/4"	20 1/2"	82"	115"	–	1 3/4"	1"	75	125
36"	6 1/2"	46"	24"	97"	132"	–	2"	1 1/8"	75	125
42"	7"	53"	27 1/2"	115"	155"	–	2"	1 1/8"	50	75

• Consult factory for higher working pressures.

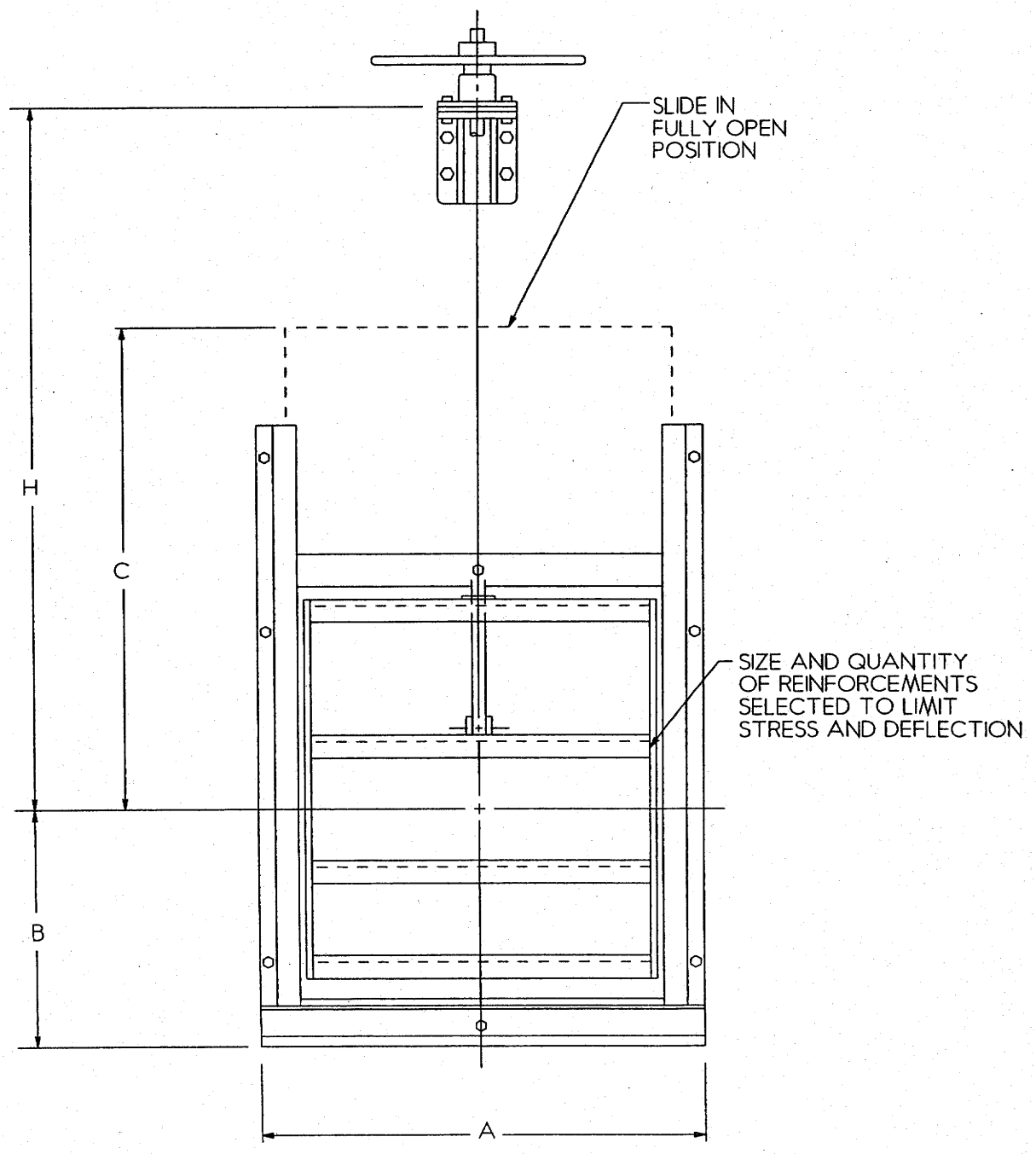


Figure 3-1

**Fabricated Slide Gates –
Not Self-Contained**

APPENDIX E.11

SEDCAD4 (input and output) General 6-hour PMP Storm Event

Copyright 1998 Pamela J. Schwab

PEABODY WESTERN KAYENTA MINE MSHA POND J7-Jr

General PMP, 6-hour

spillway @ 6710'

DJK

Montgomery Watson
165 S. Union Blvd.
Suite 410
Lakewood, Co. 80228

Phone: 303 763-5140

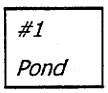
General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10000000 yr - 6 hr
Rainfall Depth:	4.700 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	End	0.000	0.000	Pond J7-Jr



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	In	3,960.300	3,960.300	6,657.41	898.27
	Out			3,965.06	898.29

Structure Detail:

Structure #1 (Pond)

Pond J7-Jr

Pond Inputs:

Initial Pool Elev:	6,710.00
Initial Pool:	555.73 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
6,710.00	44.00	3.00:1	3.00:1	70.00

Pond Results:

Peak Elevation:	6,716.59
Dewater Time:	0.48 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)
6,670.00	0.610	0.000	0.000	
6,670.50	0.698	0.327	0.000	
6,671.00	0.793	0.699	0.000	
6,671.50	0.893	1.120	0.000	
6,672.00	0.999	1.593	0.000	
6,672.50	1.111	2.120	0.000	
6,673.00	1.229	2.705	0.000	
6,673.50	1.353	3.350	0.000	
6,674.00	1.483	4.058	0.000	
6,674.50	1.618	4.833	0.000	
6,675.00	1.760	5.678	0.000	
6,675.50	1.979	6.612	0.000	
6,676.00	2.210	7.659	0.000	
6,676.50	2.454	8.824	0.000	
6,677.00	2.711	10.115	0.000	
6,677.50	2.980	11.538	0.000	
6,678.00	3.263	13.098	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
6,678.50	3.558	14.803	0.000	
6,679.00	3.866	16.658	0.000	
6,679.50	4.187	18.671	0.000	
6,680.00	4.520	20.847	0.000	
6,680.50	4.700	23.152	0.000	
6,681.00	4.884	25.548	0.000	
6,681.50	5.071	28.037	0.000	
6,682.00	5.262	30.620	0.000	
6,682.50	5.456	33.299	0.000	
6,683.00	5.654	36.077	0.000	
6,683.50	5.855	38.954	0.000	
6,684.00	6.060	41.932	0.000	
6,684.50	6.268	45.014	0.000	
6,685.00	6.480	48.201	0.000	
6,685.50	6.884	51.542	0.000	
6,686.00	7.299	55.087	0.000	
6,686.50	7.727	58.843	0.000	
6,687.00	8.167	62.816	0.000	
6,687.50	8.618	67.011	0.000	
6,688.00	9.083	71.436	0.000	
6,688.50	9.559	76.095	0.000	
6,689.00	10.047	80.996	0.000	
6,689.50	10.548	86.145	0.000	
6,690.00	11.060	91.546	0.000	
6,690.50	11.496	97.185	0.000	
6,691.00	11.941	103.044	0.000	
6,691.50	12.394	109.127	0.000	
6,692.00	12.855	115.439	0.000	
6,692.50	13.325	121.984	0.000	
6,693.00	13.803	128.765	0.000	
6,693.50	14.290	135.788	0.000	
6,694.00	14.785	143.056	0.000	
6,694.50	15.288	150.574	0.000	
6,695.00	15.800	158.346	0.000	
6,695.50	16.456	166.409	0.000	
6,696.00	17.124	174.804	0.000	
6,696.50	17.806	183.536	0.000	
6,697.00	18.501	192.612	0.000	
6,697.50	19.209	202.039	0.000	
6,698.00	19.931	211.823	0.000	
6,698.50	20.666	221.972	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
6,699.00	21.414	232.491	0.000		
6,699.50	22.176	243.388	0.000		
6,700.00	22.950	254.669	0.000		
6,700.50	23.572	266.299	0.000		
6,701.00	24.202	278.242	0.000		
6,701.50	24.840	290.502	0.000		
6,702.00	25.487	303.083	0.000		
6,702.50	26.141	315.990	0.000		
6,703.00	26.805	329.226	0.000		
6,703.50	27.476	342.796	0.000		
6,704.00	28.156	356.704	0.000		
6,704.50	28.844	370.953	0.000		
6,705.00	29.540	385.549	0.000		
6,705.50	30.405	400.534	0.000		
6,706.00	31.281	415.955	0.000		
6,706.50	32.170	431.817	0.000		
6,707.00	33.071	448.127	0.000		
6,707.50	33.984	464.890	0.000		
6,708.00	34.911	482.114	0.000		
6,708.50	35.850	499.803	0.000		
6,709.00	36.801	517.966	0.000		
6,709.50	37.765	536.606	0.000		
6,710.00	38.740	555.732	0.000		Spillway #1
6,710.50	39.784	575.362	67.981	3.49*	
6,711.00	40.841	595.518	135.962	2.50	
6,711.50	41.913	616.206	302.329	1.20	
6,712.00	42.998	637.433	493.585	0.70	
6,712.50	44.097	659.207	717.604	0.50	
6,713.00	45.210	681.533	992.277	0.45	
6,713.50	46.337	704.419	1,305.805	0.50	
6,714.00	47.477	727.872	1,665.923	0.45	
6,714.50	48.632	751.899	2,032.517	0.35	
6,715.00	49.800	776.506	2,444.368	0.35	
6,715.50	50.377	801.550	2,888.012	0.30	
6,716.00	50.958	826.884	3,363.224	0.30	
6,716.50	51.541	852.508	3,869.878	0.35	
6,716.59	51.647	857.093	3,965.055	0.10	Peak Stage
6,717.00	52.128	878.426	4,407.921		
6,717.50	52.719	904.637	4,977.361		
6,718.00	53.313	931.145	5,578.250		
6,718.50	53.910	957.951	6,165.379		

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
6,719.00	54.510	985.055	6,779.881	

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	3,960.300	1.093	0.000	0.000	81.000	F	6,657.41	898.271
	Σ	**3,960.300**						**6,657.41**	**898.271**

APPENDIX E.12

Decant Pipe Manufacturers Information

PLEXCALC BURIED SOLID WALL HIGH DENSITY POLYETHYLENE PIPE - 73 DEGREES F

Chevron Plexco®
(630) 350-3700 www.plexco.com

CALCULATION SUMMARY

P_E= PRISM LOAD (psf) =	2308.
P_L = LIVE LOAD (psf) =	.
P_T= TOTAL LOAD (psf) =	2308.
WALL CRUSH SAFETY FACTOR	
N_C= SAFETY FACTOR (CRUSH) =	9.51
WALL BUCKLE SAFETY FACTORS	
N_B = AWWA BUCKLE =	3.82
DEFLECTION	
- SHORT TERM MODULUS (%) =	4.38
- LONG TERM MODULUS (%) =	5.

INPUT VALUES

Do = Outside Diameter =	20.
DR = Dimension Ratio =	21.
H = Depth Of Soil Cover (ft) =	20.
H' = Height Of water Above Pipe (ft) =	10.
w = Soil Density (lb/ft^3) =	115.4
Pipe Embedment Material:	Silty-Sand
Compaction (% Std. Proctor):	95
E' = Modulus Of Soil Reaction (psi) =	1000
L = Deflection Lag Factor =	1.5
Use 75% of E' In Deflection Calculation	X

LIVE LOAD

Selected Live Load = No Live Load

PLEXCALC - Version 2.0

PROJECT INFORMATION

PROJECT NAME = J7Jr Decant Pipe PLEXCO 20S021

TODAY'S DATE = 36825

COMMENTS = Calculated by Montgomery Watson DJK DJK
10/26/2000, Check DJM JM.

The information contained herein cannot be guaranteed because the conditions of use are beyond our control. This document should not be substituted for the judgement of a professional engineer in determining the suitability of any pipe for a given project as the methodology herein may not accurately represent the site conditions or be inclusive of all parameters that must be considered. The user of this information assumes all risk associated with its use.

Simplified Burial Design: A conservative estimate of the ability of Driscopipe pipelines to perform in a buried environment is found in Chart 24. It is based on a minimum 2:1 safety factor and 50 year design service life. A detailed burial design starts on page 37. The detailed design should be used for critical or marginal applications or whenever a more precise solution is desired.

Detailed Burial Design:
Design by Wall Crushing: Wall crushing would theoretically occur when the stress in a pipe wall, due to the external vertical pressure, exceeded the long-term compressive strength of the pipe material. To ensure that the Driscopipe wall is strong enough to endure the external pressure the following check should be made:

$$S_A = \frac{(SDR - 1)}{2} P_T$$

Values of E′
Based on Soil Type (ASTM D2321) and Degree of Compaction

Soil Type of Initial Backfill Embedment Material	Description	E′ (psi) for Degree of Compaction (Proctor Density, %) Loose	Slight (70-85%)	Moderate (85-95%)	High (95%)
I	Manufactured angular, granular materials (crushed stone or rock, broken coral, cinders, etc.)	1,000	3,000	3,000	3,000
II	Coarse grained soils with little or no fines	N.R.	1,000	2,000	3,000
III	Coarse grained soils with fines	N.R.	N.R.	1,000	2,000
IV	Fine-grained soils	N.R.	N.R.	N.R.	N.R.
V	Organic soils (peat, muck, clay, etc.)	N.R.	N.R.	N.R.	N.R.

N.R. = Not Recommended for use by ASTM D2321 for pipe wall support

Chart 24

SDR	Maximum Burial Depth, ft. in dry soil of 100 lbs/cu. ft. Soil Modulus, psi*			Maximum External Pressure psi Soil Modulus, psi*			Maximum Deflection, % after installation Soil Modulus, psi*		
	1000	2000	3000	1000	2000	3000	1000	2000	3000
32.5	25	32	37	17	22	26	1.7	0.9	0.6
26	33	45	52	23	31	36	2.3	1.2	0.8
21	46	61	71	32	42	49	3.2	1.6	1.1
19	52	69	81	36	48	56	3.6	1.8	1.2
17	61	121	181	42	84	126	4.2	2.1	1.4
15.5	56	112	168	39	78	117	3.9	2.0	1.3
13.5	49	98	147	34	68	102	3.4	1.7	1.1
11	39	78	117	27	54	81	2.7	1.4	0.9
9.3	33	68	101	23	47	70	2.3	1.2	0.8
8.3	30	61	89	21	42	62	2.1	1.1	0.7
7.3	26	52	79	18	36	55	1.8	0.9	0.6

*assumes no external loads

JOINING PROCEDURE

The heat fusion method is a highly efficient, economical method of joining Driscopipe. The heat fusion method of joining high density polyethylene pipe began shortly after the first commercial production of high density polyethylene in the mid-1950s by Phillips Petroleum Company.

The modern day heat fusion joint is the same as the joint which was made on the first crude heat fusion equipment in 1956 . . . only the fusion equipment has evolved to gain efficiency, reliability, and convenience. The many principles learned on that early equipment for making a successful joint are still in use today. Phillips Petroleum Company designed, developed and built many new models of heat fusion equipment from 1956 until the early 1970s. Since that time, Driscopipe personnel have guided this development by others. The extensive line of fusion equipment offered by McElroy Manufacturing, Inc., Tulsa, Oklahoma is one of the results of this long history of development. Phillips pioneered the idea and development of the heat fusion joining system . . . and has used it exclusively in every high density polyethylene piping system sold by Phillips since 1956 . . . there are millions of these joints in service today.

The heat fusion method is an uncomplicated, visual procedure with straight-forward instructions. No "timing cycles" are necessary. The visual procedure allows the operator to concentrate on his work, rather than a clock . . . visually, he knows when the butt ends have melted to the degree required to fuse them together. Visually, he observes and controls fusion pressure by observing the amount and configuration of the fusion bead as it is formed.

The principle of heat fusion is to heat two surfaces to a fusion temperature, then make contact between the two surfaces and allow the two surfaces to fuse together by application of pressure. The pressure causes flow of the melted materials which effects mixing and, thus, fusion. On cooling, the original interfaces are gone and the two parts are united. Nothing is added to or changed chemically between the two pieces being joined. The picture below shows a cross section of heat fused Driscopipe.

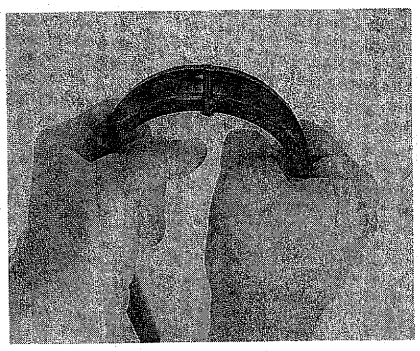
Molten high density, high molecular weight Driscopipe 8600 is very viscous and tough. During heat fusion of this material, the operator can apply relatively high pressure to form the heat fusion joint (approximately 150 pounds of pressure per square inch of pipe material) . . . with no danger of forcing the molten material from between the two ends of the pipe. Lower fusion pressures are necessary with the softer, less viscous, high and medium density materials. When high pressure is applied to the higher melt flow material most of the molten material can be forced from the fusion joint. This produces a "cold joint" or poor fusion. Pressure control can be difficult, unless the fusion equipment is designed to compensate for the melt strength of the pipe being fused. The equipment discussed in this section can be regulated for the different melt strength materials. Compatibility fusion techniques should be used when polyethylenes of different melt indexes are fused together.

Heat fusion joints may easily be cut out and re-done. This fact has a bearing on the quantity and quality of training necessary and favorably affects operator attitude toward quality in the field. These joints can be easily cut out and destructively tested in the field to check joining proficiency and equipment condition . . . and at very little cost, since there is no coupling to destroy and throw away.

In the course of heat fusion joining, the fusion operator is faced with a wide variety of job conditions. Changes in air temperature, material temperature, wind velocity, sun exposure, humidity, as well as condition of the terrain and the equipment . . . all influence the joining requirements. Estimating pre-heat timing cycles under different conditions, can become extremely confusing. Quality work under field conditions is more consistent with the straight-forward, visual procedure offered by Driscopipe. Thus, the operator can consistently produce high quality joints.

Heat fusion has successfully been accomplished in the rain with a canopy covering the fusion machine and operator as well as in below freezing conditions.

Fusion equipment is available for piping systems that range from 1/2 inch diameter tubing through 54-inch diameter pipe. Although the size range is great, the procedure and principle remain the same. You just heat Driscopipe, pressure it together, let it cool and forget it.



Heat Fusion

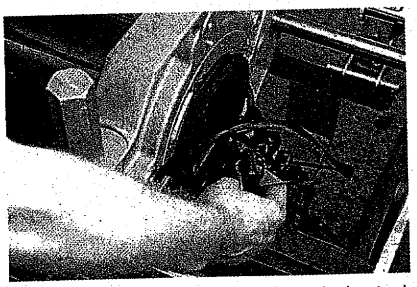
Heat fusion for Driscopipe Systems was pioneered and developed by Phillips Petroleum Company. Heat fusion techniques are recognized in the industry as cost effective joining systems of very high integrity and reliability. They do not require couplings and joints are stronger than the pipe itself – in both tension and pressure conditions. There are seven joining steps – simple, visual procedures with straight-forward, uncomplicated instructions.

Note: It is most important to maintain the proper temperature of the heater plate. Check it with a tempilstik or pyrometer for correct surface temperature.

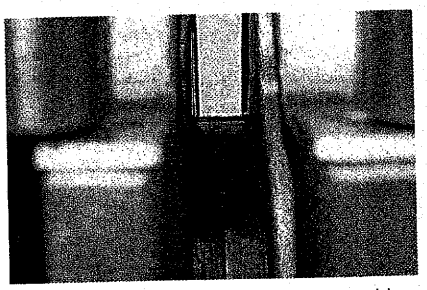
	Thermometer Readings	
Driscopipe	Coated Plates	Uncoated Plates
8600	500°F-525°F	475°F-500°F
1000	400°F-425°F	375°F-400°F

	Surface Temperature	
Driscopipe	Coated Plates	Uncoated Plates
8600	475°F-500°F	475°F-500°F
1000	375°F-400°F	375°F-400°F

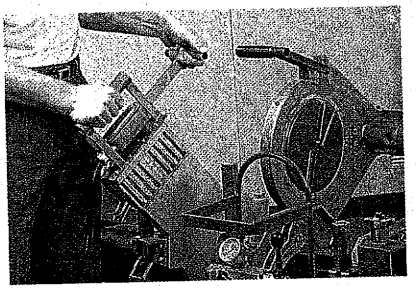
1. Clean pipe ends inside and outside with a clean cotton cloth to remove dirt, water, grease and other foreign materials.



2. Square (face) the pipe ends using facing tool of the fusion machine.

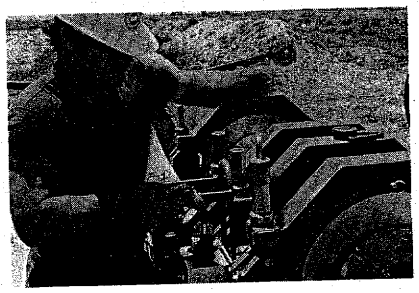


3. Check line-up of pipe-ends in fusion machine to see that pipe ends meet squarely and completely over the entire surface to be fused. This is commonly referred to as "adjusting high-low." It is advisable at this point to make sure the clamps are tight so that the pipe does not slip during the fusion process.

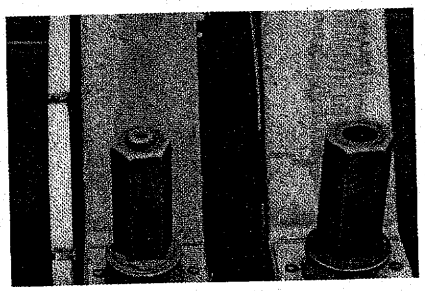


4. Insert *clean* heater plate between aligned ends, and bring ends firmly in contact with plate but *DO NOT APPLY PRESSURE* while achieving melt pattern. Allow pipe ends to heat and soften. Approximate softening depths are as follows:

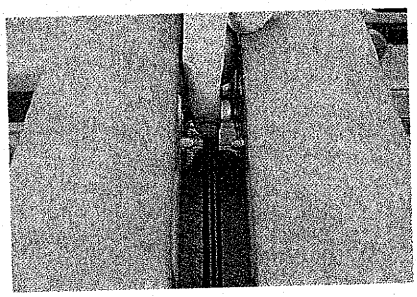
Pipe Size	Approximate Melt Bead
2" and below	1/16"
3" – 5"	1/8"
6" – 12"	3/16"
12" – 22"	1/4" – 5/16"
24" – 54"	5/16" – 7/16"



5. Carefully move the pipe ends away from the heater plate and remove the plate (If the softened material sticks to the heater plate, discontinue the joint. Clean heater plate, resquare pipe ends and start over.).
Note: One pipe end usually moves away from the heater plate first. It is good practice to "bump" the plate away from the other side and then lift it out. Never drag or slide it over the melted pipe end.



6. Bring melted ends together rapidly. *DO NOT SLAM.* Apply enough pressure to form a double roll-back bead to the body of the pipe around the entire circumference of the pipe about 1/8" to 3/16" wide. Pressure is necessary to cause the heated material to flow together.



7. Allow the joint to cool and solidify properly. This occurs when the bead feels hard and your finger can remain comfortably on the bead. Remove the pipe from the clamps and inspect the joint appearance.

Simplified Burial Design: A conservative estimate of the ability of Driscopipe pipelines to perform in a buried environment is found in Chart 24. It is based on a minimum 2:1 safety factor and 50 year design service life. A detailed burial design starts on page 37. The detailed design should be used for critical or marginal applications or whenever a more precise solution is desired.

Detailed Burial Design:
Design by Wall Crushing: Wall crushing would theoretically occur when the stress in a pipe wall, due to the external vertical pressure, exceeded the long-term compressive strength of the pipe material. To ensure that the Driscopipe wall is strong enough to endure the external pressure the following check should be made:

$$S_A = \frac{(SDR - 1)}{2} P_T$$

Values of E'

Based on Soil Type (ASTM D2321) and Degree of Compaction

Soil Type of Initial Backfill Embedment Material	Description	E' (psi) for Degree of Compaction (Proctor Density, %)			
		Loose	Slight (70-85%)	Moderate (85-95%)	High (95%)
I	Manufactured angular, granular materials (crushed stone or rock, broken coral, cinders, etc.)	1,000	3,000	3,000	3,000
II	Coarse grained soils with little or no fines	N.R.	1,000	2,000	3,000
III	Coarse grained soils with fines	N.R.	N.R.	1,000	2,000
IV	Fine-grained soils	N.R.	N.R.	N.R.	N.R.
V	Organic soils (peat, muck, clay, etc.)	N.R.	N.R.	N.R.	N.R.

N.R. = Not Recommended for use by ASTM D2321 for pipe wall support

Chart 24

SDR	Maximum Burial Depth, ft. in dry soil of 100 lbs/cu. ft. Soil Modulus, psi*			Maximum External Pressure psi Soil Modulus, psi*			Maximum Deflection, % after installation Soil Modulus, psi*		
	1000	2000	3000	1000	2000	3000	1000	2000	3000
32.5	25	32	37	17	22	26	1.7	0.9	0.6
26	33	45	52	23	31	36	2.3	1.2	0.8
21	46	61	71	32	42	49	3.2	1.6	1.1
19	52	69	81	36	48	56	3.6	1.8	1.2
17	61	121	181	42	84	126	4.2	2.1	1.4
15.5	56	112	168	39	78	117	3.9	2.0	1.3
13.5	49	98	147	34	68	102	3.4	1.7	1.1
11	39	78	117	27	54	81	2.7	1.4	0.9
9.3	33	68	101	23	47	70	2.3	1.2	0.8
8.3	30	61	89	21	42	62	2.1	1.1	0.7
7.3	26	52	79	18	36	55	1.8	0.9	0.6

*assumes no external loads

Heat Fusion Joining

The heat fusion joining technique has a long history of use for joining polyethylene pipe materials. The heat fusion method of joining PE pipe began shortly after the first commercial production of high density polyethylene in the early 1950s ... both developed by Phillips 66.

The integrity and superiority of heat fusion are now recognized universally. The modern day heat fusion joint is the same joint made in 1956 ... only the fusion equipment has evolved to gain efficiency, reliability and convenience. The principles learned on early equipment for making a successful joint are still in use today. Phillips designed, developed and built many models of heat fusion equipment from 1956 until the early 1970s. Since that time, Phillips has guided this development by others. The extensive line of high quality, efficient fusion equipment offered by McElroy Manufacturing, Inc., Tulsa, Oklahoma is one of the results of this long history of development. Phillips pioneered the idea and development of heat fusion and has used it exclusively in every high density polyethylene piping system sold by Phillips since 1956. There are millions of these joints in service today. In fact, 92% of all natural gas distribution pipe to homes, farms and factories is installed with polyethylene pipe and fittings. Heat fusion joints are industry accepted and field proven.

The heat fusion joining system has been so successful that it is the "standard" joining system for polyethylene. There are many reasons ... here are some.

Heat fusion joining ideally meets the requirements for a fast joining method to facilitate all phases of construction work in a safe and reliable manner.

The heat fusion joint is structurally superior to the socket fusion joint by configuration and, therefore, better meets the requirements of service. The heat joint configuration allows it to better disperse stresses initiated by pipe deflection and external loading. Stress concentration is minimized when the joint is placed in a strain and the joint is more "forgiving" when ground settlement occurs. In a socket joint, there is an extremely high ratio of "joint wall" to "pipe wall", resulting in stress intensification from external loading.

The Driscopipe heat fusion joining system is a simple, visual procedure with straight forward instructions. No "timing cycles" are necessary. The visual procedure allows the operator to concentrate on his work rather than a clock. Visually, he knows when the pipe ends have melted to the degree required to fuse them together. Visually, he observes and controls fusion pressure by observing the amount and configuration of the fusion bead as it is formed.

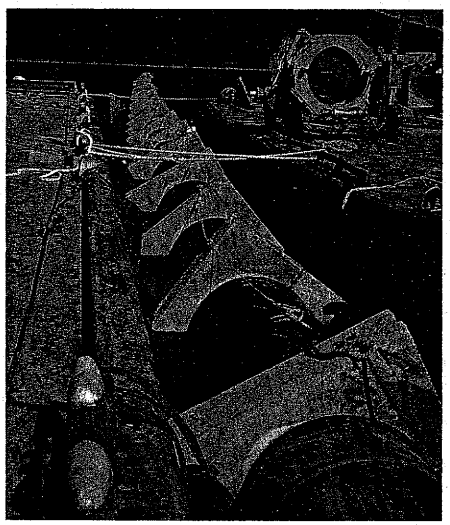
In the course of this work, the fusion operator is faced with a wide variety of job conditions. Changes in air temperature, material temperature, wind velocity, sun exposure, humidity, as well as condition of the terrain and the equipment all influence the joining requirements. Quality work under field conditions is more consistent with a simple, straight-forward, visual procedure.

One heat fusion operator, with equipment, typically does the whole operation himself, sometimes using a second person as a helper. Pipe tolerances, ovality and curvature are no problem and "melt" is easily controlled by the visual procedure.

Heat fusion joints offer a large advantage over socket coupled joints for plow-in installation and for insert renewal applications. Socket coupled pipe requires larger size plow chutes and bore holes. Heat fused pipe one size larger can usually be handled and installed through bore holes and plow chutes selected for socket coupled pipe. Larger sizes of heat fused pipe can be used inside old mains for insert renewal because it does not require the extra space for the coupling.

Heat fusion joints may easily be cut out and re-done. This fact has a bearing on the quantity and quality of training necessary and favorably affects operator attitude toward quality in the field. These joints can be easily cut out and destructively tested in the field to check joining proficiency and equipment condition and it's inexpensive. There is no coupling to destroy and throw away.

The heat fusion joining system is especially effective with Driscopipe 8600. The melt of this material is very viscous and tough. The operator can apply ample pressure to form the heat fusion joint with little danger of forcing the molten material from between the two ends of the joint, as can be done with the softer, less viscous, high density materials.



Driscopipe 8600 can be fusion joined to other polyethylene piping materials when necessary. Special joining techniques are required to achieve good joints. Phillips Driscopipe technical personnel are available to instruct and demonstrate the fusion joining procedure for joining Driscopipe to other polyethylene materials.

Fatigue Resistance

Driscopipe 8600 very high molecular weight, high density polyethylene has superior resistance to fatigue failure caused by cyclic loading. Independent laboratory tests were conducted to determine the suitability of Driscopipe 8600 for use as the cold water supply pipe and the barge mooring leg of the Mini-OTEC Project (Hawaii, 1979). In that application, 2150' of 24" 60 psi Driscopipe 8600 was deployed vertically in a deep ocean trench just offshore Keahole Point and was subject to cyclic distortion caused by wave action, current, and barge motion.

Cyclic tests showed that Driscopipe 8600 very high molecular weight PE could endure more than 100,000 cycles at a stress of 1800 psi without failure. Copies of this test report are avialable upon request.

Driscopipe 1000 offers good fatigue service life also, but not equal to 8600. Neither requires de-rating like PVC AWWA C-900 pipe. In fact, per AWWA C-906 for 4" to 63" HDPE pipe, no water hammer or fatigue de-rating factor need be applied to Driscopipe 8600 or Driscopipe 1000 ductile PE pipe.

The Driscopipe performance team offers you innovative solutions to your piping requirements. Contact your nearest Driscopipe Sales Representative. He'll give you personalized technical service, installation assistance and all the cost-saving advantages of a Driscopipe Piping System. Engineered for Performance!

Chevron Plexco

Standards & Specifications: B-3
Model Specifications for General Purpose PLEXCO PE 3408 High Density Polyethylene Pipe And Fittings.

1 General Terms and Conditions

1.1 Scope. This specification covers requirements for PLEXCO PE3408 high density polyethylene pipe and fittings for general purpose applications. All work shall be performed in accordance with these specifications.

1.2 Engineered and Approved Plans. Construction shall be performed in accordance with engineered construction plans for the work prepared under the direction of a Professional Engineer.

1.3 Referenced Standards. All standard specifications, i.e., Federal, ANSI, ASTM, etc., made a portion of these Specifications by reference, shall be the latest edition and revision thereof.

1.4 Licenses and Permits. All construction work shall be performed by a licensed and bonded General Contractor. All necessary permits shall be secured by the Contractor before commencing construction.

1.5 Inspections. All work shall be inspected by an Authorized Representative of the Customer who shall have the authority to halt construction if, in his opinion, these specifications or standard construction practices are not being followed. Whenever any portion of these specifications is violated, the Project Engineer or his Authorized Representative, shall, by written notice, order further construction to cease until all deficiencies are corrected. A copy of the order shall be filed with the Contractor's license application for future review. If the deficiencies are not corrected, performance shall be required of the Contractor's surety.

1.6 Warranty and Acceptance. The Contractor shall warrant all work to be free from defects in workmanship and materials for a period of [one year] from the date of completion of all construction. If work meets these specifications, a letter of acceptance, subject to the [one year] warranty period, shall be given at the time of completion. A final acceptance letter shall be given upon final inspection at the end of the [one year] warranty period, provided the work still complies with these specifications. In the event deficiencies are discovered during the warranty period, they shall be corrected by the Contractor without additional charge to the customer before final acceptance. During the warranty

While PLEXCO has made every reasonable effort to ensure accuracy in the preparation of these guide specifications, it does not constitute a guarantee or warranty for piping installations. These specifications are intended for use as a guide to support the designer of piping systems. These specifications may not be complete, particularly with respect to special or unusual applications; are not intended to be used as installation instructions, and should not be used in place of the advice of a professional engineer.

period, the Project Engineer shall determine if warranty repairs or replacement work shall be performed by the Contractor. The decision of the Project Engineer shall be binding upon the Contractor.

2 Polyethylene Pipe and Fittings

2.1 Qualification of Manufacturers. The Manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipe and fittings required by these Specifications. The Manufacturer's production facilities shall be open for inspection by the Customer or his Authorized Representative. Qualified Manufacturers shall be approved by the Project Engineer.

2.2 Approved Manufacturers. Manufacturers that are qualified and approved by the Project Engineer are listed below. Products from unapproved manufacturers are prohibited.

PLEXCO Performance Pipe Division of Chevron Chemical Company, LLC

2.3 Materials. Materials used for the manufacture of polyethylene pipe and fittings shall be PE3408 high density polyethylene meeting cell classification 345444C or 345444E per ASTM D 3350; and shall be Listed in the name of the pipe and fitting Manufacturer in PPI[1] TR-4, Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fittings Compounds, with a standard grade HDB rating of 1600 psi at 73°F . The Manufacturer shall certify that the materials used to manufacture pipe and fittings meet these requirements.

2.3.1 Typical material properties shall be submitted to the project design engineer for analysis . These properties are to be used for engineering evaluation and are not to be misconstrued as specification minimums.

2.4 Interchangeability of Pipe and Fittings. Polyethylene pipe and fittings shall be supplied by the same Manufacturer. Pipe and fittings from different Manufacturers shall not be interchanged.

2.4.1 Polyethylene Pipe. Polyethylene pipe shall be manufactured in accordance with ASTM F 714, Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter, or ASTM D 3035, Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter and shall be so marked. Each production lot of pipe shall be tested for (from material or pipe) melt index, density, % carbon (from pipe), dimensions and either quick burst or ring tensile strength (equipment permitting).

[1]PPI - Plastics Pipe Institute

2.4.1.1 Service Identification Stripes. Permanent identification of piping service shall be provided by co-extruding four equally spaced color stripes into the pipe outside surface. The striping material shall be the same material as the pipe material except for color. The following colors shall be used to identify piping service:

Yellow stripes - gaseous fuels
Blue stripes - potable water
Green stripes - non-potable water, wastewater, sewage
Red stripes - fire main
Purple stripes - re-use water

Stripes printed on the pipe outside surface shall not be acceptable.

2.4.2 Polyethylene Fittings & Custom Fabrications. Polyethylene fittings and custom fabrications shall be molded or fabricated by the pipe manufacturer. Butt fusion outlets shall be made to the same outside diameter, wall thickness, and tolerances as the mating pipe. All fittings and custom fabrications shall be fully rated for the same internal pressure as the mating pipe. Pressure de-rated fabricated fittings are prohibited.

2.4.2.1 Molded Fittings. Molded fittings shall be manufactured in accordance with ASTM D 3261, Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing, and shall be so marked. Each production lot of molded fittings shall be subjected to the tests required under ASTM D 3261.

2.4.2.1.1 X-Ray Inspection. The Manufacturer shall submit samples from each molded fittings production lot to x-ray inspection for voids, and shall certify that voids were not found.

2.4.2.2 Fabricated Fittings. Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe, polyethylene sheet stock, or molded fittings. Fabricated fittings shall be rated for internal pressure service equivalent to the full service pressure rating of the mating pipe. Directional fittings 16" IPS and larger such as elbows, tees, crosses, etc., shall have a plain end inlet for butt fusion and flanged directional outlets. Part drawings shall be submitted for the approval of the Project Engineer.

Polyethylene Flange Adapters. Flange adapters shall be made with sufficient through-bore length to be clamped in a butt fusion joining machine without the use of a stub-end holder. The sealing surface of the flange adapter shall be machined with a series of small v-shaped grooves to provide gasketless sealing, or to restrain the gasket against blow-out.

2.4.2.2.1 Back-up Rings & Flange Bolts. Flange adapters shall be fitted with lap joint flanges pressure rated equal to or greater than the mating pipe. The lap joint flange bore shall be chamfered or radiused to provide clearance to the flange adapter radius. Flange bolts and nuts shall be Grade 2 or higher.

2.5 Manufacturer's Quality Control. The pipe and fitting manufacturer shall have an established quality control program responsible for inspecting incoming and outgoing materials. Incoming polyethylene materials shall be inspected for density, melt flow rate, and contamination. The cell classification properties of the material shall be certified by the supplier, and verified by Manufacturer's Quality Control. Incoming materials shall be approved by Quality Control before processing into finished goods.

Outgoing materials shall be checked for:

- Outside diameter, wall thickness, and eccentricity as per ASTM D2122 at a frequency of at least once/hour or once/hour, whichever is less frequent.
- Out of Roundness at a frequency of at least once/hour or once/coil whichever is less frequent.
- Straightness, inside and outside surface finish, markings and end cuts shall be visually inspected as per ASTM F714 on every length of pipe.

Quality Control shall verify production checks and test for:

- Density as per ASTM D1505 at a frequency of at least once per extrusion lot.
- Melt Index as per ASTM D1238 at a frequency of at least once per extrusion lot.
- Carbon content as per ASTM D1603 at a frequency of at least once per day per extrusion line.
- Quick burst pressure (sizes thru 4") as per ASTM D1599 at a frequency of at least once per day per line.
- Ring Tensile Strength (sizes above 4" equipment permitting) as per ASTM D2290 at a frequency of at least once per day per line.
- ESCR (size permitting) as per ASTM F1248 at a frequency of at least once per extrusion lot.

X-ray inspection shall be used to inspect molded fittings for voids, and knit line strength shall be tested. All fabricated fittings shall be inspected for joint quality and alignment.

2.5.1 Permanent Records. The Manufacturer shall maintain permanent QC and QA records.

2.6 Compliance Tests - Manufacturer's inspection and testing of the materials. In case of conflict with Manufacturer's certifications, the Contractor, Project Engineer, or Customer may request retesting by the Manufacturer or have retests performed by an outside testing service. All retesting shall be at the requestor's expense, and shall be performed in accordance with the Specifications.

3 *Joining*

3.1 Heat Fusion Joining. Joints between plain end pipes and fittings shall be made by butt fusion, and joints between the main and saddle branch fittings shall be made using saddle fusion using only procedures that are recommended by the pipe and fitting Manufacturer. The Contractor shall ensure that persons making heat fusion joints have received training in the Manufacturer's recommended procedure. The Contractor shall maintain records of trained personnel, and shall certify that training was received not more than 12 months before commencing construction. External and internal beads shall not be removed.

3.1.1 Heat Fusion Training Services. Upon request, the Manufacturer shall provide assistance in the Customer's recommended butt fusion and saddle fusion procedures to the Contractor's installation personnel, and to inspectors representing the Customer.

3.2 Mechanical Joining. Polyethylene pipe and fittings may be joined together or to other materials by means of flanged connections (flange adapters and back-up rings) or mechanical couplings designed for joining polyethylene pipe or for joining polyethylene pipe to another material. Mechanical couplings shall be fully pressure rated and fully thrust restrained such that when installed in accordance with manufacturer's recommendations, a longitudinal load applied to the mechanical coupling will cause the pipe to yield before the mechanical coupling disjoins. External joint restraints shall not be used in lieu of fully restrained mechanical couplings.

3.3 Branch Connections. Branch connections to the main shall be made with saddle fittings or tees. Polyethylene saddle fittings shall be saddle fused to the main pipe per 3.1.

4 Installation [See Plexco/Spirolite Engineering Manual 3. System Installation.]

4.1 General. The Manufacturer shall package products for shipment in a manner suitable for safe transport by commercial carrier. When delivered, a receiving inspection shall be performed, and any shipping damage shall be reported to the Manufacturer within 7 days. Installation shall be in accordance with

Manufacturer's recommendations, and this specification. All necessary precautions shall be taken to ensure a safe working environment in accordance with applicable codes and standards.

4.2 Excavation. Trench excavations shall conform to the plans and drawings, as otherwise authorized in writing by the Project Engineer or his Approved Representative, and in accordance with all applicable codes. Excess groundwater shall be removed by the Contractor. Where necessary, trench walls shall be shored or reinforced and all necessary precautions shall be taken to ensure a safe working environment.

4.3 Large Diameter Fabricated Fittings. Fabricated directional fittings 16" IPS and larger shall be butt fused to the end of a pipe. The flanged directional outlet connections shall be made up in the trench.

4.4 Mechanical Joint & Flange Installation. Mechanical joints and flange connections shall be installed in accordance with the Manufacturer's recommended procedure. Flange faces shall be centered and aligned to each other before assembling and tightening bolts. In no case shall the flange bolts be used to draw the flanges into alignment. Bolt threads shall be lubricated, and flat washers shall be fitted under the flange nuts. Bolts shall be evenly tightened according to the tightening pattern and torque step recommendations of the Manufacturer. At least 1 hour after initial assembly, flange connections shall be re-tightened following the tightening pattern and torque step recommendations of the Manufacturer. The final tightening torque shall be 100 ft-lbs or less as recommended by the Manufacturer.

4.5 Foundation & Bedding. Pipe shall be laid on grade and on a stable foundation. Unstable or mucky trench bottom soils shall be removed, and a 6" foundation or bedding of compacted Class I material shall be installed to pipe bottom grade. Excess groundwater shall be removed from the trench before laying the foundation or bedding and the pipe. A trench cut in rock or stony soil shall be excavated to 6" below pipe bottom grade, and brought back to grade with compacted Class I bedding. All ledge rock, boulders and large stones shall be removed.

4.6 Pipe Handling. When lifting with slings, only wide fabric choker slings capable of safely carrying the load, shall be used to lift, move, or lower pipe and fittings. Wire rope or chain shall not be used. Slings shall be of sufficient capacity for the load, and shall be inspected before use. Worn or defective equipment shall not be used.

4.7 Backfilling. Pipe embedment backfill shall be Class I or II material placed and compacted to at least 90% Standard Proctor Density in 6" lifts to at least 6" above the pipe crown.

4.8 Final Backfilling. Final backfill shall be placed and compacted to finished grade. Native soils without debris, stones, boulders, clumps, frozen clods or the like larger than 8" in their largest dimension may be used.

5 Testing.

5.1 Butt Fusion Testing. On every day butt fusions are to be made, the first fusion of the day shall be a trial fusion. The trial fusion shall be allowed to cool completely, then fusion test straps shall be cut out. The test strap shall be 12" (min) or 30 times the wall thickness in length with the fusion in the center, and 1" (min) or 1.5 times the wall thickness in width. Bend the test strap until the ends of the strap touch. If the fusion fails at the joint, a new trial fusion shall be made, cooled completely and tested. Butt fusion of pipe to be installed shall not commence until a trial fusion has passed the bent strap test.

Pressure Testing. Pressure testing shall be conducted in accordance with Plexco Application Note No 8, Pressure Testing, and shall be hydrostatic testing only. Pneumatic pressure testing shall not be used.

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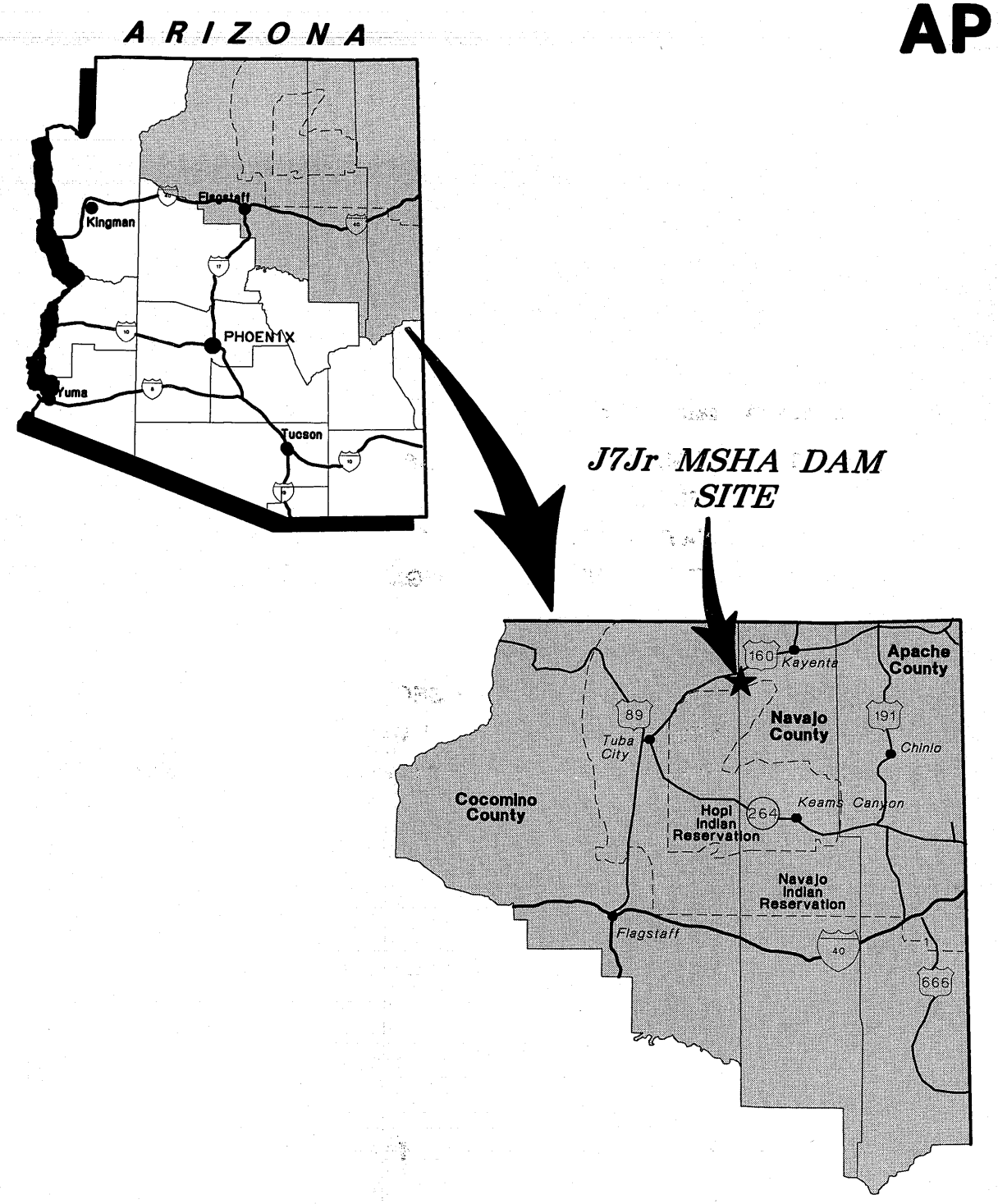
DESIGN DRAWINGS
J7Jr MSHA DAM
APRIL 2000



LIST OF DRAWINGS

DRAWING NO.	DRAWING TITLE
1	GENERAL LOCATION MAP
2	REGIONAL LOCATION
3	WATERSHED BOUNDARY
4	GEOTECHNICAL INVESTIGATION
5	SECTION LOCATIONS
6	CROSS SECTIONS
7	SPILLWAY PLAN AND SECTION LOCATIONS
8	SPILLWAY AND DECANT SYSTEM SECTIONS
9	INSTRUMENTATION PLAN VIEW

PREPARED FOR:

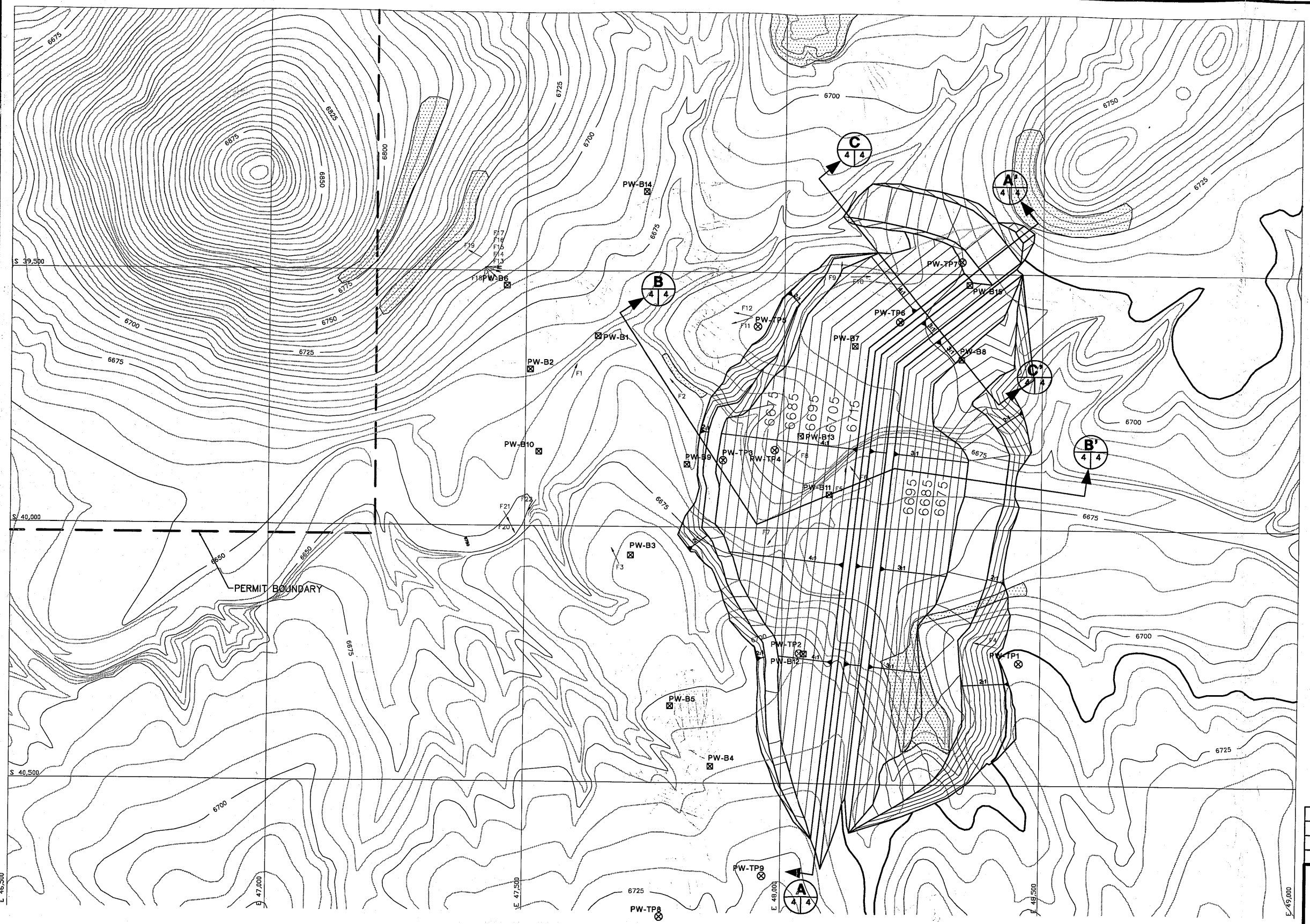
PEABODY WESTERN

PREPARED BY:

MONTGOMERY WATSON
165 South Union Boulevard, Suite 410
Lakewood, Colorado 80228

DWG.: 052-01.DWG

DRAWING No.:	REV.
1	0



LEGEND

- ⊠ BORINGS
- ⊗ TEST PITS
- F12 DIRECTION OF PHOTOGRAPHS
- OBSERVED SANDSTONE OUTCROPS

A 6 | 6 — DETAIL/SECTION NUMBER; DRAWING No. WHERE DETAIL/SECTION IS REFERENCED; DRAWING No. WHERE DETAIL/SECTION IS SHOWN

N

SCALE

100' 0 100' 200'

CONTOUR INTERVAL 25FT.

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Report	3/00	Troncoso	Holm	Troncoso

PEABODY WESTERN COAL COMPANY
KAYENTA MINE

PROJECT: J7 Jr MSHA DAM

DRAWING TITLE: GEOTECHNICAL INVESTIGATION

MONTGOMERY WATSON

Sheet 1 Of 3 Sheets

SCALE: As Shown

DRAWING No. 4

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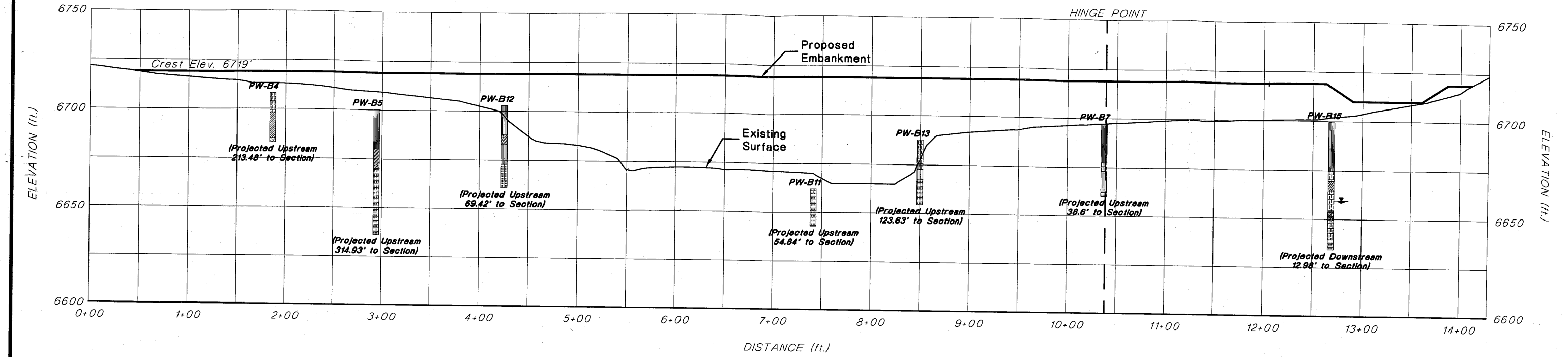

A/4 SECTION A-A'

HORIZONTAL SCALE
0 50 100

VERTICAL SCALE
0 25 50

LEGEND

- Silt
- Clay
- Sand
- Sandstone
- Siltstone/Claystone/Shale

NOTES:
1. DETAILED BOREHOLE LOGS ARE PRESENTED IN APPENDIX A.
2. MONTGOMERY WATSON HAS MADE THE ASSUMPTION THAT THE SOIL CONDITIONS DO NOT VARY APPRECIABLY BETWEEN RESTING BORING LOCATIONS. THE SUBSURFACE INFORMATION PRESENTED IN THESE CROSS-SECTIONS DOES NOT CONSTITUTE A DIRECT OR IMPLIED WARRANTY THAT THE SOIL CONDITIONS BETWEEN RESTING BORING LOCATIONS CAN BE DIRECTLY INTERPOLATED OR EXTRAPOLATED.

A/6 — DETAIL/SECTION NUMBER
DRAWING No. WHERE DETAIL/SECTION IS REFERENCED
DRAWING No. WHERE DETAIL/SECTION IS SHOWN

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0	Issued for Report	3/00	Troncoso	Holm	Troncoso

PEABODY WESTERN COAL COMPANY
KAYENTA MINE

PROJECT: J7 Jr MSHA DAM

DRAWING TITLE: GEOTECHNICAL INVESTIGATION SECTION A-A'

MONTGOMERY WATSON

Sheet 2 Of 3 Sheets
SCALE: As Shown
DRAWING No. 4

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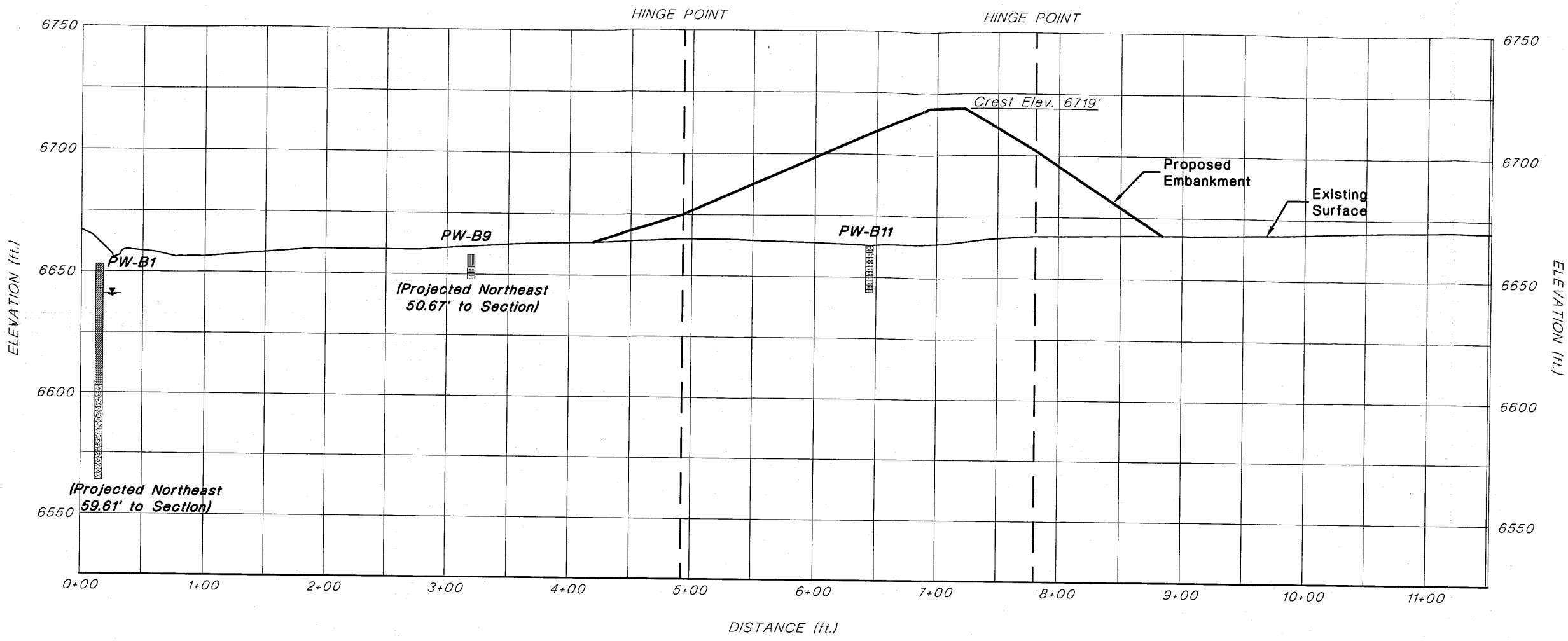
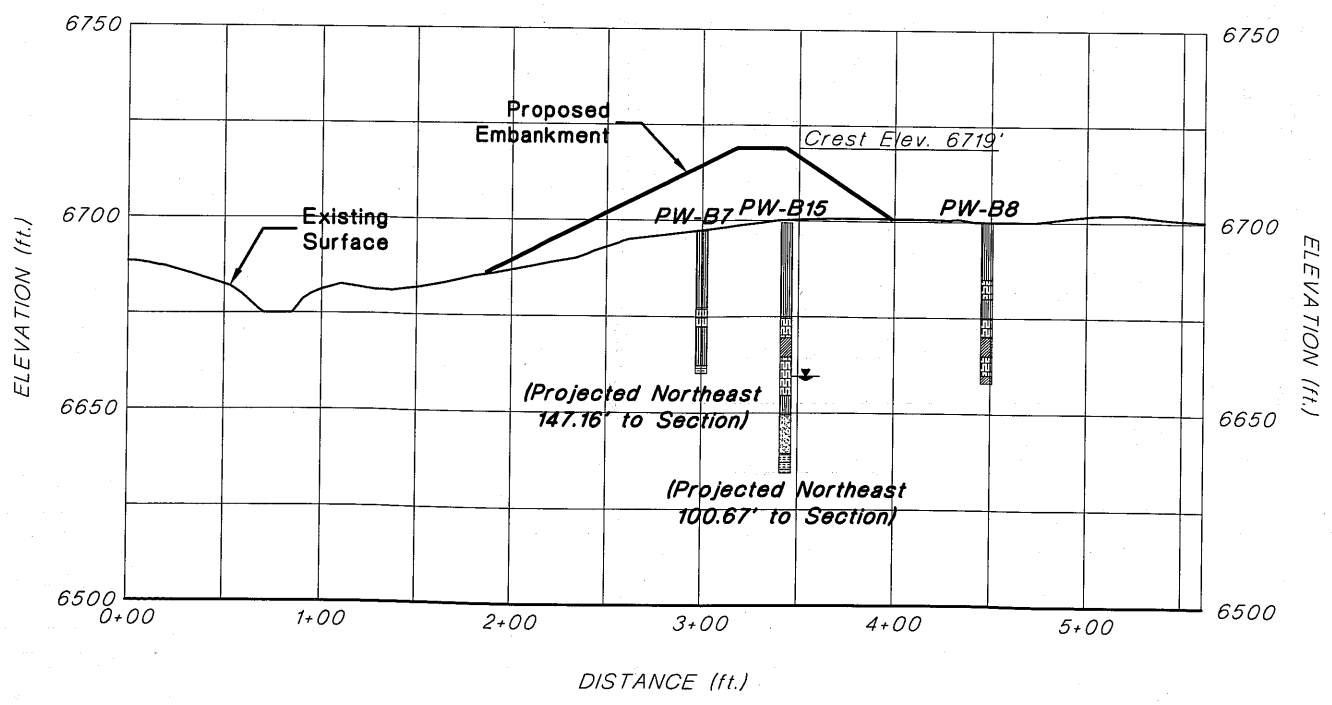


B 4 4 SECTION B-B'

HORIZONTAL SCALE
0 50 100

VERTICAL SCALE
0 25 50



C 4 4 SECTION C-C'

HORIZONTAL SCALE
0 50 100

VERTICAL SCALE
0 25 50

LEGEND

- Silt
- Clay
- Sand
- Sandstone
- Siltstone/Claystone/Shale

NOTES:

1. DETAILED BOREHOLE LOGS ARE PRESENTED IN APPENDIX A.
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A 6 6 — DETAIL/SECTION NUMBER
DRAWING No. WHERE DETAIL/SECTION IS REFERENCED
DRAWING No. WHERE DETAIL/SECTION IS SHOWN

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Report	3/00	Troncoso	Holm	Troncoso

PEABODY WESTERN COAL COMPANY
KAYENTA MINE

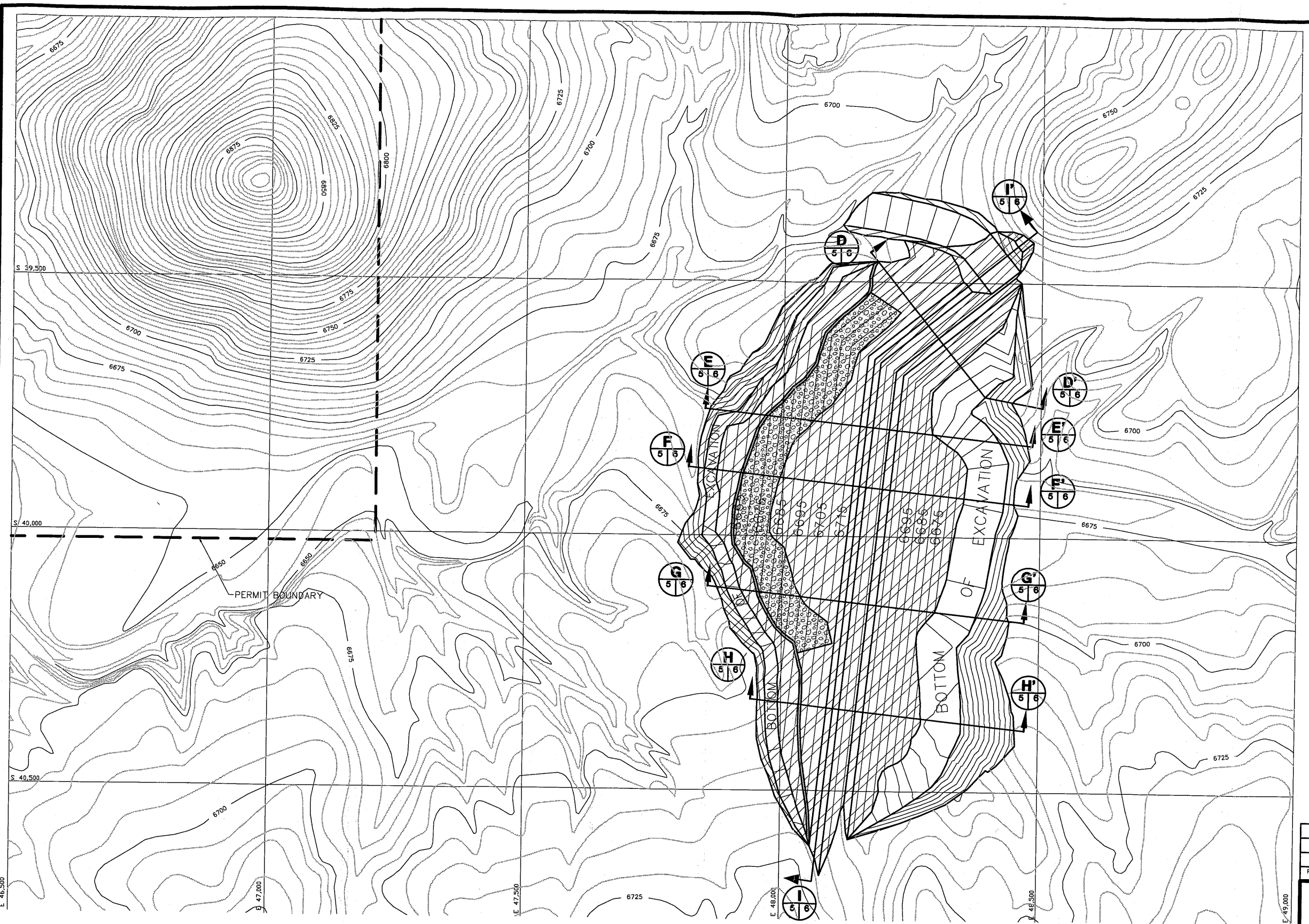
PROJECT: J7 Jr MSHA DAM

DRAWING TITLE: GEOTECHNICAL INVESTIGATION SECTIONS B-B' AND C-C'

MONTGOMERY WATSON

Sheet 3 Of 3 Sheets
SCALE: As Shown
DRAWING No. 4

AutoCAD FILE: 092-02c.DWG PROJECT NUMBER: 1342092



NOTE: EXCAVATION ON DOWNSTREAM END OF EMBANKMENT WILL BE FILLED WITH COMPACTED FILL MATERIAL

LEGEND

- TOE DRAIN ZONE – 2
- COMPACTED FILL – ZONES 3 & 4
- RIPRAP

DETAIL/SECTION NUMBER (A, 6 | 6)
DRAWING No. WHERE DETAIL/SECTION IS REFERENCED
DRAWING No. WHERE DETAIL/SECTION IS SHOWN

N

SCALE
100' 0 100' 200'
CONTOUR INTERVAL 25FT.

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Report	3/00	Troncoso	Holm	Troncoso

PEABODY WESTERN COAL COMPANY
KAYENTA MINE

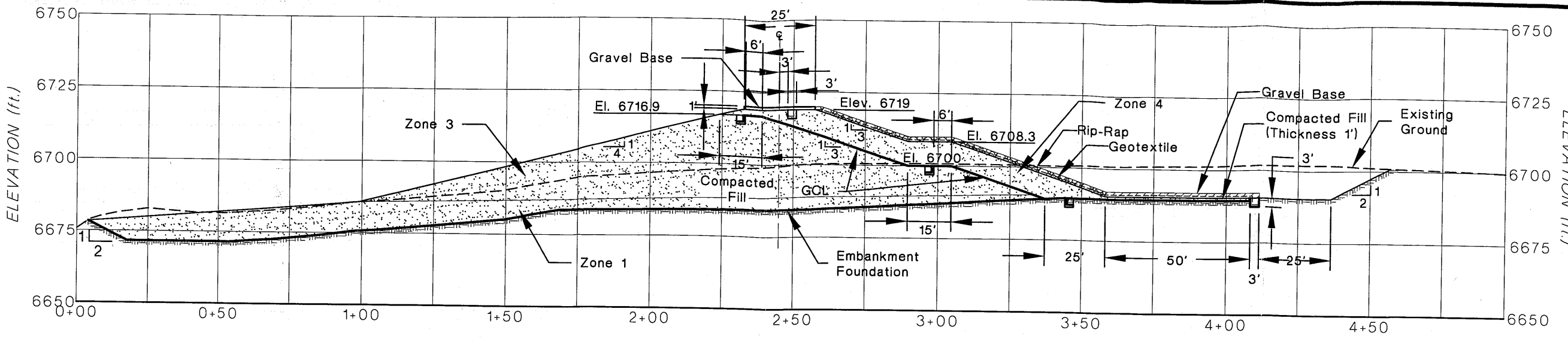
PROJECT: J7 Jr MSHA DAM

DRAWING TITLE: PLAN VIEW SECTION LOCATIONS

MONTGOMERY WATSON

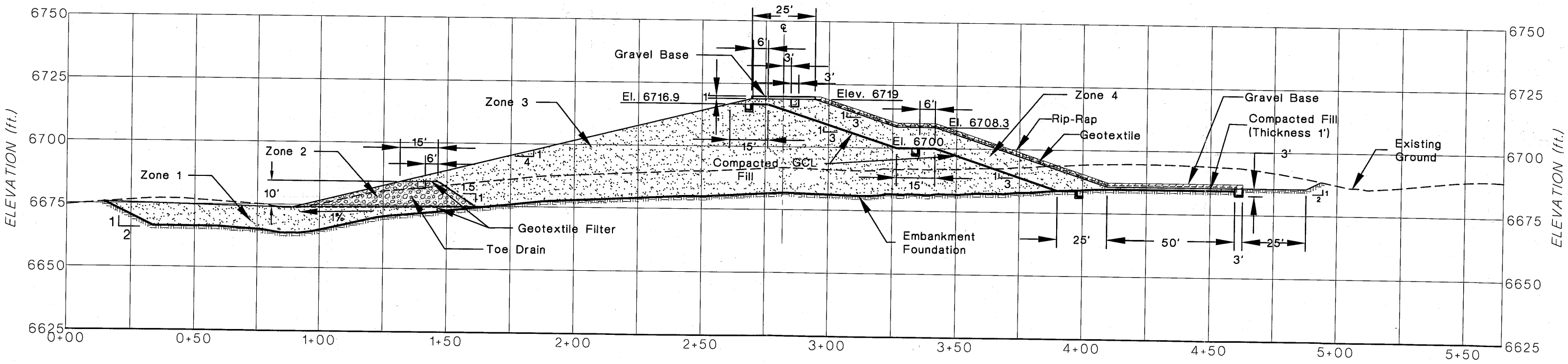
Sheet 1 Of 1 Sheets
SCALE: As Shown
DRAWING No. 5

AutoCAD FILE: 052-05.DWG PROJECT NUMBER: 1342052



D 5 6 SECTION D-D'

scale:1"=40'



E 5 6 SECTION E-E'

scale:1"=40'

NOTES:

1. TOPSOIL, COMPRESSIBLE AND INADEQUATE FOUNDATION MATERIALS AS DETERMINED BY THE CQA ENGINEER SHALL BE REMOVED AS PART OF THE EMBANKMENT FOUNDATION EXCAVATION.
2. FOUNDATION BELOW THE BLANKET DRAIN WILL BE GRADED TO PROVIDE A DOWNSTREAM SLOPE OF 1%.

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Report	3/00	Troncoso	Holm	Troncoso

PEABODY WESTERN COAL COMPANY
KAYENTA MINE

PROJECT: J7 Jr MSHA DAM

DRAWING TITLE: CROSS-SECTIONS D-D' AND E-E'

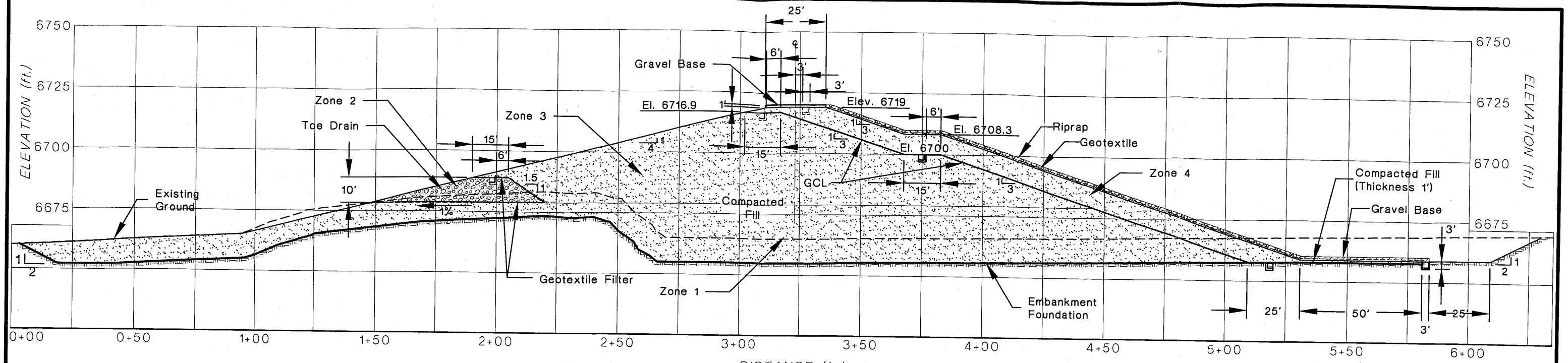
MONTGOMERY WATSON

Sheet 1 Of 4 Sheets

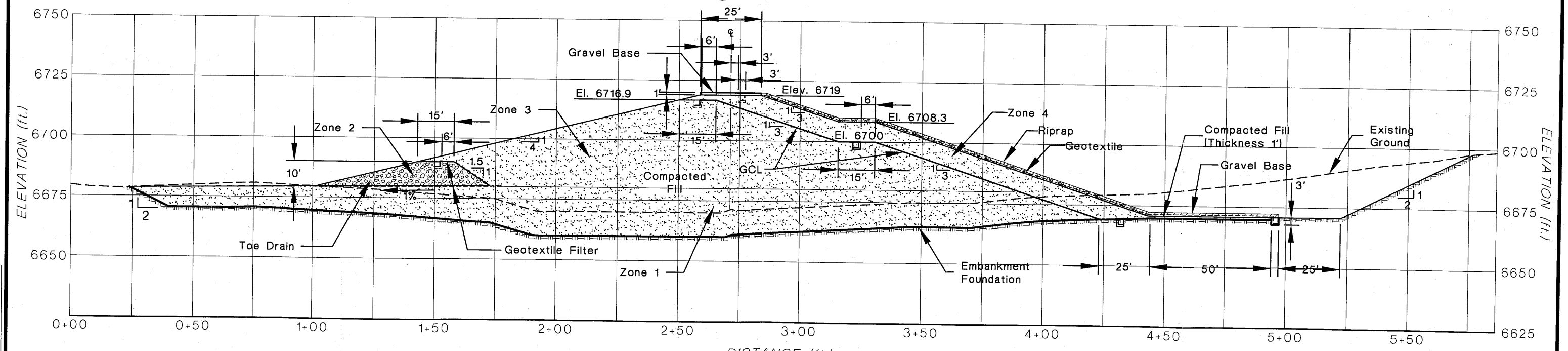
SCALE: As Shown

DRAWING No. 6

AutoCAD FILE: 092-06b.DWG PROJECT NUMBER: 1342052



F 5 6 SECTION F-F'
scale:1"=40'



G 5 6 SECTION G-G'
scale:1"=40'

NOTES:
1. TOPSOIL, COMPRESSIBLE AND INADEQUATE FOUNDATION MATERIALS AS DETERMINED BY THE CQA ENGINEER SHALL BE REMOVED AS PART OF THE EMBANKMENT FOUNDATION EXCAVATION.
2. FOUNDATION BELOW THE BLANKET DRAIN WILL BE GRADED TO PROVIDE A DOWNSTREAM SLOPE OF 1%.

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Report	3/00	Troncoso	Holm	Troncoso

PEABODY WESTERN COAL COMPANY
KAYENTA MINE

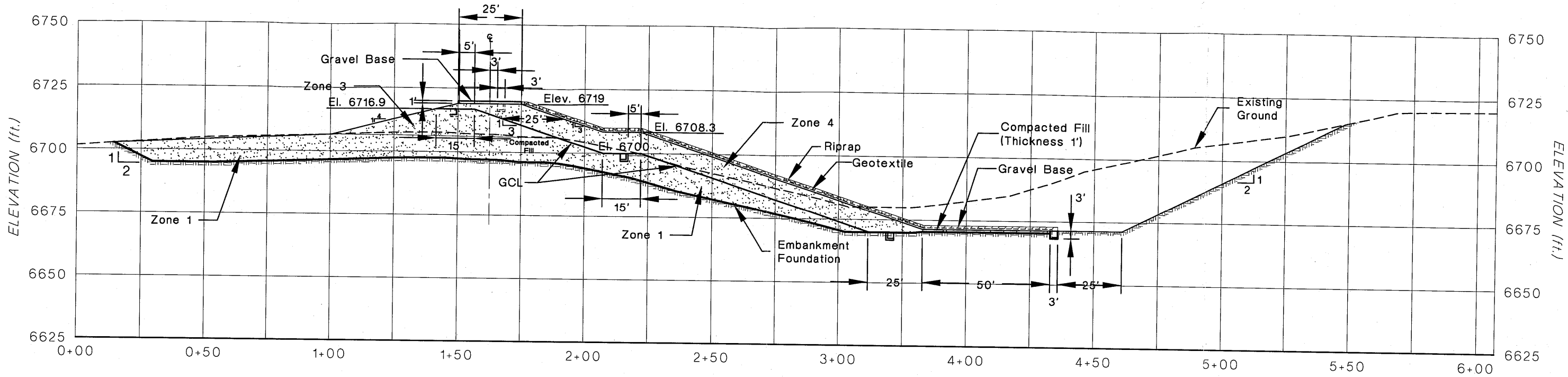
PROJECT: J7 Jr MSHA DAM

DRAWING TITLE: CROSS-SECTIONS F-F' AND G-G'

MONTGOMERY WATSON

Sheet 2 Of 4 Sheets
SCALE: As Shown
DRAWING No. 6

PROJECT NUMBER: 342052
AutoCAD FILE: 052-06b.DWG



DISTANCE (ft.)

H (5|6) SECTION H-H'

scale:1"=40'

NOTES:

1. TOPSOIL, COMPRESSIBLE AND INADEQUATE FOUNDATION MATERIALS AS DETERMINED BY THE CQA ENGINEER SHALL BE REMOVED AS PART OF THE EMBANKMENT FOUNDATION EXCAVATION.
2. FOUNDATION BELOW THE BLANKET DRAIN WILL BE GRADED TO PROVIDE A DOWNSTREAM SLOPE OF 1%.

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Report	3/00	Troncoso	Holm	Troncoso

PEABODY WESTERN COAL COMPANY
KAYENTA MINE

PROJECT: J7 Jr MSHA DAM

DRAWING TITLE: CROSS-SECTION H-H'

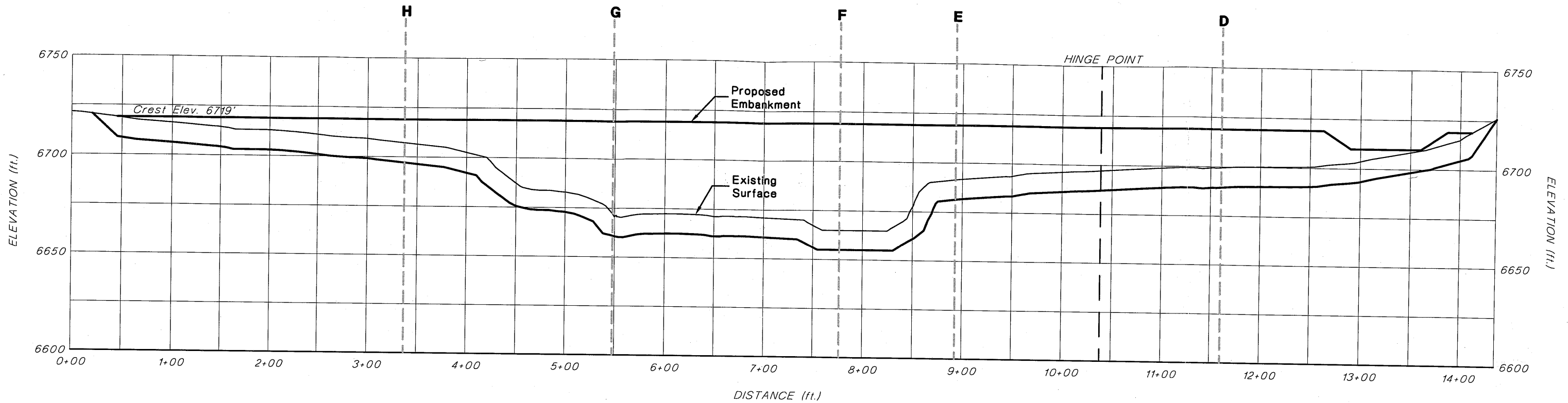
MONTGOMERY WATSON

Sheet 3 Of 4 Sheets

SCALE: As Shown

DRAWING No. 6

AutoCAD FILE: 052-6cs-r03 PROJECT NUMBER: 1242052



SECTION I-I'

(I / 5 6)

HORIZONTAL SCALE
0 50 100

VERTICAL SCALE
0 25 50

NOTES:
1. TOPSOIL, COMPRESSIBLE AND INADEQUATE FOUNDATION MATERIALS AS DETERMINED BY THE CQA ENGINEER SHALL BE REMOVED AS PART OF THE EMBANKMENT FOUNDATION EXCAVATION.
2. FOUNDATION BELOW THE BLANKET DRAIN WILL BE GRADED TO PROVIDE A DOWNSTREAM SLOPE OF 1%.

(A / 6 6) DETAIL/SECTION NUMBER
DRAWING No. WHERE DETAIL/SECTION IS REFERENCED
DRAWING No. WHERE DETAIL/SECTION IS SHOWN

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Report	3/00	Troncoso	Holm	Troncoso

PEABODY WESTERN COAL COMPANY
KAYENTA MINE

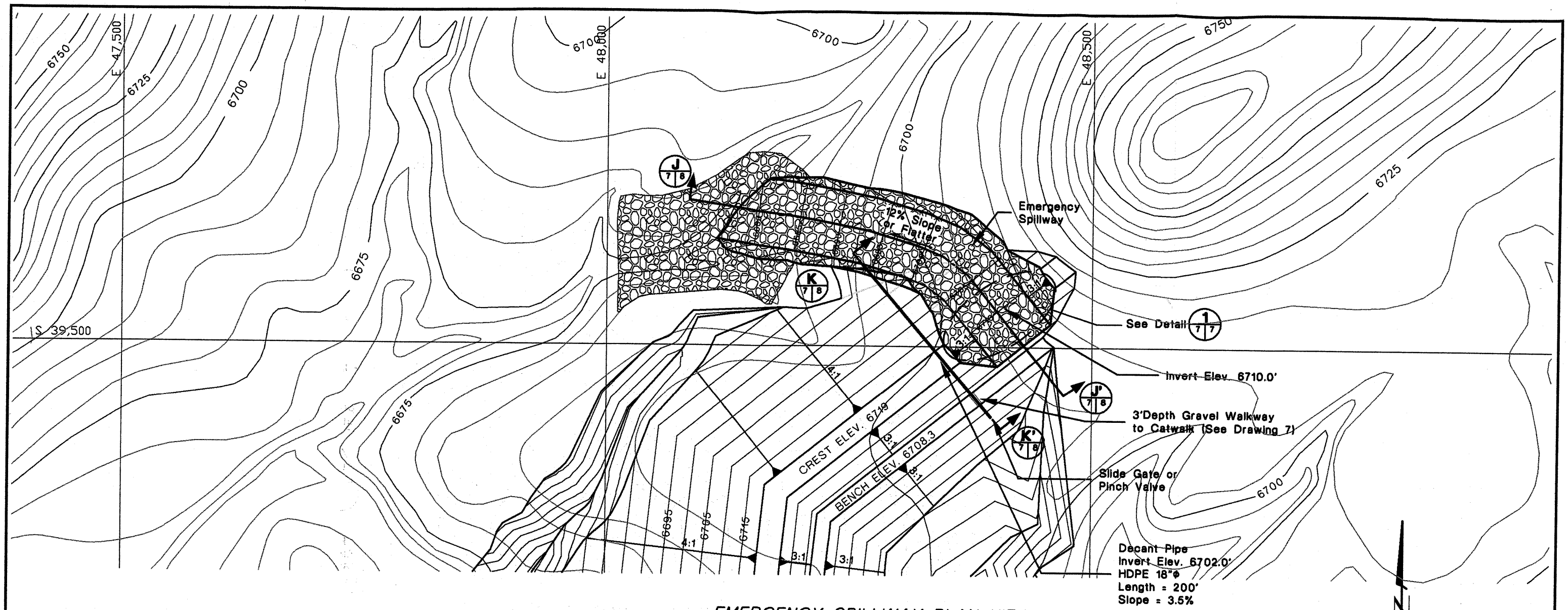
PROJECT: J7 Jr MSHA DAM

DRAWING TITLE: CROSS SECTION I-I'

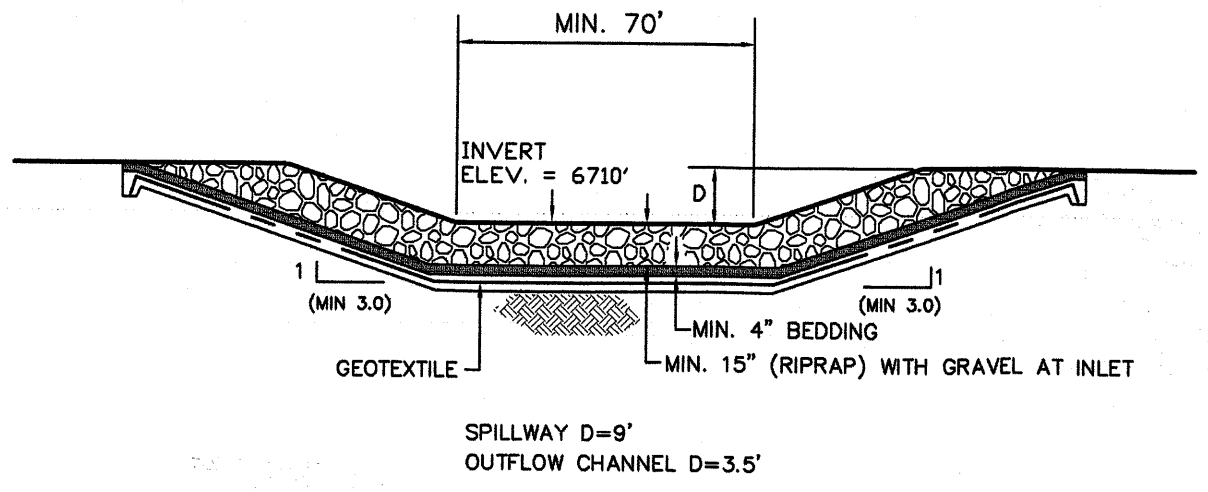
MONTGOMERY WATSON

Sheet 4 Of 4 Sheets
SCALE: As Shown
DRAWING No. 6

AutoCAD FILE: 052-6d.DWG PROJECT NUMBER: 1342052



EMERGENCY SPILLWAY PLAN VIEW
scale:1"=100'



SPILLWAY D=9'
OUTFLOW CHANNEL D=3.5'

1 7 7 DETAIL OF EMERGENCY SPILLWAY
Not to Scale

A 6 6
- DETAIL/SECTION NUMBER
- DRAWING No. WHERE DETAIL/SECTION IS REFERENCED
- DRAWING No. WHERE DETAIL/SECTION IS SHOWN

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Report	3/00	Keuscher	Holm	Leidich

PEABODY WESTERN COAL COMPANY
KAYENTA MINE

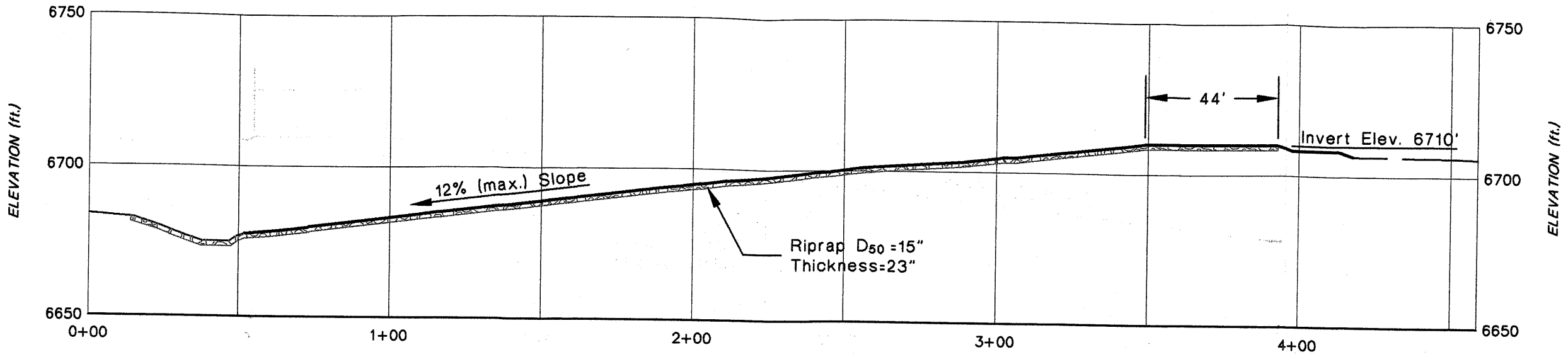
PROJECT: **J7 Jr MSHA DAM**

DRAWING TITLE: **SPILLWAY PLAN AND DECANT PIPE LOCATION**

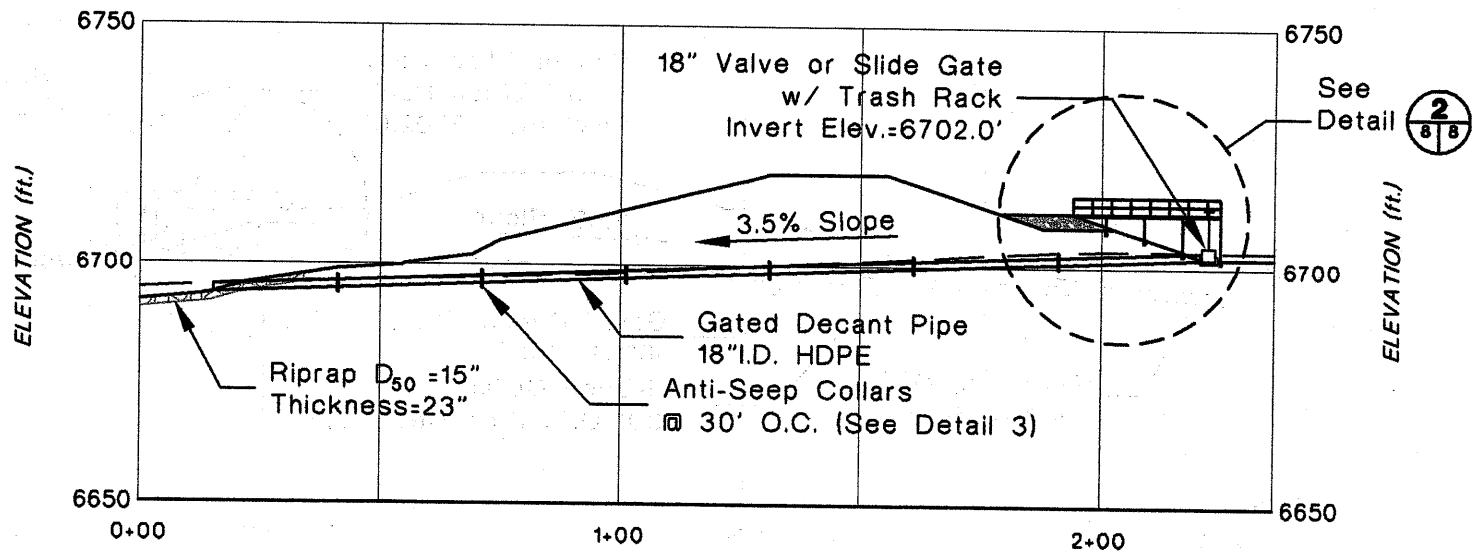
MONTGOMERY WATSON

Sheet 1 Of 1 Sheets
SCALE: As Shown
DRAWING No. 7

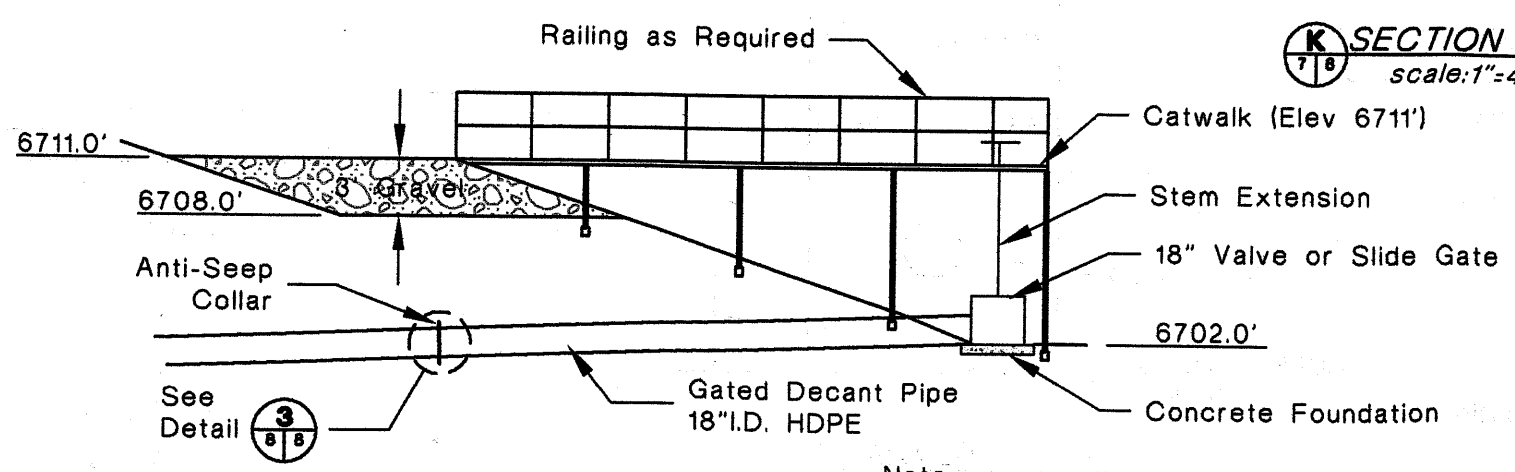
AutoCAD FILE: 052-07.DWG PROJECT NUMBER: 2342052



J 7|8 SECTION J-J'
scale:1"=40'

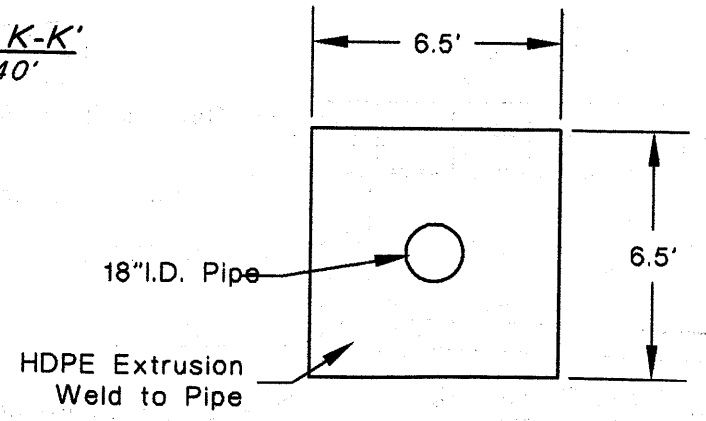


K 7|8 SECTION K-K'
scale:1"=40'



2 8|8 DETAIL 2
not to scale

Note:
Catwalk will be Designed and Constructed in Accordance with all Federal and Local Regulations.



3 8|8 DETAIL 3
ANTI-SEEP COLLAR
not to scale

A 8|8
DETAIL/SECTION NUMBER
DRAWING No. WHERE DETAIL/SECTION IS REFERENCED
DRAWING No. WHERE DETAIL/SECTION IS SHOWN

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Report	3/00	Keuscher	Holm	Leidich

PEABODY WESTERN COAL COMPANY
KAYENTA MINE

PROJECT: J7 Jr MSHA DAM

DRAWING TITLE: SPILLWAY AND DECANT SYSTEM SECTIONS

MONTGOMERY WATSON

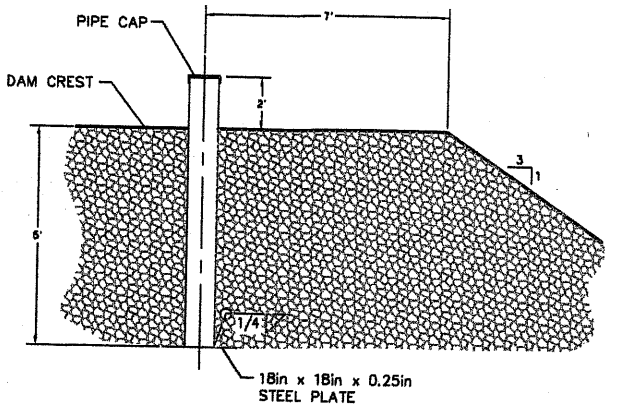
Sheet 1 Of 1 Sheets
SCALE: As Shown
DRAWING No. 8

AutoCAD FILE: 052-08DWG PROJECT NUMBER: 1342052

LEGEND

⊠ STANDPIPE PIEZOMETERS

⊗ SETTLEMENT MONUMENTS



TYPICAL SURVEY MONUMENT DETAIL
NOT TO SCALE

N

SCALE
100' 0 100' 200'
CONTOUR INTERVAL 25FT.

S 39,500
S 40,000
S 40,500
E 46,500
E 47,000
E 47,500
E 48,000
E 48,500
E 49,000
PERMIT BOUNDARY
P-1
P-2
P-3
P-4
P-5

NOTES:
1. LOCATION OF PIEZOMETERS AND SETTLEMENT MONUMENTS ARE APPROXIMATE.
2. BOTTOM OF PIEZOMETERS WILL BE PLACED APPROXIMATELY 5' ABOVE CONTACT BETWEEN EMBANKMENT FILL AND NATURAL GROUND.

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Report	3/00	Troncoso	Holm	Troncoso

PEABODY WESTERN COAL COMPANY
KAYENTA MINE

PROJECT: **J7 Jr MSHA DAM**

DRAWING TITLE: ***INSTRUMENTATION PLAN VIEW***

MONTGOMERY WATSON

Sheet 1 Of 1 Sheets
SCALE: As Shown
DRAWING No. 9

PROJECT NUMBER: 3242052
AutoCAD FILE: 052-09.DWG

REV. NO.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Report	3/00	Keuscher	Hohn	Leidich

PEABODY WESTERN COAL COMPANY
KAYENTA MINE

PROJECT: **J7 Jr MSHA DAM**

DRAWING TITLE: **WATERSHED BOUNDARY**

MONTGOMERY WATSON

Sheet 1 Of 1 Sheets

SCALE: As Shown

DRAWING No. 3

AutoCAD FILE 052-01.dwg PROJECT NUMBER 0242052

N-9
N-10
N-2
N-7/8
N-1
N-11
N-12
N-6
N-14
N-14 WEST
N-14 EAST
N14-HM
N-14 COAL PREPARATION PLANT
N14-FM
N14-GM
N14-DM
N14-EM
J16-AM
J-1
J-2
J2-AM
J-3
J-4
J-14
J-13
J-5
J-6
J7-DAM
J-7
J-10
J-8
J-9
J7-JR
J-16
J16-L
J-19
J-21
J-23
J-28
AZ-0001D PERMIT BOUNDARY
T37N
T36N
R18E
R19E
AZ-0001 PERMIT
N-14 WYE
NAVAJO (S&C) 250-001(14-20-0603-8580)
CENTRAL ENGINEERING OFFICE
N-6 SHOP/ FACILITIES
CENTRAL WAREHOUSE AND OPERATIONS
N-6 PRELL BIN
N-6 RAMP #14
KAYENTA MINE OFFICE AND SHOP FACILITIES (J-28)
J-21 PRELL BIN
BLACK MESA MINE OFFICE AND SHOP FACILITIES
NO COAL
NAVAJO - HOPI PARTITION LINE
T36N
T35N
T34N
R20E
R21E
COAL MINE WASH
YELLOW WATER CANYON WASH
TOADLENA WASH
N-7/8 DIVERSION
YELLOW WATER CANYON WASH DIVERSION
COAL MINE DIVERSION
N-14 DIVERSION
J-16 DIVERSION
REED VALLEY DIVERSION
J-7 DIVERSION
WHITEROCK WASH
REED VALLEY WASH
DRY OUT VALLEY WASH
MOENKOPI WASH
SAGEBRUSH WASH
YUCCA FLAT WASH
RED ROCK WASH
RED BEAR VALLEY WASH
ONYOSTO WASH
RESTING CATTLE VALLEY WASH

LEGEND

- AZ-0001/AZ-0001D PERMIT BOUNDARY
- LEASE BOUNDARY
- NAVAJO-HOPI PARTION
- COAL RECOVERY LINE
- PRE-LAW AREA (12-16-77)
- WATERSHED BOUNDARY
- EXISTING IMPOUNDMENT
- CULVERTS
- DIVERSIONS
- SECTION CORNER
- MSHA-SIZE DAM

NOTES:

1. For additional information, see Volume 1, Chapter 6, 'Sediment and Water Control Facility Plan' and Drawing No. 85400

ENGINEER'S CERTIFICATION

ENGINEER _____ DATE _____

-N-

SCALE: 1" = 2000'

SHEET INDEX

K-6	L-6		
K-7	L-7	M-7	N-7
K-8	L-8	M-8	N-8
K-9	L-9	M-9	N-9
K-10	L-10	M-10	N-10
K-11	L-11	M-11	N-11

REVISIONS		
CHK'D	DATE	DESCRIPTION
JGS	3-24-00	J7/JR REV.

DRAWING# 85402

MSHA DAM LOCATION MAP

KAYENTA AND BLACK MESA MINES

PEABODY WESTERN P.O. BOX 650 KAYENTA AZ, 86033

DESIGNED BY: PWCC	SCALE: 1"=2000'
DRAWN BY: ELI	DRAWING DATE: 03-24-2000
CHECKED BY: JGS	PHOTO DATE: 11-19-84
CONTOUR INTERVAL: 40'	

DRAWING FILE: Mce_ce\FACILITIES\WATER STRUCTURES\MSHA_DAM_MAP#85402-03-23-00