APPLICATION FOR A PERMIT TO CONSTRUCT AND OPERATE A CLASS I LANDFILL FACILITY
JUNGO DISPOSAL SITE

Humboldt County, Nevada

REPORT OF DESIGN

Revision 6

VOLUME I

Prepared For

Jungo Land and Investments, Inc.

Prepared by

Golder Associates Inc.

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REGISTERED PROFESSIONAL ENGINEER STATE OF NEVADA
12-5-2012
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No. 03011

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1.0 INTRODUCTION

This report is submitted as an integral component of the application for a permit to construct and operate a Class I municipal solid waste landfill facility at the Jungo Disposal Site located in Humboldt County, Nevada. The Jungo Disposal Site is located approximately 30 miles west of Winnemucca, Nevada along Jungo Road as shown in ***Figure 1***. Jungo Land and Investments, Inc. (JLII) will be the landfill developer and operator.

This report (***Volume I***) includes the Report of Design and was prepared in accordance with Nevada Administrative Code (NAC), Sections 444.677 through 444.683. ***Volume II*** includes the site design and development drawings. The Plan of Operations is included in ***Volume III, which also includes the Monitoring Plan, Closure Plan, and Postclosure Monitoring Plan***.

The landfill is located on a 634-acre parcel that consists of Section 7 of Township 35N (T35N), Range 33E (R33E). The landfill disposal footprint encompasses 562-acres within Section 7, T35N, R33E. The site development will include a rail yard for unloading waste containers transported by the rail, an office trailer, and a maintenance shop. Additional detail on the supporting facilities is provided in the Plan of Operations.

This Report of Design is organized as follows:

- Section 1 – Introduction
- Section 2 – Report of Design
- Section 3 – References

The Engineering Design Report is divided into the following three volumes:

- Volume I includes the text, tables, and figures for the Report of Design various reports, and supporting appendices consisting of data, test results and engineering calculations;
- Volume II includes the site development drawings; and
- Volume III includes the Plan of Operations.

2.0 REPORT OF DESIGN

The Report of Design was prepared in compliance with NAC, Sections 444.680 and 444.681. The Report of Design provides a description of the physical setting, and therefore, Section 2.1 also discusses the site location with respect to the location restrictions specified in NAC, Section 444.678.

2.1 Physical Setting

2.1.1 Site Location, Zoning and NAC Location Restrictions

The Jungo Disposal Site is located at the southern end of Desert Valley approximately 30 miles west of Winnemucca along the south side of Jungo Road as shown in ***Figure 1***. Regionally, the site is located in an arid, relatively flat, desert basin bound by the Jackson Mountains to the west and northwest, the Antelope Range to the southwest, Alpha Mountain to the south, and the Eugene Mountains to the southeast. The site vicinity is sparsely vegetated with greasewood.

The site is located on a 634-acre parcel consisting of Section 7 of Township 35N, Range 33E of the Mount Diablo Baseline and Meridian. The Jungo Disposal Site is bounded by Union Pacific Railroad property to the northwest and elsewhere by publicly-owned land administered by the Bureau of Land Management (BLM). ***Figure 2*** shows the property parcel in relation to the railroad and surrounding property sections.

The Jungo Disposal Site and surrounding property are zoned M-3 – Open Land Use. An M-3 designation allows for conditional commercial uses, such as landfill disposal operations, provided such uses are approved by the Humboldt Planning Commission (HPC). The HPC issued JLII a Special Use Permit in April 2007 that allows the site to be developed as a municipal waste disposal site.

NAC 444.678 specifies location restrictions for Class I landfills. The Jungo Disposal Site satisfies these requirements as follows:

- **NAC 444.678 – General:**
  - NAC 444.678 (1) The site design includes all-weather access to the landfill including an access road surfaced with aggregate. The rail unloading area will include paved areas and areas surfaced with aggregate to provide dust control and all-weather access.
  - NAC 444.678 (2) and (3) The landfill design includes containment systems, controls, and monitoring systems that will prevent uncontrolled migration of landfill gas, control leachate, and prevent degradation of groundwater.
  - NAC 444.678 (4) The site has soil available that is workable and compactable for use in covering the refuse.
  - NAC 444.678 (5) The disposal site also conforms to Humboldt County's land use planning.
  - NAC 444.678 (6) The nearest public highway (Interstate 80) is more than 30 miles from the site.
  - NAC 444.678 (9) The nearest surface water body is more than 14 miles from the site. The landfill is located within 100 feet of the uppermost groundwater aquifer. However, to prevent degradation of the groundwater aquifer, the landfill design incorporates extensive protective measures consisting of low-permeability

containment systems, conservatively designed leachate control system, and landfill gas control systems. These protective measures are described in Section 2.3.

- **NAC 444.6783 – Airport Safety**: There are no airports within 10,000 feet of the site.
- **NAC 444.6785 – Floodplain**: The site is not located within a floodplain. The site is located within a desert basin where precipitation temporarily collects in shallow depressions until it evaporates or infiltrates into the underlying soils.
- **NAC 444.679 – Wetlands**: The site is not located within a wetland area. The nearest wetlands in Desert Valley are more than 25 miles to the north along Bottle Creek Slough.
- **NAC 444.6791 – Fault Areas**: The site is located in a region that is underlain by a thick sequence of sediments that are at least 6,000 feet thick and do not show any surficial evidence of faulting (i.e. scarps). There are no mapped faults within 200 feet of the landfill. The nearest quaternary fault to the site is located in the Eugene Mountains at a distance of approximately 3 miles from the site.
- **NAC 444.6793 – Seismic Impact Zones:** The Jungo Disposal Site is located within a seismic impact zone, which is defined as a location that has a 10 percent probability of exceedance in a 250-year period of experiencing a seismically induced peak ground acceleration of 0.1g or greater. As required by NAC 444.6793, the Jungo Disposal Site is designed to withstand the peak ground acceleration without damaging environmental containment systems and controls, including the liner and cover systems. Seismic impacts are evaluated in Section 2.3.
- **NAC 444.6795 – Unstable Areas:** The Jungo Disposal Site is not located in an area that is considered geologically unstable, such a landslide prone areas, karst terrain, or excessively soft soils that could result in foundation failure. The site soils are expected to experience consolidation under loading by refuse. However, the landfill is designed to accommodate the settlement without adversely affecting the liner system as discussed in Section 2.3.

Additional detail on location restrictions is provided in the Plan of Operations.

2.1.2 Climate and Hydrology

The site is located in an arid region, where precipitation is controlled primarily by the rain-shadow effects imposed by the Sierra Nevada range located 150 miles to the west. The Jackson Mountains located on the west side of Desert Valley, cause a similar orographic effect, but of a lesser magnitude (Berger, 1995).

Precipitation results primarily from thunderstorms in the summer, and snow and rain in the winter. The mean annual precipitation is estimated to be approximately 8 inches. The mean annual precipitation in Winnemucca located 30 miles to the east (1897-2006) is 8.3 inches. Three different sources (Western Regional Climate Center; World Climate.com; and Berger, 1995) provide mean annual precipitation values ranging between 7.97 inches to 9.1 inches for a precipitation gauge at the Jungo-Meyers Ranch, located approximately 4 miles west of the Jungo Disposal Site. This precipitation gauge was measured from 1968 to 1986.

Temperatures in the summer months occasionally exceed 100° F. Winters are cool with temperatures often below 0°F. Based on data from Rye Patch Reservoir located 14 miles to the south, evaporation from free water sources is approximately 48-inches per year (Cohen, 1966). The prevailing wind direction in Desert Valley is toward the west-southwest.

The 25-year, 24-hour storm event is estimated to be 1.62 inches (NOAA, 2006).

2.1.3 Topography and Drainage

The Antelope Range, Alpha Mountain, and Eugene Mountains form the topographic divides at the southern end of the Desert Valley near the general location of the Jungo Disposal Site. The low-points of these topographic divides range from approximately 4,250 feet msl to 4,400 msl.

The valley floor is relatively flat. At the southern end of the valley, the elevations generally range from 4,180 feet msl to 4,155 feet msl and slope from the southeast to the northwest. At the Jungo Disposal Site, the elevations range from a high of 4,177 feet msl at the southeast corner of the property to a low of 4,172 feet msl at the southwest corner of the property.

Desert Valley is a 1,052 square mile hydrographic sub-area within the Black Rock Desert Region hydrographic basin. Streams from the surrounding mountains are ephemeral and rarely discharge to the valley floor and instead infiltrate through the upper coarse alluvial fans or evaporate (Berger, 1995). Precipitation or snow melt on the valley floor accumulates in localized depressions until it infiltrates or evaporates.

At the Jungo Disposal Site, these shallow depressions are on the order of several inches deep. During normal precipitation events, water accumulates in the depressions until it evaporates or infiltrates into the subsurface soils. In the event of intense storms, it is possible that localized depressions may fill and then sheet flow to the next depressions located to the north or west. This is consistent with the United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) (2007), which estimates that ponding may occur locally to depths of 6 to 12 inches.

Large alkali flats are located in larger depressions that are approximately 2 miles west and north of the Jungo Disposal Site with surface elevations ranging from 4,162 to 4,164 feet msl. These alkali flats are located in an area identified by Berger (1995) as containing hard-pan, or low-permeability clays and silts, which impede infiltration.

2.1.4 Geology

The following sections describe the regional geologic conditions and the site-specific geologic conditions based on subsurface explorations completed as part of the initial site characterization program.

2.1.4.1 Regional Geology

Desert Valley lies within the Basin and Range Geomorphic Province, which is characterized by north-south trending uplifted mountain ranges adjacent to down-dropped valleys or basins. Desert Valley is a north-south trending structural basin with a relatively flat valley floor that is approximately 55-miles long and 12-miles wide. Mountain ranges provide topographic boundaries at the edges of the valley floor. The Jungo Disposal Site is located in the southernmost portion of Desert Valley. This end of Desert Valley is bound to the west by the Jackson Mountains, to the southwest by the Antelope Range, and to the east by the Eugene Mountains. ***Figure 3*** shows the regional geologic map.

The lithology of the area is comprised of two major types - consolidated rock and basin fill. The rock is found in the surrounding mountains and underlying the valley basin fill sediments. Predominant rock

types include Tertiary-age volcanic flows, clastic sedimentary rocks from the Jurassic or Triassic ages, and Permian-age or older volcanic rocks. These formations are generally considered to have low permeability.

At the base of the mountains, alluvial fans consisting of eroded sediments from the mountains occur. These cone-shaped deposits contain coarse sediments typically deposited by stream and debris flows.

The alluvial deposits range from partly consolidated to unconsolidated fill material. The Older Alluvium unit, consisting of poorly sorted, subangular to subrounded sand to cobbly gravel, has been identified to occur along several range fronts, high on the alluvial fans. Toward the valley floor, this unit underlies the Younger alluvium of the valley floor. The Older Alluvium grades finer toward the valley center and becomes partially consolidated.

In addition to the coarser-grained alluvial fan sediments, the basin contains aeolian, lacustrine, and volcanic deposits. During late Pleistocene time, Desert Valley was inundated by ancient Lake Lahontan, which reached depths of nearly 200 feet in Desert Valley. The contact between Older Alluvium and Younger Alluvium is typically drawn at the elevation of the highest Lake Lahontan terrace. The Younger Alluvium, located on the valley floor and beneath stream channels, includes Pleistocene and Recent lake sediments, shoreline deposits, stream deposits, and aeolian deposits. The total depth of the sediments in the basin is estimated to be 6,000 to 7,000 feet in the vicinity of the Jungo Disposal Site (Berger, 1995).

Older Alluvium, consisting of poorly-sorted, subangular to subrounded sand to cobbly gravel, generally occurs along the range fronts and grades finer toward the toes of the alluvial fans. Older Alluvium is primarily dissected alluvial fan deposits that are coarser than the Younger Alluvium found on the valley floors and in stream channels.

2.1.4.2 Site Geology

An initial site characterization program was completed to evaluate the site-specific geologic conditions, hydrogeologic conditions, and engineering properties of the underlying soils. This initial characterization program consisted of the examination and logging of the surficial soils, the completion of five borings to depths of 100 to 145 feet below ground surface (bgs), and the completion of a geotechnical laboratory testing program.

The site soils are mapped as Younger Alluvium and classified as Boton Playas described as unconsolidated alluvial sediments (USDA, NRCS, 2006). Boton soils consist of volcanic ash and loess over lacustrine deposits. The surficial soils are relatively uniform and consist of silty fine sands, classified as a silty sand (denoted as "SM") in accordance with the Unified Soils Classification System (USCS).

Five borings were completed using hollow-stem auger drilling methods under the observation of a Golder engineer who logged the soil samples and recorded groundwater conditions. The locations of the borings are shown in ***Figure 4***. Soil samples were collected at 5-foot intervals using a combination of standard split spoon samplers, modified California samplers, and Shelby (thin-walled) tubes.

The standard split spoon samples and modified California samples were obtained in accordance with the Standard Method for Penetration Test and Split Barrel Sampling of Soils as described in ASTM D1586. This sampling method consists of driving the split spoon sampler a distance of 18 to 24 inches into undisturbed soil. The number of blows required to drive a standard split spoon sampler the final 12-inches is known as the Standard Penetration Resistance "N", which provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Because drilling mud was not used during the drilling program, caution should be used in interpreting N values in cohesionless soils

below the groundwater surface. Soil samples obtained for consolidation characteristic testing were obtained by pushing a three-inch outer diameter thin-walled tube into the undisturbed soil in accordance with the Standard Practice for Thin Walled Tube Sampling of Soils as described in ASTM D 1587.

All samples were placed in air-tight sample bags or sealed directly in the thin-walled tube to minimize moisture loss during transport to the laboratory. Soil samples were classified in accordance with Golder technical procedures and the Unified Soil Classification System.

The four borings located near the corners of the property were converted into groundwater monitoring wells (MW-1 through MW-4). The boring completed in the middle of the site was abandoned by backfilling the boring annulus with a cement-bentonite grout.

Summary boring logs and monitoring well completion logs are included in ***Appendix A***. The blow counts (N-values) on the logs have not been corrected for overburden stresses.

Section 2.1.4.2.1 summarizes the subsurface geologic conditions observed. Section 2.1.4.2.2 summarizes the geotechnical engineering properties measured from the laboratory testing program.

2.1.4.2.1 Site Soil Conditions

The subsurface soils consist of interbedded sands, silts, and clays. ***Figures 5 and 6*** illustrate the subsurface lithology to a depth of 100 to 145 feet bgs, which is summarized below:

- **Upper Silty Sands**. The uppermost soils are predominately silty fine sands with occasional thin lenses of silt. These soils occur at the ground surface and extend to depths of approximately 35 to 40 feet bgs.
- **Upper Silty Clays and Clayey Silts**. A 10- to 18-foot thick layer of primarily silty clay and clayey silt underlies the uppermost silty sands.
- **Middle Sands**. At a depth of 55 to 60 feet bgs, the borings encountered predominately sands that are interbedded with silty sands and thin lenses of silts and silty clays. This soil zone was observed to be 18 to 30 feet thick.
- **Lower Clay and Clayey Silt**. A 12- to 20-foot thick clay layer was first encountered at a depth of 70 to 80 feet bgs. The upper portion of this layer is generally comprised of highly plastic and compressible clay, while the lower portion consists of low to moderately plastic clay.
- **Lower Sand and Silty Sand**. The deepest boring penetrated the lower clay and clayey silt zone at a depth of 115 feet and encountered interbedded sands, silty sands, and thin lenses of silt to the full depth of the boring at 145 feet.

As an approximate percentage of the lithologic section, clean sands comprise 10 percent, silty sands comprise 40 percent, silts comprise 10 percent, silty and sandy clays comprise 30 percent, and highly plastic clays comprise 10 percent.

2.1.4.2.2 Geotechnical Properties

Representative soil samples, collected from the borings during the investigation, were submitted to the laboratory for the following analyses:

- Moisture-density;
- Atterberg Limits;

- Grain-size distribution;
- Consolidation; and
- Consolidated-Undrained (CU) triaxial shear strength (with pore pressure measurements).

The key geotechnical properties are summarized below.

- SPT blow counts (N-Values, uncorrected) in the sands above the water table range from approximately 16 to 20 per foot in the upper 5 to 10 feet and generally increase to 40 at a depth of 45 to 55 feet. Based on the blow-counts, the sands are considered to be dense.
- The moisture content of the upper silty sand layer ranged from 12 to 18 percent. The dry density of the upper silty sand ranged from 92 to 106 pounds per cubic foot (pcf).
- The dry density of the silty clays ranged from 86 to 89 pcf. The dry density of the highly plastic clay was measured to be 59 pcf in two samples.
- The Plasticity Index of the silty clay (CL) layers ranged from 20 to 30. The Plasticity Index for the highly plastic clay (CH) was measured between 56 and 72.
- Consolidation tests indicated that the soils are generally normally consolidated. In some cases, the soils might be slightly over-consolidated, which may be related to the recent regional decline in groundwater levels and the older groundwater declines that occurred after ancient Lake Lahontan dried up. The primary compression index (C_c) for the silty clay and silt (CL-ML) was measured to be 0.16 to 0.26 with an initial void ratio of 0.9 to 1.0. The primary compression index (C_c) for the highly plastic clay (CH) was measured to be 0.66 to 0.71 with an initial void ratio of approximately 1.87. The lowest coefficient of consolidation (C_v) values were generally measured at between 0.01 to 0.08 ft/day, which corresponded to the high plasticity clays and some of the low plasticity clays.
- CU-triaxial shear strength tests measured effective stress strength parameters for the silty clays that can be defined by a friction angle of 26 to 27 degrees and cohesion of 1,500 to 2,100 psf. The measured effective stress strength parameters for the highly plastic clays can be defined by a friction angle of 19 to 21 degrees and cohesion of 800 to 975 psf.

Appendix B includes a summary of laboratory tests that were completed as part of the initial site characterization.

2.1.4.2.3 Summary

The initial site characterization indicates that the site is underlain by interbedded sands, silts, and clays. Four soil sequences were identified throughout the site in all five borings and included an upper silty sand, an upper silty clay and clayey silt, a middle sand, and a lower clay and clayey silt. One boring extended to a depth of approximately 145 feet encountered a fifth soil sequence consisting of a lower sand and silty sand. The base of the landfill, as described in Section 2.3 will be founded in the upper silty sand. Groundwater was first encountered in the middle sand layer at a depth of approximately 59

to 60 feet. The upper silty clay layer occurs between the base of the landfill and first occurrence of groundwater.

The initial site characterization also indicated that the soils are normally consolidated, the silty clays and silts are moderately compressible, and that the highly plastic clay at a depth of approximately 80 to 90 feet is highly compressible.

As described in Section 2.3, the compressive characteristics of the underlying soils pose a significant constraint to the height and weight of refuse that can be placed on the liner. Excessive settlement of the foundation could result in adverse drainage grades on the landfill. Due to the critical aspect of these geotechnical properties, additional geotechnical borings will be completed prior to the construction of the base containment system as follows:

- A minimum of six borings will be installed for each module (each module is approximately 55-acres in area). After the explorations are completed for the first one or two modules, the number of borings may be increased or decreased based on the variability of the observed subsurface conditions. For the five borings that were completed for the initial characterization, the soil conditions were relatively consistent.
- The borings will be installed to depths of at least 200 to 300 feet.
- The underlying silts and clays will be sampled for further consolidation testing.
- Additional standard penetration test (SPT) measurements will be collected to allow for confirmation of the initial liquefaction assessment (Section 2.3.4.4 and Appendix K).

The above geotechnical investigations and testing will be used to confirm the current lithologic and geotechnical model. If these investigations indicate differing conditions, the lithologic and geotechnical model will be updated and the landfill design modified if necessary. Potential landfill design modifications may include changes to the drainage grades on top of the base liner or potential changes in the landfill heights. All design changes will be submitted the Nevada Department of Environmental Protection for review and approval prior to implementation.

2.1.5 Hydrogeology

2.1.5.1 Regional Hydrogeology

The partially-consolidated to unconsolidated basin-fill deposits in Desert Valley comprise the primary water-bearing unit. The deposits generally function as a single, heterogeneous aquifer rather than one with defined, contiguous fine-grained aquitards layered between coarser-grained water-bearing units. Most shallow groundwater occurs in unconfined conditions, while groundwater found at depth below finer-grained deposits occurs in semi-confined conditions (Berger, 1995).

Most groundwater recharge in the Desert Valley basin occurs as precipitation that falls on the mountains surrounding the basin. The primary mechanisms for recharge are for the rainfall or snowmelt to infiltrate exposed weathered and/or fractured bedrock or for the runoff to percolate through the coarser-grained alluvial fan deposits. With most recharge occurring at the higher elevations, groundwater at the eastern and western valley margins primarily flows from the higher elevations downgradient toward the center of the basin. Additional groundwater recharge does occur in the subsurface from the Quinn and Kings River Valleys located in the northern portion of the basin (Berger, 1995).

A groundwater divide bisects the Desert Valley basin from east to west. The location of the divide has been shown to migrate over time in response to changes in groundwater elevations, but has generally remained in the central to southern-central area of the basin located north of the Jungo Disposal Site. Groundwater on the northern side of the divide flows to the north toward the Quinn River and discharges out the northwestern side of the basin at Pine Valley. Groundwater on the southern side of the divide flows to the southwest and likely exits the basin near the Antelope Range (Berger, 1995). The Jungo Disposal Site is located on the southern side of the groundwater divide.

Ranges of horizontal groundwater hydraulic conductivities have been estimated by calculating average values for the different lithologic units encountered in the upper 180 feet of saturated basin-fill deposits in Desert Valley. Using the lithologic data, areas of the basin were roughly categorized as having horizontal conductivities either greater than 50 feet/day (ft/day) or less than 50 ft/day (Berger, 1995). Most of the basin was estimated to have a horizontal conductivity less than 50 ft/day ($<1.7 \times 10^{-2}$ cm/s), while some smaller areas of the basin were estimated to have conductivities greater than 50 ft/day. The Jungo Disposal Site is located in an area identified by Berger (1995) to have horizontal hydraulic conductivities less than 50 ft/day.

Prior to 1985, groundwater withdrawal in the Desert Valley basin occurred primarily for agriculture and irrigation, with lesser amounts for domestic and livestock use. In 1985, significant mining and associated dewatering operations began in the northern portion of the valley on the northern side of the groundwater divide at the Sleeper Mine. Basin-wide groundwater elevations measured in 1991 demonstrated that groundwater elevations in the basin had been affected by the mine dewatering. In general, elevations measured in 1991 (while mine dewatering was occurring) were lower than those from "pre-development" (late 1950's to early 60's) conditions. ***Figure 7*** compares groundwater flow directions in 1991 with estimated pre-development conditions in 1975. These 1991 measurements also showed that the groundwater divide had migrated toward the south. The Desert Valley basin groundwater elevations range from approximately 4100 to 4130 feet mean sea level (msl) (Berger, 1995).

Appendix C includes an evaluation of historical groundwater levels for the Desert Valley Basin. The data review determined that, in the vicinity of the Jungo Road site, groundwater levels have declined approximately 10 feet over the past 30 years. The decline is attributed to past and current groundwater withdrawal for agricultural use and mine dewatering. As such, with continued agricultural groundwater use and other development-related uses, groundwater elevations in the vicinity of the site will continue to decline, and therefore, they are not likely to exceed pre-development levels (i.e., approximately 1975 levels) and indeed may not rise beyond present day levels.

The data review presented in ***Appendix C*** also indicates that groundwater levels in the basin are not impacted by seasonal changes including periods with above average precipitation. ***Figure 8*** shows the historical trends in groundwater elevations for wells within the southern portion of the basin in comparison to annual precipitation values. ***Figure 9*** shows the locations of these reference wells. As indicated in ***Figure 8***, groundwater levels did not respond to several above-average rainfall years occurring in the late 1990's (1996, 1997, 1999, and 2001). To the contrary, groundwater levels continued to decline an additional two to three feet. Basin development and long-term groundwater use patterns (e.g., groundwater extraction for irrigation) appear to be a more significant factor in groundwater elevation change than annual precipitation.

2.1.5.2 Site Hydrogeology

In soil borings completed during the site investigation, first groundwater was encountered at approximately 59 to 60 feet bgs in the middle sand/silty sand layer, above a layer of low to high plasticity clay. Four of the five borings were converted to groundwater monitoring wells. The well

locations are shown on ***Figure 4*** and the well construction details are provided in ***Appendix A***. Quarterly depth-to-water measurements have been taken in the wells since their installation in January 2007. These measurements indicate that groundwater occurs at elevations similar to those recorded in the initial soil borings. Therefore, first-encountered groundwater occurs under unconfined, water-table conditions, consistent with the regional hydrogeologic model.

As described above, water levels in the basin have decreased, and in the area of the site have declined approximately 10 feet over the past 30 years. Current depth to groundwater at the site is approximately 59 to 60 feet bgs (***Table 3***). Therefore, assuming a return to 1975 groundwater levels, the highest anticipated groundwater levels at the site are estimated to be approximately 50 feet bgs.

Water-level measurements collected between January 2007 and November 2007 have exhibited no seasonal variation. The maximum change in elevation during 2007 is less than one foot. In April 2007, a pressure transducer and datalogger were installed in well MW-1 to allow for continuous recording of groundwater levels to further evaluate any potential seasonal or other short-term variation.

A groundwater contour map of the site has been prepared using groundwater elevations measured in the site wells (***Figure 10***). Based on these measurements, groundwater flows toward the southwest, consistent with the basin flow net prepared by Berger (1995). The gradient is estimated to be 0.0003.

Groundwater Velocity

Rising head slug tests were conducted in each well on February 2, 2007 to determine the hydraulic conductivity of the middle sand and silty sand. With these data, hydraulic conductivities were calculated for each well. To determine a hydraulic conductivity for the site, the geometric mean of the four individual well conductivities was calculated. As such, the hydraulic conductivity at the site is estimated to be 1.2×10^{-4} cm/s. The slug test data is presented in ***Appendix D***.

Using the calculated gradient (i), the hydraulic conductivity (K), and the estimated effective porosity of the water-bearing zone (n_e), the approximate groundwater seepage velocity can be calculated using Darcy's Law ($v = Ki/n_e$). An effective porosity value of 0.15 for the sandy zones is assumed, based on information from Cohen (1963). Groundwater seepage velocity beneath the site is estimated to be 2.4×10^{-7} cm/s (0.25 feet per year [ft/yr]).

Vertical Gradient

The landfill is likely located in an area of groundwater discharge. According to Berger (1995), most precipitation and groundwater recharge occurs in the mountains surrounding the basin, with recharge through fractured rock or intermittent streamflow along coarse channel deposits on alluvial fans (located along the edges of the valley). In addition, Berger (1995) states that some recharge may occur in the south-central portion of the valley (north of Jungo) in the area covered by active sand dunes. Note that during extremely wet years, when the playa is saturated, there may be some minor recharge from the playa.

All four site groundwater monitoring wells are screened in the shallowest water-bearing zone beneath the site. There are no deeper wells at the site capable of providing data on the vertical hydraulic gradient beneath the site. Berger (1995) suggested that only small vertical gradients existed in Desert Valley prior to development. Both upward and downward vertical gradients were determined for wells located near the Sleeper Mine in the northern part of the valley (Berger, 1995). These vertical gradients were apparently induced by mine dewatering and artificial recharge in the immediate area of the nested wells. Based on the lack of development near the Jungo area, and based on the work by Berger (1995), it is likely that only small vertical gradients exist in this area.

There is a 12- to 20-foot thick clay layer (lower clay and clayey silt) beneath the first water-bearing zone (middle sands). Vertical, downward flow through the lower clay layer could occur if there was a downward gradient beneath the site. Given that there may be small vertical gradients in the area, if there was a 1/10-foot difference in head between the upper water-bearing zone and the next deeper sand layer, the vertical gradient would be approximately 0.008 (0.1 foot/12 feet [intervening clay layer minimum thickness]). Berger (1995) estimated the vertical hydraulic conductivity for fine-grained deposits in Desert Valley to be 3×10^{-6} cm/sec. Using an effective porosity of 0.05 for the clay layer (Berger, 1995), if the vertical gradient was upward (the site is likely located in an area of groundwater discharge with an upward gradient), the potential upward groundwater flow velocity would be 0.5 ft/yr. The theoretical minimum transport time for water to flow through the underlying clay layer would be approximately 24 to 40 years. However, due to path tortuosity in clay layers, the actual transport time through the clay layer would likely be longer, due to the greater length of the flow path traveled.

2.1.6 Seismicity

As defined by NAC 444.6793, the site is located within a seismic impact zone, which means the site is located in an area with a 10 percent or greater probability that the maximum horizontal acceleration in lithified earth material will exceed 0.10g in a 250-year period.

Quaternary faults within a 10-mile radius of the site tend to be limited in length (10 km or less), and therefore, these faults have a limited capacity to generate large earthquakes. The nearest Quaternary fault is the Eugene Mountains Fault located approximately 3 miles southeast of the site. The nearest significant fault is the Western Humboldt Range fault zone located more than 20 miles southeast of the site.

Using the 2002 United States Geological Survey (USGS) database, Golder initially estimated the design peak ground acceleration (PGA) to be 0.28g (in bedrock) at the Jungo Disposal Site for an earthquake event with a 10 percent probability of exceedance in a 250-year period. Subsequent to this initial evaluation, the USGS seismic ground motion database was updated in 2008 to include the latest, state-of-the-art relationships between earthquake magnitude, distance from the epicenter, and peak bedrock accelerations. Using the 2008 USGS seismic hazard mapping database, the revised estimated design bedrock PGA for this site is 0.25g.

The Jungo Disposal Site landfill containment systems and environmental controls are designed to withstand an earthquake event resulting in a PGA of 0.25g without compromising the integrity of the containment systems and environmental controls. Section 2.3.4.4 describes these seismic impact evaluations.

2.2 Landfill Capacity and Site Development

2.2.1 Refuse Quantities and Landfill Capacity

The Jungo Disposal Site will serve as a regional disposal site for portions of Northern California and possibly Humboldt County. Although waste from Humboldt County is currently disposed of in the Humboldt County Regional Landfill, should the Humboldt County Commission so desire, the Jungo Disposal Site will accept local waste. Any refuse from Humboldt County will be delivered to the site in refuse hauling trucks. Refuse from Northern California will be delivered to the site by rail. Northern California includes the metropolitan Bay Area, including the nine county San Francisco Bay Area, and including tributary communities along the rail route. The metropolitan Bay Area and the tributary communities along the rail route have a total population of approximately 8 to 9 million. Refuse from Northern California will comprise more than 95% of the waste stream, which is estimated to be up to an average of 4,000 tons/day.

The site will accept only municipal solid waste (MSW). Typically, MSW from Northern California is processed to remove recyclable or compostable materials including selected metals, plastics, and greenwaste. In addition, a screening program exists to remove hazardous waste before it is loaded into waste containers. The screening program is described in the Operating Plan (***Volume III***).

The waste will be comprised of residential, commercial and selected special wastes, which will include construction and demolition (C&D) wastes, and waste tires. Wastes will be containerized for rail delivery to the disposal site. At the point of loading, most wastes will be commingled. Exceptions to commingling can include tires and inerts. No hazardous wastes will be accepted. Specific waste handling procedures have been developed for several of the segregated waste types accepted for disposal. The Jungo Disposal Site will not accept bulky metal waste, medical waste, liquid waste, and sludges.

JLII anticipates that the majority of the waste stream will be comprised of municipal solid waste from residential and commercial sources. The estimated quantities of the MSW and the various special wastes are summarized as follows:

- Residential and Commercial MSW: 70% to 100%
- Contaminated Soils (non-hazardous): 0 to 30%
- C&D Wastes: 0 to 15%
- Tires: 0 to 15%

The quantities of special wastes may vary seasonally depending on the length and size of the disposal contracts. However, residential and commercial MSW is expected to comprise at least 70 percent of the waste stream, and at times, may comprise the entire waste stream.

Figures 11 and 12 illustrate the landfill base grading system and the final refuse fill geometry, respectively. The maximum refuse thickness is 200 feet at the center of the landfill. The maximum refuse height extends approximately 200 feet above the surrounding grades at the center of the landfill.

The disposal volume is approximately 104 million cubic yards. Based on an estimated in place effective density of 1,100 pounds/cubic yard (pcy), the landfill has a refuse capacity of approximately 57.1 million tons. Effective density is defined as the weight of disposed refuse divided by the total volume occupied by refuse and soil cover. For initial planning, it assumed that approximately 600,000 tons of refuse will be disposed annually. Accordingly, this disposal rate would result in a projected life of 95 years. The projected life will decrease as the disposal tonnages increase.

The base grades have been designed to maximize the separation between the bottom of the liner system and groundwater. The minimum separation distance is approximately 24 to 26 feet at the sumps after settlement of the base grades due to the weight of the overlying refuse. The average separation distance will be approximately 37 to 38 feet following base settlement induced by refuse loading (Section 2.3.4.1). Section 2.3 describes the containment systems and controls used to protect the underlying groundwater from potential impacts of leachate and landfill gas.

The excavation will generate a total excavation volume of approximately 13 million cubic yards of soil, of which approximately 6 million cubic yards will be used to construct the liner system and the final cover system. Approximately 7 million cubic yards of soil are available for daily and intermediate soil cover use, which requires a refuse to soil cover ratio of approximately 14:1. As described in the Plan of Operations, measures will be incorporated to limit soil usage for refuse disposal through the extensive use of Alternative Daily Cover (ADC) materials and a reduced soil cover thickness.

2.2.2 Site Development

The site development is illustrated in the landfill design drawings provided in ***Volume II***. The landfill disposal boundary is located 100 feet from the west, south, and east property boundaries. The disposal boundary is located 200 to 300 feet from the north property boundary to allow the development of a rail yard for unloading waste containers.

As shown in ***Drawing 3 (Volume II)***, the landfill will be developed with 10 modules measuring approximately 56 acres each in area, where each module will contain a sump to collect and remove leachate. The site will be developed in phases with phases consisting of the construction of approximately 20 to 30-acres of the base liner. The landfill will also be closed in phases as the site is developed. Drawings 10 through 16 illustrate the landfill development, including base liner, refuse fill, and final cover construction at 2, 10, 25, 50 and 75 years following initial site development. During site development, areas that reach final grade will be allowed to consolidate and settle for a minimum 5-year period prior to final cover construction to reduce post-closure settlement impacts on the final cover. The final closure phase is an exception where the final cover will be constructed within 6-months of the placement of the last refuse shipment.

The Jungo Disposal Site will include the following facilities:

- A rail yard for unloading and loading waste containers;
- An administrative trailer;
- An equipment maintenance shop; and
- A break-room trailer for equipment operators and laborers.

Figure 13 shows the anticipated location of the initial facilities development. The locations of the equipment maintenance shop, and administrative and break-room trailers are anticipated to be temporary and may be relocated on the site as the landfill is developed. Specifically, the equipment maintenance shop and break-room trailer are likely to be periodically relocated near the active disposal area to reduce the travel time for equipment and site personnel.

The administration trailer and break-room will provide potable water and restrooms for site personnel. Wastewater will be discharged to a septic system located at the northwestern boundary of the site. Percolation tests will be completed to properly size and design the septic system.

The landfill perimeter will be bounded by a fence that is located 20 to 70 feet from the outer limits of the refuse disposal area.

2.3 Containment System and Environmental Controls

The Jungo Disposal Site is designed with an extensive system of low-permeability containment layers, high-permeability leachate controls to minimize leachate head on the liner, and a landfill gas collection and disposal system to control landfill gas. The containment system design and environmental controls include the following enhanced landfill gas and leachate control features to provide additional groundwater protection:

A double liner system with primary and secondary leachate collection

- A high capacity leachate collection and removal system LCRS on top of a composite liner system. The high capacity will limit maximum leachate build-up to a fraction of an inch and thereby reduce the leakage potential of leachate.
- Additional pipes will be incorporated in the LCRS system that can be tied to a gas control system. This allows the potential to develop a vacuum on top of the liner to minimize the potential for the migration of landfill gas through the liner.

The following sections describe details of the containment systems and controls, and the engineering analyses used to support the landfill design.

2.3.1 Liner Design and Base Grading

The base liner system consists of a prescriptive composite liner system, in accordance with NAC 444.681, comprised of the following components from top to bottom on the floor of the landfill (see Drawing 4, Volume II):

- 2-foot-thick operations soil layer;
- 1-foot thick gravel blanket for the primary LCRS with a permeability of 1 cm/s or greater;
- central leachate collection piping within each module to provide redundant leachate capacity;
- 16-oz geotextile cushion;
- 60-mil high-density polyethylene (HDPE) primary geomembrane;
- 2-foot thick compacted low-permeability soil liner with a permeability (k) less than or equal to $1x10^{-7}$ cm/s;
- A secondary geocomposite drainage layer for the secondary LCRS; and
- A 60-mil high-density polyethylene (HDPE) secondary geomembrane

On the side-slopes, the base liner system is comprised of the following components from top to bottom:

- 2-foot-thick operations soil layer;
- Geocomposite drainage layer (geonet with geotextile heat-bonded to both sides) for the LCRS;
- 60-mil HDPE primary geomembrane;
- 2-foot thick compacted low-permeability soil liner ($k \leq 1x10^{-7}$ cm/s).
- A secondary geocomposite drainage layer for the secondary LCRS; and
- A 60-mil high-density polyethylene (HDPE) secondary geomembrane

The base grading plan is shown in ***Figure 11***. The landfill will be divided into 10 modules with each module measuring approximately 56 acres each in area. The modules will be oriented in a north-south direction and the base grades are designed to minimize excavation depths and thereby maximize

separation between the top of the composite liner system and groundwater. The floor of the landfill is graded at two percent toward the center of each module. The flowlines within each module extend from a center ridgeline oriented in an east-west direction and slope at a 1 percent grade to the north or south perimeter of the landfill. At the center ridge-line, the high end of the LCRS flow-line is near the existing ground surface. The maximum excavation depth is approximately 32 feet at each sump. Accordingly, the excavation plan results in the following groundwater separation distances immediately following construction (measured between groundwater and the top of the primary geomembrane liner):

- A minimum of 29 feet at the sump locations;
- A maximum of 60 feet at the center of the landfill; and
- An average separation distance of approximately 45 feet.

Based on the subsurface explorations described in Section 2.1.4, a generalized lithologic sequence indicates that the site is underlain by interbedded sands silts and clays. Two relatively low-permeability silt and clay layers were observed in each of the five borings, which appear to be relatively consistent across the site. The upper most silt and clay layer occurs at a depth of approximately 35 feet and 50 feet bgs, and therefore, provides another low-permeability barrier layer between the landfill and groundwater, which occurs at a depth of 59 to 60 feet bgs.

The existing site soils will not meet the permeability requirements for the low-permeability soil liner. Therefore, either suitable clay soils will be imported, or the on-site soils will be admixed with bentonite to produce a soil liner material with a permeability of 1×10^{-7} cm/s or less. Typically, an admixture of 5 to 9 percent of sodium bentonite by dry weight is required to produce a soil material that will meet this permeability requirement. The admixture percentage depends on the initial composition of the soils and the source of the bentonite. For the admix alternative, a bentonite admix design will be completed as part of the final drawings and technical specifications that will be prepared prior to the construction of each liner phase. In addition, construction quality assurance testing requirements will be established to verify that permeability requirements are achieved.

Construction Quality Assurance (CQA) will be completed during the liner construction activities to ensure that the construction complies with the liner design plans and specifications. Following each liner construction project, a certification report will be prepared and submitted to provide documentation that the construction activities were completed in accordance with the design plans and applicable federal and state regulations. A Nevada registered civil engineer will supervise CQA activities and certify the report.

Typical CQA activities will include, but are not limited to the following:

- Verification of the low-permeability soil materials including material quality, thickness, and compaction;
- Verification of the LCRS gravel including material quality and thickness;
- Observation and inspection of the geosynthetic materials for conformance with the engineering plans and specifications;
- Conformance testing of soil and geosynthetic materials;
- Documentation of construction procedures, and identification and resolution of construction problems; and

- Preparation of a CQA report providing documentation that the closure activities and construction complied with the project plans and specifications.

Table 2 summarizes the minimum CQA Plan requirements.

2.3.2 Leachate Collection and Removal System (LCRS)

The landfill liner system design includes a blanket LCRS (***Drawing 4, Volume II***) that has a high hydraulic capacity that is designed to collect leachate while minimizing leachate head build-up on the liner. The maximum leachate head on the liner is estimated to be only a fraction of one-inch, which is considerably less than the 12-inch (30 centimeter) maximum depth allowed by NAC 444.681. The leakage potential of a liner system is reduced by decreasing the potential head build-up on the liner system.

On the floor of the landfill, the LCRS will consist of a one-foot thick gravel blanket with a 6-inch diameter HDPE drainage pipe located on the center of the flow-line of each module (***Drawing 4***). Leachate collected within each module will be conveyed to a 2-foot deep, gravel filled sump measuring approximately 40 feet by 40 feet in plan area. Liquids will be extracted from an HDPE riser pipe using either submersible pumps or a pneumatic pump system.

Based on very conservative estimates of leachate generation, the LCRS on the floor has a factor of safety of more than 200 for hydraulic capacity. Similarly, the side-slope drainage geocomposite drainage layer has a minimum factor of safety of approximately 50 for hydraulic capacity. Section 2.3.4.3 further describes the design hydraulic capacity of the LCRS. The LCRS design is very conservative in that the design leachate generation rates are expected to significantly exceed actual leachate generation rates. Golder's experience with leachate generation in landfills located in arid regions indicates that very little leachate will be generated at the Jungo Disposal Site during operation.

Extracted leachate will be used for dust control over constructed, lined modules. In the event that the collected leachate exceeds the dust control needs, the excess leachate will be re-circulated within the landfill. However, such recirculation volumes are expected to be very small with a negligent impact on the moisture content of the waste or depth of leachate head on the liner.

Leachate pipes will be designed to withstand the weight of the refuse without crushing or buckling. HDPE pipes with a size-dimension ratio (SDR) of 11 or less can readily withstand the loads imposed by 200 feet of refuse.

2.3.3 Landfill Gas Control

A gas control system will be used to collect and dispose of landfill gas. At a minimum, the gas control will comply with Federal New Source Performance Standards (NSPS) and Emission Guidelines and require a Title V Permit (40 CFR Part 70 and NAC 445B) prior to operating the gas controls. Conceptually, the landfill gas system will consist of a system of horizontal and vertical gas wells, HDPE collection and header pipes, and condensate sumps. Initially, landfill gas will be disposed of using flares. A Waste-To-Energy (WTE) system may be used to dispose of gas and generate electricity if such a system is determined to be feasible for the Jungo Disposal Site.

Refuse gas wells will be installed as the refuse is placed, or alternatively drilled into the refuse after refuse placement. Operation of the gas control system will not occur until there is sufficient amount of methane to operate a flare disposal system. For landfills that receive 12 to 20 inches of annual precipitation in the western U.S., this typically requires 1 to 2 million tons of refuse in place and a minimum of 2 to 4 years of decomposition. Due to the arid climate of the Jungo Disposal Site, a longer time period may be required before sufficient gas is generated for flare operations.

As a further groundwater protective measure, perforated gas extraction pipes will be incorporated in the LCRS layer to allow gas withdrawal from above the liner system. This will further reduce the potential of gas migration from the liner system.

2.3.4 Liner Engineering Evaluations

To ensure the liner performs as intended, engineering evaluations described in the following sections were completed to evaluate foundation settlement, slope stability, leachate drainage capacity, drainage, and closure design.

2.3.4.1 Base Settlement

The placement of refuse changes the stresses acting on the foundation soils, which will result in settlement of the soils supporting the liner system for portions of the landfill. This settlement will tend to result in flatter drainage grades along the liner system in the future. The analyses presented in this section evaluate the magnitude of the calculated settlements and the resulting impact on the future drainage capacity of the LCRS.

A conservative settlement model was developed for the initial landfill design. The model used the five general lithologic layers described in Section 2.1.4, and incorporated the thickest observed clay layers. In addition, the model considered soils to a depth of 300 feet. The soils between a depth of 145 feet and 300 feet were modeled to consist of soils similar to that observed in the upper 145 feet.

Foundation settlement calculations included in ***Appendix E*** indicate a maximum settlement of 16 feet in the center of the landfill and 4.5 feet of settlement at the sumps. The resulting post-settlement drainage grades will range from 0.2 to 0.9 percent along the flowlines. Base settlement on the LCRS hydraulic capacities is discussed in Section 2.3.4.3.

Due to the need to maintain positive drainage on top of the liner for leachate control, base settlement is a critical design feature for this landfill. Therefore, additional borings will be completed for each module as described in 2.1.4.2.3. Prior to the final design of each module, additional soil testing will be completed to determine whether the current settlement model is appropriate or requires modification. Appropriate design changes will be implemented if necessary. Potential landfill design modifications may include changes to the drainage grades on top of the base liner or potential changes in the landfill heights. Substantive design changes will be submitted the Nevada Department of Environmental Protection for review and approval prior to implementation.

In addition to evaluating changes to the drainage grades on the liner, the potential impact of the elongation of the liner system on the slope was considered. Assuming zero settlement at the slope crest and 4.5 feet of settlement at the sump, the resulting liner elongation is computed to be 2.3 percent.

Accepted industry standards for textured HDPE geomembranes (GRI-GM13) specifies that these materials include a minimum elongation at yield of 12 percent and elongation at break of 120 percent. Elongation at yield represents the maximum strain under which the liner performs elastically. Prudent design standards limits strains below the yield strains.

The maximum strain of 2.3 percent is more than 5 times lower than the yield strain specified by GRI-GM13. The addition of negligible strains due to seismically-induced permanent displacements (Section 2.3.4.4) to the above relatively low settlement induced strains will result in overall strains that are well below the maximum yield strain for textured HDPE geomembranes.

Settlement monitoring will be completed during filling to verify settlement predictions. The settlement monitoring program will consist of vibrating wire sensor plates installed below the base of the liner

system using the RST vibrating wire liquid level settlement monitoring system or equivalent. This type of instrumentation extends liquid filled tubes between a stationary reservoir at the edge of the landfill to sensor plates placed underneath the landfill. A vibrating wire transducer is used to measure the hydraulic pressure due to the elevation difference between the reservoir and sensor plate. As the landfill base grades settle, the measured hydraulic pressure will increase.

Figure 14 shows the proposed monitoring system array for the first constructed landfill cell located in the northeast corner of the site. Monitoring sensors will be included at intervals of approximately 100 feet along the LCRS flowline where the postconstruction settlements are the most critical as discussed in Section 2.3.4.3. Additional sensors will be included on the floor of the landfill as shown in Figure 14. The monitoring system will be included as part of the final construction plans and specifications provided to NDEP for review prior to construction. The specifications will also include provisions for establishing survey control for reservoir stations.

Settlement monitoring data will be collected at least quarterly during operations. The results of the settlement monitoring will be presented as part of two comprehensive landfill performance reviews as described in the July 2011 Groundwater Protection Evaluation Plan prepared by Golder. These landfill performance reviews will be completed at the end of the construction sequences shown in Drawings 11 and 12 (Volume II). The settlement monitoring will review the actual results to predicted results, confirm whether the results are within predicted parameters, and if necessary, review changes to landfill design in the event the initial settlement measurements are greater than those predicted. This will allow design changes, such as reducing the final grading height, to be made prior to the development of adverse drainage grades.

2.3.4.2 Slope Stability

Slope stability evaluations were completed to verify adequate stability under static and design seismic conditions. The primary failure mode of concern is the potential failure along the liner system, which generally has relatively low interface shear strengths. Potential failure of the underlying foundation soils was also considered.

Slope stability was evaluated using the computer program SLIDE (V. 3.047), which uses a two-dimensional method of slices and limit equilibrium methods to calculate factors of safety. The program was used to search for the failure plane with the lowest factor of safety.

Key assumptions common to the foundation and refuse slope stability analyses are summarized below.

- The shear strength of the refuse was modeled by a linear failure envelope represented by an internal angle of friction of 30 degrees and a cohesion of 200 pounds per square foot (psf), which is within the range of refuse strength parameters reported by Singh and Murphy (1990). These parameters are close to the values recommended by Kavazanjian (2001), which presents a refuse shear strength model with an internal friction angle of 33 degrees with a minimum shear strength of 500 psf.

- The unit weight of the total waste fill mass was assumed to be 70 pcf, which is a typical value for the unit weight of the refuse. Total weight is higher than effective density because it includes the weight of cover materials. This unit weight is conservative for a site that will extensively use ADC to minimize soil cover use.

- The critical liner interface is expected to occur between the compacted clay and textured HDPE geomembrane or compacted clay/geocomposite drainage layer. The design interface shear strength was assumed to be defined by an effective friction angle of 12 degrees with no cohesion. Based on Golder's experience in performing interface shear strength tests on liner materials, this design interface shear strength is expected to be conservative. Interface direct shear strength testing will be completed once the low-permeability soils are identified as part of the final liner design plans. Interface direct shear testing will be completed as part of the Construction Quality Assurance Program to ensure that the minimum design liner interface shear strength is achieved.

- Seismic stability was initially evaluated using the simplified seismic design procedure developed by Bray et. al. (1998) and assuming a design PGA value of 0.28g for bedrock. Additional analyses were subsequently completed using the updated PGA estimate of 0.25g and a more rigorous approach to model ground motions within the landfill as discussed in Section 2.3.4.4 and Appendix K.

- The underlying sands were assumed to have a shear strength corresponding to a friction angle of 30 degrees. The low plasticity clay was assumed to have a friction angle of 27 degrees based on the result of laboratory testing. The highly plastic clay was assumed to have a friction angle of 20 degrees based on the results of laboratory testing.

- The underlying clays were assumed to be drained during loading. Preliminary analyses indicate that the clays will reach 80 percent consolidation within 4 years of loading. Therefore, the development of excess pore pressures should be negligible.

Appendix F includes the results of the slope stability analyses. For potential failure along the liner, a static factor of safety of 1.9 was computed, and permanent seismically induced displacements were calculated to be less than 1 inch. Displacements of up to 6 to 12-inches along the liner system are generally accepted as being within the tolerance limits of liner systems without resulting in adverse damage.

Potential failure of the foundation soils is not a critical failure mode since the shear strengths of the native soils are considerably higher than the assumed liner interface shear strength.

2.3.4.3 Leachate Generation and LCRS Capacity

A very conservative leachate generation model was developed to conservatively size the hydraulic capacity of the LCRS. A conservative approach was used to provide an additional level of environmental protection relative to leachate management.

The model was developed using the computer program Hydrologic Evaluation of Landfill Performance (HELP). ***Appendix G*** includes details on the HELP modeling for the Jungo Disposal Site. The conservatively developed HELP model estimates a peak leachate generation rate of 75 gallons/acre/day (gpad) for the Jungo Disposal Site. This estimated leachate generation rate is very high for an arid site with only 8-inches of average annual precipitation. This level of leachate generation is comparable to modern, composite-lined landfills in Northern California with an average annual average precipitation of 25 to 30 inches. Golder's experience with landfills in arid regions is that they produce very limited to no leachate. The proposed Rawhide Landfill in Nevada, which is located in an area with approximately 6-inches of annual precipitation, estimated no leachate production.

The design of the LCRS consists of a high permeability gravel blanket draining a 2 percent grades toward perforated HDPE collection pipes. The HDPE pipes drain at a one percent grade toward the perimeter of the landfill.

The impact of base settlement is most severe in a direction perpendicular to the refuse slopes, which is in a direction parallel to the LCRS collection pipes. The settlement calculations indicate a post-settlement grade of approximately 0.2 percent along these pipes. Settlement impacts along the floor grades toward the LCRS pipes will be considerably less since the differential stresses and resulting differential settlements are less in the flow direction along the floor toward the pipes and the initial base grades along the flow will be 2 percent.

The table below summarizes the results of capacity and head predictions on the floor of the landfill draining toward the LCRS pipes and along the LCRS flowline. The critical portion of the drainage grades occurs along the outer 450 feet of the landfill where the greatest amount of differential loading occurs over the shortest distances.

Hydraulic Capacity Calculation Summary

LCRS Location	Before Settlement			After Settlement		
	Slope	Factor of Safety	Max. Predicted Head (Inch)	Slope	Factor of Safety	Max. Predicted Head (inch)
Landfill Floor	2.0%	450	0.02	1.5%	340	0.04
LCRS Flowline	1.0%	115	<6	0.2%	50	<6

Supporting calculations are summarized in Appendix G.

Given potential base settlement and the maximum leachate generation rates, the resulting factor of safety values and predicted maximum leachate head on the liner far exceeds minimum regulatory requirements. In addition, the peak leachate head depth on the landfill floor liner is estimated to be less than 0.1 inch.

2.3.4.4 Seismic Impact Evaluation

Appendix K includes a discussion of the seismic impact evaluations. These evaluations included the following:

- Permanent seismically induced displacements estimated to be zero to 0.6 inches, which is more than 10 times lower than the maximum allowable permanent seismically-induced displacement of 6 to 12 inches. The currently accepted practice for landfill liner design generally limit permanent displacements to 6 to 12 inches along landfill base liners. Permanent displacements within 6 to 12 inches are not expected to adversely compromise the liner integrity, leachate collection and removal system, or other environmental controls.
- A preliminary liquefaction assessment was completed using available data. The computed factor of safety against liquefaction is computed to be greater than 1.0. In most cases, the factor of safety is significantly larger than 1.0. These calculations in conjunction with the relatively high standard penetration test blow counts for silty sands and sandy silts, depth of

groundwater, and high vertical stresses imposed by the landfill indicate that liquefaction is unlikely at the Jungo Disposal Site.

As part of the more detailed subsurface drilling program discussed in Section 2.1.6, additional liquefaction analyses will be completed to confirm that liquefaction potential is negligible.

2.3.4.5 Drainage Controls During Operations

Drainage controls will be implemented during site development to control surface water run-on and run-off. Surface water run-on will be prevented by the following measures:

- A 4-foot high perimeter berm will be constructed to prevent run-on from shallow (6-inch to 12-inch) ponding that may occur locally following intense thunderstorms. The perimeter berm will be constructed in phases concurrent with landfill development. Details of the phased construction of the perimeter berm are located in Section 2.4.
- Temporary retention basins will be located adjacent to module excavations to collect precipitation that occurs within the landfill excavation footprint. Water will be pumped from the temporary basin to the perimeter of the landfill. Drawing 10 illustrates an example of such a basin.

Surface water run-off will be controlled by ditches and down-drains that will be sized to accommodate a 25-year, 24-hour storm event in accordance with NAC 444.6885. A shallow ditch will be included around the perimeter of the site. The perimeter ditch will promote the accumulation of water until it exceeds the ditch depth and sheetflows westward to the surrounding grades where it will accumulate in shallow depressions until it evaporates or infiltrates into the underlying soil.

2.3.5 Closure Design

The prescriptive cover system (NAC 444.6891) requires a minimum 6-inch thick erosion layer underlain by minimum 18-inch thick infiltration layer. In addition, the permeability of the cover shall be equal to or less than $1x10^{-5}$ cm/s or less than the permeability of any component of the bottom liner, whichever is less.

A final cover system will be constructed over the waste at the Jungo Disposal Site as part of the closure activities. The final cover system is a prescriptive cover, in accordance with NAC 444.6891) consisting of the following components (***Drawing 8, Volume II***):

- A minimum 2-foot thick vegetative soil layer;
- A geocomposite drainage layer;
- A 60-mil HDPE geomembrane layer (textured on both sides); and
- A one-foot thick foundation layer.

The Jungo Cover System uses a vegetated, 2-foot thick erosion layer in place of the minimum 6-inch thick erosion layer. In addition, a geocomposite drainage layer, 60-mil HDPE geomembrane and a one-foot thick foundation layer are substituted for the minimum 18-inch thick infiltration layer. These modifications are necessary to result in a cover system that is no more permeable than the bottom liner in accordance with NAC 444.6891(a) (i.e. install low-permeability geomembrane component) and to establish an erosion resistant layer over the geomembrane layer that is capable of supporting the growth of native plants per NAC 444.6891(b).

The above cover system provides a low-permeability barrier that has permeability less than or equal to the base liner system. HELP modeling of the cover system indicates that a negligible amount of water will infiltrate through the cover. HELP analyses for the closed conditions are summarized in ***Appendix G***.

The Jungo Disposal Site will pursue an alternative Evapotranspirative (ET) final cover design once the landfill is in operation. An ET cover typically consists of 3 to 5 feet of soil that stores infiltration and then releases it through evapotranspiration. Based on Golder's experience with ET covers, the site climate and soil types appear suitable for an effective ET cover system. The alternative ET cover design will include supporting soil laboratory testing and unsaturated flow modeling. If the modeling results indicate that ET cover is equivalent or superior to the prescriptive cover system, then a field trial will be constructed on portions of the landfill that have achieved final grades. A work plan detailing the laboratory testing, modeling, and field trial program will be prepared and submitted to NDEP for review and approval.

2.3.5.1 Final Cover Grading

Figure 12 shows the final cover grades for Jungo Disposal Site landfill. The final cover grades reach a maximum elevation of 4,172 feet mean sea level (msl) and maintain a maximum side-slope inclination of 4H:1V (horizontal to vertical). To facilitate drainage and minimize erosion, 25-foot wide benches are incorporated into the side-slopes a maximum of every 50 feet vertically. The top surface will be graded at 5 percent to accommodate postclosure refuse settlements and maintain positive drainage.

2.3.5.2 Erosion

Final landfill slopes will be inclined no steeper than 4H:1V. Minimum final surface slopes will be 5 percent. To mitigate potential wind and water erosion, the vegetative layer thickness was increased from one foot to two feet.

As part of the closure activities, the integrity of the final site face will be maintained by the placement of a vegetative layer to provide erosion control. A Revegetation Plan is attached to this Report of Design in ***Appendix L***.

A surface water erosion analysis was completed for the slopes using the Revised Universal Soil Loss Equation program, RUSLE Version 1.06 (United States Office of Surface Mining and Reclamation, 1998). The analysis conservatively assumes that the cover is poorly vegetated although the cover will be properly vegetated with suitable desert grasses. The results of the conservative analyses indicate an estimated maximum soil loss for the proposed final grades of 0.03 inches/year which is less than an average of approximately 1–inch over a 30 year postclosure period. The surface water erosion soil loss analysis is presented in ***Appendix H***.

Wind erosion was also evaluated for the Jungo Disposal Site. Golder consulted with wind erosion specialists working for the United States Department of Agriculture, Natural Resource Conservation Service (NRCS), Wind Research Unit. Because of the complexity of wind erosion calculations, which were primarily developed for agricultural applications, NRCS staff recommended the use of Single-Event Wind Erosion Evaluation Program (SWEEP, Ver. 1), which is a part of the Wind Erosion Prediction System (WEPS). WEPS is a process-based, continuous, daily time-step model that simulates weather, field conditions, and erosion.

Using SWEEP, wind erosion is estimated to be negligible if the Leaf Area Index (LAI) is less greater than approximately 0.3. The desert vegetation for closure is estimated to have an LAI that will vary seasonally from 0.2 to 0.4. Conservatively assuming an LAI value of 0.2 is representative of half of the year, Golder conservatively estimated that the annual soil erosion for the final cover would be less than 0.15 inches per year, or less than 4.5 inches over a 30-year postclosure period. If the LAI is 0.3 or greater, the estimated annual soil loss due to wind erosion is estimated to be negligible. The wind erosion soil loss analysis is presented in ***Appendix H***.

2.3.5.3 Postclosure Cover Settlement

Settlement analyses were performed to evaluate the impact of postclosure settlement on the final cover grades. Refuse settlement typically exhibits a large, rapid, initial settlement rate referred to as primary settlement, which is followed by a long-term, progressively decreasing, settlement rate that is referred to as secondary settlement. Primary settlement generally occurs within weeks to months of the initial refuse placement. However, secondary settlement occurs for many years as waste materials decompose and compress.

The calculated postclosure settlements assume that primary settlements are complete prior to closure, but secondary settlements will continue throughout the entire 30-year postclosure monitoring period. As indicated in ***Appendix I***, the postclosure grades following settlement will be greater than three percent, which is sufficient to promote positive drainage from the cover.

2.3.5.4 Cover Veneer Slope Stability

The stability of the cover system considers the potential occurrence of a failure within the final cover components. This failure mode is primarily a function of the interface strengths of the cover materials and the maximum final slope inclinations. Static stability analyses were completed using an infinite slope analysis and verified by the computer program XSTABL (v. 5.2.02). Yield accelerations were determined using the computer program XSTABL (v. 5.202). XSTABL uses two-dimensional, limit-equilibrium methods to evaluate stability.

Evaluation of the stability of the cover components was based on the following assumptions:

- The maximum cover grade was assumed to be 4H:1V (maximum slope in between benches). Following closure, settlement will reduce the slope height and inclination, which will tend to increase slope stability with time;
- The critical interface occurs between either the vegetative soil layer/geocomposite drainage layer or the geocomposite/textured geomembrane layer. Based on a shear strength data base prepared by Golder's Geosynthetics Laboratory (***Appendix F***), the critical shear strength parameters were assumed to be represented by an internal friction angle of 23 with no adhesion. At low normal loads, the interface shear strength between the textured geomembrane and underlying low-permeability soil layer is expected to be greater than 23 degrees based on Golder's data base.
- The simplified seismic design procedure by Bray et. al. (1998) was used to estimate seismic displacements for the cover system using the initial design PGA of 0.28g developed based on the USGS database. As discussed in Section 2.1.6, the design PGA has been revised to a lower value of 0.25g based on updated USGS seismic hazard mapping database.

The factor of safety for static conditions is calculated to be 1.7 (***Appendix F***). The results for the design seismic loading conditions indicate seismically induced permanent displacements of less than 4-inches. Based on current engineering practice, a maximum allowable seismically induced permanent displacement of 6 to 12 inches is acceptable for modern, geosynthetic landfill covers located in a seismic impact zone.

2.3.5.5 Surface Water Controls

Surface water controls will be installed on the final cover system to control surface water run-off and minimize erosion of the cover system. Drawing 7 illustrates a conceptual surface water drainage plan for the Jungo Disposal Site at closure. Surface water will be controlled by ditches on the slope benches, berms on the top-deck of the landfill, and down-drains along the side-slopes. All surface water controls are sized to accommodate the 25-year, 24-hour storm event (NAC 444.6885).

During site development, surface water will be managed as follows:

- Surface water run-off from active disposal areas will be directed to the interior sides of the landfill to temporary stormwater basins where it will be pumped to a temporary, lined, storage impoundment. The water will be sampled from the lined impoundment, and if free of waste constituents, it will be discharged to a run-on/run-off control basin where the water will be stored until it evaporates or infiltrates into the subsurface soils. A copy of the sampling results will be provided to the Nevada Department of Wildlife for review. If the water is impacted, it will be retained in the pond until it can be used as dust control over lined areas of the landfill footprint and/or evaporated within the basin.

- Surface water run-off from the permanent exterior slopes will be directed to a broad (28- to 30-foot wide), shallow perimeter ditch. The ditch ranges from 2 to 6 feet in depth and drains gradually to a stormwater run-on/run-off control basin where the water will evaporate or infiltrate into the subsurface soils.

Drawings 10 through 14 illustrate the above basin controls. For illustration purposes, the temporary lined basin and run-on/run-off control basin are shown in the southwest corner near the end of site development. During initial development these basins may be temporarily located closer the disposal operations and then relocated periodically in a southwesterly direction as the site development progresses. At closure, the liner for the temporary lined basin will be removed and disposed of in the landfill and then basin regarded to incorporate it as part of the final run-on/run-off control basin.

If ongoing sampling of the surface water from the temporary, lined basin indicates that the site operations are managed such that surface water consistently is not impacted by waste constituents, then JLII will propose, for NDEP's review and approval, the reduction of the frequency of sampling and testing or the elimination of the sampling and testing.

In the event that surface water in the temporary basin is impacted by waste constituents, JLII will investigate and evaluate the source(s) of the impacts. This will include, but not limited to, identifying and promptly repairing any erosion rills that expose refuse and allow contact between refuse and surface water and/or leachate seeps that may be commingling with surface water. If the Nevada Department of Wildlife determines that water impoundments may lead to wildlife mortality then an Industrial Artificial Pond Permit (IAPP) will be obtained. The temporary basin will be designed to accommodate a minimum 25-year, 24 hour storm event (1.62-inches).

At final build-out, the surface water run-off from the 25-year, 24 hour storm event is estimated to be 22 acre feet. The storage capacity of the final run-on/run-off control basin and perimeter ditches is

approximately 37 acre-feet, which will accommodate more than a 25-year, 24-hour storm events while maintaining a minimum freeboard of one foot. More than two back-to-back 25-year storm events are required to result in an off-site stormwater release. ***Appendix J*** includes the stormwater calculations.

2.4 Phased Construction Of The Perimeter Berm And Surface Water Controls

Additional information on the phased construction of the perimeter berm and surface water controls for the JDS are provided in the following sections. Section 2.4.1 provides design considerations and design details for the construction of the run-on control berm. Section 2.4.2 presents the construction phasing details.

2.4.1 Run-on control berm

The topography at the JDS is relatively flat. In the vicinity of the JDS, shallow depressions cause temporary ponding of water during large storm events or significant snowmelt. This temporary ponding is typically 6 to 12 inches or less in depth, although ponding may reach depths of approximately 2 feet in localized areas. To mitigate surface water run-on to the landfill, a perimeter berm will be constructed to minimum elevation of 4180 feet mean sea level (msl), which is approximately 5 feet above the existing ground surface.

Design considerations for the perimeter berm include the following:

- Seepage rate through the berms
- Erosion of the perimeter berm soils

These design considerations are discussed in the following sections.

2.4.1.1 Seepage Rate

Water may seep through the perimeter berm toward the landfill under extended periods of ponding. However, the rate of seepage is expected to be relatively low and easily manageable based on the following:

- Seepage through the berm is directly proportional to the seepage gradient through the berm, which is relatively low for the JDS. The seepage gradient is controlled by the height of ponding and seepage travel distance through the berm. For ponding depths of 2 feet and a berm cross-section greater than 60 feet in width, the seepage gradient is expected to reach a maximum of approximately 0.02 to 0.03. Figure M1a shows a typical section through the perimeter berm.
- Seepage is also directly proportional to the permeability of the berm soils. As indicated in Section 2.1, the upper soils at the JDS contain a significant quantity of fines (i.e. silt and clay sized fraction). Based on Golder's experience with similar soils, the berm soils are expected to exhibit permeabilities of between 5×10^{-6} cm/s to 1×10^{-4} cm/s, which is sufficiently low to limit seepage to easily management volumes.

Using a permeability of 1x10-4 cm/s for the berm soils, Golder estimates that a preliminary seepage rate of approximately 0.1 gallons per minute (gpm) for each 1,000 lineal feet of berm. If the permeability of the berm soils were 10 times greater than anticipated, the seepage rate would be 1 gpm per 1,000 lineal feet of berm. This rate of seepage could be easily managed by pumps.

Shallow ditches will be constructed on the landfill side of the berms to collect any seepage through the berm. Seepage will be collected in localized sumps consisting of an excavated shallow depression where water will be pumped back outside the berm.

Although additional mitigation measures are not expected to be necessary, relatively simple measures could be implemented to further reduce seepage volumes through the berm. Figure M1b shows a low-permeability vertical barrier consisting of low-permeability clay or grout that could be installed through the berm to further reduce seepage rates.

2.4.1.2 Erosion

The design of the perimeter berm needs to consider potential impacts due to wind and wave erosion. To mitigate wind erosion, the perimeter berm will be surfaced with a compacted aggregate base to a minimum depth of 6-inches. This aggregate base material, which will be the same material used for surfacing site access roads, will be extended down the side slopes of the berm.

The development of wave erosion protection measures usually involves the estimate of wave height. Current methods for estimating wave height are based on relatively deep water (i.e. deeper than 5 feet). In deep water, wave height is a function of the wind speed and fetch length, where fetch is the distance the wind blows across a water body. In shallow water, friction between the base of the wave and the bottom of the surface water basin, as well as the depth of water, provide significant physical limits to the wave height regardless of the wind speed or fetch length. For the JDS, Golder considers a wave height of 12-inches to be relatively conservative for ponding depths that are typically 12-inches or less with only localized ponding of up to 2 feet.

Accordingly, wave erosion potential will be mitigated by placing riprap along the lower portion of the berm. The riprap will have a Median particle size of 6 inches and will be placed to a thickness of 1 foot. As a conservative measure, this riprap will be extended to Elevation 4178 feet on the outer portion of the berm, which corresponds to height of approximately 3 feet on the outside edge of the berm.

Monitoring will be completed during operations of the landfill to confirm that the above erosion protection measures are functioning as intended. If signs of erosion are observed, then appropriate corrective actions will be completed, which may include increasing the size, height, or depth of riprap.

2.4.1.3 Perimeter Berm Construction Details

Based on the information presented in Sections 2.4.1.1 and 2.4.1.2, Figure 2 shows the design section of the berm that incorporates the following seepage and erosion controls:

- A shallow ditch will be constructed on the interior side of the berm that will direct seepage water toward temporary collection sumps.
- Prior to berm construction, permeability tests will be run on representative soil samples to characterize the permeability of the berm soils.
- The soils will be compacted to a minimum relative compaction of 90 percent per ASTM D1557 and exhibit a permeability of 1x10-3 cm/s or less. In the event that the soils have a permeability greater than 1x10-3 cm/s, the berm will be constructed with a cut-off barrier with a permeability of 1x10-6 cm/s or less using the concept shown in Figure M2.

- Aggregate base will be extended on the side-slopes and riprap constructed on the lower 3 feet of outer berm.

2.4.2 Phased Construction Sequencing

As discussed in the Report of Design (Volume I), the perimeter berm and surface water basins may be constructed in phases or the final berm and ponds may be constructed at the beginning of the project. The Design Drawings (Volume II) simplistically show the final perimeter berm and surface-water control ponds in the construction sequencing plans. The drawings in Appendix M illustrate the phased construction of run-on and run-off controls.

The decision on whether to construct the final surface water run-on and run-off controls or phase the construction as part of the initial landfill development will be made during the preparation of construction level plans and specifications that will be submitted for NDEP approval. This decision will be made based on potential construction timing constraints and cost evaluations that compare short-term construction costs and total life-cycle construction costs. Phasing the surface water controls will reduce short-term construction costs, but may result in greater total life cycle construction costs as temporary controls are removed and reconstructed several times throughout the site development.

The Drawings in Appendix M illustrate the phased construction approach for the 10-year construction sequencing plans. Appendix M, Drawing 1 shows an overview of the estimated landfill footprint at the end of 10 years and 25 years. Appendix M, Drawings 2 and 3 provide details showing the temporary and permanent storm-water controls for the 10-year and 25-year development sequence, respectively. Drawing 5 of the Design Drawings (Volume II) shows the final storm-water controls at the completion of the landfill development.

Appendix M, Drawing 1 (10-Year Development Sequence) incorporates the following features:

- A perimeter berm measuring approximately 10,600 feet in length. The north and east sides of the berm would be permanent, whereas the south and west sides would be temporary.

- Small storm-water sumps will be constructed adjacent to the bottom of the landfill module excavation to allow collection of surface water that will be pumped to a temporary lined basin, where it will be sampled and tested prior to discharge to a temporary unlined basin.

- Water from the unlined-basin will be stored until it infiltrates, evaporates, or is extracted for use in dust control.

Appendix M, Drawing 2 (25-Year Development Sequence) incorporates the following features:

- A perimeter berm measuring approximately 15,400 feet in length. The north and east sides of the berm would be permanent, whereas the south and west sides would be temporary.

- Small detention basins would be constructed adjacent to the bottom of the landfill module excavation to allow collection of surface water that will be pumped to a temporary lined basins, where it will be sampled and tested prior to discharge to a temporary unlined basin.

- Water from the unlined-basin will be stored until it infiltrates, evaporates, or is extracted for use in dust control.

The above concepts illustrate how the temporary controls would be developed at two specific time frames during the landfill development. This same approach would be used throughout the site development until the final storm-water controls are completed.

3.0 REFERENCES

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TABLE 1
EARTHWORK BALANCE

Item	Quantity (cy)
1. Excavation[1]	13,500,000
2. Berms	200,000
3. Liner	
a. Clay Liner	1,813,387
b. Operations Layer	1,813,387
Subtotal	3,626,773
4. Final Cover Construction	
a. Foundation Layer	906,693
b. Vegetative Soil Cover	1,813,387
Subtotal	2,720,080
5. Soil Available For Daily Cover	6,953,147
6. Landfill Volumes[2]	
a. Gross Volume	111,100,000
b. Net Volume	103,846,453
c. Daily Soil Cover Volume at 14:1[3]	6,923,097

Notes

1. Includes an average expansion factor of 10%.
2. Gross Volume from top of cover to bottom of liner
   Net Volume = Gross Volume minus cover and liner volume (include 900,000 cy for LCRS)
3. Daily Soil Cover Volume of 14:1 requires extensive use of ADC materials.

TABLE 2
CQA PLAN REQUIREMENTS

1.	A delineation of the CQA management organization, including a chain of command
2.	A detailed description of the level of experience and training of the contractor, work crew, and CQA inspectors.
3.	Description of the CQA testing protocols
4.	CQC manufacturer data on all geosynthetics utilized
5.	CQA documentation requirements
6.	Subgrade inspection and testing procedures including compaction testing frequency.
7.	Low-hydraulic-conductivity soil layer inspection and testing procedures and frequencies including field and laboratory testing. At a minimum include field compaction testing, permeability testing (field and/or laboratory), and laboratory testing for particle-size distribution, Atterberg limits, soil classification, and Proctor compaction.
8.	LCRS layer inspection and laboratory testing procedures and frequencies. At a minimum include laboratory testing for permeability, particle-size distribution, and soil classification.
9.	Operations layer inspection and laboratory testing procedures and frequencies. At a minimum include laboratory testing for particle-size distribution.
10.	Geosynthetic layers (geomembrane, geotextiles, and geocomposites): • Preconstruction quality control program • Conformance testing procedures and frequencies • Inspection of subgrade surface • Inspection of placement • Seam testing procedures and frequencies for geomembranes • Inspections of installation of anchors and seals

Table 2
Monitoring Well Construction Details

Well Designation	Ground Surface Elevation	Well TOC Elevation	Borehole Diameter	Well Casing Diameter	Total Depth of Boring	Well Casing Length	Screened Interval	Sand Pack Interval	First Encountered Water	Depth to Water (4/7/07)	Geologic Unit Monitored
	(Ft-MSL)	*(Ft-MSL)*	*(inches)*	*(inches)*	*(Ft-BGS)*	*(feet)*	*(Ft-BGS)*	*(Ft-BGS)*	*(Ft-BGS)*	*(from TOC)*	
MW-1	4,175.26	4,177.78	8	2	103	83	59 - 79	55 - 84	60	62.45	Sand, Silty sand/Sandy silt
MW-2	4,175.23	4,177.74	8	2	102	83	60 - 80	55 - 80	68	61.29	Sand, Silty sand/Sandy silt
MW-3	4,174.84	4,177.04	8	2	103	80	66 - 76	64 - 88	60	62.53	Silty clay/Clayey silt
MW-4	4,176.96	4,179.15	8	2	102	83	60 - 80	58 - 90.5	60	63.18	Sand

Notes:

Ft-MSL - Feet, mean sea level

Ft-BGS - Feet, below ground surface

TOC - Top of well casing

TABLE 3
MEASURED GROUNDWATER DEPTH SUMMARY

Location	Measurement Date	Ground Surface Elevation (ft msl)	Depth to Groundwater (ft)	Groundwater Elevation (ft msl)
MW-1	2/1/2007	4,175.26	59.96	4,115.30
MW-2	2/1/2007	4,175.23	58.87	4,116.36
MW-3	2/1/2007	4,174.84	60.44	4,114.40
MW-4	2/1/2007	4,176.96	61.06	4,115.90

Table 3
Monitoring Parameters and Methods

Sample Designation Sampling Date	Recommended Method
Field Parameters	
pH	150.1 (field)
Specific Conductance	120.1 (field)
Turbidity	180.1 (field)
General Monitoring Parameters	
Alkalinity, bicarbonate	EPA 310.1
Alkalinity, carbonate	EPA 310.1
Chloride	EPA 300.0
Nitrate/Nitrite as N	EPA 353.2
Sulfate	EPA 300.0
Total Dissolved Solids	EPA 160.1
Calcium, dissolved	EPA 6010
Magnesium, dissolved	EPA 6010
Potassium, dissolved	EPA 6010
Sodium, dissolved	EPA 6010
Total Metals, Appendix I List	
Antimony	EPA 6020
Arsenic	EPA 6020
Barium	EPA 6010
Beryllium	EPA 6010
Cadmium	EPA 6020
Chromium	EPA 6010
Cobalt	EPA 6010
Copper	EPA 6010
Lead	EPA 6020
Nickel	EPA 6020
Selenium	EPA 6020
Silver	EPA 6010
Thallium	EPA 6020
Vanadium	EPA 6010
Zinc	EPA 6010
Organic Compounds	
Volatile Organic Compounds, Appendix I List	EPA 8260

TABLE 4
CLOSURE COST ESTIMATE

INITIAL 25-ACRE CELL

Item	Unit	Unit Cost	Quantity	Total
1. Final Soil Cover[1]				
a. Foundation Layer	cy	$ 3.00	82,000	$ 246,000
b. Compacted Clay	cy	$ 25.00	41,000	$ 1,025,000
b. Vegetative Layer	cy	$ 3.00	82,000	$ 246,000
2. Geosynthetic Layers[1]				
a. Geomembrane (60 mil HDPE)	sf	$ 0.70	1,100,000	$ 770,000
b. Geocomposite drainage layer	sf	$ 0.70	1,100,000	$ 770,000
3. Design/CQA				
a. Design, plans, specifications	ls	$ 50,000	1	$ 50,000
b. CQA	acre	$ 5,000	25.3	$ 126,263
4. Revegetation	acre	$ 1,000	25.3	$ 25,253
5. Gas Control		$ -	-	$ -
6. Drainage Structures				
a. CMP and drop inlets	lf	$ 25	800	$ 20,000
b. V-ditches	lf	$ 2	800	$ 1,600
7. Closure Survey, Settlement Monuments	ls	$ 2,500	1	$ 2,500
			Total	$ 3,282,615

Notes
1. Cover Profile - 2 Ft Foundation L; 1 Ft Clay, Geomembrane, Geocomposite, 2 Ft Vegetative Layer.
2. Active gas control not required for initial cell.

MAXIMUM PROJECTED CLOSURE AREA - 205 ACRES

Item	Unit	Unit Cost	Quantity	Total
1. Final Soil Cover[1]				
a. Foundation Layer	cy	$ 3.00	661,467	$ 1,984,400
b. Compacted Clay	cy	$ 25.00	330,733	$ 8,268,333
b. Vegetative Layer	cy	$ 3.00	661,467	$ 1,984,400
2. Geosynthetic Layers[1]				
a. Geomembrane (60 mil HDPE)	sf	$ 0.50	8,929,800	$ 4,464,900
b. Geocomposite drainage layer	sf	$ 0.58	8,929,800	$ 5,179,284
3. Design/CQA				
a. Design, plans, specifications	ls	$ 100,000	1	$ 100,000
b. CQA	acre	$ 5,000	205.0	$ 1,025,000
4. Revegetation	acre	$ 1,000	205.0	$ 205,000
5. Gas Control				
LFG Control System	/ac	$ 15,000	205.0	$ 3,075,000
Flare and upgrades	ea	$1,000,000	1.0	$ 1,000,000
6. Drainage Structures				
a. CMP and drop inlets	lf	$ 25	7,000	$ 175,000
b. V-ditches	lf	$ 2	20,000	$ 40,000
7. Closure Survey, Settlement Monuments	ls	$ 10,000	1	$ 10,000
			Total	$ 27,511,317

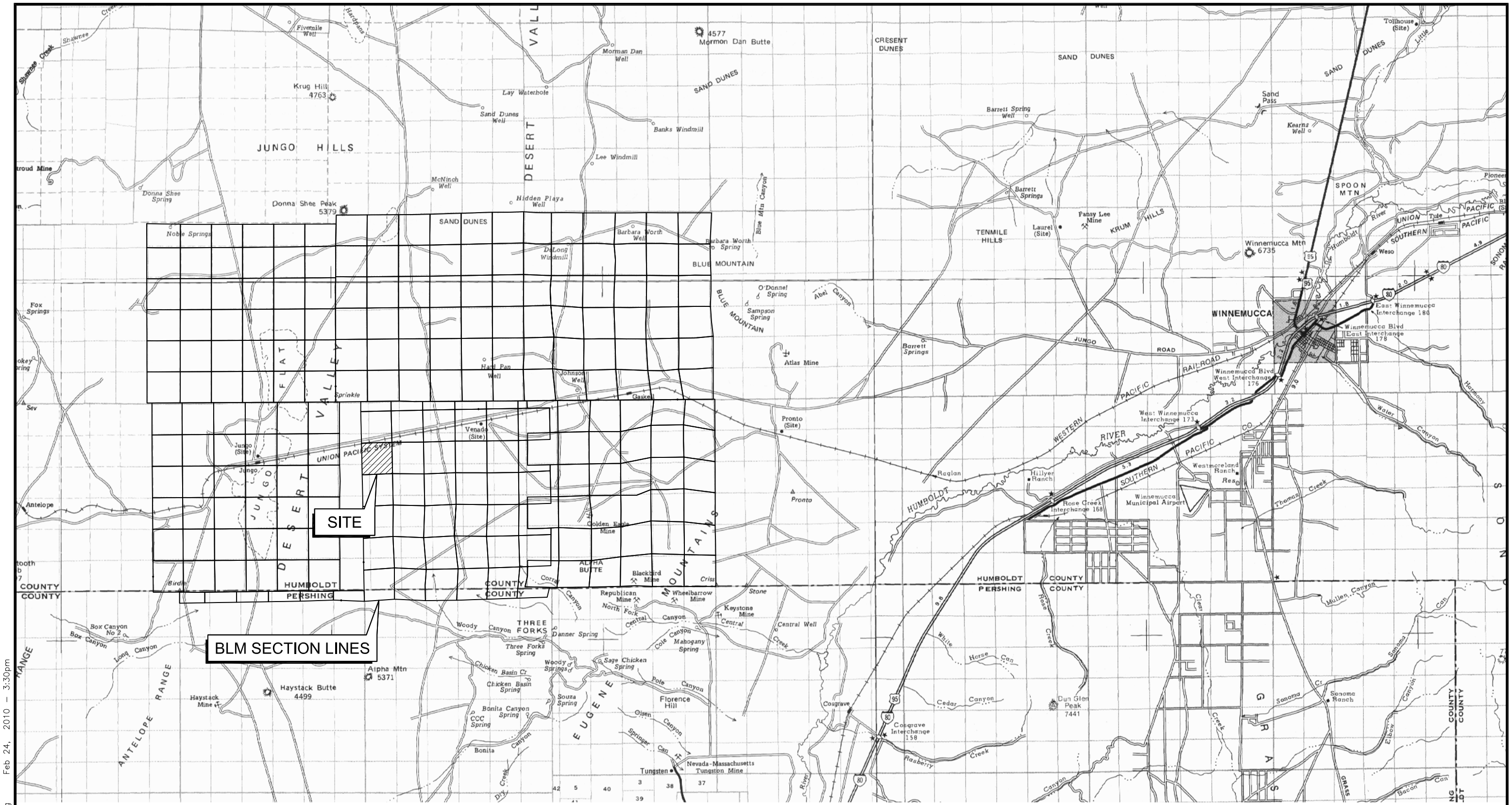
Notes
1. Cover Profile - 2 Ft Foundation L; 1 Ft Clay, Geomembrane, Geocomposite, 2 Ft Vegetative Layer.
2. Includes additional flare installed for closure. Other flares assumed to be installed during operations.

TABLE 5
POST-CLOSURE MONITORING AND MAINTENANCE COST ESTIMATE

Item	Unit	Unit Cost	Annual Quantity	Total
1. Vegetation Maintenance	acre	$ 250	55.0	$ 13,750
2. Leachate - Sampling and Testing, O&M	annually	$ 5,000	1	$ 5,000
3. Landfill Gas Monitoring/Maintenance	annually	$215,000	1	$ 215,000
5. Groundwater Monitoring/Maintenance	annually	$ 50,000	1	$ 50,000
6. Surface Water Monitoring/Maintenance	annually	$ 5,000	1	$ 5,000
7. Drainage/Cover Maintenance	annually	$125,000	1	$ 125,000
8. Security Maintenance	annually	$ 1,000	1	$ 1,000
9. Inspections	annually	$ 2,000	1	$ 2,000
				$ -
			Total Annual Cost	$ 416,750
			Annual Cost/acre	$ 738
			Total Annual Cost x 30 yrs	$12,502,500

Notes

1. Postclosure costs are projected at full build-out.



NOTE

1. MAP IMAGE OBTAINED FROM NEVADA DOT MAP ATLAS 30' SERIES (METRIC). DATE OF MAPS: 1980, 1987.

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W E
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3 0 3
SCALE MILES

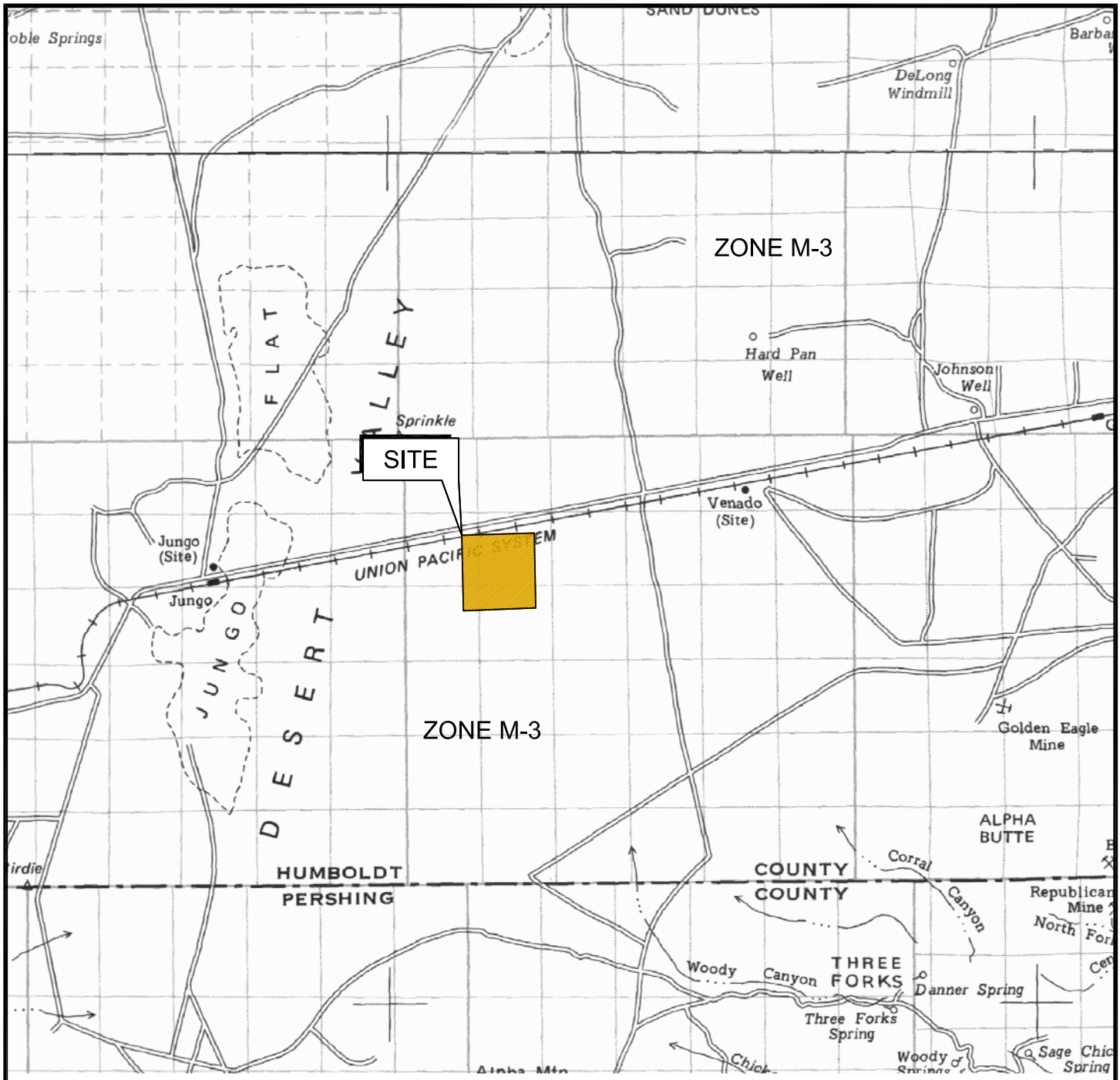
Golder Associates
Sacramento, CA

SECTION 7, T35N, R33E
APN 05-411-07
SITE LOCATION MAP

FIGURE 1

PROJECT No. 0637079 FILE No. Fig 1 – Site CADD JDR DATE 05/29/07

Drawing file: Fig 1 – Site Location.dwg Feb 24, 2010 – 3:30pm



LEGEND

PROPOSED LANDFILL SITE

N
W E
S

NOTE

1. MAP IMAGE OBTAINED FROM NEVADA DOT MAP ATLAS 30' SERIES (METRIC). DATE OF MAPS: 1980, 1987.

2 0 2
SCALE MILE

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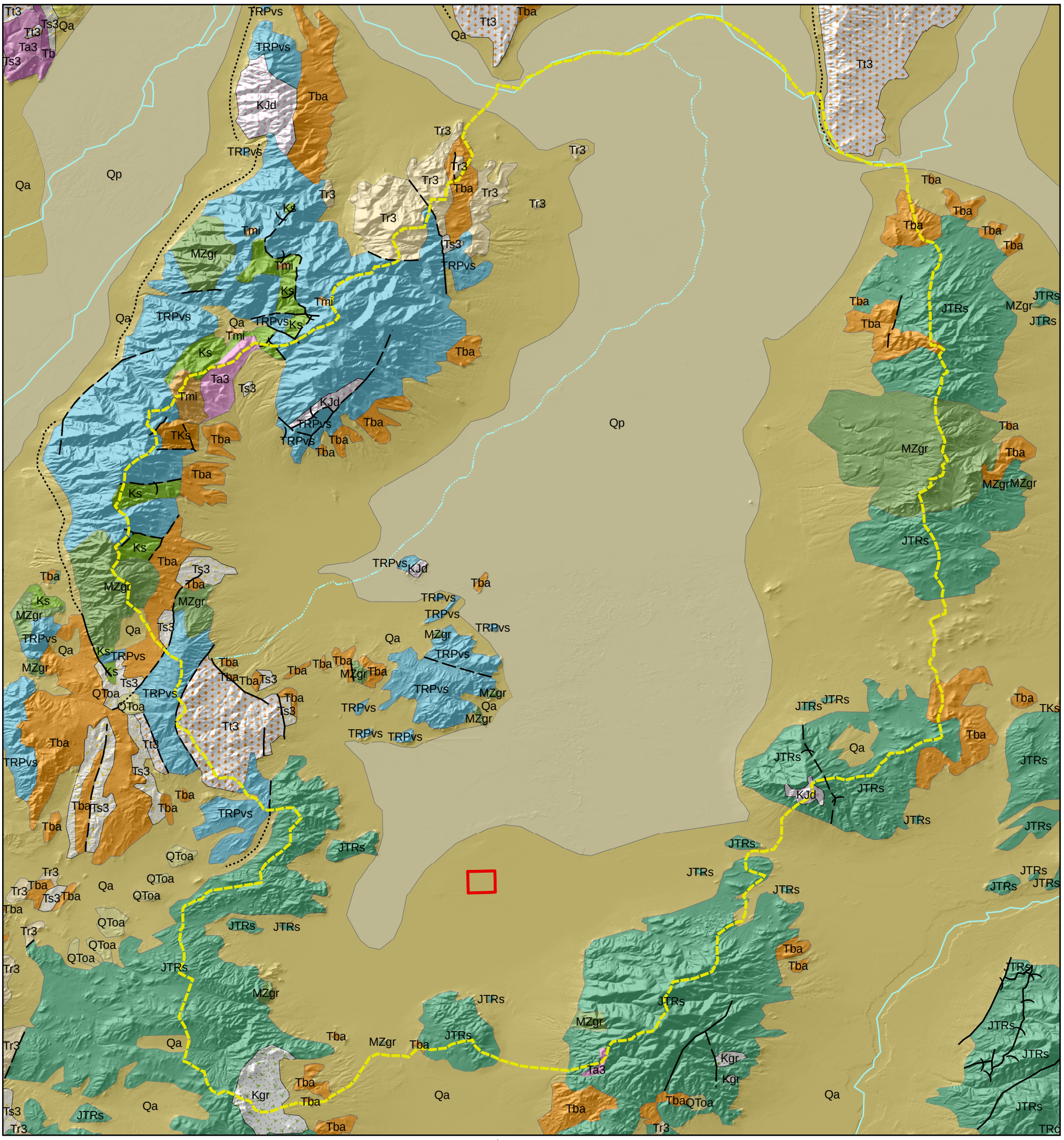
Sacramento, CA

SITE PROPERTY MAP

FIGURE 2

PROJECT No. 063-7079 FILE No. Fig 2 – Site CADD JDR DATE 05/29/07

Drawing file: Fig 2 – Site Property Map.dwg Feb 24, 2010 – 4:34pm



Source: State of Nevada, BLM, USGS

Map Projection:
Geographic Coodinate System
North American 1983 (Feet)

5 0 5
Miles

This figure was originally produced in color. Reproduction in black and white may result in a loss of information.

LEGEND

- Jungo Road Landfill Site
- Desert Valley Basin Limit
- Stream
- Stream Intermittent
- Reservoir
- Normal fault, approximate
- Normal fault, concealed
- Normal fault
- Thrust fault
- Thrust fault, approximate

GEOLOGIC UNIT

- Ch, silicious (western) assemblage, sandstone
- Osv, silicious (western) assemblage, chert
- Msv, siliceous and volcanic assemblage, extrusive rock
- MZgr, plutonic, quartz monzonite
- PMh, siliceous and volcanic assemblage, chert
- TRPvs, siliceous and volcanic assemblage, andesite
- TRk, Jur-Trias West, andesite
- TRlgr, Jur-Trias West, granite
- TRc, Jur-Trias West, limestone
- JTRs, Jur-Trias West, shale
- TJgr, plutonic, quartz monzonite
- KJd, plutonic, diorite
- Kgr, plutonic, quartz monzonite
- Ks, sedimentary, siltstone
- TKs, sedimentary, conglomerate
- Tmi, intrusive, intrusive rock
- Tri, intrusive, granitoid
- Ta2, volcanic and shallow intrusive, latite
- Tt2, volcanic and shallow intrusive, rhyolite
- Tba, volcanic and shallow intrusive, basalt
- Ta3, volcanic and shallow intrusive, latite
- Tr3, volcanic and shallow intrusive, rhyolite
- Ts3, sedimentary, conglomerate
- Tt3, volcanic and shallow intrusive, rhyolite
- Tb, volcanic and shallow intrusive, basalt
- Tts, sedimentary, conglomerate
- QToa, sediment, unconsol., alluvium
- QTb, volcanic and shallow intrusive, basalt
- Qls, sediment, unconsol., landslide
- Qp, sediment, unconsol., playa
- Qa, sediment, unconsol., alluvium

DRAFT

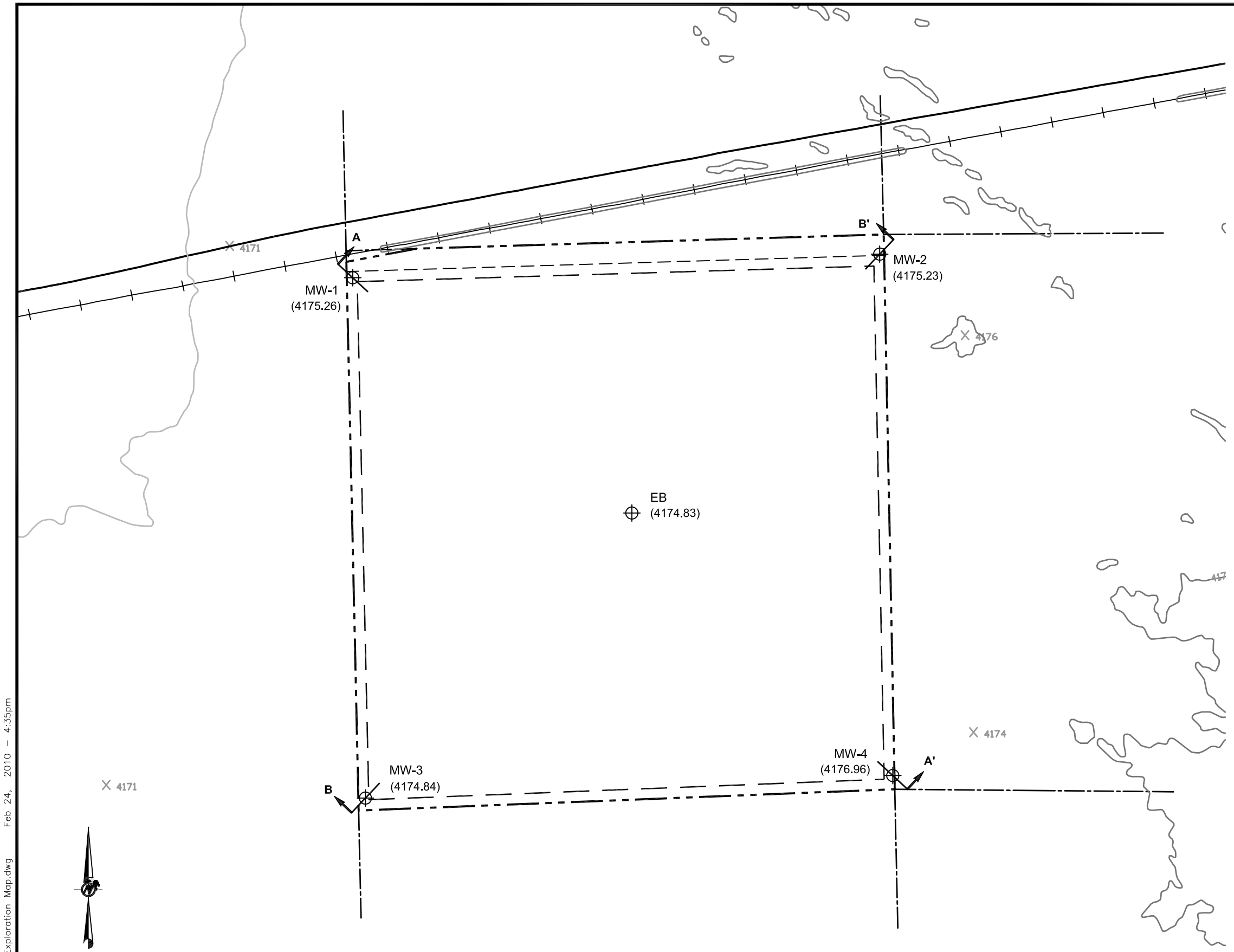
FIGURE **3**

REGIONAL GEOLOGIC MAP

JUNGO ROAD LANDFILL/NV

063-7079 | Draft_Geology.mxd | MOD: 4/27/07 | JDR

Golder Associates



LEGEND

	PROPERTY BOUNDARY
	LIMIT OF LANDFILL
	LIMIT OF PROPOSED RAILYARD
	LIMIT OF SECTION
MW-2	BORING WELL LOCATION AND ID
(4175.26)	GROUND ELEVATION AT WELL (FT MSL)
A A'	GEOLOGIC SECTION (FIGURE 5 & 6)

1,000 0 1,000
SCALE FEET

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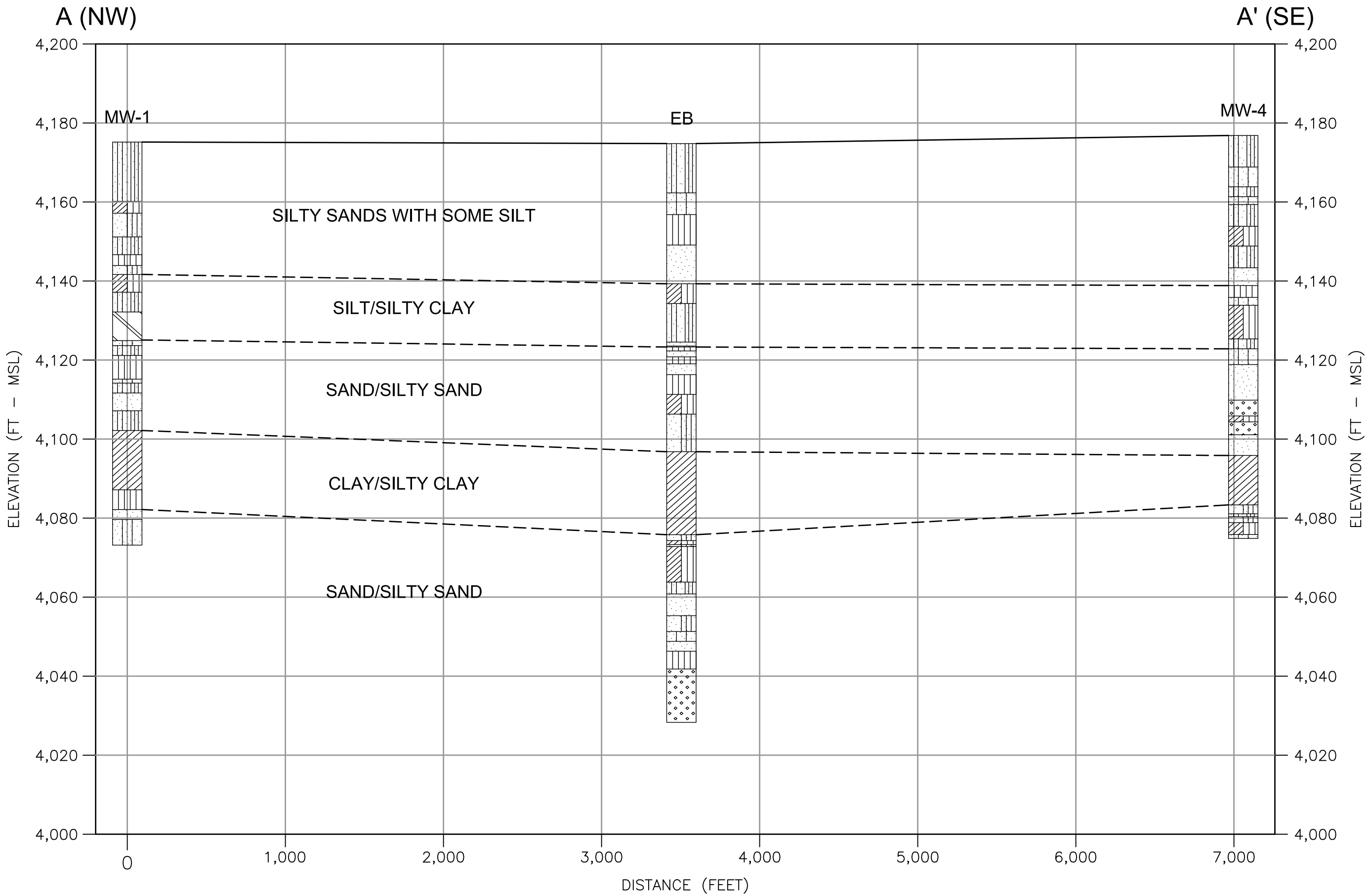
Sacramento, CA

SITE EXPLORATION PLAN

FIGURE 4

PROJECT No. 063-7079 FILE No. Fig 10 - Sit CADD JDR DATE 05/29/07

Drawing file: Fig 4 - Site Exploration Map.dwg Feb 24, 2010 - 4:35pm



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600 0 600
SCALE HORIZONTAL FEET

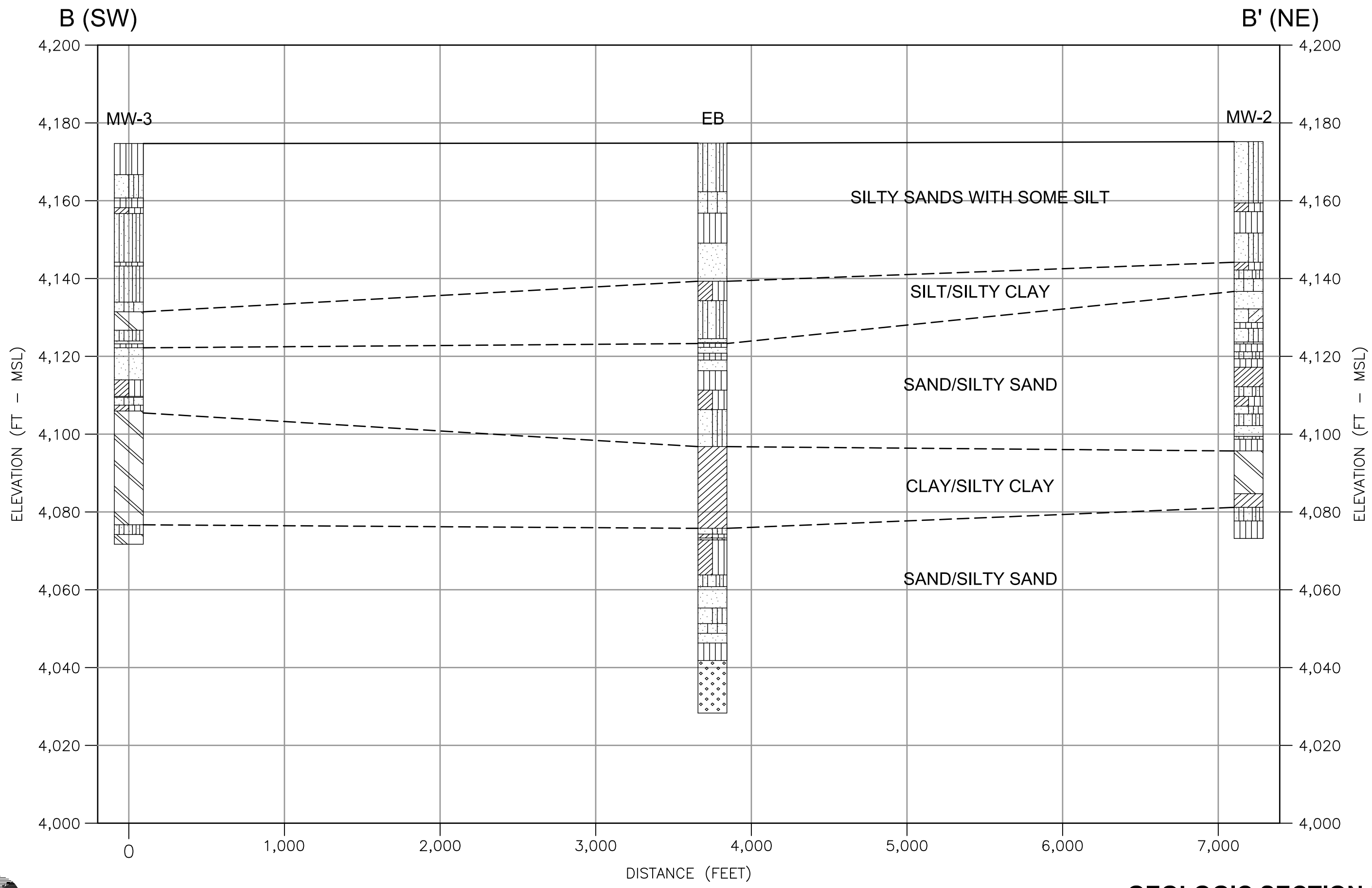
24 0 24
SCALE VERTICAL FEET

GEOLOGIC SECTION A-A'

FIGURE 5

PROJECT No. 0637079 FILE No. Fig 5 – Geo CADD JDR DATE 05/29/07

Drawing file: Fig 5 – Geologic Sect A–A.dwg Feb 24, 2010 – 4:35pm



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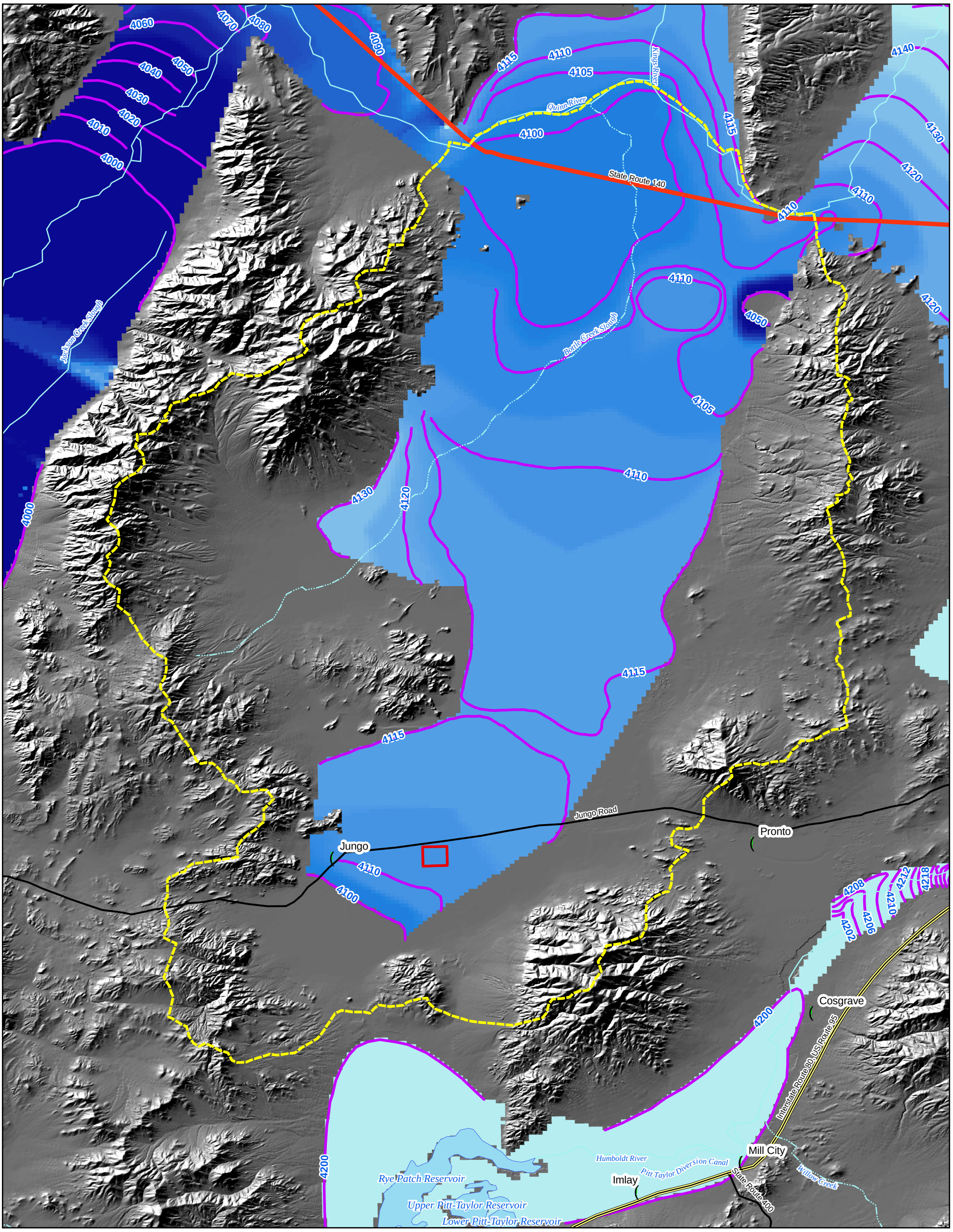
GEOLOGIC SECTION B-B'

FIGURE 6

PROJECT No. 0637079 FILE No. Fig 6 – Geo CADD JDR DATE 05/29/07

Drawing file: Fig 6 – Geologic Sect B-B.dwg Feb 24, 2010 – 4:36pm



This figure was originally produced in color. Reproduction in black and white may result in a loss of information.

LEGEND

- Desert Valley Basin
- Jungo Road Landfill
- Cities
- Stream
- Stream Intermittent
- Reservoir
- Expressway
- Limited Access Highway
- Principal Highway
- Other Highway
- Groundwater Contour
- Groundwater Elevation
- High : 4150
- Low : 4050

5 0 5
Miles

Map Projection:
Geographic Coodinate System
North American 1983 (Feet)

Source: BLM, USGS

DRAFT

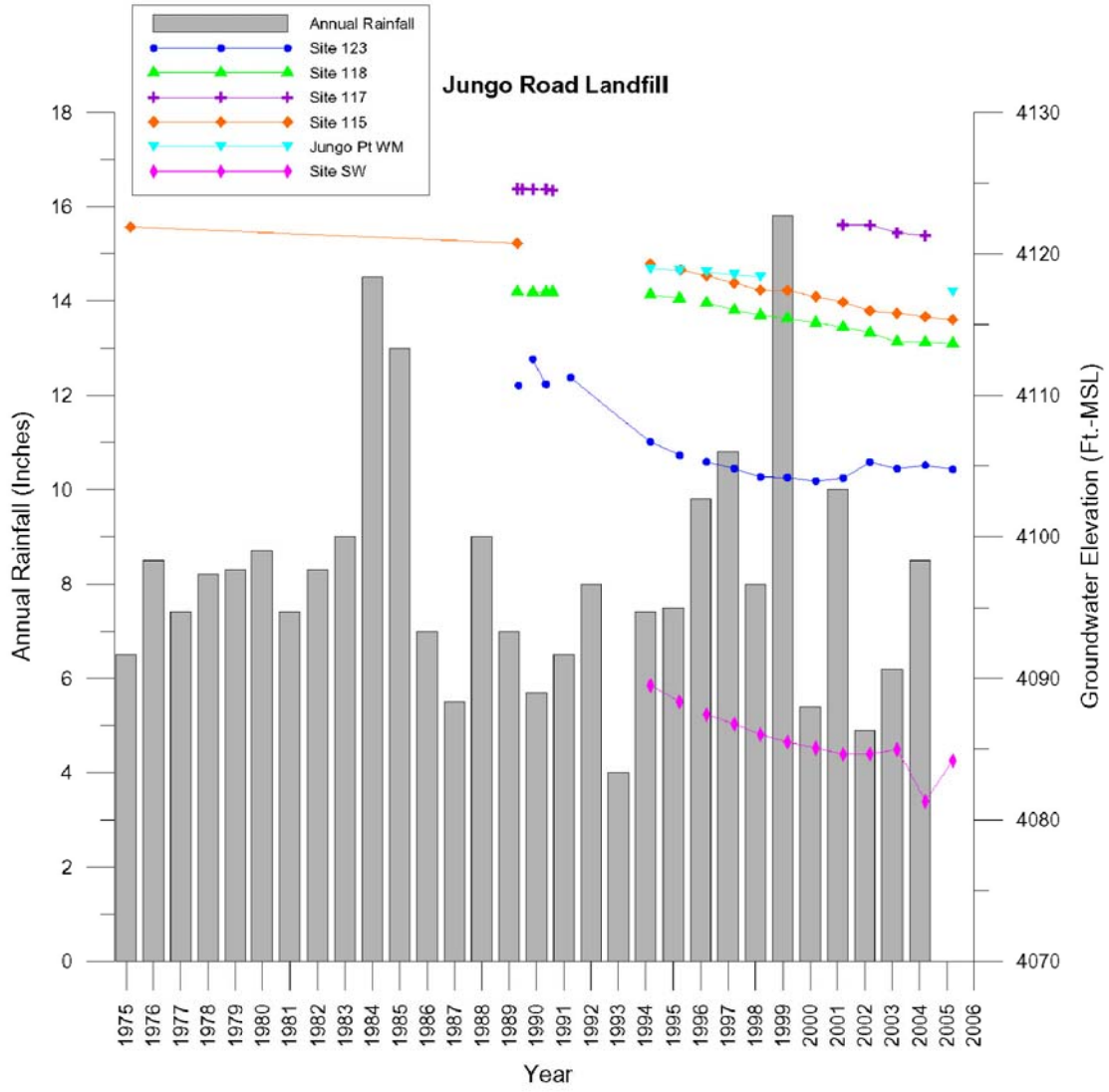
FIGURE 7

REGIONAL GROUNDWATER ELEVATIONS

JUNGO ROAD LANDFILL/NV

063-7079 | Draft-GW Map.mxd | MOD: 4/27/07 | JDR

Golder Associates



GROUNDWATER ELEVATION TRENDS IN DESERT VALLEY

FIGURE 8

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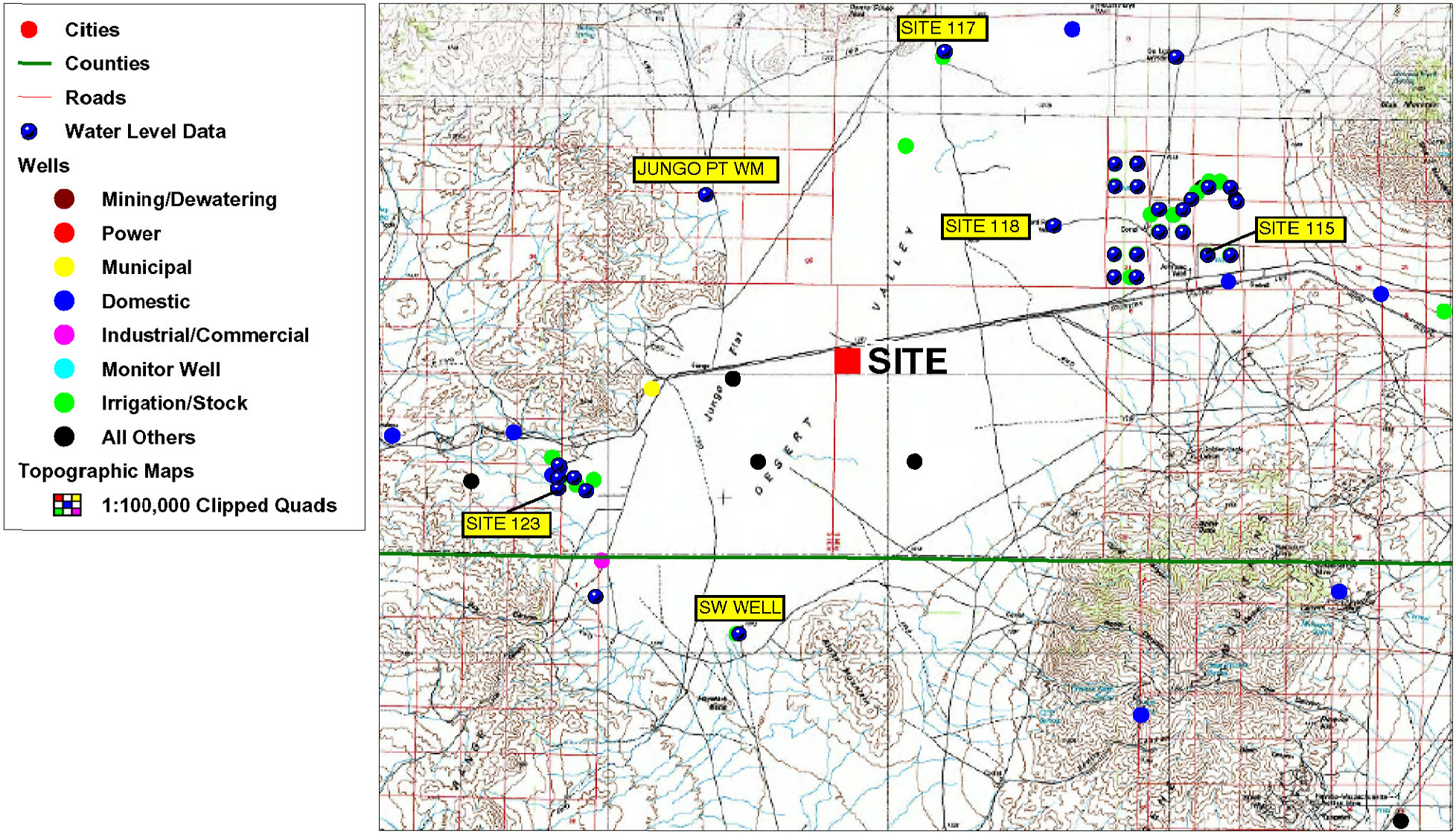
PROJECT No. 0637079 FILE No. Fig 8 – GW CADD JDR DATE 05/30/07

Drawing file: Fig 9 – Regional Wells.dwg Feb 24, 2010 – 4:38pm



SCALE 1 : 200,000

2 0 2 4 6

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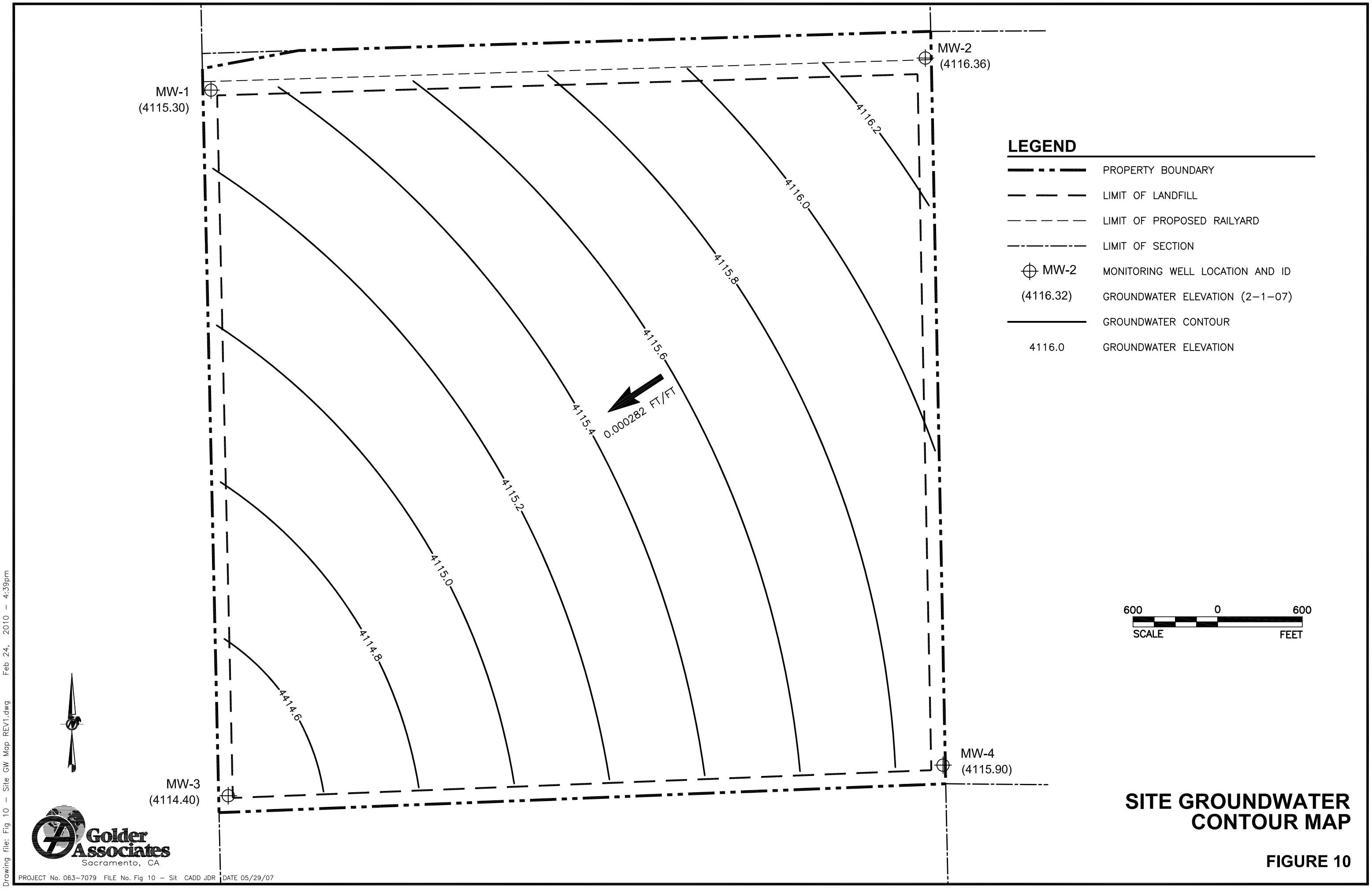
LOCATION OF REGIONAL WELLS IN DESERT VALLEY

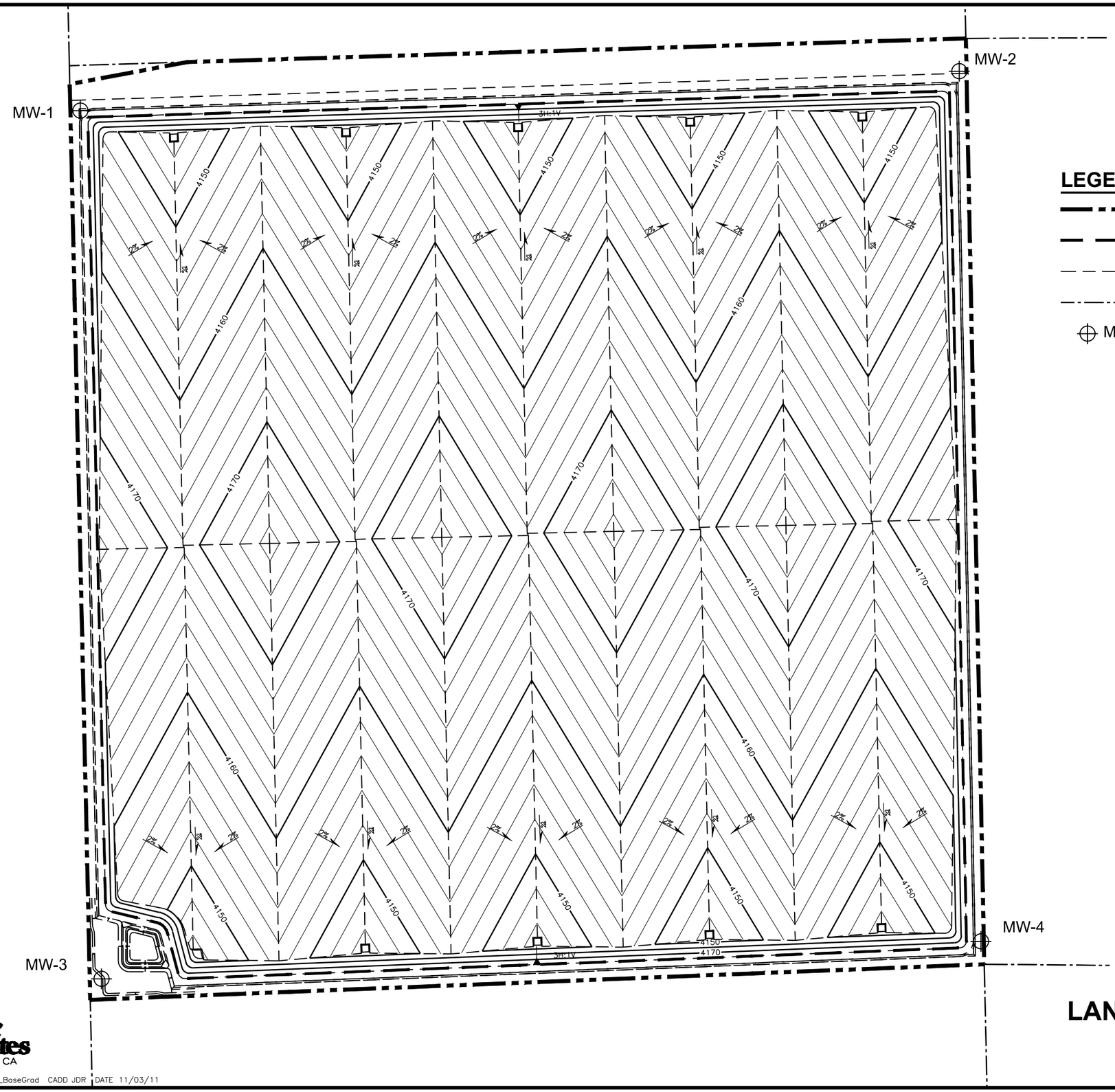
FIGURE 9

PROJECT No. 0637079 FILE No. Fig 9 – Reg CADD JDR DATE 05/30/07



SITE GROUNDWATER CONTOUR MAP

FIGURE 10



LEGEND

- PROPERTY BOUNDARY
- LIMIT OF LANDFILL
- LIMIT OF PROPOSED RAILYARD
- LIMIT OF SECTION
- MW-2 MONITORING WELL LOCATION AND ID

600 0 600
SCALE FEET

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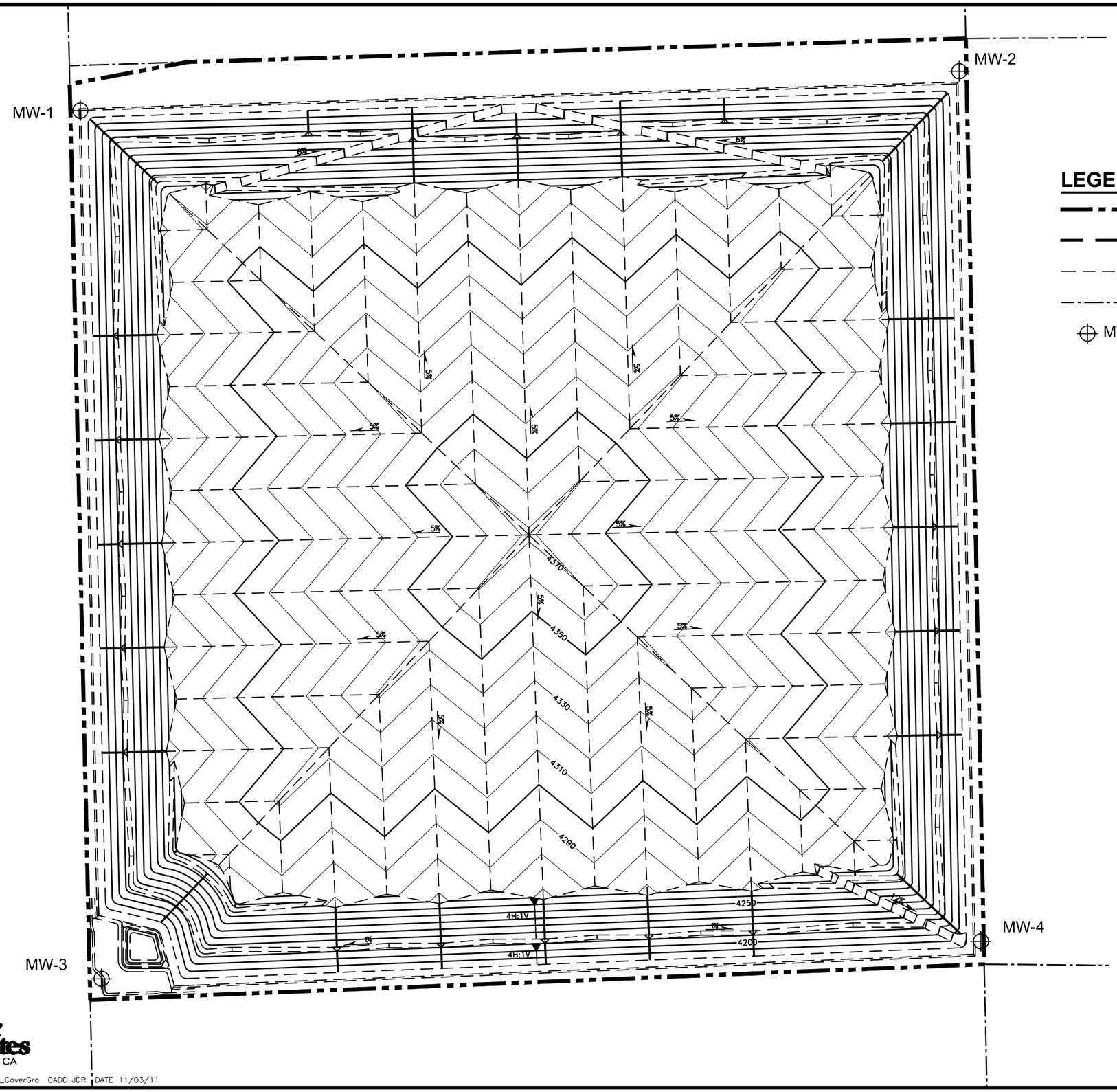
Sacramento, CA

LANDFILL BASE GRADING PLAN

FIGURE 11

PROJECT No. 0637079 FILE No.F11_BaseGrad CADD JDR DATE 11/03/11

Drawing file: 0637079100_F11_BaseGrade.dwg Nov 03, 2011 – 4:46pm



LEGEND

- PROPERTY BOUNDARY
- LIMIT OF LANDFILL
- LIMIT OF PROPOSED RAILYARD
- LIMIT OF SECTION
- MW-2 MONITORING WELL LOCATION AND ID

600 0 600
SCALE FEET

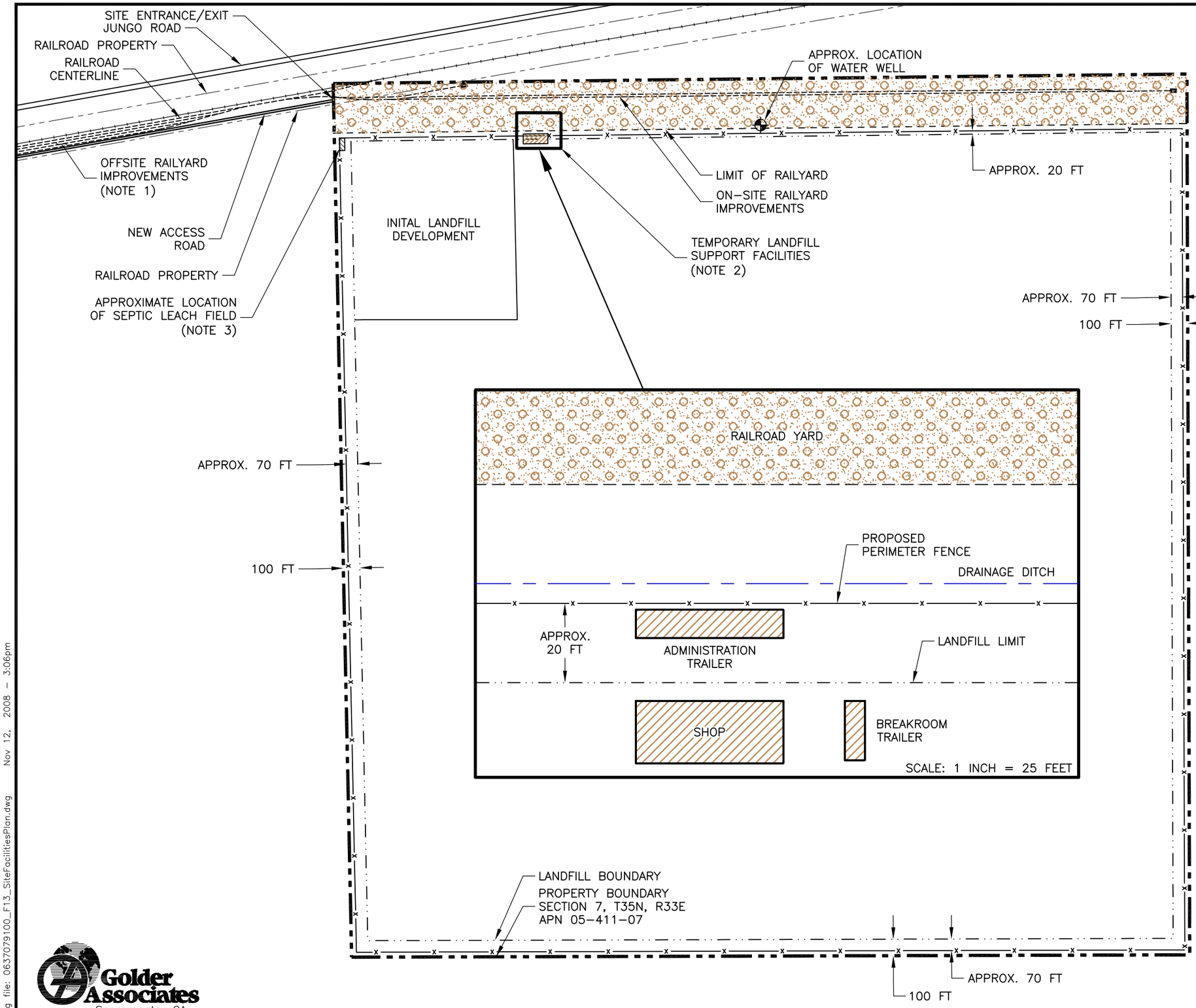
Golder Associates
Sacramento, CA

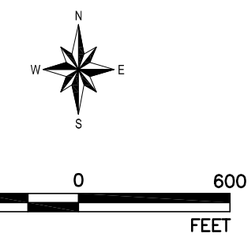
LANDFILL FINAL COVER GRADING PLAN

FIGURE 12

PROJECT No. 0637079 FILE No. F12_CoverGra CADD JDR DATE 11/03/11

Drawing file: 0637079100_F12_CoverGrade.dwg Nov 03, 2011 – 4:47pm





LEGEND

- PROPERTY BOUNDARY
- LANDFILL BOUNDARY
- PROPOSED PERIMETER FENCE

NOTES

1. OFF-SITE RAILYARD IMPROVEMENTS LOCATED ON UNION PACIFIC PROPERTY.
2. LANDFILL SUPPORT FACILITIES MAY BE MOVED WITHIN THE PROPERTY LIMITS AS THE SITE IS DEVELOPED.
3. PERCOLATION TESTS WILL BE COMPLETED TO DESIGN THE SEPTIC SYSTEM.

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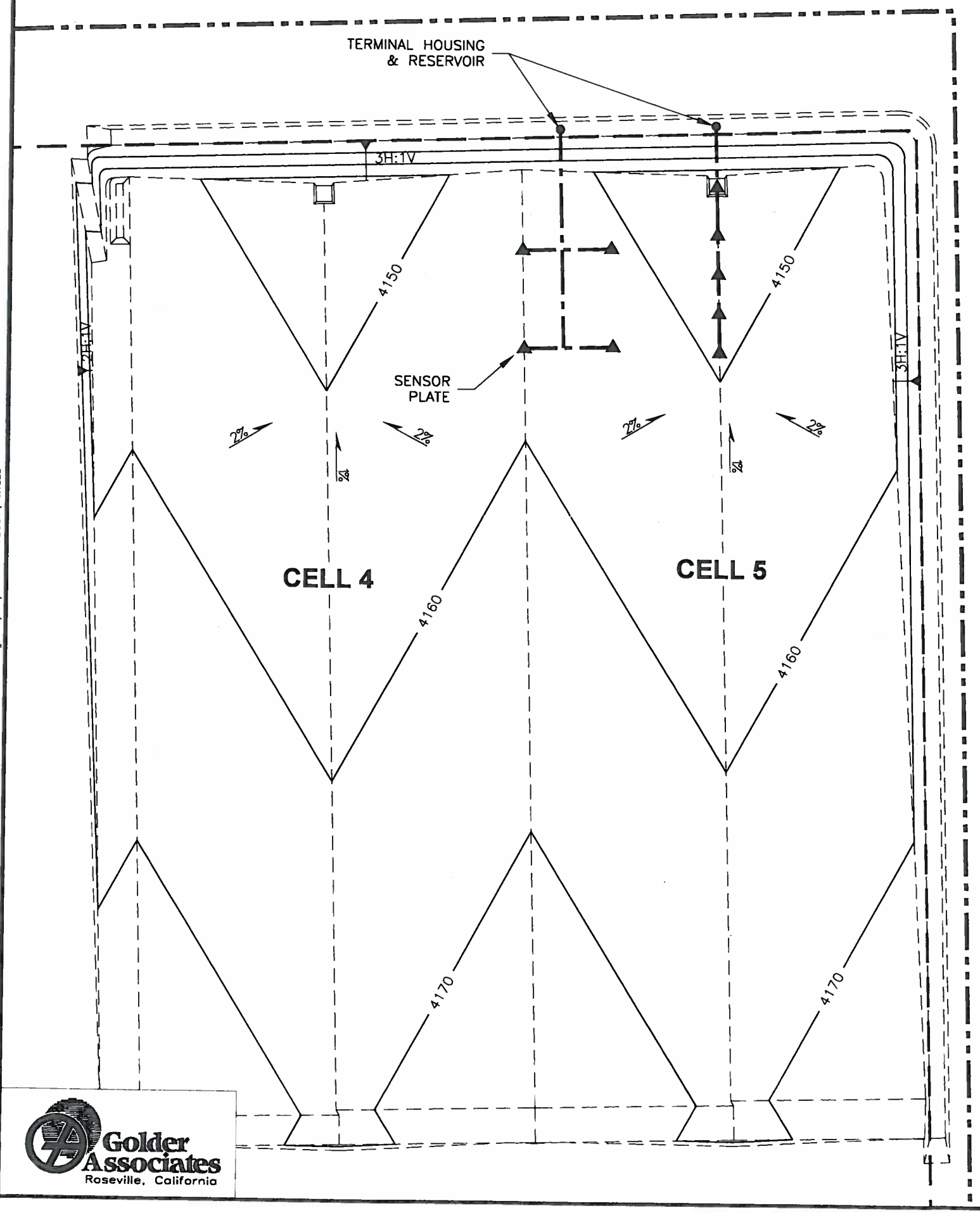
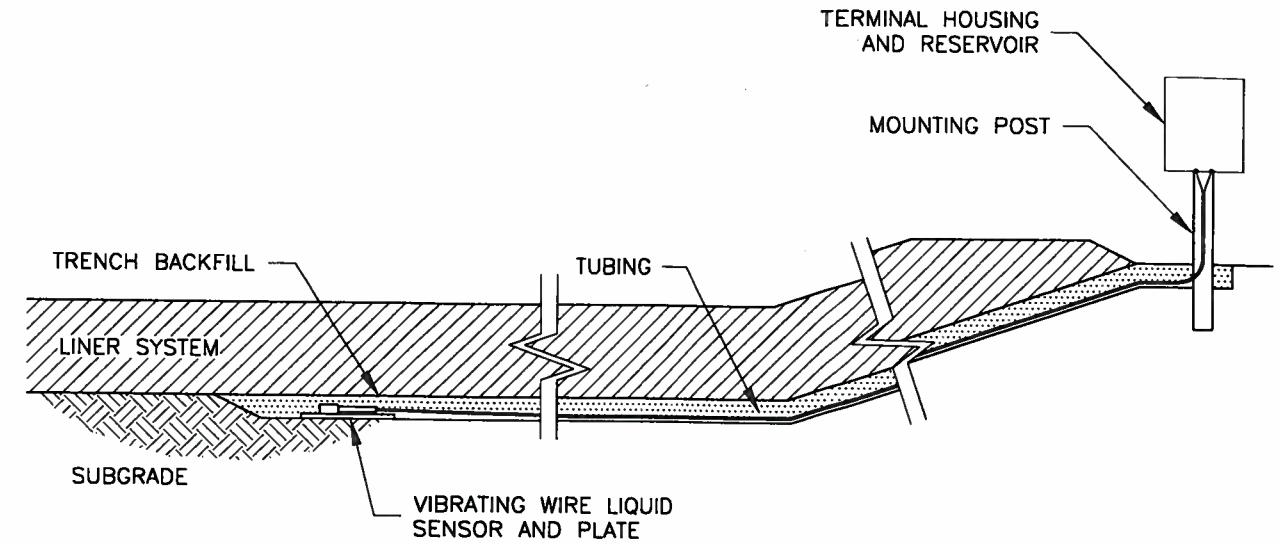
PROJECT No. 0637079 FILE No. 0637079100 CADD JDR DATE 11/11/08

Drawing file: 0637079100_F13_SiteFacilitiesPlan.dwg Nov 12, 2008 - 3:06pm

SITE FACILITIES PLAN

FIGURE 13





TYPICAL SETTLEMENT SYSTEM

(NOT TO SCALE)

LEGEND

- PROPERTY BOUNDARY
- LIMIT OF LANDFILL
- BURIED SENSOR WIRE AND TUBING
- SENSOR PLATE
- 14% — GRADE INDICATOR
- 3H:1V — SLOPE INDICATOR

NOTE

1. CELL 5 WILL BE THE FIRST CONSTRUCTED CELL.

300 0 300
SCALE FEET

Golder Associates
Roseville, California

N:\Projects_2006\063-7079-100 (Norcal-Permit Docs)\Figs\0637079100-F1-BASE_GRADES.dwg, 03/30/11 08:23:20am, JRaub

FIGURE 14
SETTLEMENT MONITORING PLAN
JUNGO ROAD LANDFILL

APPENDIX A
SUMMARY BORING LOGS

Golder Associates
1009 Enterprise Way, Suite 350
Roseville, CA 95678
Telephone: 916-786-2424
Fax: 916-786-2434

BORING NUMBER EB

PROJECT NUMBER 063-7079-100
PROJECT NAME Subsurface Investigation
LOCATION Jungo Road, Winnemucca, NV
DRILLING METHOD Hollow Stem Auger
SAMPLING METHOD Cal Modified, SPT, Shelby
GROUND ELEVATION 4174.80
TOP OF CASING ---
LOGGED BY AAH

DATE STARTED 1/12/07
DATE COMPLETED 1/13/07
CASING TYPE/DIAMETER ---
SCREEN TYPE/SLOT ---
GRAVEL PACK TYPE ---
GROUT TYPE/QUANTITY ---
DEPTH TO WATER 57.1
GROUND WATER ELEVATION 4117.7

REMARKS Approximately 7 feet of heave in the bottom of the borehole at 145 feet bgs.

DEPTH TO WATER	BLOW COUNTS	RECOVERY (inches)	SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
	6 7 9	16	SPT		5	SM-ML		SILTY SAND/SANDY SILT with trace to little CLAY. Light Yellowish Brown (2.5Y 1/3). ~50-60% fine sand, ~40-50% low plasticity fines. Dry. Loose.	
	6 7 9	16	SPT		10				12.5
	5 7 8	15	SPT		15	SM		SILTY SAND with trace CLAY. Light Yellowish Brown (2.5Y 1/3). ~70-80% fine sand, ~20-30% low plasticity fines. Dry. Loose.	18.0
	8 14 15	12	SPT		20	ML		CLAYEY SILT with some SAND. Light Yellowish Brown (2.5Y 1/3). Dry. Loose. Compact. Sample submitted for lab analyses. 15.7% fine sand, 84.3% low to medium plasticity fines.	

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BORING NUMBER EB

PROJECT NUMBER 063-7079-100 **DATE STARTED** 1/12/07

PROJECT NAME Subsurface Investigation **DATE COMPLETED** 1/13/07

Continued from Previous Page

DEPTH TO WATER	BLOW COUNTS	RECOVERY (inches)	SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
						SP		SAND with trace to little fines. Light Olive Brown (2.5Y 5/4). ~90-95% fine to medium sand, ~5-10% low plasticity fines. Moist. Compact. *(continued)*	54.0
	5 19 29	14	SPT		55	ML		CLAYEY SILT with little to some fine SAND. Olive Brown (2.5Y 4/4). ~10-20% fine sand, ~80-90% low plasticity fines. Moist. Compact.	55.8
▼						SP		SAND with trace to little fines.	58.5
	5 8 8	18	SPT		60	ML		CLAYEY SILT with some SAND. Light Olive Brown (2.5Y 5/4). Moist. Loose. Sample submitted for lab analyses. 0.7% medium grained sand, 16.8% fine grained sand, 82.5% low to medium plasticity fines.	63.5
	5 6 7	16	SPT		65	ML-CL		CLAYEY SILT/SILTY CLAY with little to some fine SAND. Light Olive Brown (2.5Y 5/4). ~10-20% fine sand, ~80-90% low to medium plasticity fines. Moist. Loose. Greenish Grey (Gley1 5/10Y). ~5% fine sand, ~95% low plasticity fines.	68.5
▽					70	SP-SM		SAND with little to some fines. Very Dark Grey (2.5Y 4/1). Wet to saturated.	
	22 19 50	18	MC		75			SAND with trace fines. Very Dark Grey (2.5Y 4/1). ~5% coarse sand, ~45% medium sand, ~45% fine sand, ~5% fines. Saturated. Submitted sample for lab analyses. Unit Weight: Wet 154.1, Dry 126.9. MC = 21.4%.	78.0
	4 5 22		SPT		80	CH		CLAY with some SAND and trace GRAVEL. Greenish Grey (Gley1 5/10 Y). Moist. Firm to stiff. FAT CLAY and some SAND. Sample submitted for lab analyses. 1.5% fine gravel, 0.7% coarse grained sand, 2.2% medium sand, 13.3% fine sand, 82.3% low to high plasticity fines. Liquid limit 60. Plasticity index 34. 95.6% <#40. 82.3% <#200.	

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BORING NUMBER EB

PROJECT NUMBER 063-7079-100 **DATE STARTED** 1/12/07

PROJECT NAME Subsurface Investigation **DATE COMPLETED** 1/13/07

Continued from Previous Page

DEPTH TO WATER	BLOW COUNTS	RECOVERY (inches)	SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
	15 19					SM-ML		sand, 98.6% low to medium plasticity fines. SILTY SAND/SANDY SILT with little to some CLAY. Very Dark Grey (2.5Y 4/1). ~50-60% fine sand, ~40-50% low plasticity fines. Compact. Moist to wet.	111.0 114.0
					115	SP		SAND with trace to little fines. Very Dark Grey (2.5Y 4/1). ~90-95% fine to medium sand, ~5-10% low plasticity fines. Wet to saturated.	119.5
	14 20 25	18	SPT		120	SP-SM		SAND with trace to little CLAY. Very Dark Grey (2.5Y 4/1). ~70-80% fine to medium sand, ~20-30% low plasticity fines. Compact. Wet to saturated. SILTY CLAY/CLAYEY SILT with little to some fine sand. Very Dark Grey (2.5Y 4/1). ~5% fine sand, ~95% low plasticity fines. Moist. Very stiff.	123.5
	0 6 8	18	MC		125	SM		SILTY SAND with trace to little CLAY. Very Dark Grey (2.5Y 4/1). ~60-70% fine sand, ~30-40% low plasticity fines. Saturated, flowing sand.	126.0
						SP		SAND with trace to little fines. Dark Grey to Dark Greyish Brown (2.5Y 4.2). ~90-95% fine to medium sand, ~5-10% low plasticity fines. Wet to saturated. Loose.	128.5
	7 13 23	18	SPT		130	ML		CLAYEY SILT and SAND. Dark Greyish Brown (2.5Y 7/2). Trace of white mineral. Moist. Firm to very stiff. Submitted sample for lab analyses. 3.7% coarse sand, 9.1% medium sand, 21.3% fine sand, 50.8% silt, 15.1% low plasticity clay. Liquid limit 48. Plasticity index 15. 87.2% <#40. 65.9% <#200.	133.0
					135	SW		SAND with trace to little fines. Dark Greyish Brown (2.5Y 4/2). ~90-95% fine to medium sand, ~5-10% low plasticity fines. Wet to saturated.	

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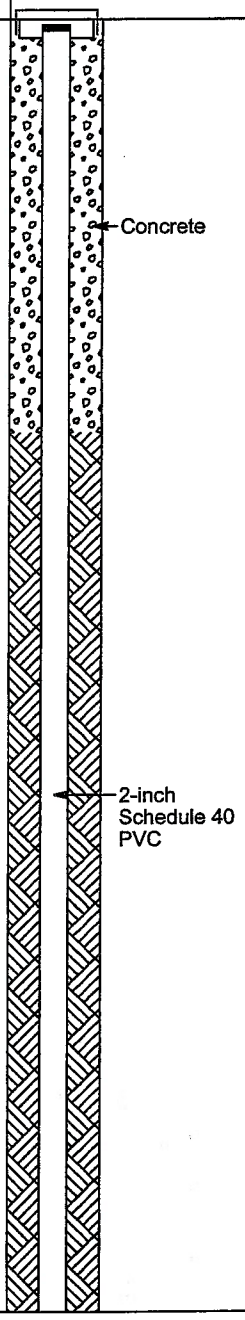
WELL NUMBER MW-1

PROJECT NUMBER 063-7079-100
PROJECT NAME Subsurface Investigation
LOCATION Jungo Road, Winnemucca, NV
DRILLING METHOD Hollow Stem Auger
SAMPLING METHOD Cal Modified, SPT, Shelby
GROUND ELEVATION 4177.78
TOP OF CASING ---
LOGGED BY AAH
REMARKS

DATE STARTED 1/10/07
DATE COMPLETED 1/14/07
CASING TYPE/DIAMETER Schedule 40 PVC / 2-inch
SCREEN TYPE/SLOT Factory Slot / 0.020-inch
GRAVEL PACK TYPE Colorado Silica Sand
GROUT TYPE/QUANTITY Cement Type I&II / 42
DEPTH TO WATER 57.8
GROUND WATER ELEVATION 4120.0

DEPTH TO WATER	BLOW COUNTS	RECOVERY (inches)	SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
	5 8 10	13	SPT		5	SM-ML		SILTY SAND/SANDY SILT with trace to little CLAY. Light Yellowish Brown (2.5Y 6/3). ~50-60% fine sand, ~40-50% low plasticity fines. Dry. Loose to compact.	
	8 10 12	14	SPT		10				
	5 8 12	15	SPT		15	ML-CL		CLAYEY SILT/SILTY CLAY with trace to little fine SAND. Light Yellowish Brown (2.5Y 6/3). ~5-10% fine sand, ~90-95% low plasticity fines. Dry. Loose to compact.	15.0
	8 13 15	14	SPT		20	SP-SM		SAND with little to some fines. Light Yellowish Brown (2.5Y 6/3). ~80-90% fine sand, ~10-20% low plasticity fines. Dry. Loose to compact.	18.0
						SM-ML			24.0

WELL DIAGRAM



Golder Associates
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Telephone: 916-786-2424
Fax: 916-786-2434

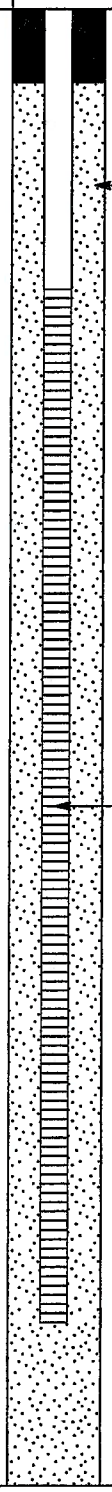
WELL NUMBER MW-1

PROJECT NUMBER 063-7079-100 **DATE STARTED** 1/10/07

PROJECT NAME Subsurface Investigation **DATE COMPLETED** 1/14/07

Continued from Previous Page

DEPTH TO WATER	BLOW COUNTS	RECOVERY (inches)	SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
								plasticity fines. Moist. Compact. Trace rootlets.	54.0
	400 750 1000 1200	4	SHELBY		55	ML		CLAYEY SILT with little to some fine SAND. Light Olive Brown (2.5Y 5/3). ~10-20% fine sand, ~80-90% low plasticity fines. Moist.	
▼									60.0
▽					60	SM		SILTY SAND with trace CLAY. Olive Brown (2.5Y 4/4). ~70-80% fine to medium sand, ~20-30% low plasticity fines. Moist to wet.	61.0
						SM-ML		SILTY SAND/SANDY SILT with little CLAY. Light Olive Brown (2.5Y 5/4). ~50-60% fine sand, ~40-50% low plasticity fines. Moist to wet.	63.5
	11 22 49	18	SPT		65	SP		SAND with trace fines. Dark Greyish Brown (2.5Y 4/2). ~5-10% coarse sand, ~10-15% medium sand, ~75-85% fine sand, ~5% low plasticity fines. Wet to saturated. Compact to dense.	68.0
	9 14 19		SPT		70	SM-ML		SILTY SAND/SANDY SILT with trace CLAY. Olive Brown (2.5Y 4/3). ~50-60% fine sand, ~40-50% low plasticity fines. Wet to saturated. Compact.	73.0
						CH		FAT CLAY with trace SAND. Mixture of Light Greenish Grey (Gley1 7/10Y) and Greenish Grey (Gley1 6/5Y)(Gley1 5/10Y). Moist. Firm.	
	5 8 10	18	MC		75			Submitted sample for lab analyses. Unit Weight: Wet 105.8, Dry 82.6. MC = 28.1%.	
	3 4 8	18	SPT					Sample submitted for lab analyses. 0.2% coarse sand, 1.2% medium sand, 2.0% fine sand, 96.6% low to high plasticity fines. Liquid limit 74. Plasticity index 44. 98.6% <#40. 96.6% <#200.	
	500 650 800 900	21	SHELBY		80			Greenish Grey (Gley1 6/5Y). Sample submitted for lab analyses. Dry Density 58.7 pcf. Liquid Limit 83. Plasticity Index 56. Pc=11.83. Cc=0.66. Cs=0.08. e_o=1.870	



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Telephone: 916-786-2424
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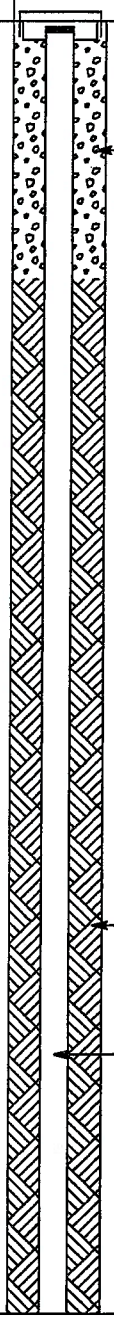
WELL NUMBER MW-2

PROJECT NUMBER 063-7079-100
PROJECT NAME Subsurface Investigation
LOCATION Jungo Road, Winnemucca, NV
DRILLING METHOD Hollow Stem Auger
SAMPLING METHOD Cal Modified, SPT, Shelby
GROUND ELEVATION 4175.18
TOP OF CASING ----
LOGGED BY AAH
REMARKS

DATE STARTED 1/8/07
DATE COMPLETED 1/10/07
CASING TYPE/DIAMETER Schedule 40 PVC / 2-inch
SCREEN TYPE/SLOT Factory Slot / 0.020-inch
GRAVEL PACK TYPE Colorado Silica Sand
GROUT TYPE/QUANTITY Cement Type I&II / 25
DEPTH TO WATER 56.3
GROUND WATER ELEVATION 4118.9

DEPTH TO WATER	BLOW COUNTS	RECOVERY (inches)	SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
						SP-SM		SAND with little to some fines. Light Yellowish Brown (2.5Y 6/3). ~80-90% fine sand, ~10-20% low plasticity fines. Dry. Loose to compact.	
	6 8 11	16	SPT		5				
	7 7 10	14	SPT		10				
	7 8 7	14	SPT		15				15.8
						ML-CL		CLAYEY SILT/SILTY CLAY with little to some fine SAND. Light Yellowish Brown (2.5Y 6/3). ~10-20% fine sand, ~80-90% low plasticity fines. Dry. Loose. Trace of oxide staining.	18.0
						ML		SANDY SILT. Light Yellowish Brown (2.5Y 6/3). Dry. Loose.	
	7 9 10	17	SPT		20			Submitted sample for lab analyses. 0.2% medium sand, 9.5% fine sand, 90.3% low plasticity fines.	23.5
						SP-SM		SAND with little to some fines. Light Yellowish Brown (2.5Y 6/3). ~80-90% fine sand, ~10-20% low plasticity fines. Dry. Loose to compact.	

WELL DIAGRAM



LOG A EWNN01 MODIFIED 4 REVISED WITH LAB DATA 063-7079-100 JUNGO RD.GPJ LOG A EWNN01.GDT 6/1/07

Golder Associates
1009 Enterprise Way, Suite 350
Roseville, CA 95678
Telephone: 916-786-2424
Fax: 916-786-2434

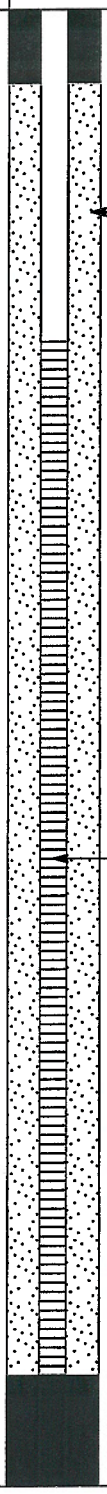
WELL NUMBER MW-2

PROJECT NUMBER 063-7079-100 **DATE STARTED** 1/8/07

PROJECT NAME Subsurface Investigation **DATE COMPLETED** 1/10/07

Continued from Previous Page

DEPTH TO WATER	BLOW COUNTS	RECOVERY (inches)	SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
						ML		CLAYEY SILT with trace to little fine SAND. Brown (10YR 5/3). ~5-10% fine sand, ~90-95% low plasticity fines. Moist. Compact. *(continued)*	54.0
	7 9 15	16	SPT		55	SM-ML		SILTY SAND/SANDY SILT with little to some CLAY. Olive Brown (2.5Y 4/3). ~50-60% fine sand, ~40-50% low plasticity fines. Moist.	55.8
▼						ML		CLAYEY SILT with trace to little fine SAND. Light Olive Brown (2.5Y 5/3). ~5-10% fine sand, ~90-95% low plasticity fines. Moist.	58.0
	5 8 9	16	SPT		60	CL		SILTY CLAY with some SAND. Light Olive Brown (2.5Y 5/3). Moist. Submitted sample for lab analyses. 2.9% coarse sand, 2.8% medium sand, 12.7% fine sand, 81.6% low plasticity fines. Liquid limit 42. Plasticity index 18. 94.3% <#40. 81.6% <#200.	63.0
						SM-ML		SILTY SAND/SANDY SILT with little to some CLAY. Light Olive Brown (2.5Y 5/3). ~40-50% fine sand, ~50-60% low plasticity fines. Moist. Loose.	
	3 5 11	18	SPT		65	ML-CL		CLAYEY SILT/SILTY CLAY with trace to little fine SAND. Light Olive Brown (2.5Y 5/3). ~5-10% fine sand, ~90-95% low plasticity fines. Moist.	65.5
▼						SP-SM		SAND with little to some fines. Olive Brown (2.5Y 4/4). ~75-90% fine sand, ~10-25% low plasticity fines. Wet to saturated.	68.0
	2 6 12	18	SPT		70	SM-ML		SANDY SILT/SANDY SILT. Dark Greyish Brown (2.5Y 4/2). Loose to compact. Submitted sample for lab analyses. 0.1% coarse sand, 0.8% medium sand, 38.0% fine sand, 61.1% low plasticity fines.	70.0
						SP		SAND with trace to little fines. Dark Greyish Brown (2.5Y 4/2). ~90-95% fine to medium sand, ~5-10% low plasticity fines. Wet to saturated.	73.0
	0 10 18	18	MC		75	SM-ML		Submitted sample for lab analyses. Unit Weight: Wet 115.9, Dry 36.9. MC = 33.3%.	75.8
	4 9 12		SPT			ML		SILTY SAND/SANDY SILT with trace to little CLAY. Light Brownish Grey (2.5Y 6/2). ~50-60% fine sand, ~40-50% low plasticity fines. CLAYEY SILT/SILTY CLAY with trace to little SAND. Light Yellowish Brown (2.5Y 6/3). ~5-10% fine sand, ~90-95% low plasticity fines. Moist. Compact.	76.5
	5 11 14	17	SPT		80	CL-CH		SILTY CLAY with trace to little fine SAND. Greenish Grey (Gley1 5/8GY). ~5-10% fine sand, ~90-95% low plasticity fines. Moist. Firm to stiff.	79.5



LOG A EWNN01 MODIFIED 4 REVISED WITH LAB DATA 063-7079-100 JUNGO RD.GPJ LOG A EWNN01.GDT 6/1/07

Golder Associates
1009 Enterprise Way, Suite 350
Roseville, CA 95678
Telephone: 916-786-2424
Fax: 916-786-2434

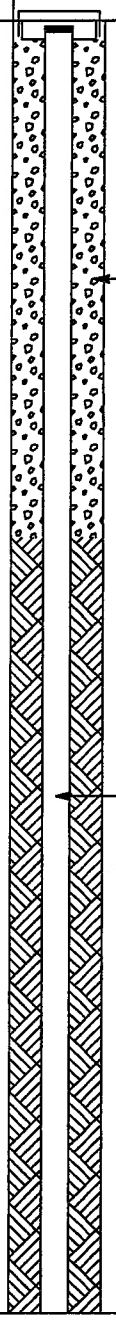
WELL NUMBER MW-3

PROJECT NUMBER 063-7079-100
PROJECT NAME Subsurface Investigation
LOCATION Jungo Road, Winnemucca, NV
DRILLING METHOD Hollow Stem Auger
SAMPLING METHOD Cal Modified, SPT, Shelby
GROUND ELEVATION 4177.04
TOP OF CASING ----
LOGGED BY AAH
REMARKS

DATE STARTED 1/3/07
DATE COMPLETED 1/6/07
CASING TYPE/DIAMETER Schedule 40 PVC / 2-inch
SCREEN TYPE/SLOT Factory Slot / 0.020-inch
GRAVEL PACK TYPE Colorado Silica Sand
GROUT TYPE/QUANTITY Cement Type I&II / 50
DEPTH TO WATER 57.8
GROUND WATER ELEVATION 4119.2

DEPTH TO WATER	BLOW COUNTS	RECOVERY (inches)	SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
	5 9 10	13	SPT		5	ML		SANDY SILT with some CLAY. Light Brownish Grey (2.5Y 6/2). ~50% fine sand, ~50% low plasticity fines. Dry. Loose	8.0
	7 14 17	15	SPT		10	SP-SM		FINE SAND with little to some SILT. Light Brownish Grey (2.5Y 6/2). Dry. Loose	14.0
	6 7 4	17	SPT		15	ML		SILT with some CLAY. Light Yellowish Brown (2.5Y 6/3). ~5% fine sand, ~95% low plasticity fines. Loose.	16.5
						ML-CL		CLAYEY SILT/SILTY CLAY. Light Yellowish Brown (2.5Y 6/3). Dry. Stiff.	18.0
	9 12 14	17	SPT		20	SM-ML		SILTY SAND/SANDY SILT. Light Yellowish Brown (2.5Y 6/3). Dry. Stiff. Sample submitted for lab analyses. 0.3% medium sand, 51.9% fine sand, 47.8% low plasticity fines.	

WELL DIAGRAM



LOG A EWNN01 MODIFIED 4 REVISED WITH LAB DATA 063-7079-100 JUNGO RD.GPJ LOG A EWNN01.GDT 6/1/07

Golder Associates
1009 Enterprise Way, Suite 350
Roseville, CA 95678
Telephone: 916-786-2424
Fax: 916-786-2434

WELL NUMBER MW-3

PROJECT NUMBER 063-7079-100 **DATE STARTED** 1/3/07

PROJECT NAME Subsurface Investigation **DATE COMPLETED** 1/6/07

Continued from Previous Page

DEPTH TO WATER	BLOW COUNTS	RECOVERY (inches)	SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH	WELL DIAGRAM
	11 18 22	18	SPT		55	SP		SAND with trace to little SILT and CLAY. Light Yellowish Brown (2.5Y 6/3). ~90% fine to medium sand, ~10% fines. Dry. Compact. *(continued)* Light Olive Brown (2.5Y 5/3). Dry to moist. Low plasticity fines.		
▼										
▽	7 8 7	18	SPT		60			Dark Greyish Brown (2.5Y 4/2). Moist to wet. Loose.	60.8	
	600 900 1300 1500		SHELBY			ML-CL		CLAYEY SILT/SILTY CLAY with some fine SAND. Light Olive Brown (2.5Y 5/3). ~15% fine sand, ~85% low plasticity fines. Moist. Submitted sample for lab analyses. Dry density 87.0 pcf. Pc=10.55. Cc=0.26. Cs=0.04. e_o=0.938		Bentonite Chip Seal
	9 17 22	16	SPT		65	SP		SAND with little fines. Dark Greyish Brown (2.5Y 4/4). ~90% fine to medium sand, ~10% low plasticity fines. Moist to wet. Compact.	65.0 65.3	Colorado Silica Sand
	8 10 12	18	SPT			SM		SILTY SAND with some CLAY. Greyish Brown (2.5Y 3/4). ~70-80% fine sand, ~20-30% low plasticity fines. Moist. Compact.	67.3	
						CL-ML		SILTY CLAY/CLAYEY SILT with little SAND. Greyish Brown (2.5Y 3/4). ~10% fine sand, ~90% low plasticity fines. Moist. Stiff. Compact.	68.8	
	9 16 23	18	SPT		70			SILTY CLAY with some SAND. Dark Greenish Grey (Gley1 5/5GY). Wet. Loose. Submitted sample for lab analyses. 27.9% fine to medium sand, 72.1% low to high plasticity fines.		Slotted PVC 0.020-inch
	5 8 10	18	MC		75	CL-CH				
	5 6 9	18	SPT					Submitted sample for lab analyses. Unit Weight: Wet 106.4, Dry 87.8. MC = 21.1%.		
	4 5 11	18	SPT		80			Firm.		

Golder Associates
1009 Enterprise Way, Suite 350
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Fax: 916-786-2434

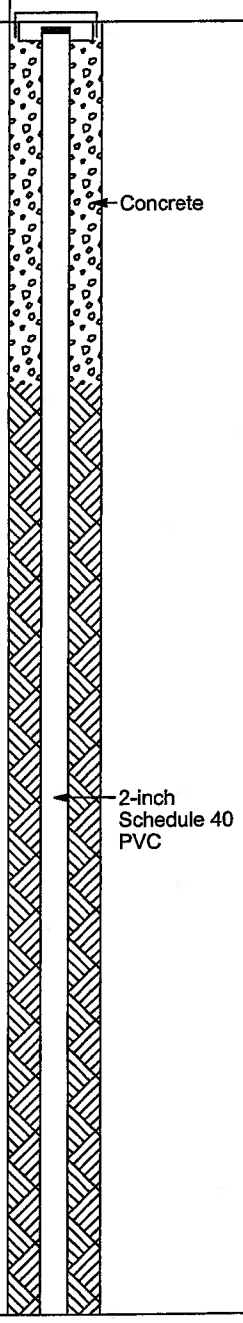
WELL NUMBER MW-4

PROJECT NUMBER 063-7079-100
PROJECT NAME Subsurface Investigation
LOCATION Jungo Road, Winnemucca, NV
DRILLING METHOD Hollow Stem Auger
SAMPLING METHOD Cal Modified, SPT, Shelby
GROUND ELEVATION 4176.84
TOP OF CASING ---
LOGGED BY AAH
REMARKS

DATE STARTED 1/6/07
DATE COMPLETED 1/8/07
CASING TYPE/DIAMETER Schedule 40 PVC / 2-inch
SCREEN TYPE/SLOT Factory Slot / 0.020-inch
GRAVEL PACK TYPE Colorado Silica Sand
GROUT TYPE/QUANTITY Cement Type I&II / 47
DEPTH TO WATER 58.8
GROUND WATER ELEVATION 4118.0

DEPTH TO WATER	BLOW COUNTS	RECOVERY (inches)	SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
	6 9 10	16	SPT		5	SM-ML		SILTY SAND/SANDY SILT with some CLAY. Light Yellowish Brown (2.5Y 6/3). ~40-50% fine sand, ~50-60% low plasticity fines. Dry. Loose.	8.0
	6 10 11	12	SPT		10	SM		SILTY SAND with trace CLAY. Light Yellowish Brown (2.5Y 6/3). ~60-70% fine sand, ~30-40% low plasticity fines. Dry. Loose to compact.	13.0
	6 11 13	16	SPT		15	SM-ML		SILTY SAND/SANDY SILT with some CLAY. Light Yellowish Brown (2.5Y 6/3). ~40% fine sand, ~60% low plasticity fines. Dry. Loose.	15.5
						SM		SILTY SAND with trace CLAY. Light Yellowish Brown (2.5Y, 6/3). ~60-70% fine sand, ~30-40% low plasticity fines. Dry. Compact.	17.5
	7 13 16	10	SPT		20	SM-ML		SILTY SAND/SANDY SILT with little to some CLAY. Light Yellowish Brown. (2.5Y 6/3). ~40-50% fine sand, ~50-60% low plasticity fines. Dry. Loose to compact.	23.0
						ML-CL		SILTY CLAY/CLAYEY SILT with some fine to medium SAND. Light Yellowish Brown (2.5Y 6/3). Dry. Stiff to very stiff/Compact.	

WELL DIAGRAM



LOG A EWNN01 MODIFIED 4 REVISED WITH LAB DATA 063-7079-100 JUNGO RD.GPJ LOG A EWNN01.GDT 6/1/07

Golder Associates
1009 Enterprise Way, Suite 350
Roseville, CA 95678
Telephone: 916-786-2424
Fax: 916-786-2434

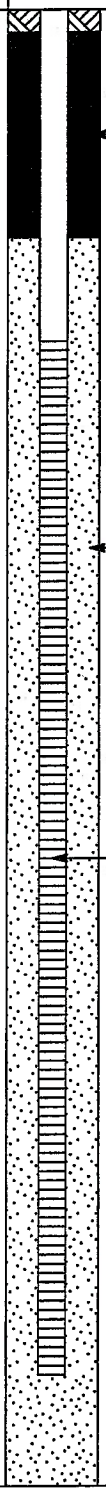
WELL NUMBER MW-4

PROJECT NUMBER 063-7079-100 **DATE STARTED** 1/6/07

PROJECT NAME Subsurface Investigation **DATE COMPLETED** 1/8/07

Continued from Previous Page

DEPTH TO WATER	BLOW COUNTS	RECOVERY (inches)	SAMPLE ID.	EXTENT	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
								SILTY SAND with little CLAY. Light Olive Brown (2.5Y 5/3). ~70-80% fine sand, ~20-30% low plasticity fines. Moist. Compact.	54.0
	13 21 27	14	SPT		55	SM			
								SAND with little to some fines. Dark Greyish Brown (10YR 4/2). ~80-90% fine to medium sand, ~10-20% low plasticity fines. Moist to wet. Compact.	58.0
▼									
▽	15 50 25	17	SPT		60	SP			
	2 13 22	18	SPT		65			SAND with trace to little fines. Dark Grey (10YR 4/1). ~90-95% fine to medium sand, ~5-10% low plasticity fines. Wet to saturated. Very loose to compact. Trace coarse sand.	67.0
						SW		SAND with some GRAVEL, trace fines. Wet to Saturated. Compact to dense. Submitted sample for lab analyses. 14.6% fine gravel, 10.5% coarse sand, 18% medium sand, 56.8% fine sand, 0.1% low plasticity fines.	
	10 30 35	18	SPT		70				71.0
						ML-CL		CLAYEY SILT with some fine SAND. Dark Greenish Grey (Gley1 4/5GY). ~15-25% fine sand, ~75-85% low plasticity fines. Moist. Hard. Dense.	72.5
						SW		SAND with trace fines. Dark Grey (10YR 4/1). ~5-10% coarse sand, ~40-50% medium sand, ~30-40% fine sand, ~5% low plasticity fines. Saturated. Compact.	
	10 22 47	18	MC		75			Submitted sample for lab analyses. Unit Weight: Wet 113.8, Dry 97.6. MC = 16.6.	75.8
						SP		SAND with trace fines. Dark Grey (10YR 4/1). ~60-70% fine sand, ~20-30% medium sand, ~5-10% low plasticity fines. Saturated. Dense to compact.	
					80			Little fines.	81.0
						CH		FAT CLAY with trace fine SAND. Greenish Grey (Gley1 5/5GY). Moist.	



APPENDIX B
GEOTECHNICAL LABORATORY RESULTS

MOISTURE CONTENT & UNIT WEIGHT TEST RESULTS

Sample Identification	Depth, ft.	Wet Unit Weight, lb/ft.^{3}	Dry Unit Weight, lb/ft.^{3}	Moisture Content, %
EB	51	152.5	128.4	18.8
EB	75	154.1	126.9	21.4
EB	100	95.6	73.4	30.3
MW-1	50	110.0	90.4	21.6
MW-1	75.5	105.8	82.6	28.1
MW-1	91	123.0	96.2	27.9
MW-2	50.5	117.5	96.1	22.2
MW-2	75.5	115.9	86.9	33.3
MW-2	90	103.9	83.6	24.3

Test Method: ASTM D2216, ASTM D2937

PROJECT NUMBER: 07-116 January 23, 2007

Jungo Rd

SIERRA TESTING LABORATORIES, INC.
GEOTECHNICAL AND MATERIALS TESTING SERVICES

5040 Robert J. Mathews Blvd., El Dorado Hills, CA 95762
Phone: (916) 939-3460 FAX: (916) 939-3507

MOISTURE CONTENT & UNIT WEIGHT TEST RESULTS

Sample Identification	Depth, ft.	Wet Unit Weight, lb/ft.^{3}	Dry Unit Weight, lb/ft.^{3}	Moisture Content, %
MW-3	50	120.6	97.0	24.3
MW-3	76	106.4	87.8	21.1
MW-3	100	114.0	97.8	16.6
MW-4	51	121.1	94.8	27.8
MW-4	75	113.8	97.6	16.6
MW-4	95.5	112.8	87.8	28.4

Test Method: ASTM D2216, ASTM D2937

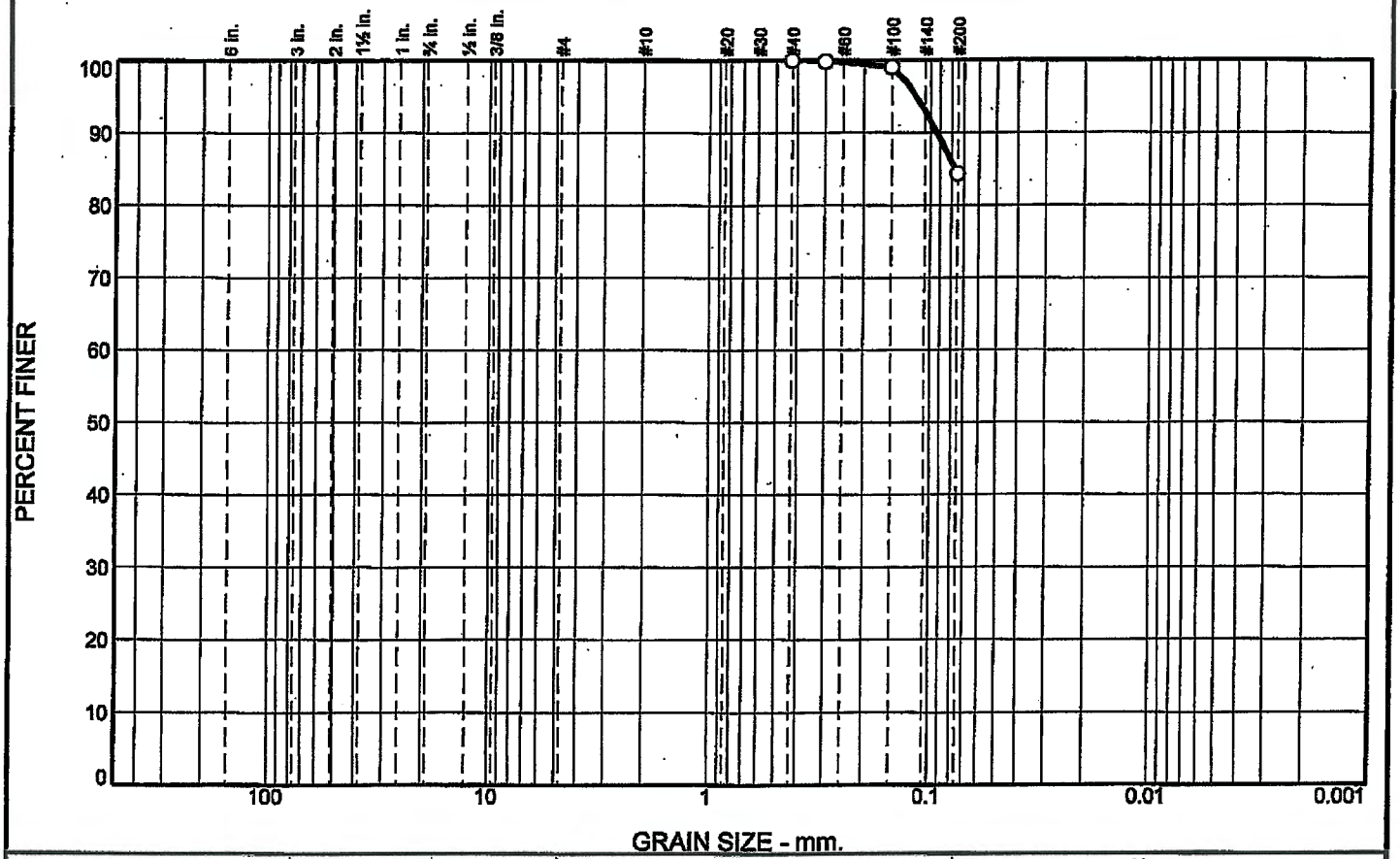
PROJECT NUMBER: 07-116 | January 23, 2007

Jungo Rd

SIERRA TESTING LABORATORIES, INC.
GEOTECHNICAL AND MATERIALS TESTING SERVICES

5040 Robert J. Mathews Blvd., El Dorado Hills, CA 95762
Phone: (916) 939-3460 FAX: (916) 939-3507

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	15.7	84.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#40	100.0		
#50	99.9		
#100	99.0		
#200	84.3		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.0769 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

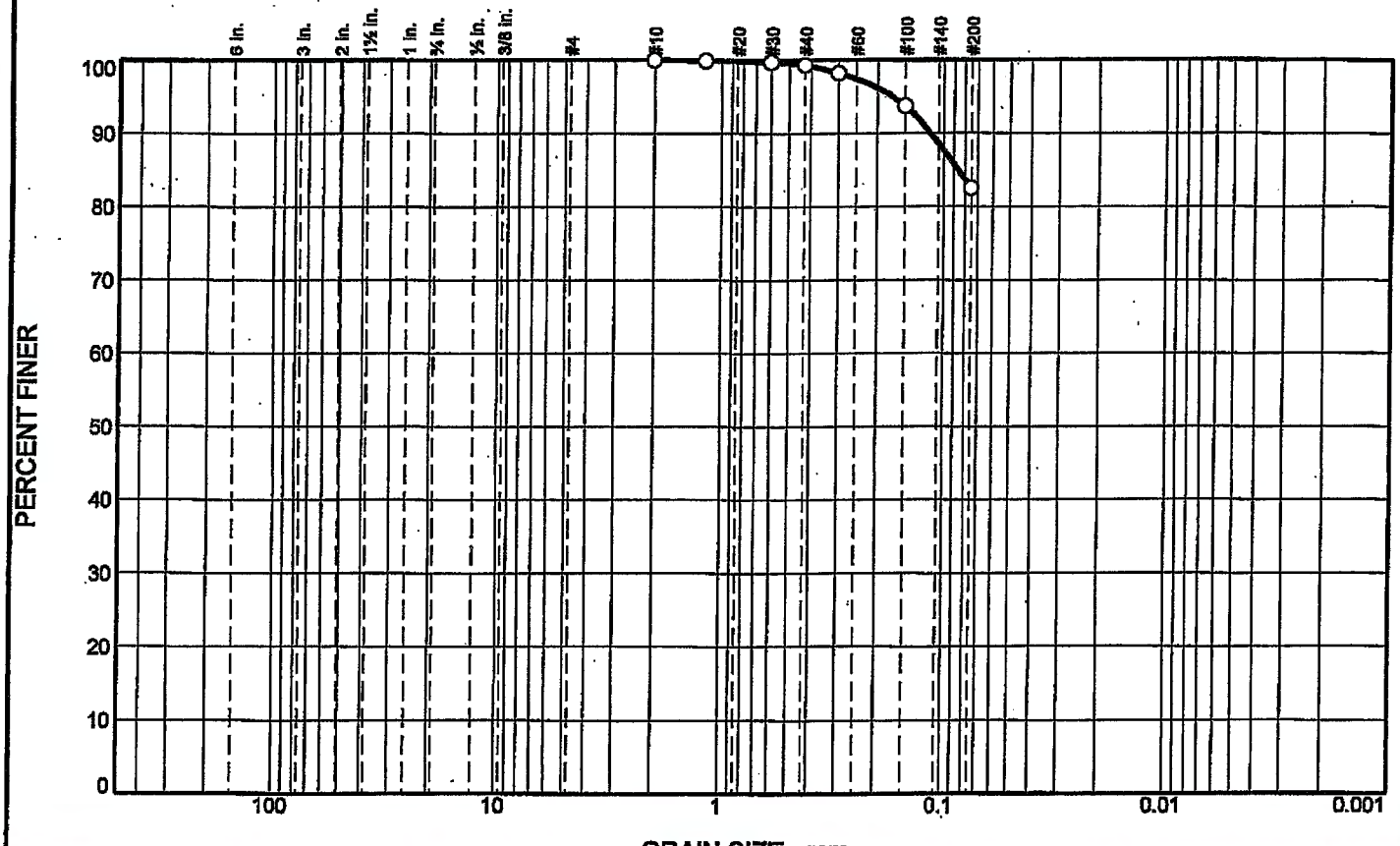
Sample Number: EB
Source of Sample: EB **Depth:** 20.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.7	16.8	82.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#16	99.9		
#30	99.7		
#40	99.3		
#50	98.2		
#100	93.7		
#200	82.5		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.0858 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

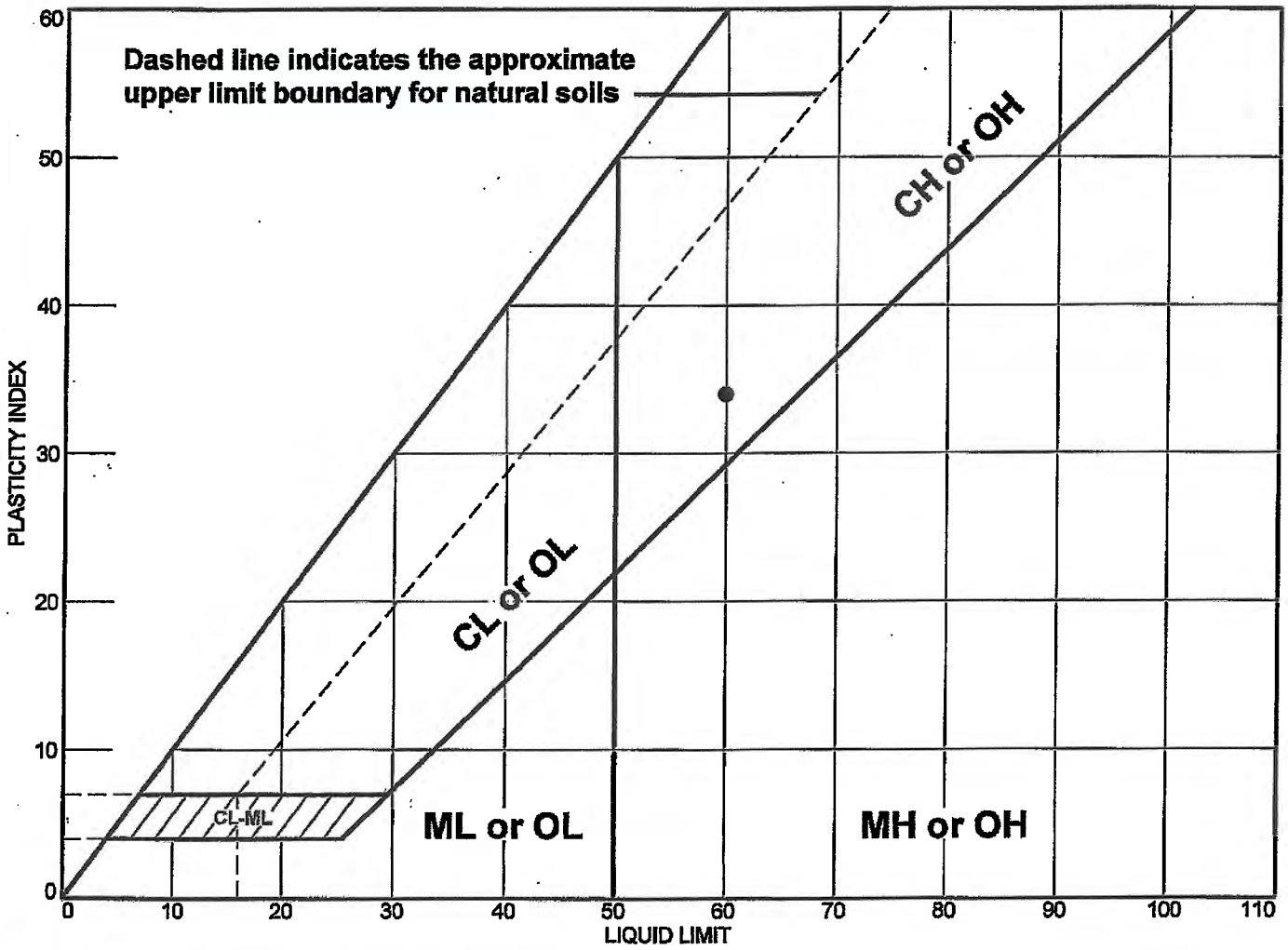
Sample Number: EB
Source of Sample: EB **Depth:** 60.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		60	26	34	95.6	82.3	CH

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd

Golder Job No. 063-7079

● **Source of Sample:** EB **Depth:** 80.0 **Sample Number:** EB

Remarks:

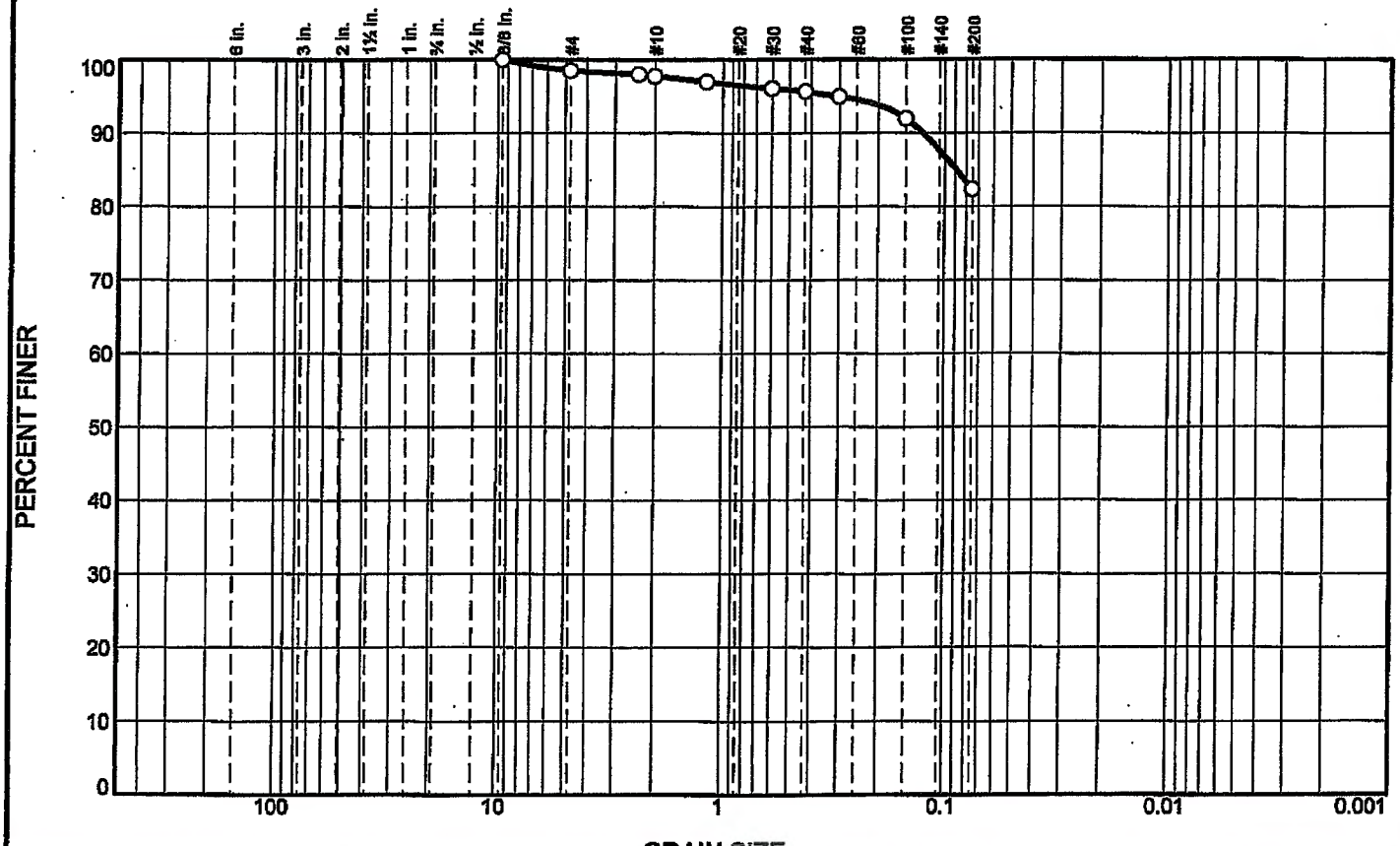
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure

Tested By: MS **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.5	0.7	2.2	13.3	82.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 Inch	100.0		
#4	98.5		
#8	98.0		
#10	97.8		
#16	97.0		
#30	96.1		
#40	95.6		
#50	95.0		
#100	91.9		
#200	82.3		

* (no specification provided)

Material Description

Atterberg Limits

PL= 26 LL= 60 PI= 34

Coefficients

D_{85}= 0.0885 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(30)

Remarks

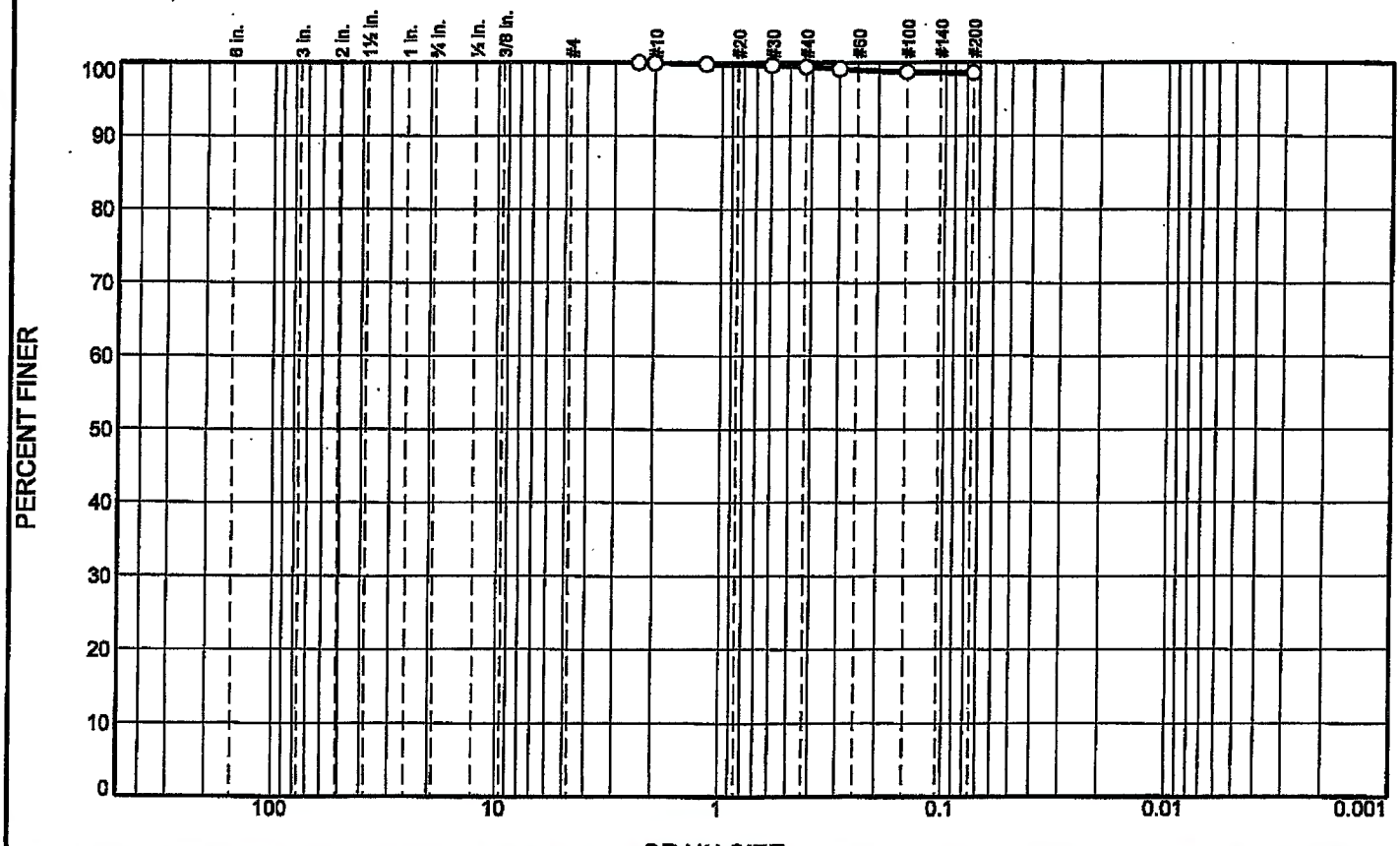
Sample Number: EB
Source of Sample: EB **Depth:** 80.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.4	0.9	98.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#8	100.0		
#10	99.9		
#16	99.8		
#30	99.7		
#40	99.5		
#50	99.1		
#100	98.7		
#200	98.6		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

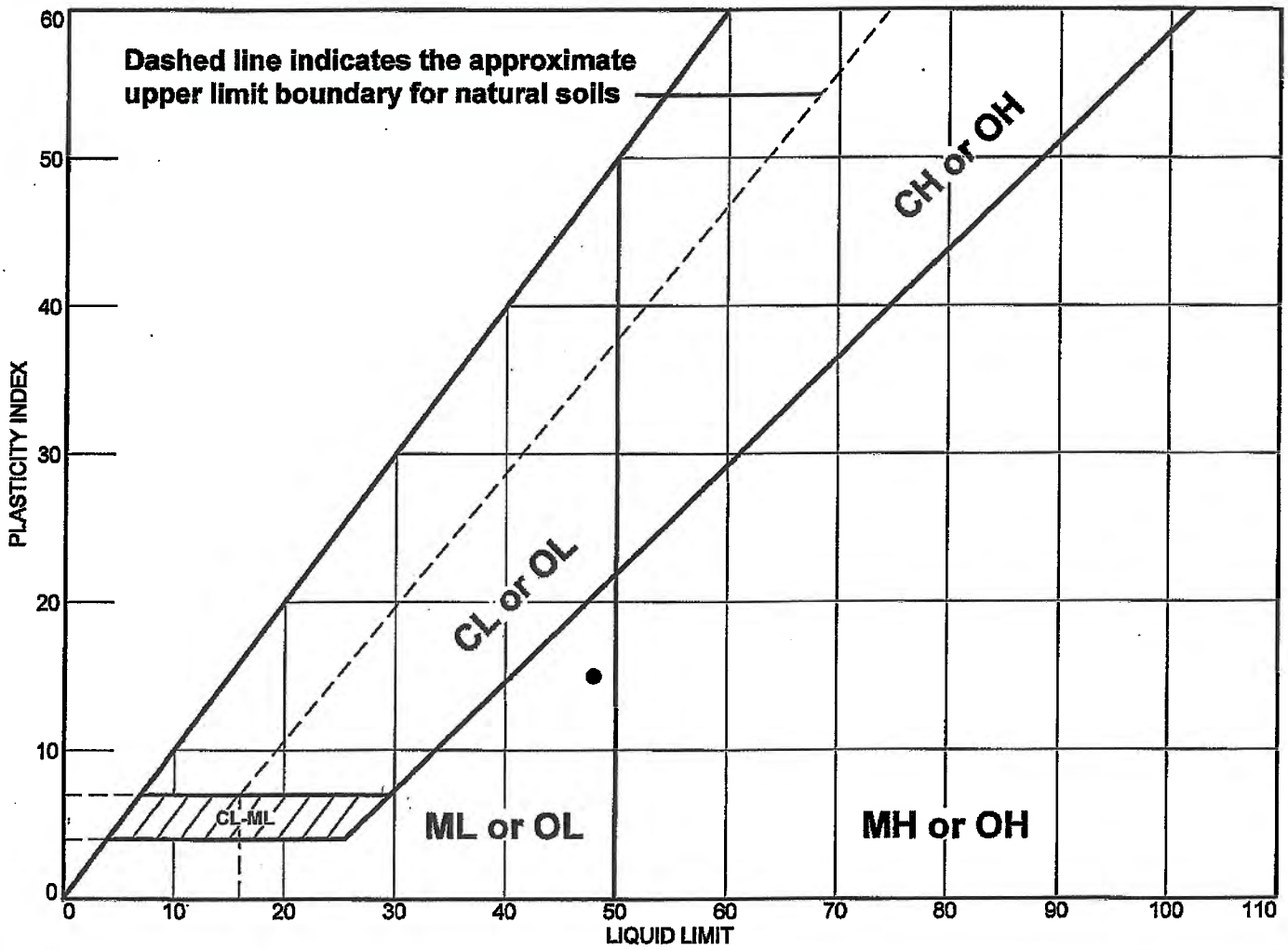
Sample Number: EB
Source of Sample: EB **Depth:** 110.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		48	33	15	87.2	65.9	ML

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd

Golder Job No. 063-7079

● **Source of Sample:** EB **Depth:** 130.0 **Sample Number:** EB

Remarks:

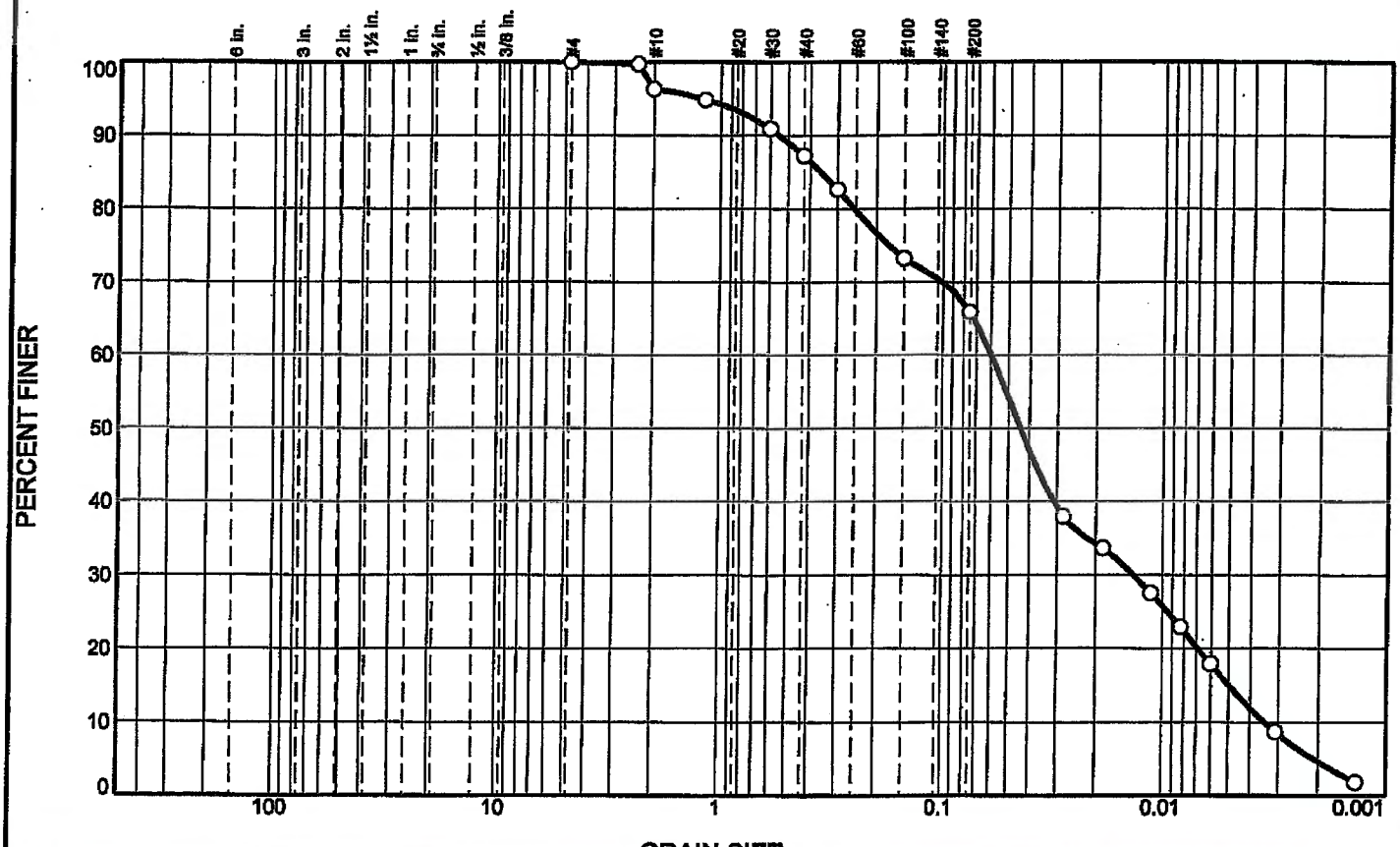
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure

Tested By: JS **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	3.7	9.1	21.3	50.8	15.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.7		
#10	96.3		
#16	94.8		
#30	90.9		
#40	87.2		
#50	82.6		
#100	73.3		
#200	65.9		

* (no specification provided)

Material Description

Atterberg Limits

PL= 33 LL= 48 PI= 15

Coefficients

D_{85}= 0.3564 D_{60}= 0.0596 D_{50}= 0.0438
D_{30}= 0.0134 D_{15}= 0.0050 D_{10}= 0.0034
C_u= 17.32 C_c= 0.87

Classification

USCS= ML AASHTO= A-7-5(10)

Remarks

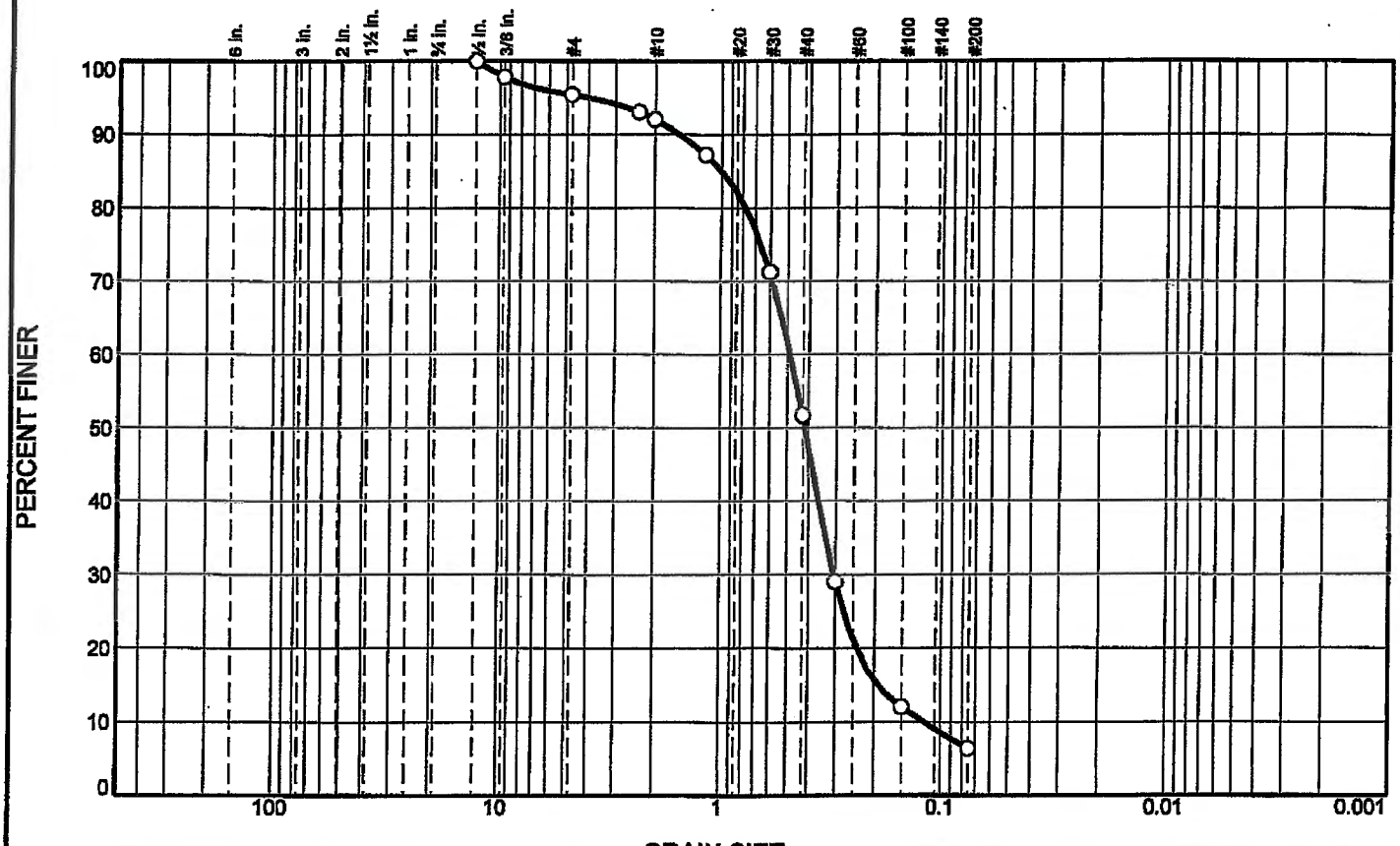
Sample Number: EB
Source of Sample: EB **Depth:** 130.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	4.6	3.4	40.2	45.4	6.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2 Inch	100.0		
3/8 Inch	97.8		
#4	95.4		
#8	93.1		
#10	92.0		
#16	87.2		
#30	71.3		
#40	51.8		
#50	29.1		
#100	12.1		
#200	6.4		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.9937 D_{60}= 0.4837 D_{50}= 0.4140
D_{30}= 0.3051 D_{15}= 0.1928 D_{10}= 0.1185
C_u= 4.08 C_c= 1.62

Classification

USCS= AASHTO=

Remarks

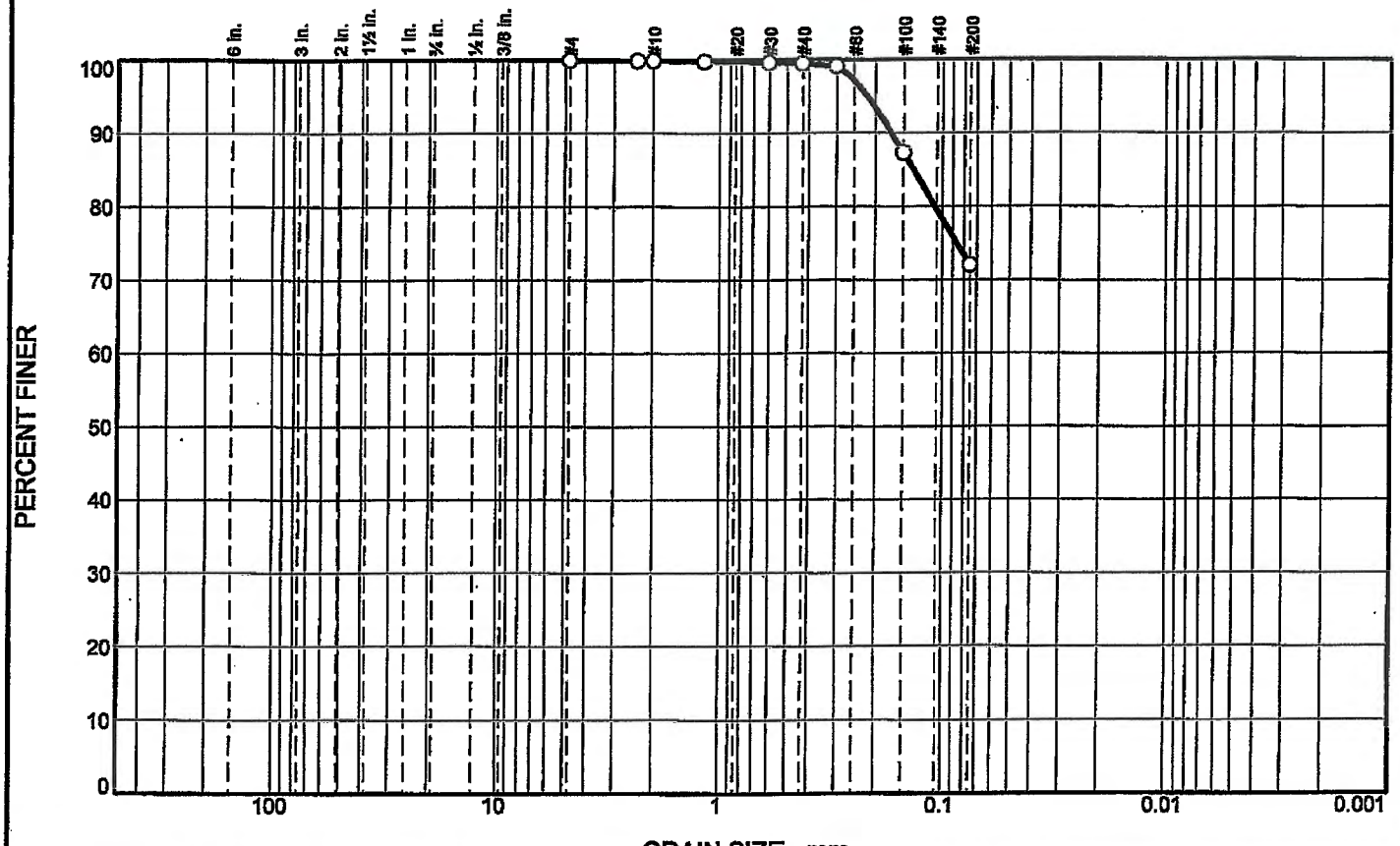
Sample Number: EB
Source of Sample: EB **Depth:** 145.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.4	27.5	72.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.9		
#10	99.9		
#16	99.8		
#30	99.6		
#40	99.5		
#50	99.1		
#100	87.3		
#200	72.0		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.1352 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

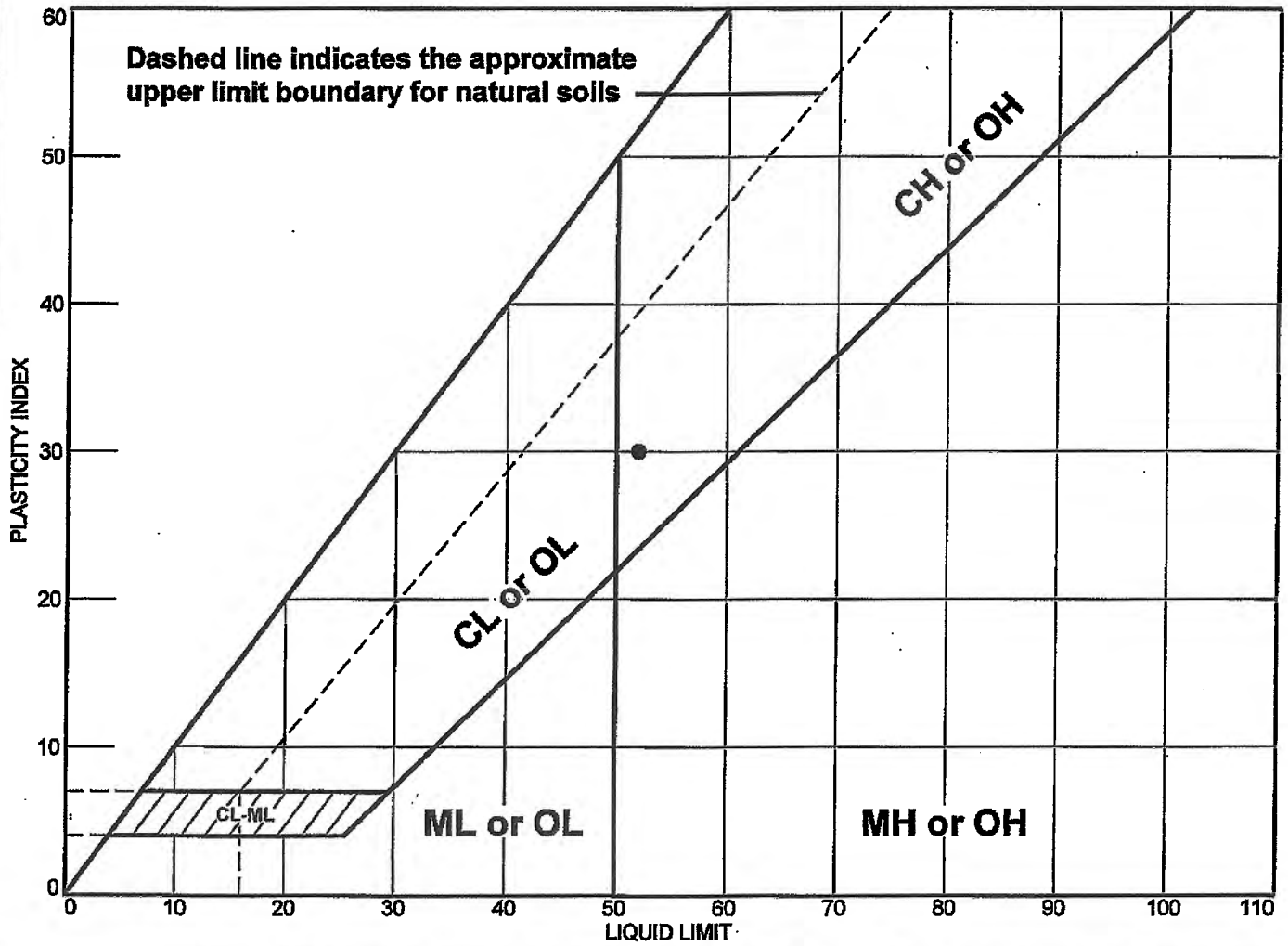
Sample Number: MW-1
Source of Sample: MW-1 **Depth:** 30.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		52	22	30	98.3	88.0	CH

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd

Golder Job No. 063-7079

● **Source of Sample:** MW-1 **Depth:** 45.0 **Sample Number:** MW-1

Remarks:

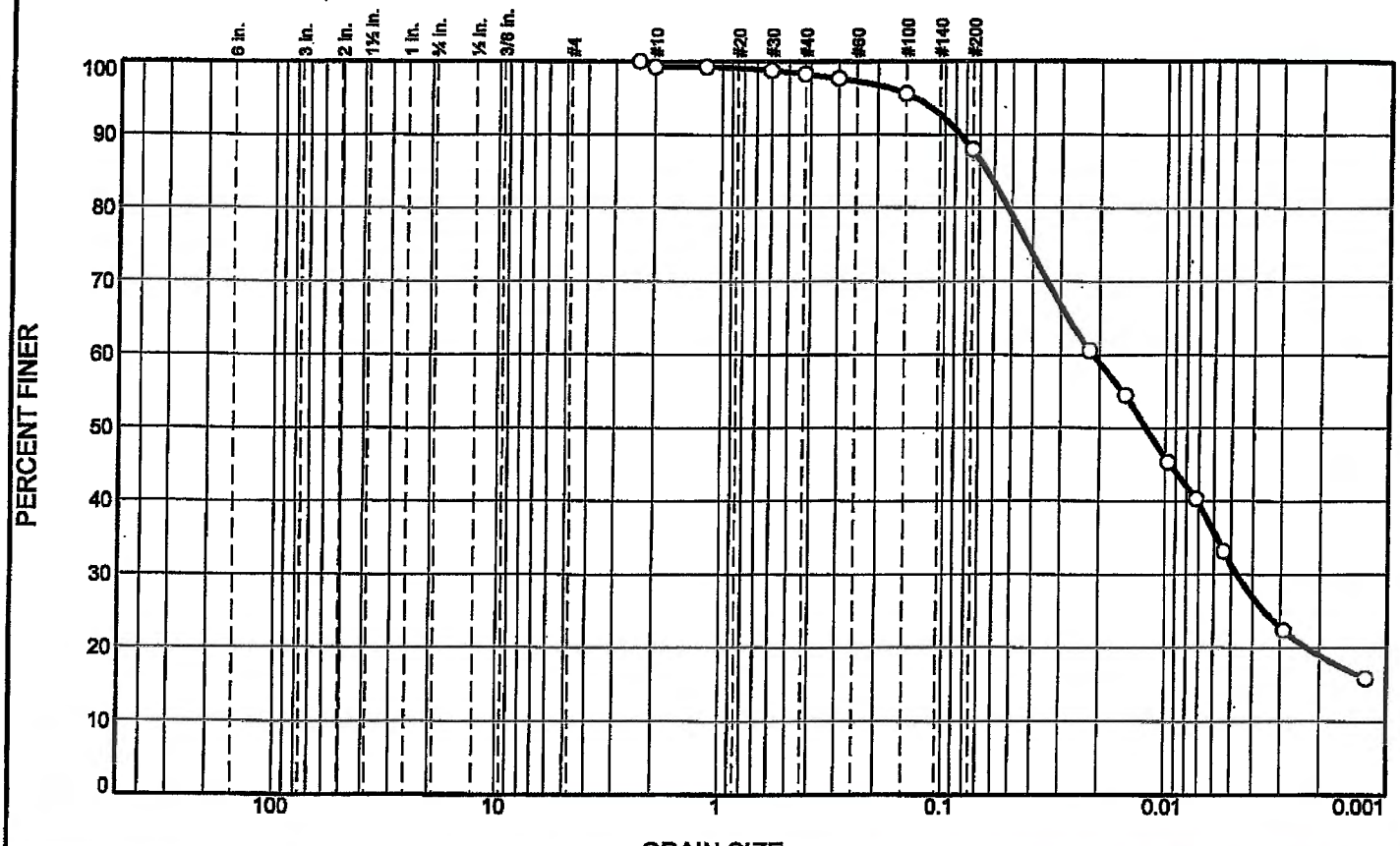
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure

Tested By: JS **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.8	0.9	10.3	56.7	31.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#8	100.0		
#10	99.2		
#16	99.2		
#30	98.8		
#40	98.3		
#50	97.7		
#100	95.6		
#200	88.0		

* (no specification provided)

Material Description

Atterberg Limits

PL= 22 LL= 52 PI= 30

Coefficients

D_{85}= 0.0643 D_{60}= 0.0214 D_{50}= 0.0123
D_{30}= 0.0047 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(28)

Remarks

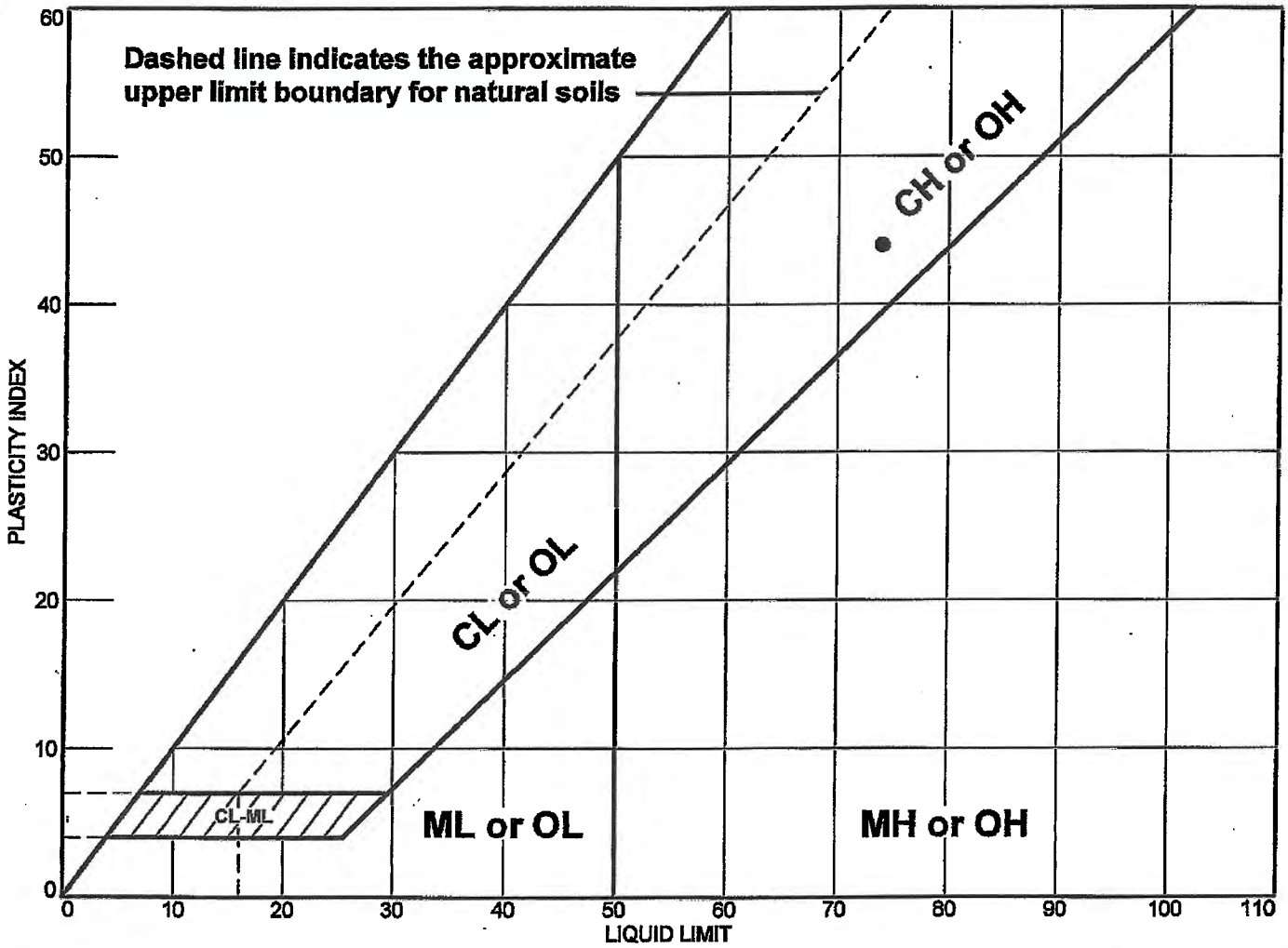
Sample Number: MW-1
Source of Sample: MW-1 **Depth:** 45.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: MPW **Checked By:** CMW

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		74	30	44	98.6	96.6	CH

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd

Golder Job No. 063-7079

● **Source of Sample:** MW-1 **Depth:** 76.5 **Sample Number:** MW-1

Remarks:

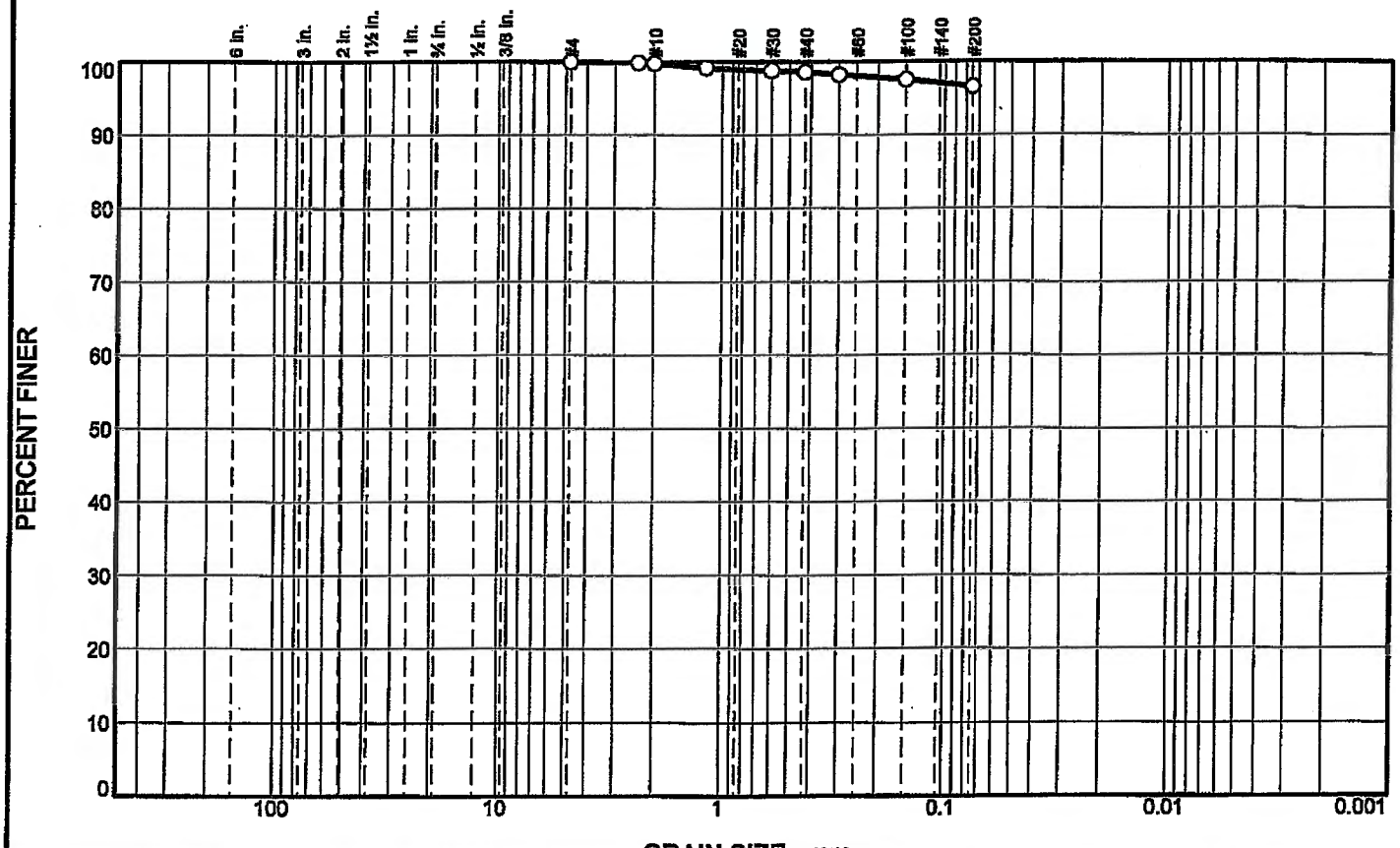
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure

Tested By: JS **Checked By:** Jf

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	1.2	2.0	96.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.9		
#10	99.8		
#16	99.2		
#30	98.8		
#40	98.6		
#50	98.2		
#100	97.5		
#200	96.6		

* (no specification provided)

Material Description

Atterberg Limits

PL= 30 LL= 74 PI= 44

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO= A-7-5(51)

Remarks

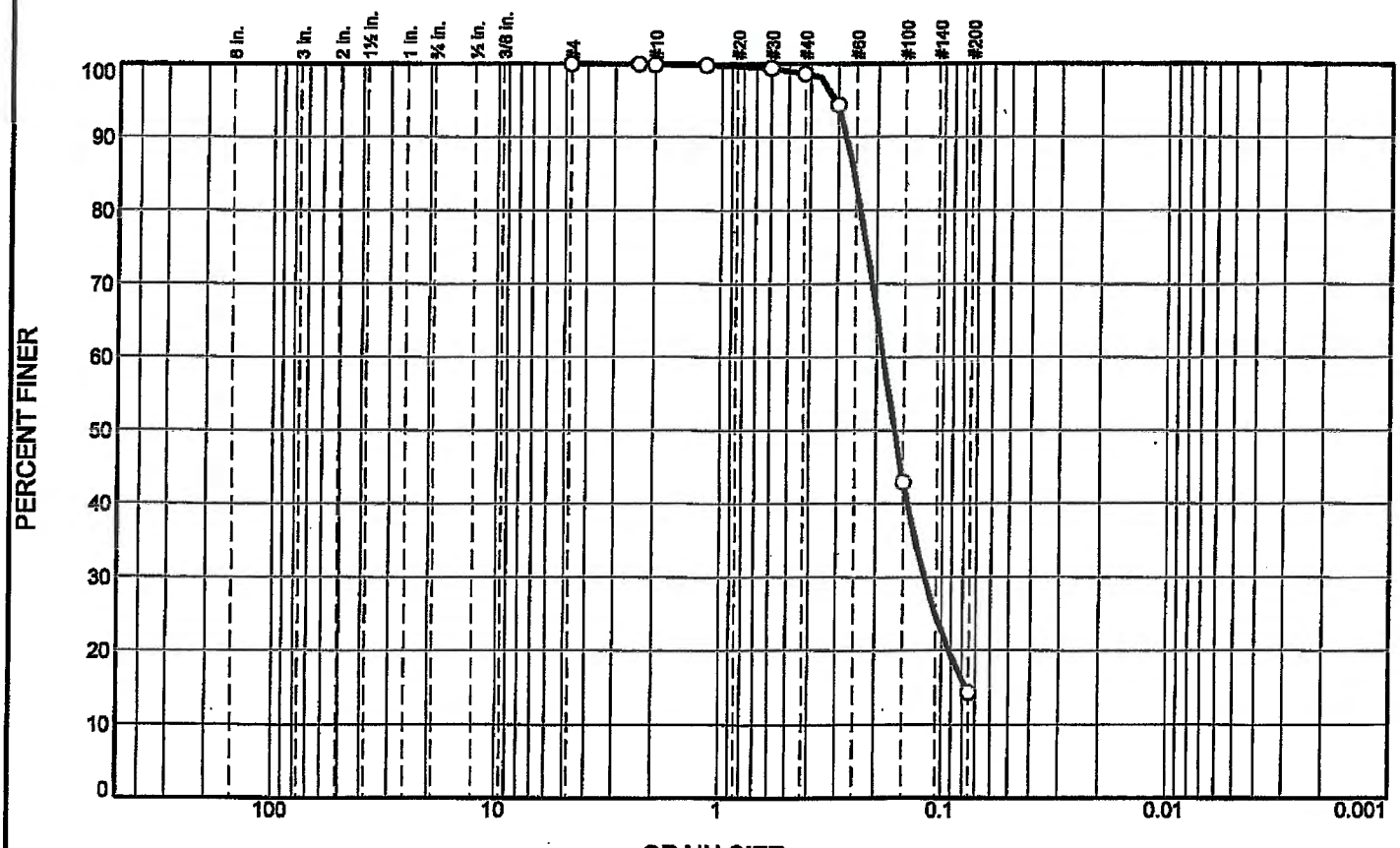
Sample Number: MW-1
Source of Sample: MW-1 **Depth:** 76.5 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	1.2	84.4	14.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.9		
#10	99.9		
#16	99.8		
#30	99.4		
#40	98.7		
#50	94.4		
#100	43.0		
#200	14.3		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.2522 D_{60}= 0.1854 D_{50}= 0.1646
D_{30}= 0.1199 D_{15}= 0.0769 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

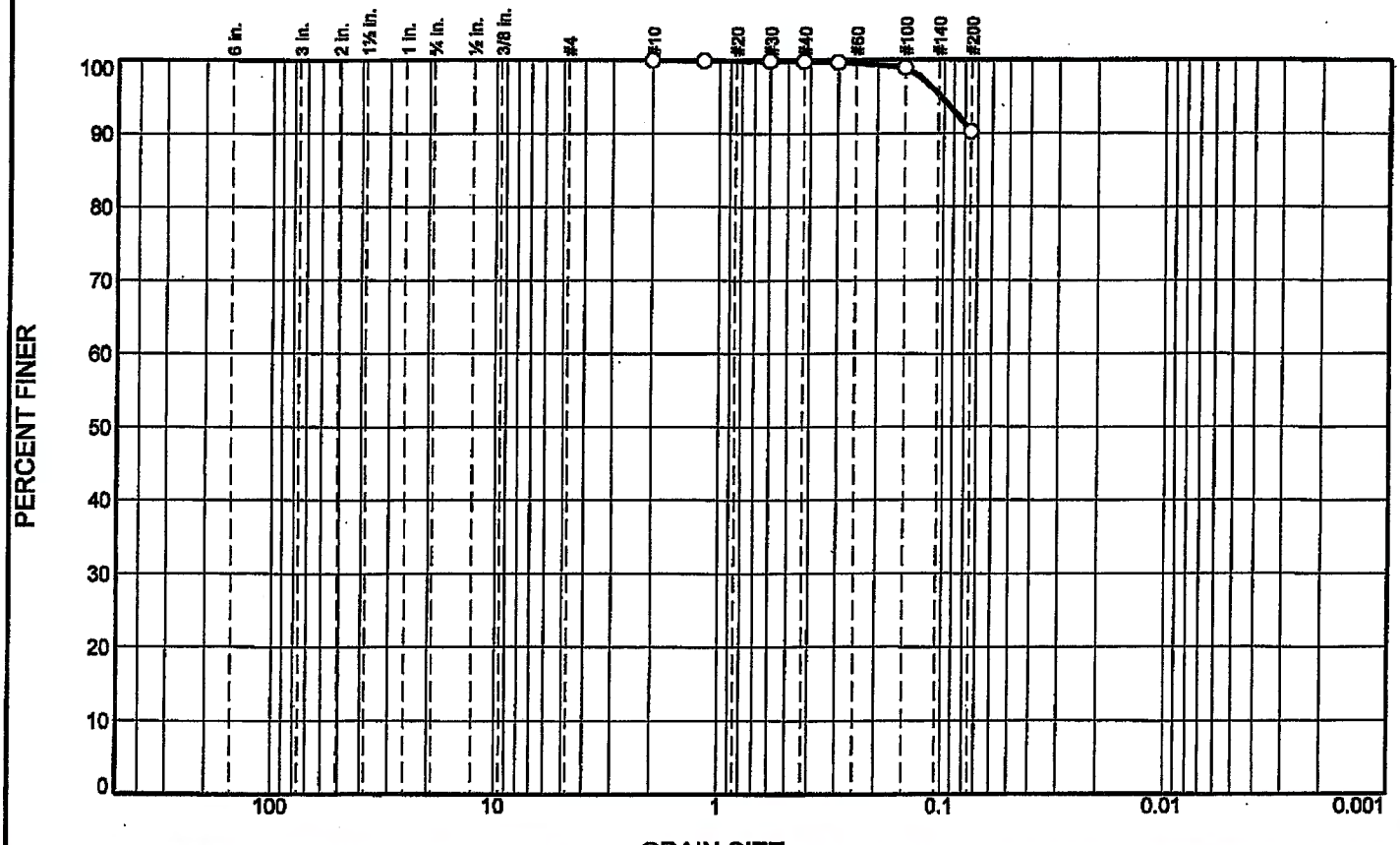
Sample Number: MW-1
Source of Sample: MW-1 **Depth:** 100.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	9.5	90.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#16	99.9		
#30	99.9		
#40	99.8		
#50	99.7		
#100	99.0		
#200	90.3		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

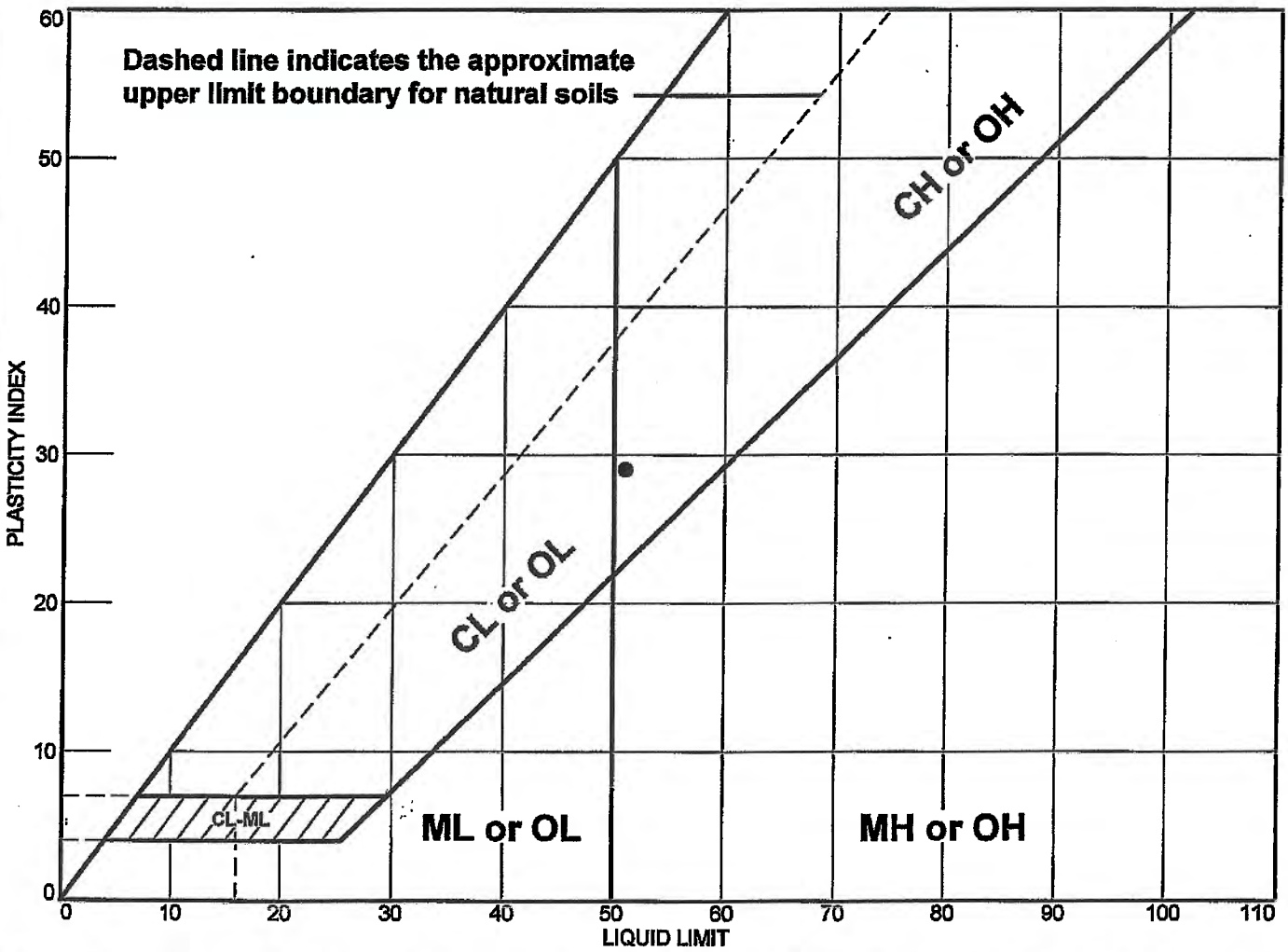
Sample Number: MW-2
Source of Sample: MW-2 **Depth:** 20.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		51	22	29	99.0	6.4	SP-SC

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd

Golder Job No. 063-7079

● **Source of Sample:** MW-2 **Depth:** 45.0 **Sample Number:** MW-2

Remarks:

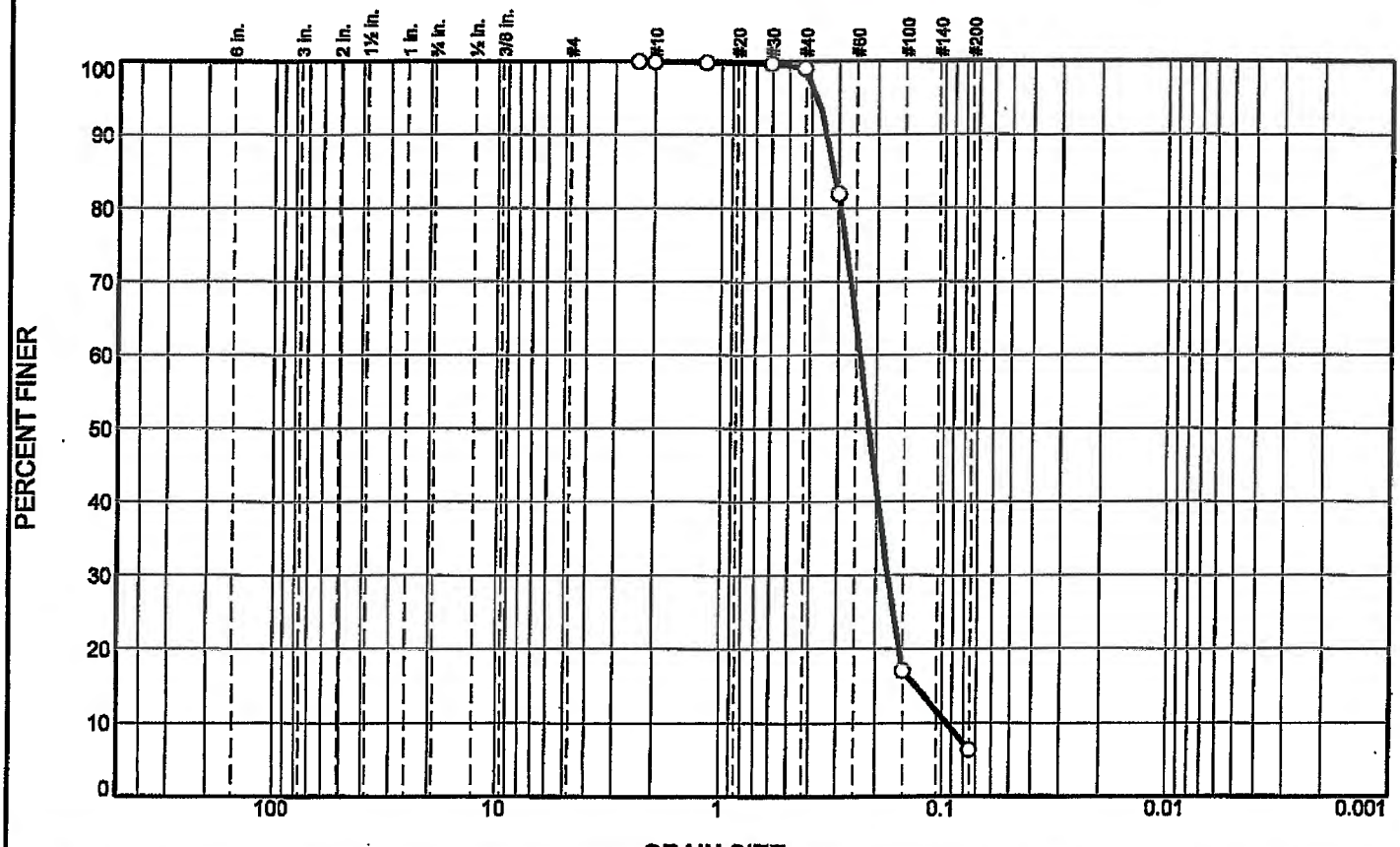
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure

Tested By: MS **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.9	92.6	6.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#8	100.0		
#10	99.9		
#16	99.8		
#30	99.7		
#40	99.0		
#50	81.9		
#100	17.1		
#200	6.4		

* (no specification provided)

Material Description

Atterberg Limits

PL= 22 LL= 51 PI= 29

Coefficients

D_{85}= 0.3125 D_{60}= 0.2373 D_{50}= 0.2156
D_{30}= 0.1766 D_{15}= 0.1312 D_{10}= 0.0949
C_u= 2.50 C_c= 1.39

Classification

USCS= SP-SC AASHTO= A-2-7(0)

Remarks

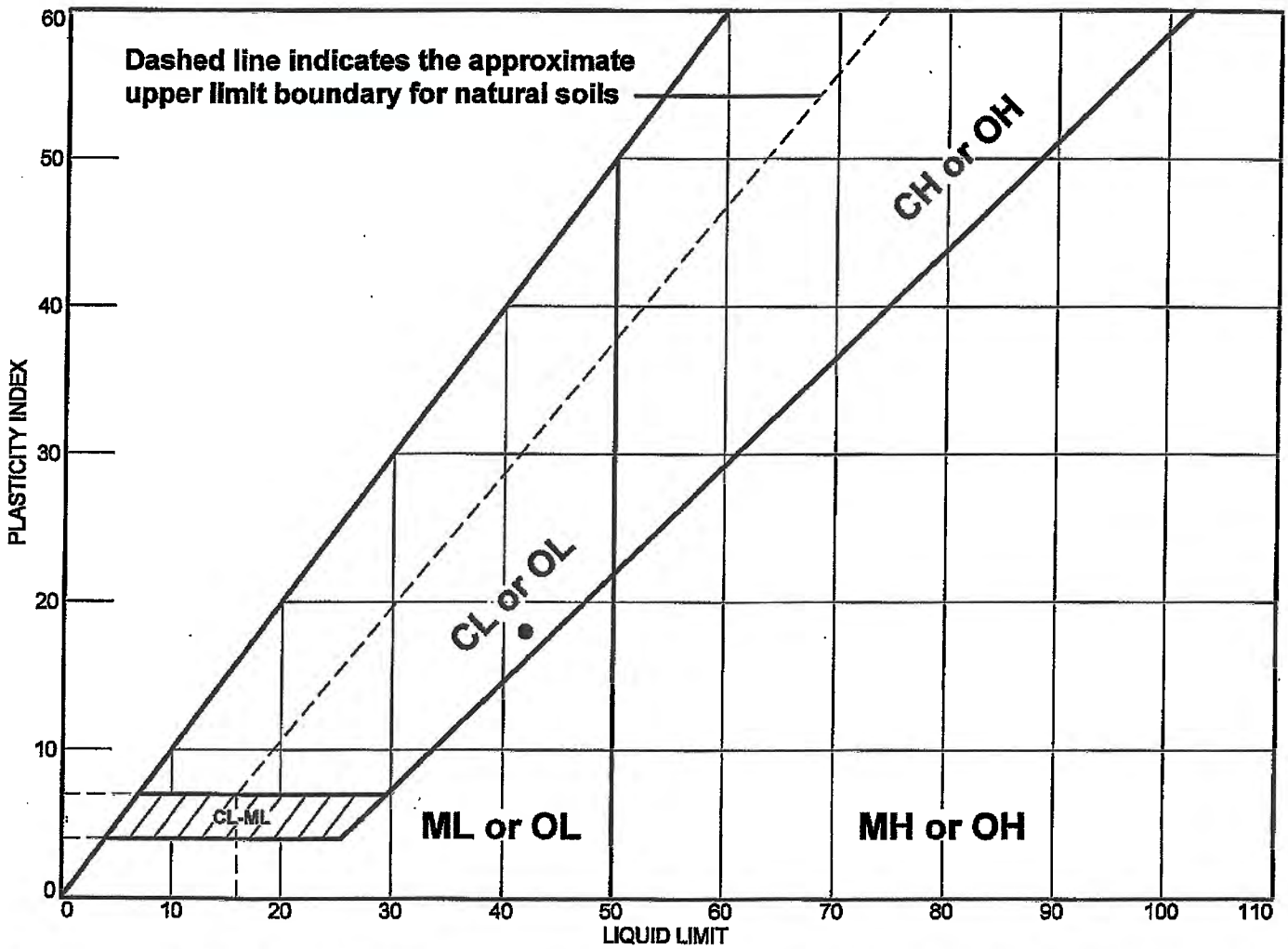
Sample Number: MW-2
Source of Sample: MW-2 **Depth:** 45.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		42	24	18	94.3	81.6	CL

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd

Golder Job No. 063-7079

● **Source of Sample:** MW-2 **Depth:** 60.0 **Sample Number:** MW-2

Remarks:

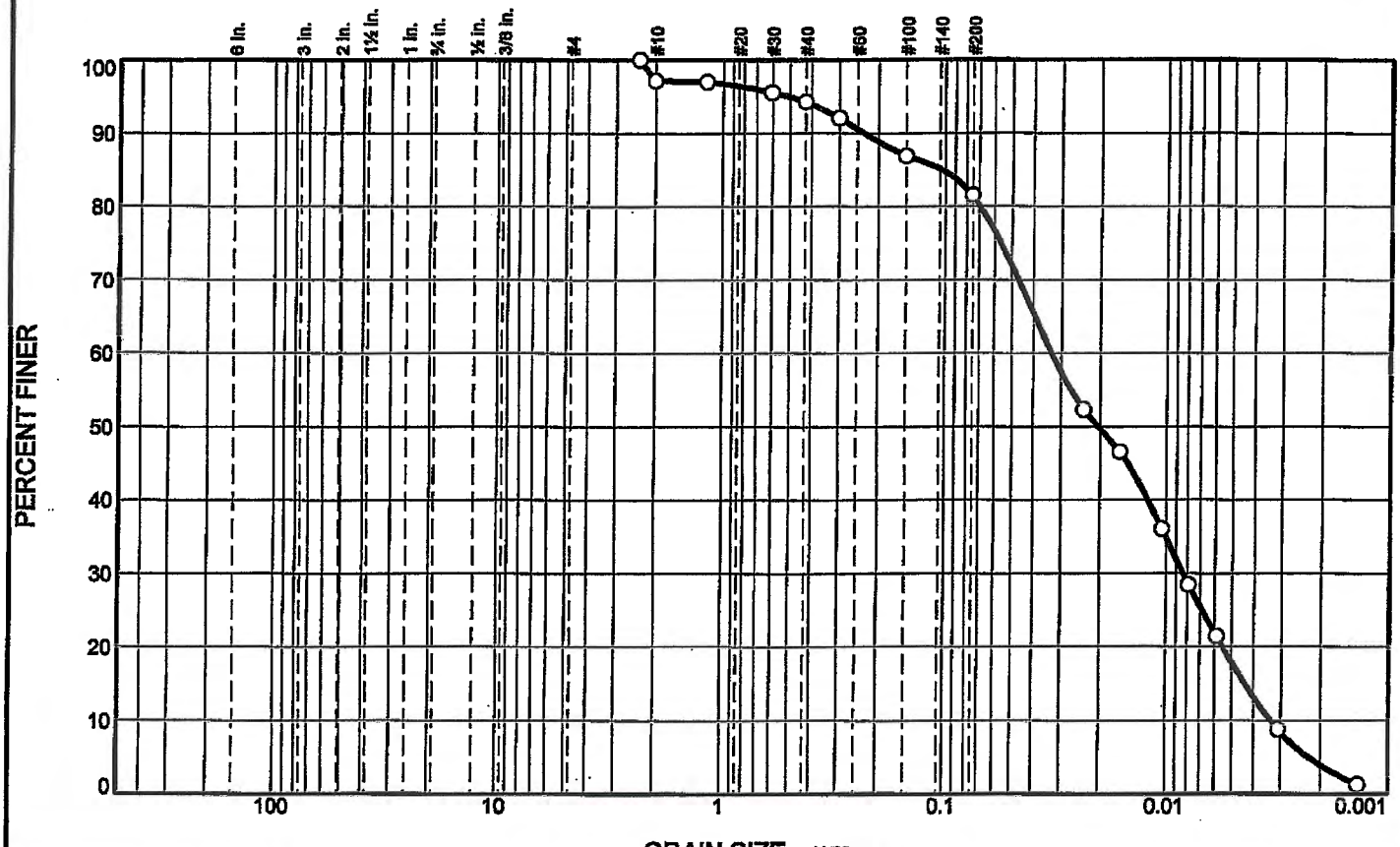
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure

Tested By: MS **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	2.9	2.8	12.7	63.6	18.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#8	100.0		
#10	97.1		
#16	97.0		
#30	95.6		
#40	94.3		
#50	92.1		
#100	86.9		
#200	81.6		

* (no specification provided)

Material Description

Atterberg Limits

PL= 24 LL= 42 PI= 18

Coefficients

D_{85}= 0.1024 D_{60}= 0.0329 D_{50}= 0.0203
D_{30}= 0.0084 D_{15}= 0.0043 D_{10}= 0.0033
C_u= 9.89 C_c= 0.64

Classification

USCS= CL AASHTO= A-7-6(15)

Remarks

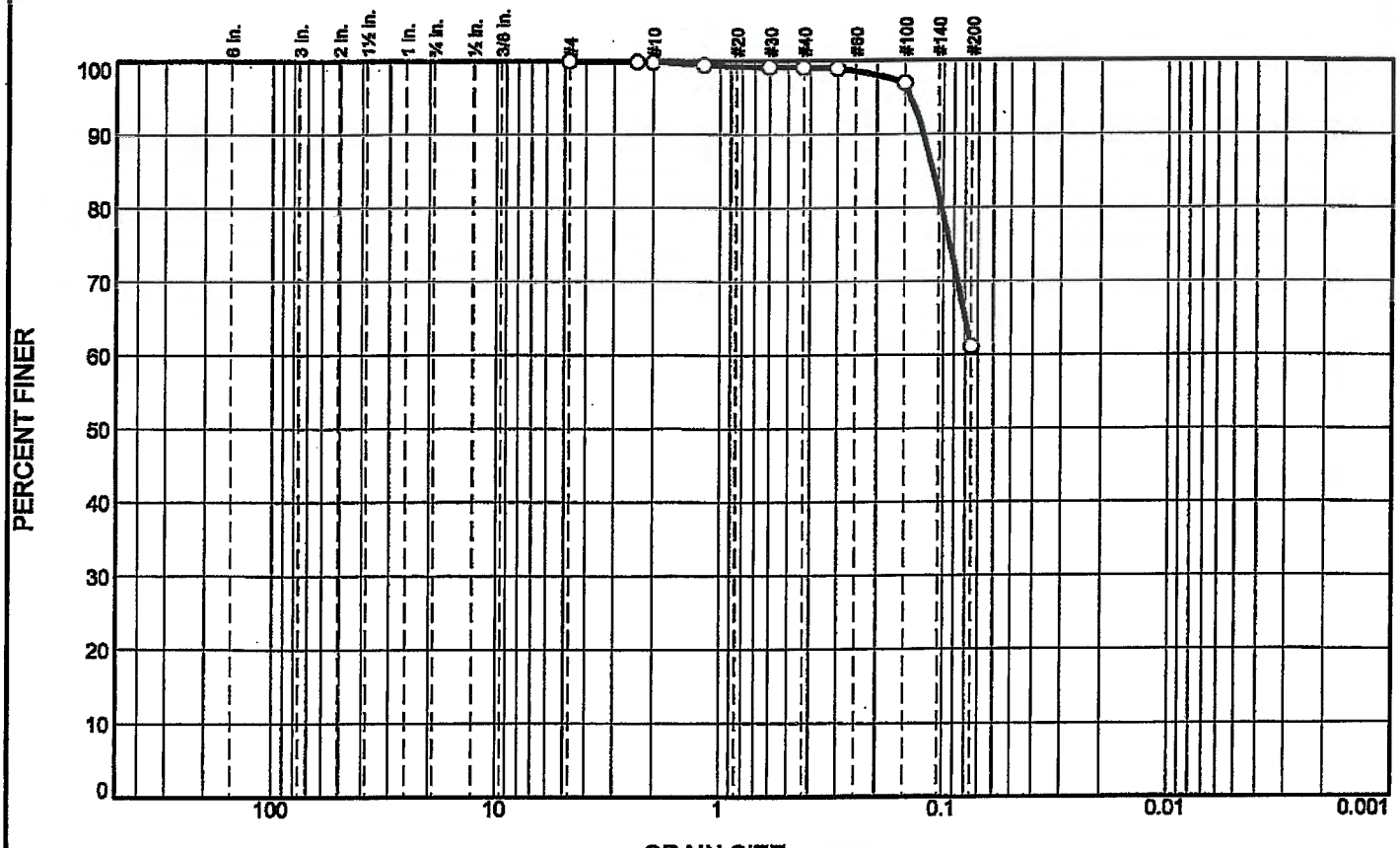
Sample Number: MW-2
Source of Sample: MW-2 **Depth:** 60.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.8	38.0	61.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.9		
#10	99.9		
#16	99.4		
#30	99.1		
#40	99.1		
#50	98.9		
#100	96.9		
#200	61.1		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.1112 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

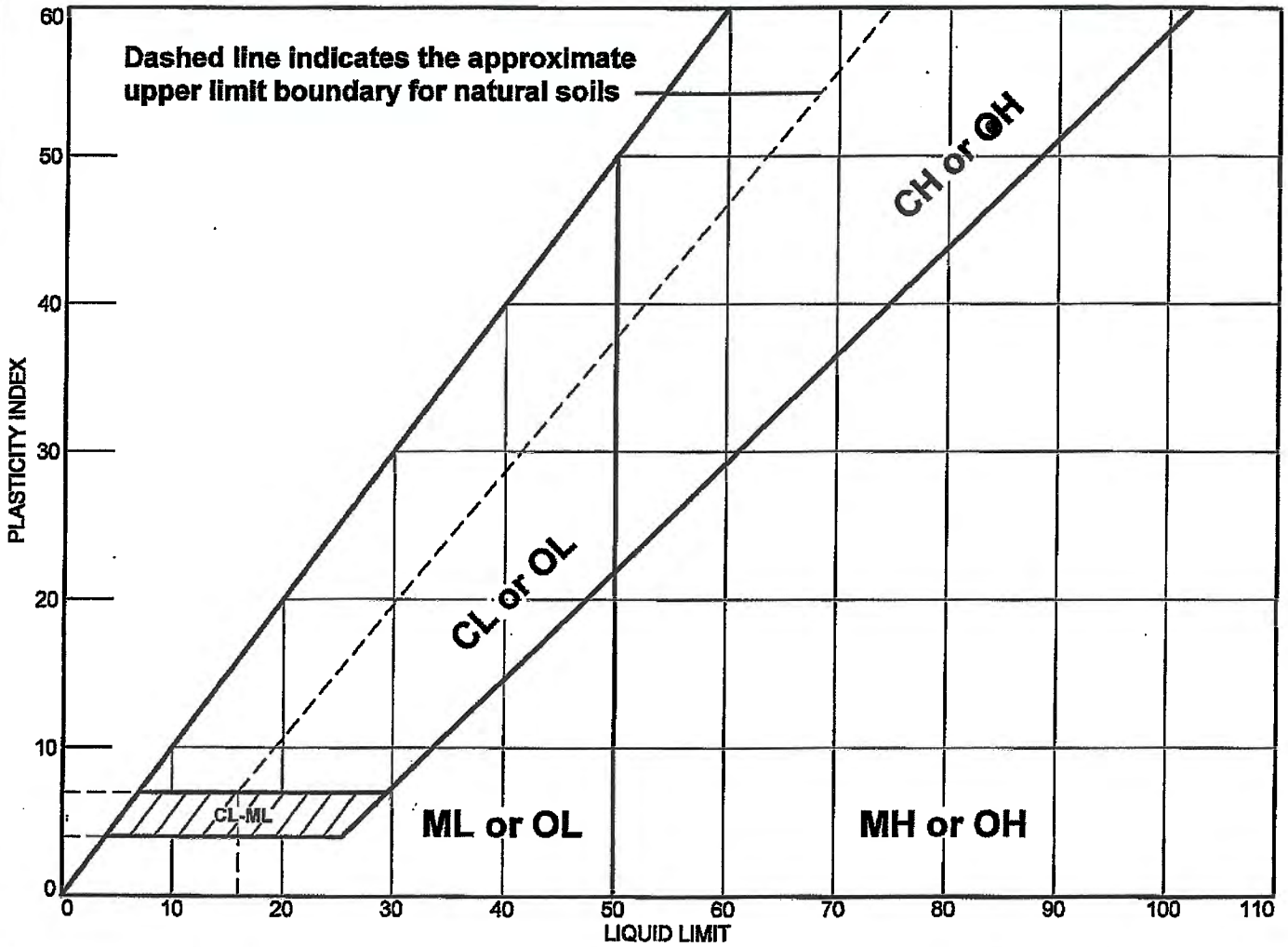
Sample Number: MW-2
Source of Sample: MW-2 **Depth:** 70.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		84	32	52	99.6	98.6	CH

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd

Golder Job No. 063-7079

● **Source of Sample:** MW-2 **Depth:** 90.5 **Sample Number:** MW-2

Remarks:

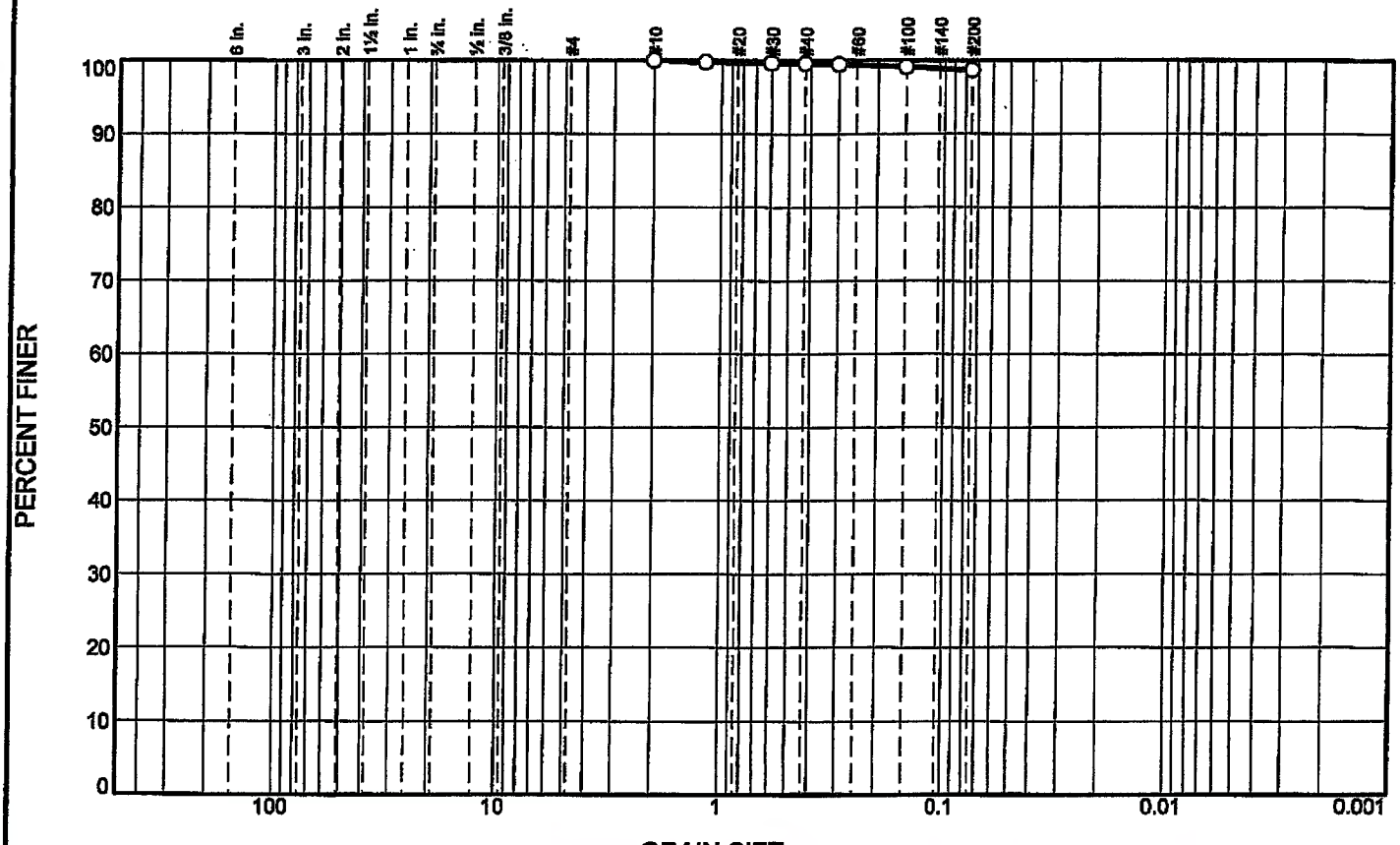
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure

Tested By: MS **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.4	1.0	98.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#16	99.8		
#30	99.7		
#40	99.6		
#50	99.5		
#100	99.2		
#200	98.6		

* (no specification provided)

Material Description

Atterberg Limits

PL= 32 LL= 84 PI= 52

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO= A-7-5(62)

Remarks

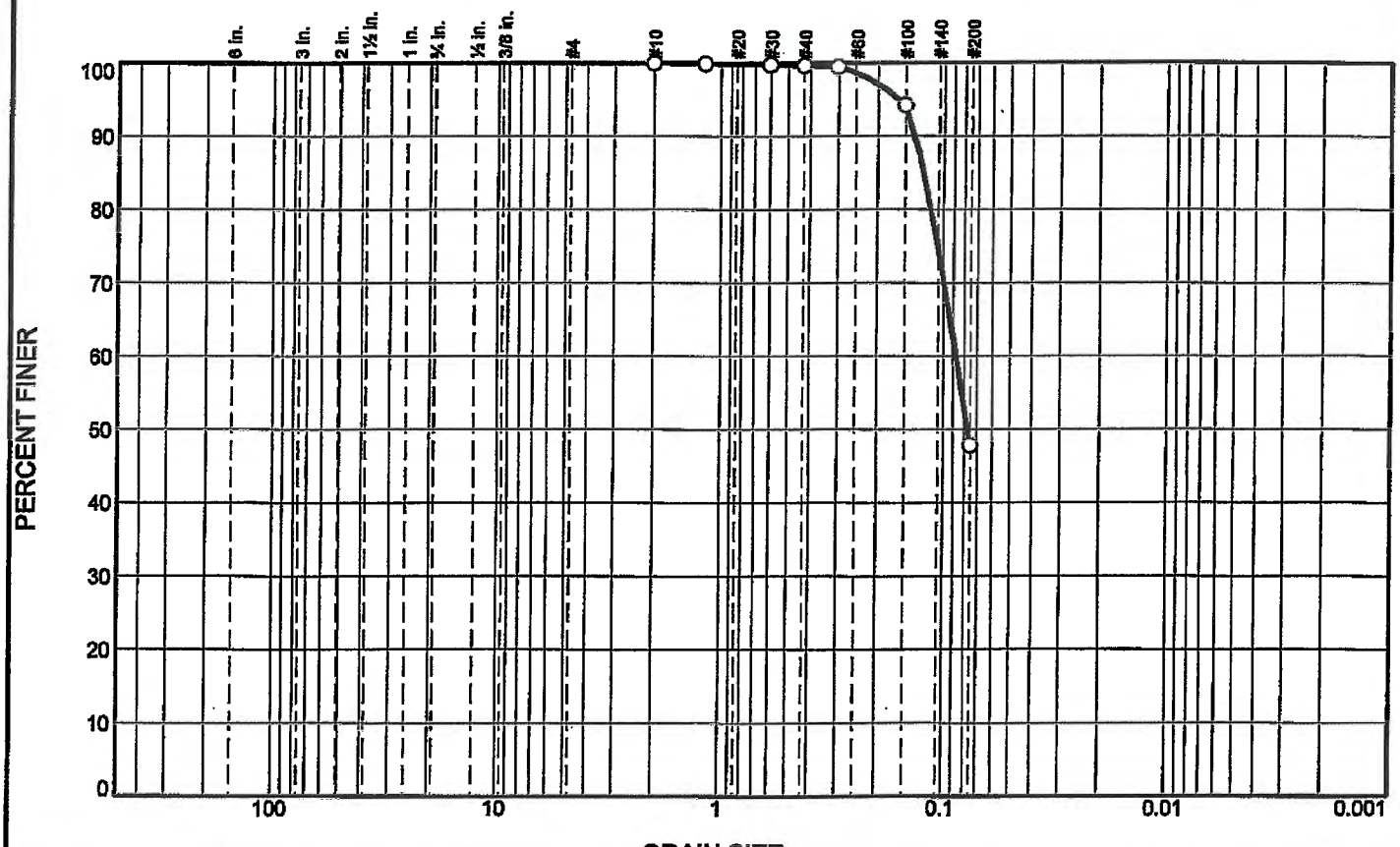
Sample Number: MW-2
Source of Sample: MW-2 **Depth:** 90.5 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.3	51.9	47.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#16	99.9		
#30	99.8		
#40	99.7		
#50	99.5		
#100	94.2		
#200	47.8		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.1236 D_{60}= 0.0870 D_{50}= 0.0770
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

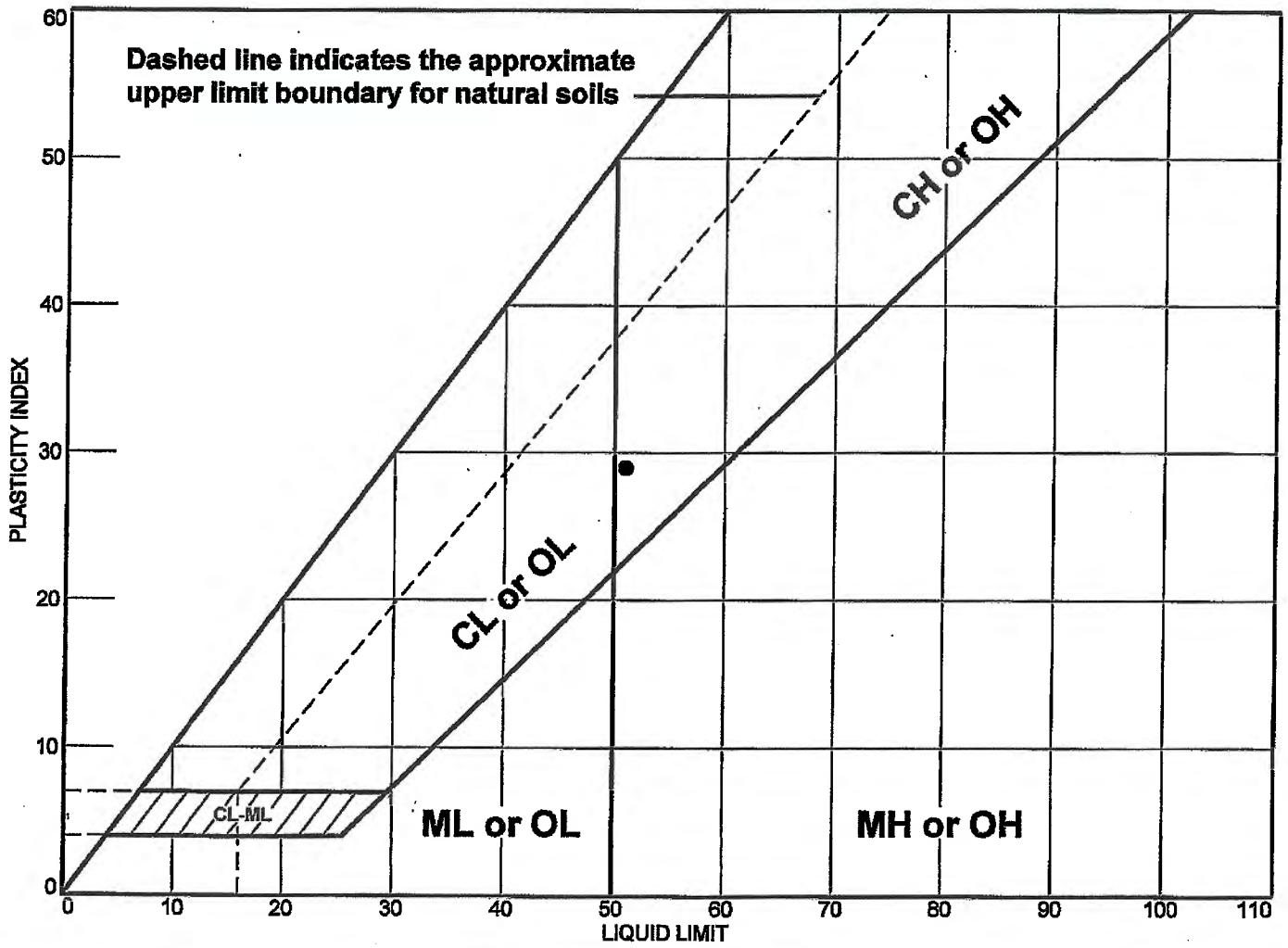
Sample Number: MW-3
Source of Sample: MW-3 **Depth:** 20.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		51	22	29	99.0	97.2	CH

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd

Golder Job No. 063-7079

● **Source of Sample:** MW-3 **Depth:** 45.0 **Sample Number:** MW-3

Remarks:

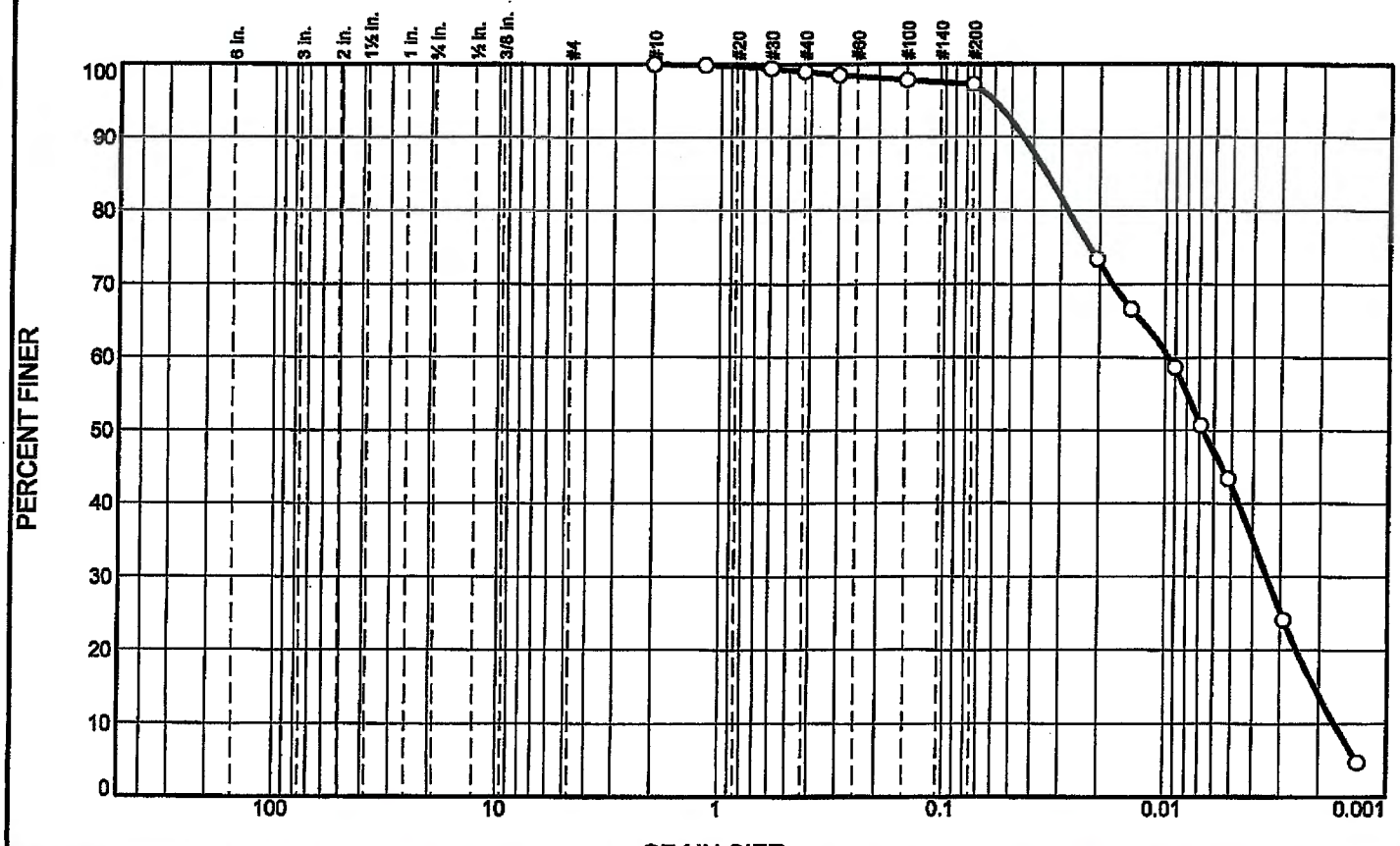
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure

Tested By: MS **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.0	1.8	54.8	42.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#16	99.9		
#30	99.4		
#40	99.0		
#50	98.5		
#100	97.8		
#200	97.2		

* (no specification provided)

Material Description

Atterberg Limits

PL= 22 LL= 51 PI= 29

Coefficients

D_{85}= 0.0345 D_{60}= 0.0095 D_{50}= 0.0067
D_{30}= 0.0034 D_{15}= 0.0021 D_{10}= 0.0017
C_u= 5.60 C_c= 0.73

Classification

USCS= CH AASHTO= A-7-6(31)

Remarks

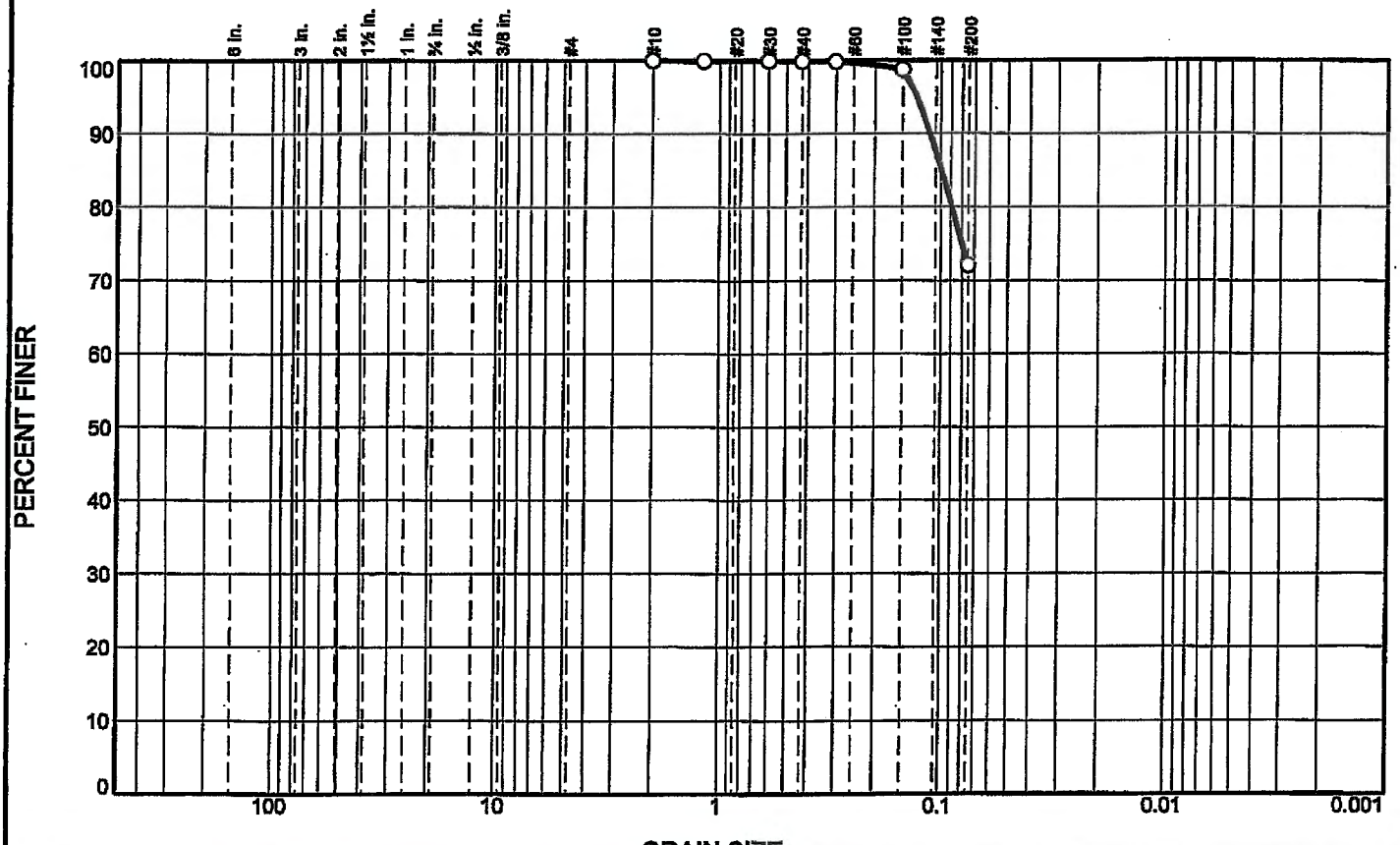
Sample Number: MW-3
Source of Sample: MW-3 **Depth:** 45.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** CMW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.1	27.8	72.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#16	100.0		
#30	100.0		
#40	99.9		
#50	99.9		
#100	98.8		
#200	72.1		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.0988 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

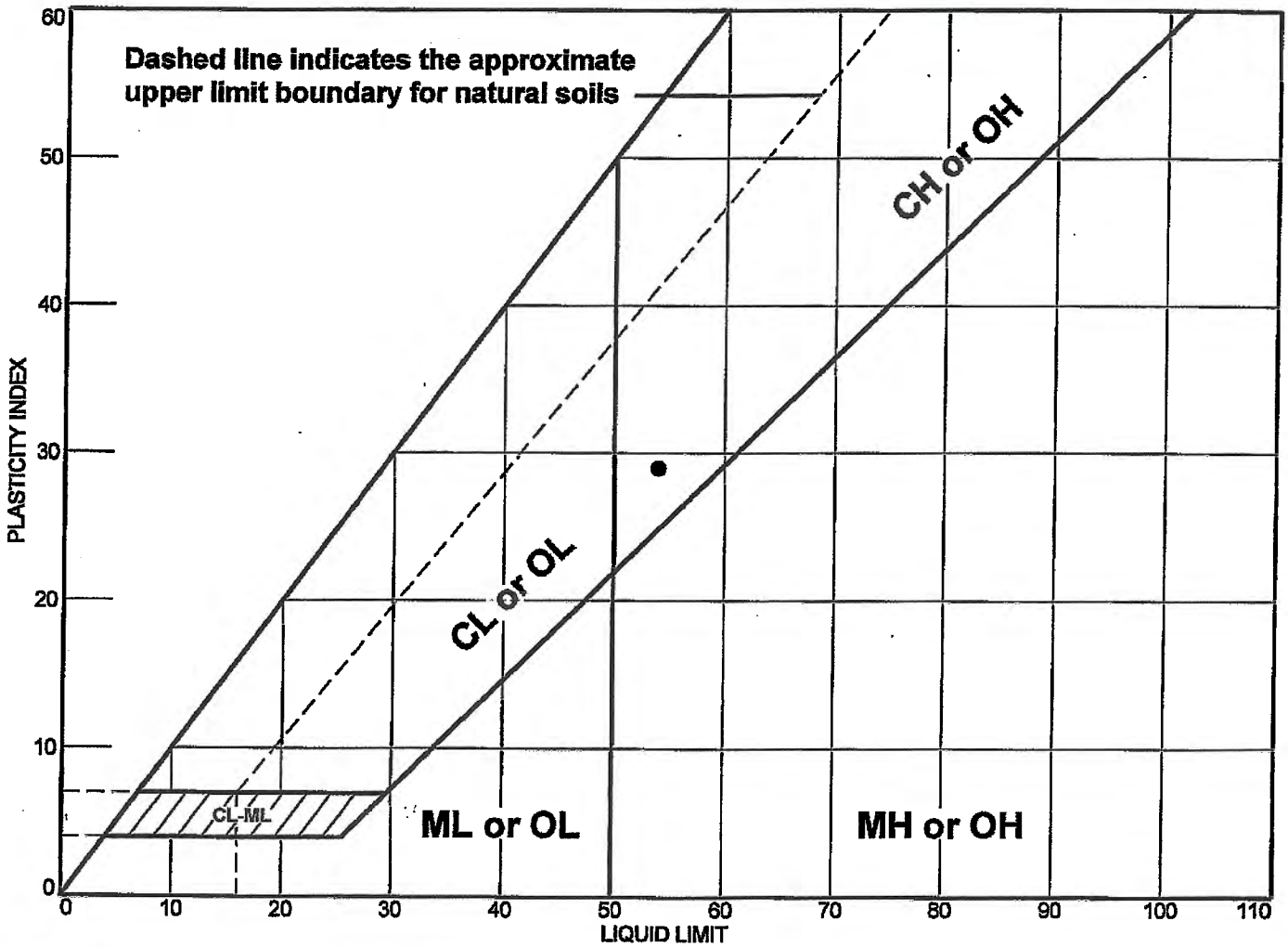
Sample Number: MW-3
Source of Sample: MW-3 **Depth:** 70.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		54	25	29	99.7	99.0	CH

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd

Golder Job No. 063-7079

● **Source of Sample:** MW-3 **Depth:** 85.0 **Sample Number:** MW-3

Remarks:

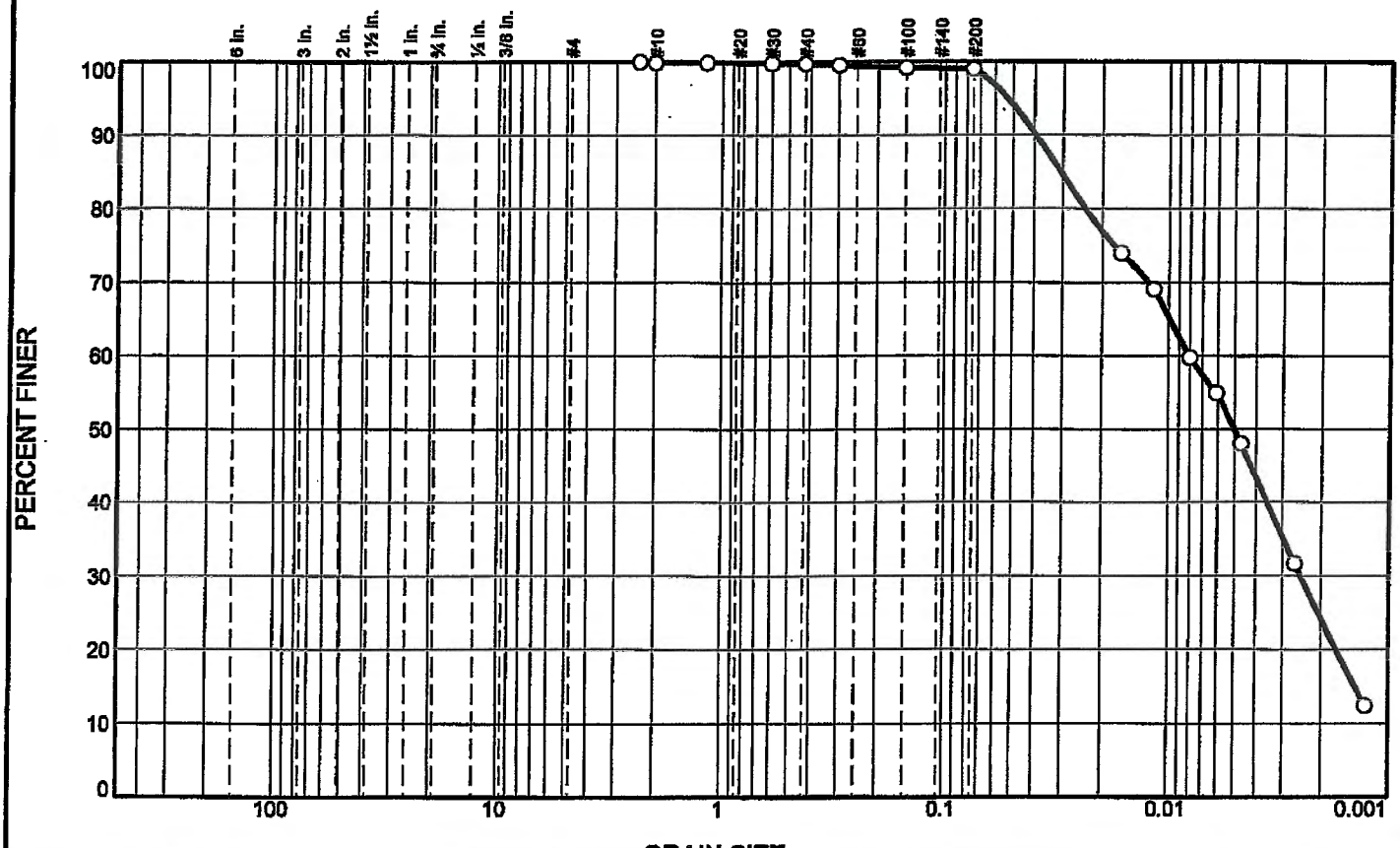
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure

Tested By: Ms **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.2	0.7	48.9	50.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#8	100.0		
#10	99.9		
#16	99.9		
#30	99.8		
#40	99.7		
#50	99.5		
#100	99.2		
#200	99.0		

* (no specification provided)

Material Description

Atterberg Limits

PL= 25 LL= 54 PI= 29

Coefficients

D_{85}= 0.0305 D_{60}= 0.0081 D_{50}= 0.0050
D_{30}= 0.0025 D_{15}= 0.0014 D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(33)

Remarks

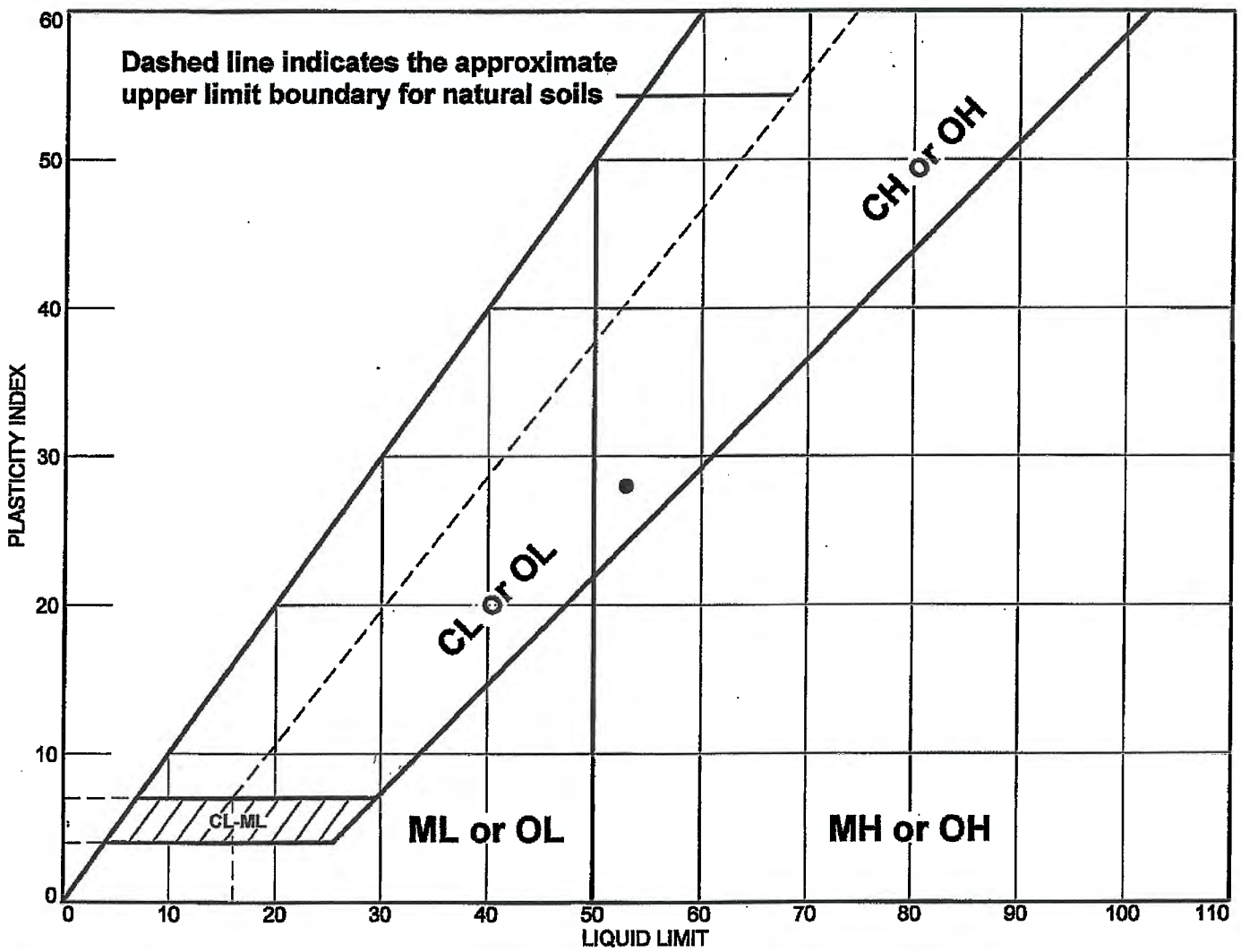
Sample Number: MW-3
Source of Sample: MW-3 **Depth:** 85.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** CMW

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		53	25	28	99.7	94.3	CH

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd

Golder Job No. 063-7079

● **Source of Sample:** MW-3 **Depth:** 101.5 **Sample Number:** MW-3

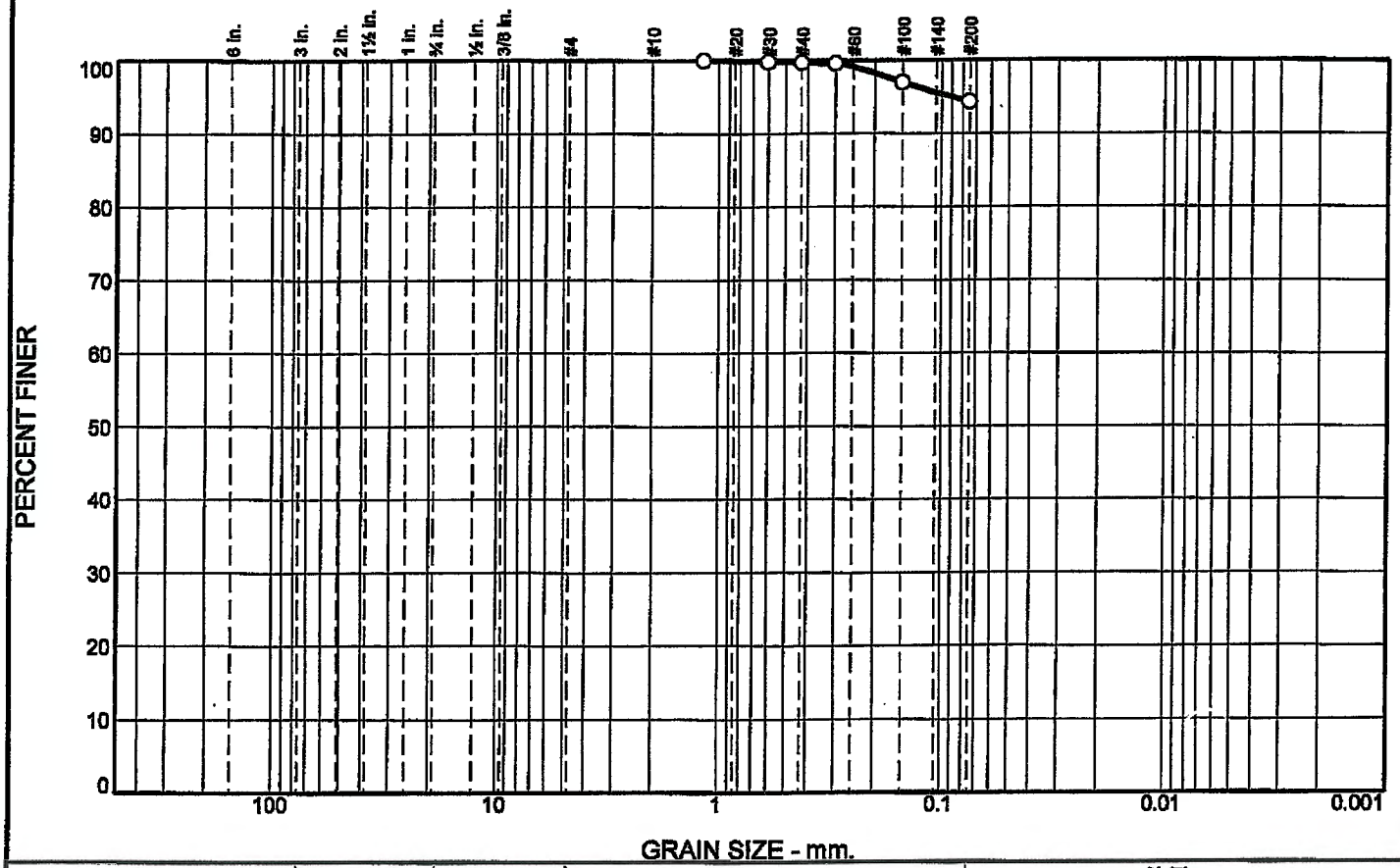
Remarks:

SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.3	5.4	94.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#16	100.0		
#30	99.9		
#40	99.7		
#50	99.6		
#100	97.0		
#200	94.3		

* (no specification provided)

Material Description

Atterberg Limits

PL= 25 LL= 53 PI= 28

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(30)

Remarks

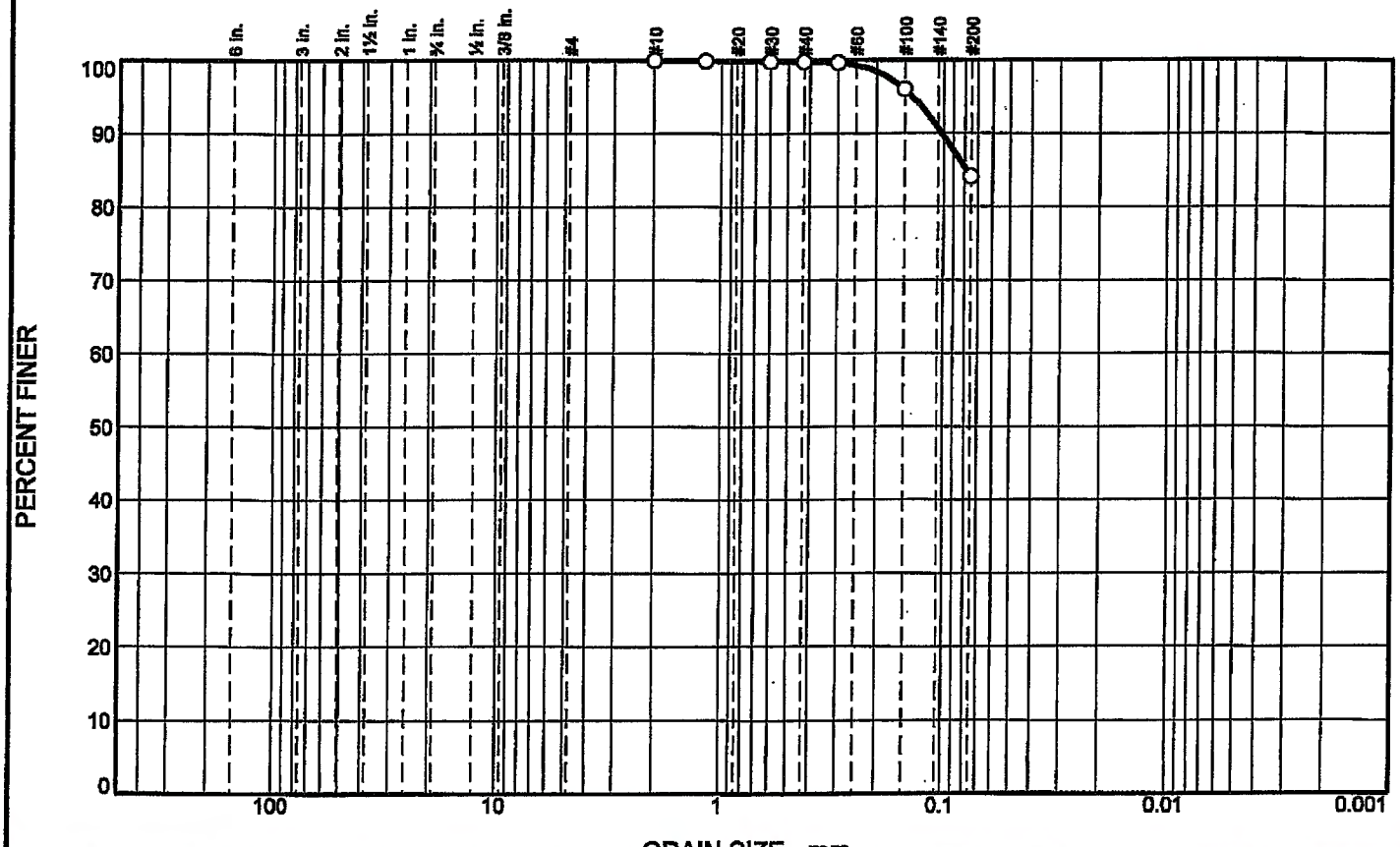
Sample Number: MW-3
Source of Sample: MW-3 **Depth:** 101.5 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	15.7	84.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#16	99.9		
#30	99.8		
#40	99.8		
#50	99.6		
#100	96.0		
#200	84.1		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.0784 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

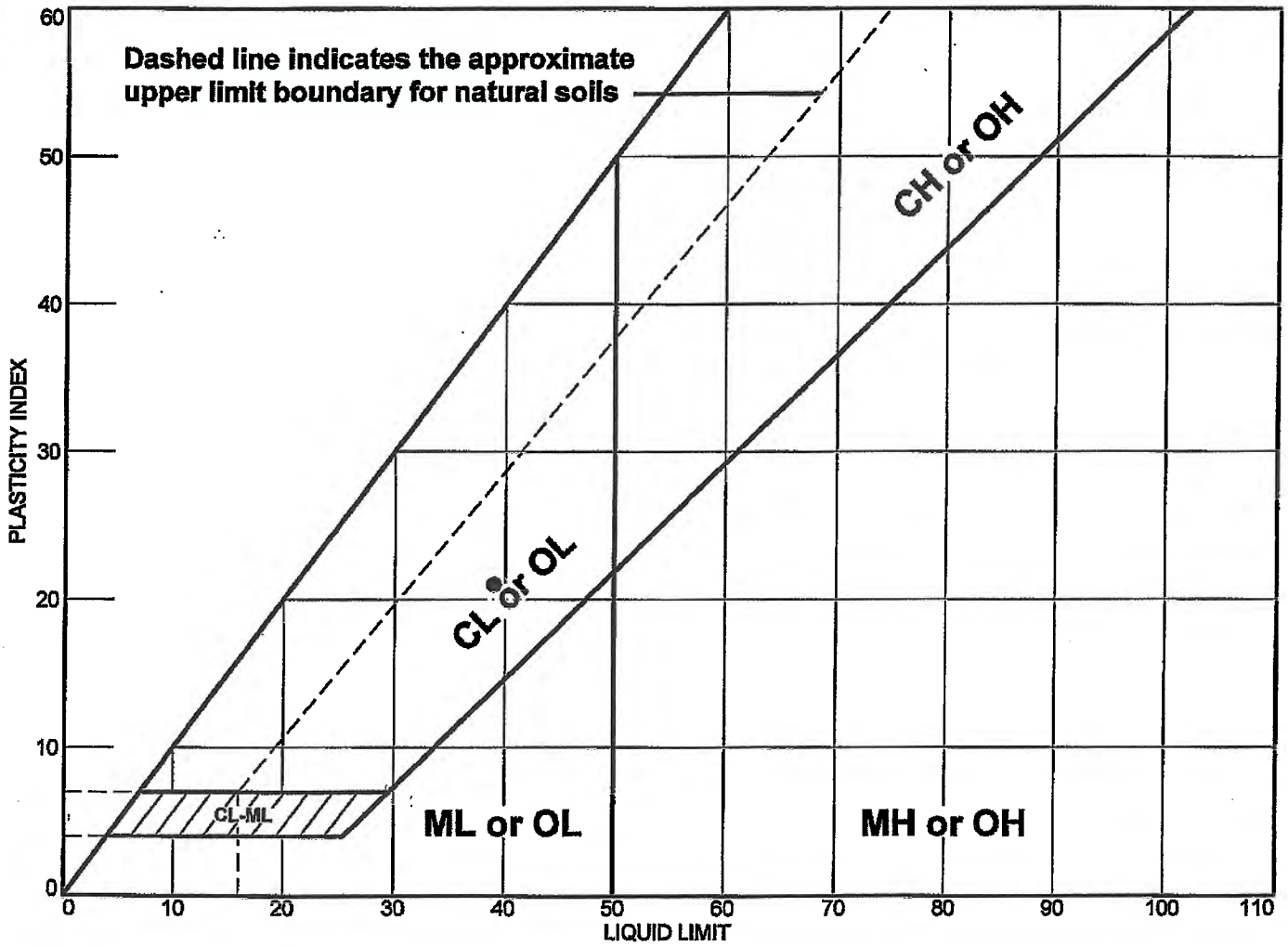
Sample Number: MW-4
Source of Sample: MW-4 **Depth:** 25.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		39	18	21	99.1	92.8	CL

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd

Golder Job No. 063-7079

● **Source of Sample:** MW-4 **Depth:** 40.0 **Sample Number:** MW-4

Remarks:

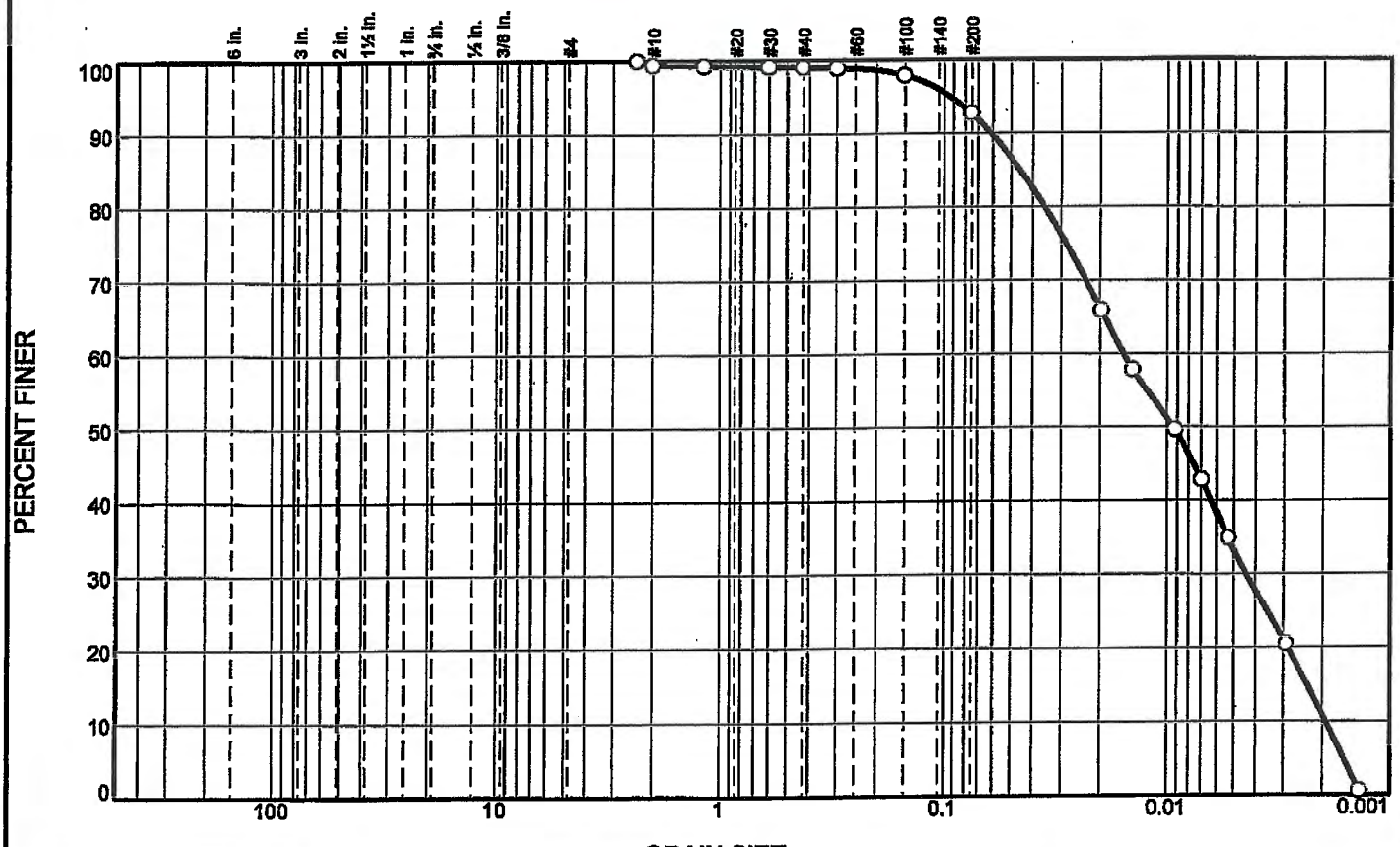
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure

Tested By: JS **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.6	0.3	6.3	59.5	33.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#8	100.0		
#10	99.4		
#16	99.3		
#30	99.2		
#40	99.1		
#50	99.0		
#100	98.0		
#200	92.8		

* (no specification provided)

Material Description

Atterberg Limits

PL= 18 LL= 39 PI= 21

Coefficients

D_{85}= 0.0453 D_{60}= 0.0156 D_{50}= 0.0093
D_{30}= 0.0044 D_{15}= 0.0023 D_{10}= 0.0019
C_u= 8.12 C_c= 0.64

Classification

USCS= CL AASHTO= A-6(20)

Remarks

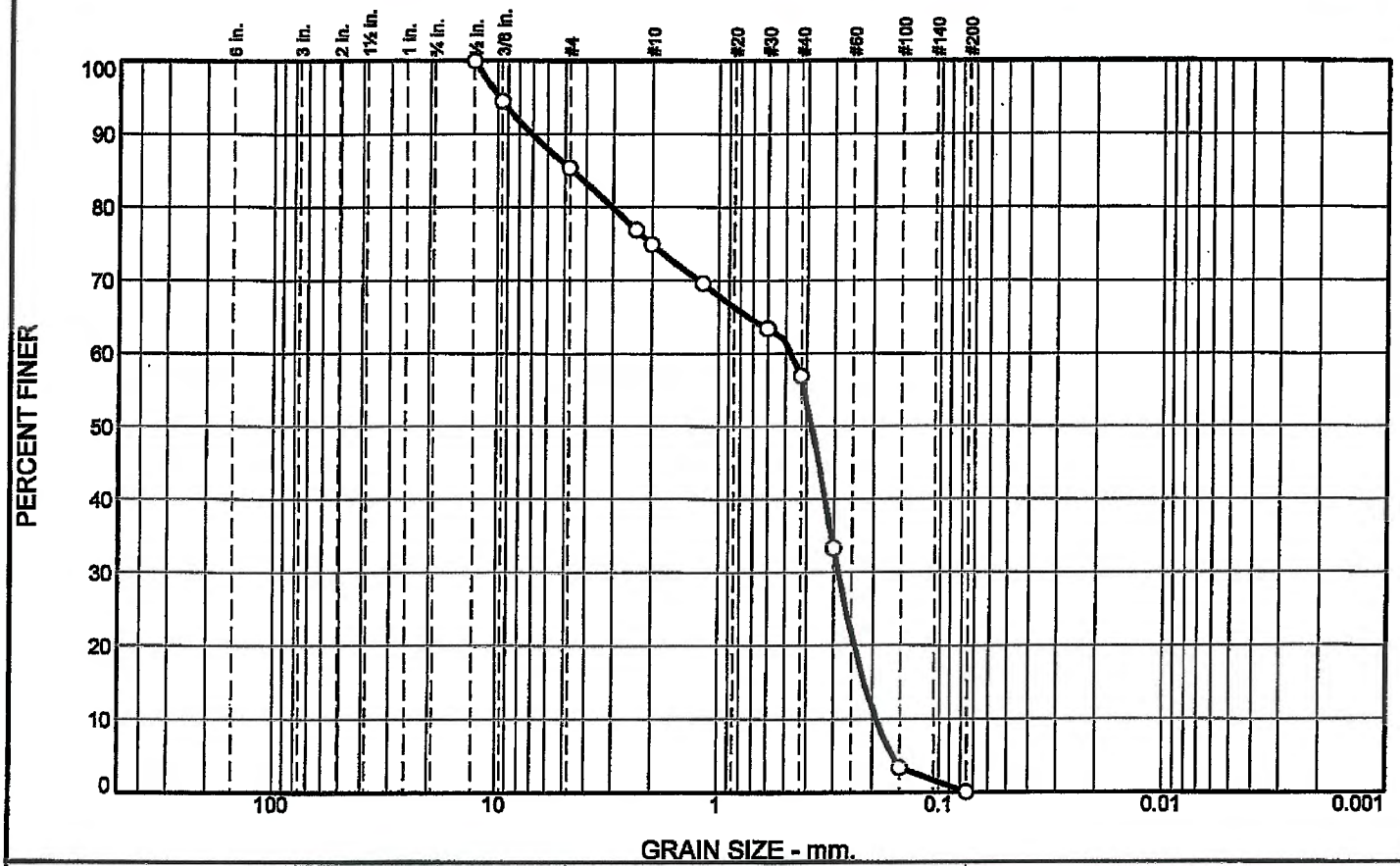
Sample Number: MW-4
Source of Sample: MW-4 **Depth:** 40.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** CMW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	14.6	10.5	18.0	56.8	0.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2 Inch	100.0		
3/8 Inch	94.5		
#4	85.4		
#8	76.9		
#10	74.9		
#16	69.6		
#30	63.4		
#40	56.9		
#50	33.3		
#100	3.4		
#200	0.1		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 4.5909 D_{60}= 0.4625 D_{50}= 0.3766
D_{30}= 0.2858 D_{15}= 0.2180 D_{10}= 0.1922
C_u= 2.41 C_c= 0.92

Classification

USCS= SP AASHTO=

Remarks

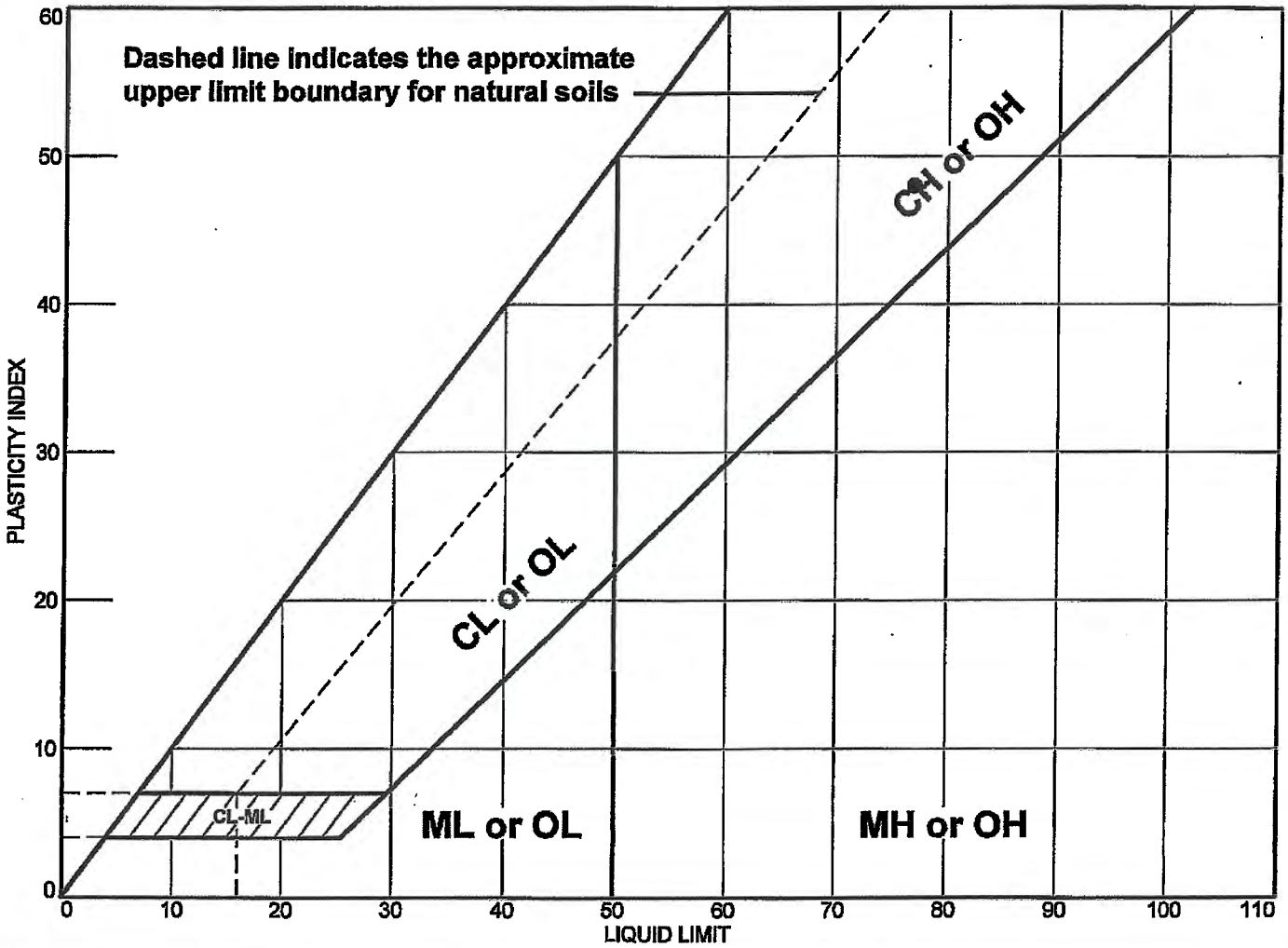
Sample Number: MW-4
Source of Sample: MW-4 **Depth:** 70.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		77	29	48	99.9	99.6	CH

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd

Golder Job No. 063-7079

● **Source of Sample:** MW-4 **Depth:** 85.0 **Sample Number:** MW-4

Remarks:

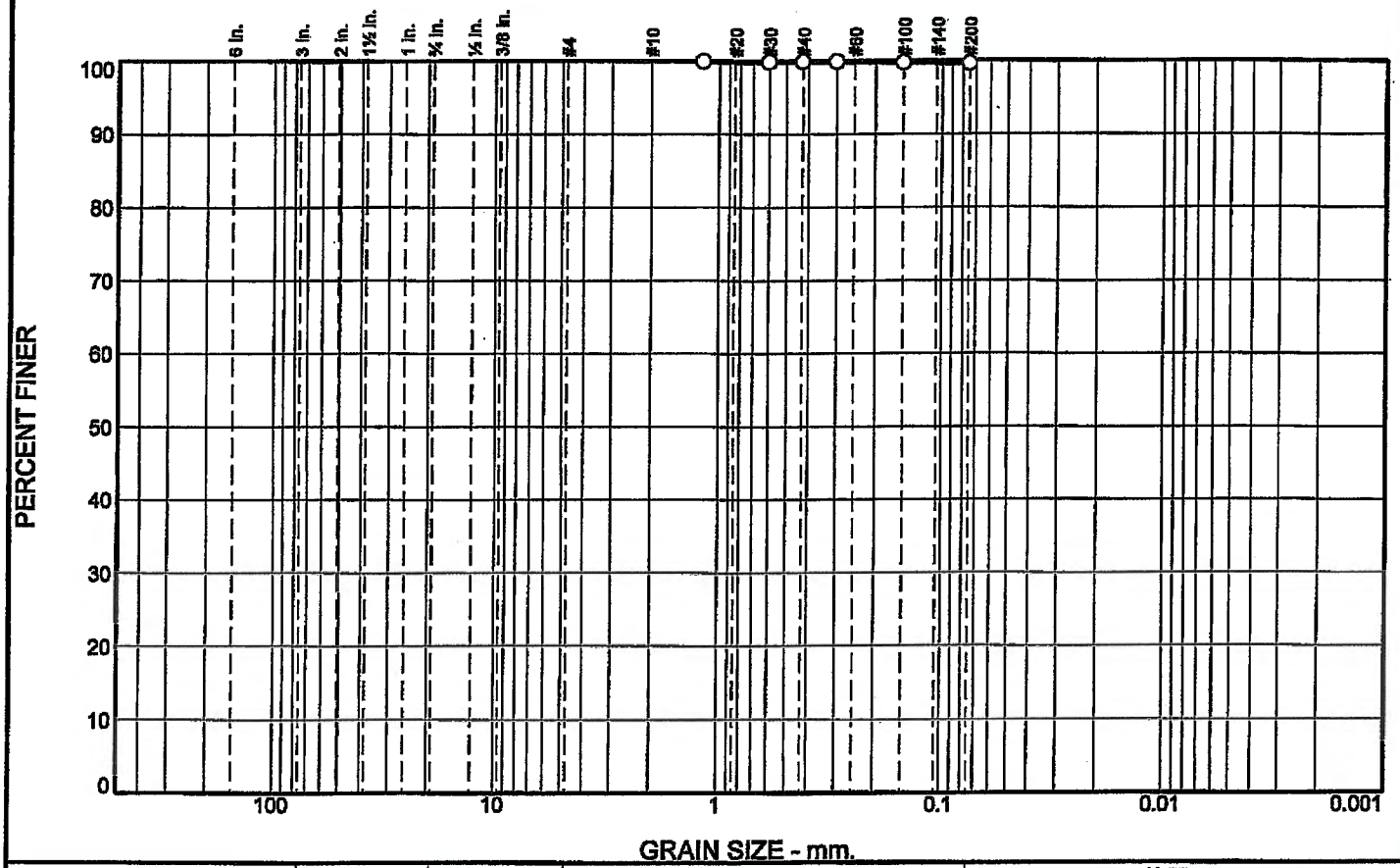
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure

Tested By: MS **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.1	0.3	99.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#16	100.0		
#30	99.9		
#40	99.9		
#50	99.9		
#100	99.8		
#200	99.6		

* (no specification provided)

Material Description

Atterberg Limits

PL= 29 LL= 77 PI= 48

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(57)

Remarks

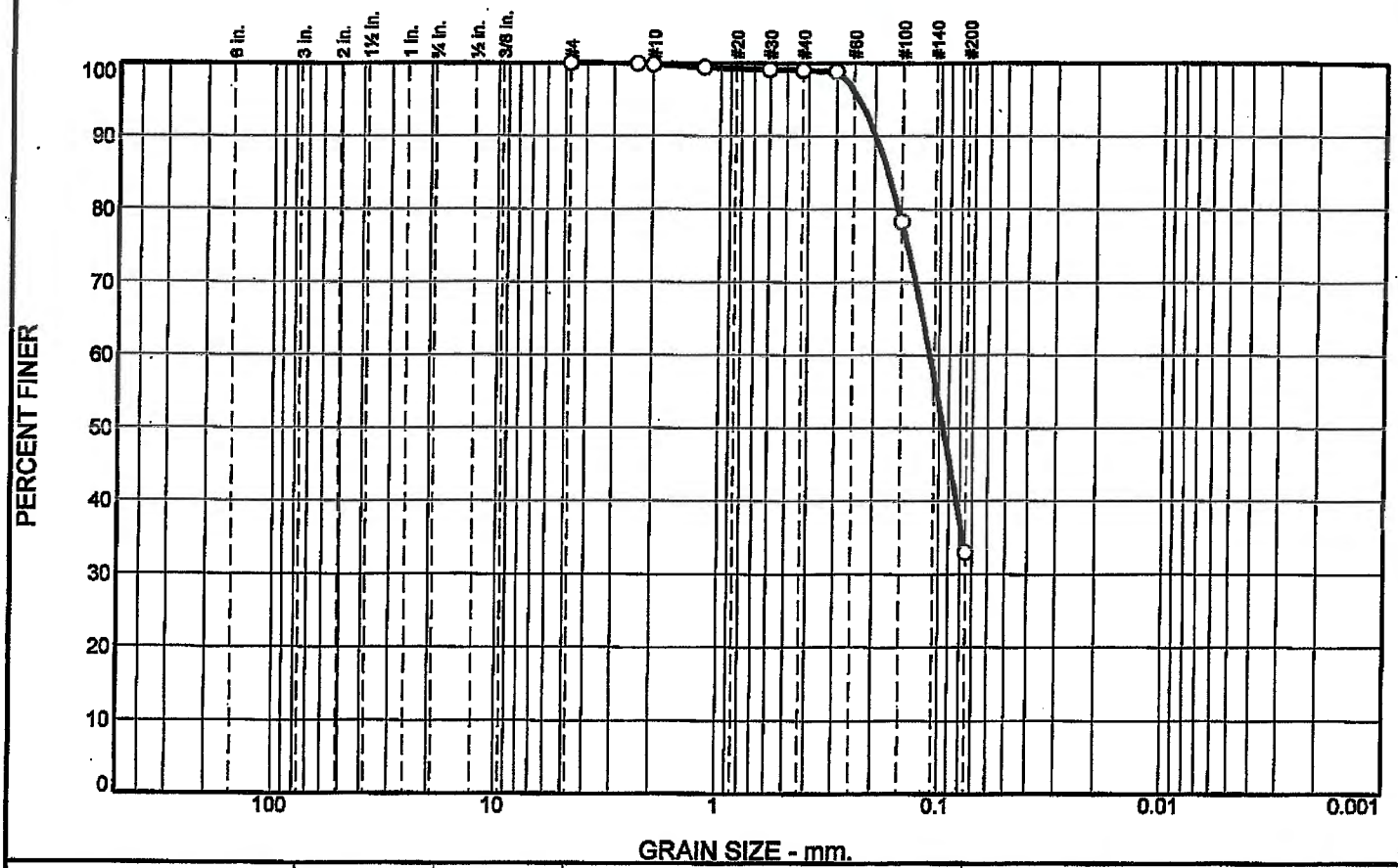
Sample Number: MW-4
Source of Sample: MW-4 **Depth:** 85.0 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.9	66.0	33.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	100.0		
#10	99.9		
#16	99.4		
#30	99.1		
#40	99.0		
#50	98.8		
#100	78.3		
#200	33.0		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.1729 D_{60}= 0.1101 D_{50}= 0.0951
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

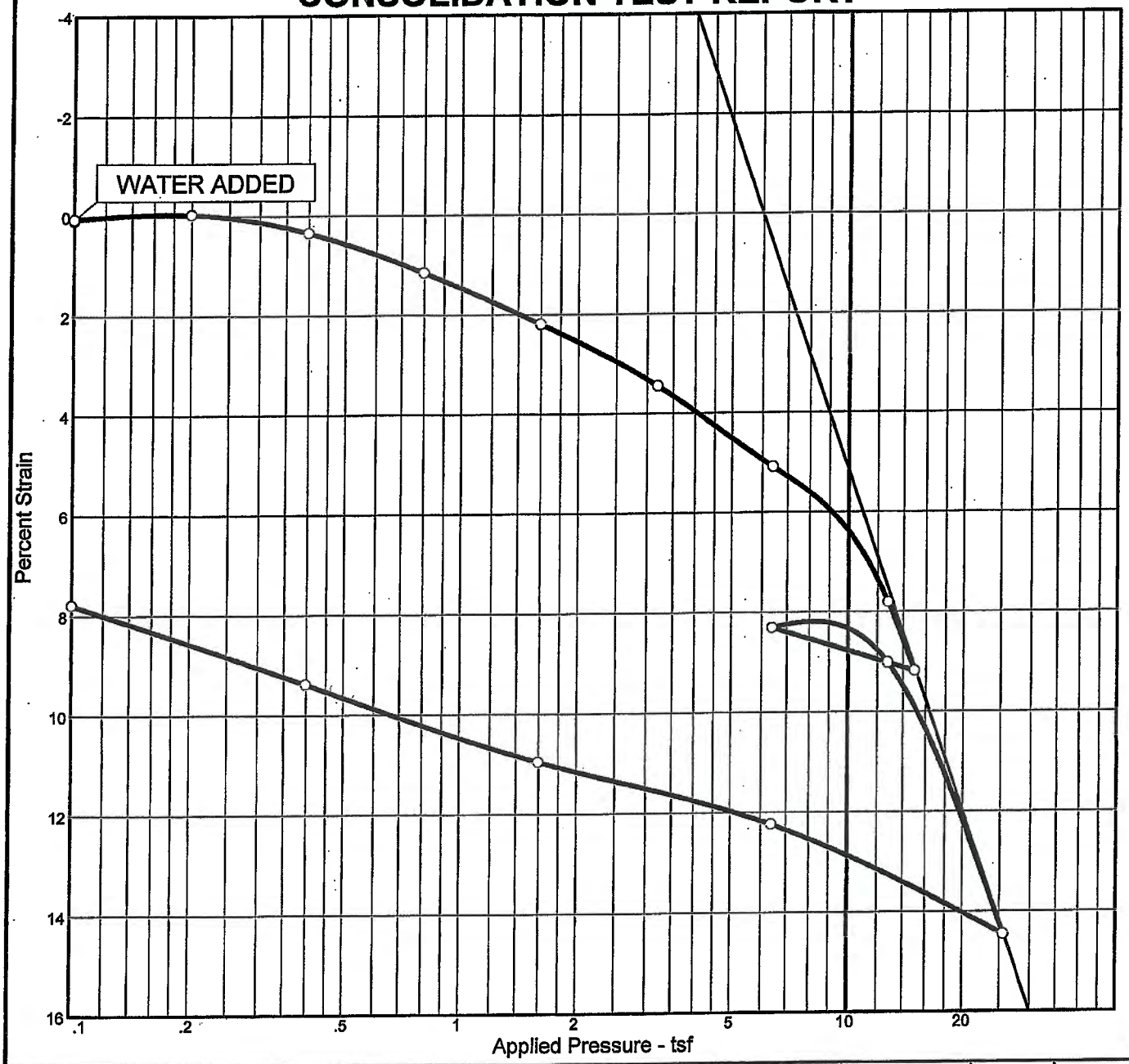
Sample Number: MW-4
Source of Sample: MW-4 **Depth:** 96.5 **Date:** 1/23/07

SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Client: Golder Associates, Inc.
Project: Jungo Rd
Golder Job No. 063-7079
Project No: 07-116 **Figure**

Tested By: PD **Checked By:** JF

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_s	Swell Press. (tsf)	Swell %	e_o
97.1 %	67.3 %	58.7	83	56	2.70		11.83	0.66	0.08	0.28		1.870

MATERIAL DESCRIPTION	USCS	AASHTO

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd
Golder Job No. 063-7079

Source: MW-1 **Sample No.:** MW-1 **Elev./Depth:** 80.0

Remarks:

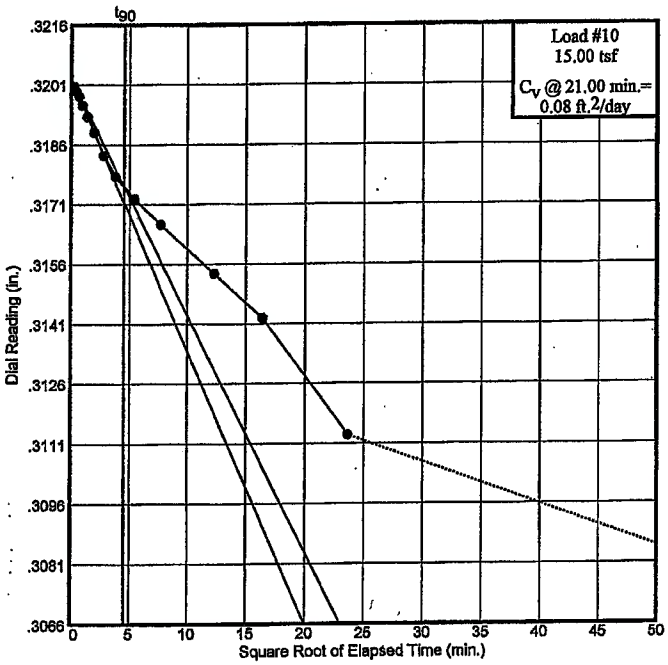
SIERRA TESTING LABS, INC.

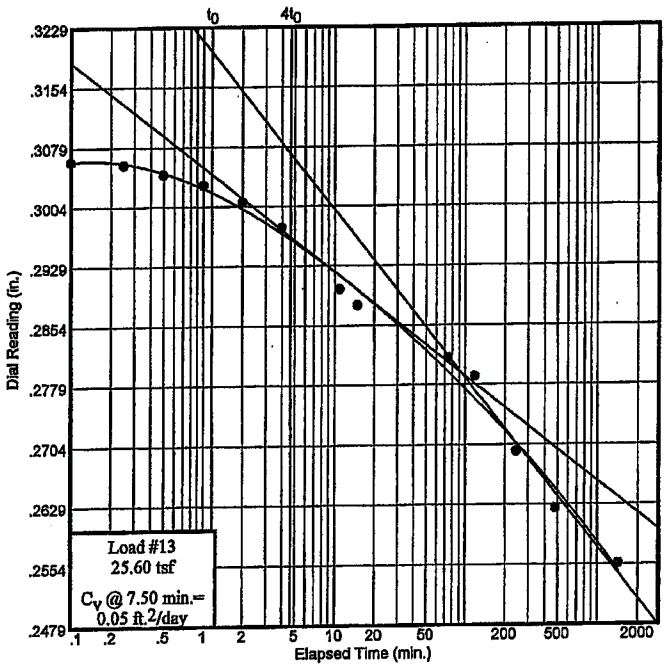
El Dorado Hills, CA

Figure

Dial Reading vs. Time

Project No.: 07-116
Project: Jungo Rd
Golder Job No. 063-7079
Source: MW-1 Sample No.: MW-1 Elev./Depth: 80.0



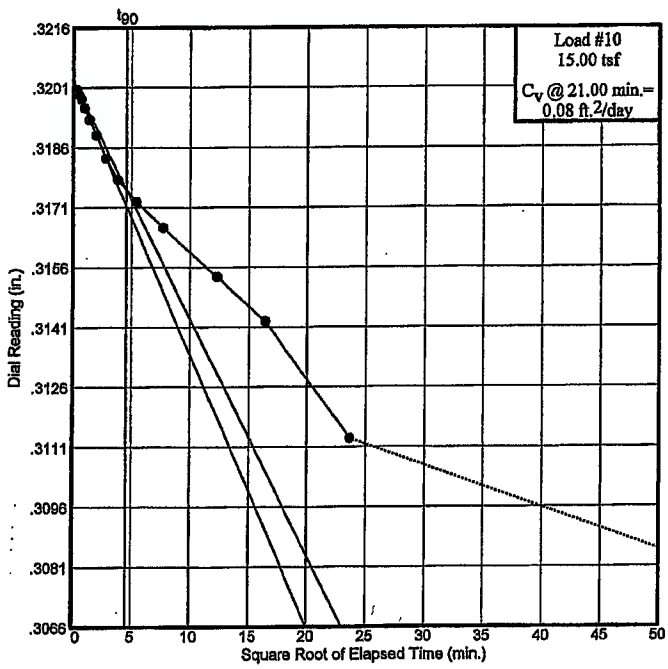


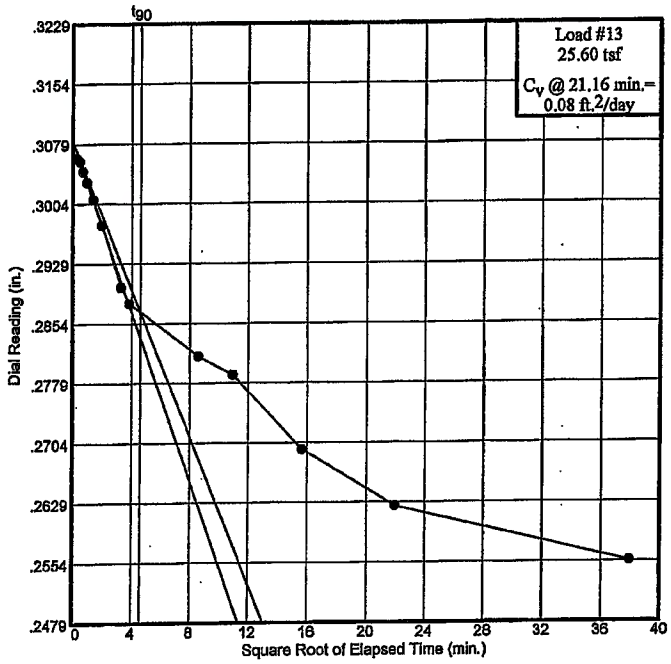
SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Figure

Dial Reading vs. Time

Project No.: 07-116
Project: Jungo Rd
Golder Job No. 063-7079
Source: MW-1 Sample No.: MW-1 Elev./Depth: 80.0



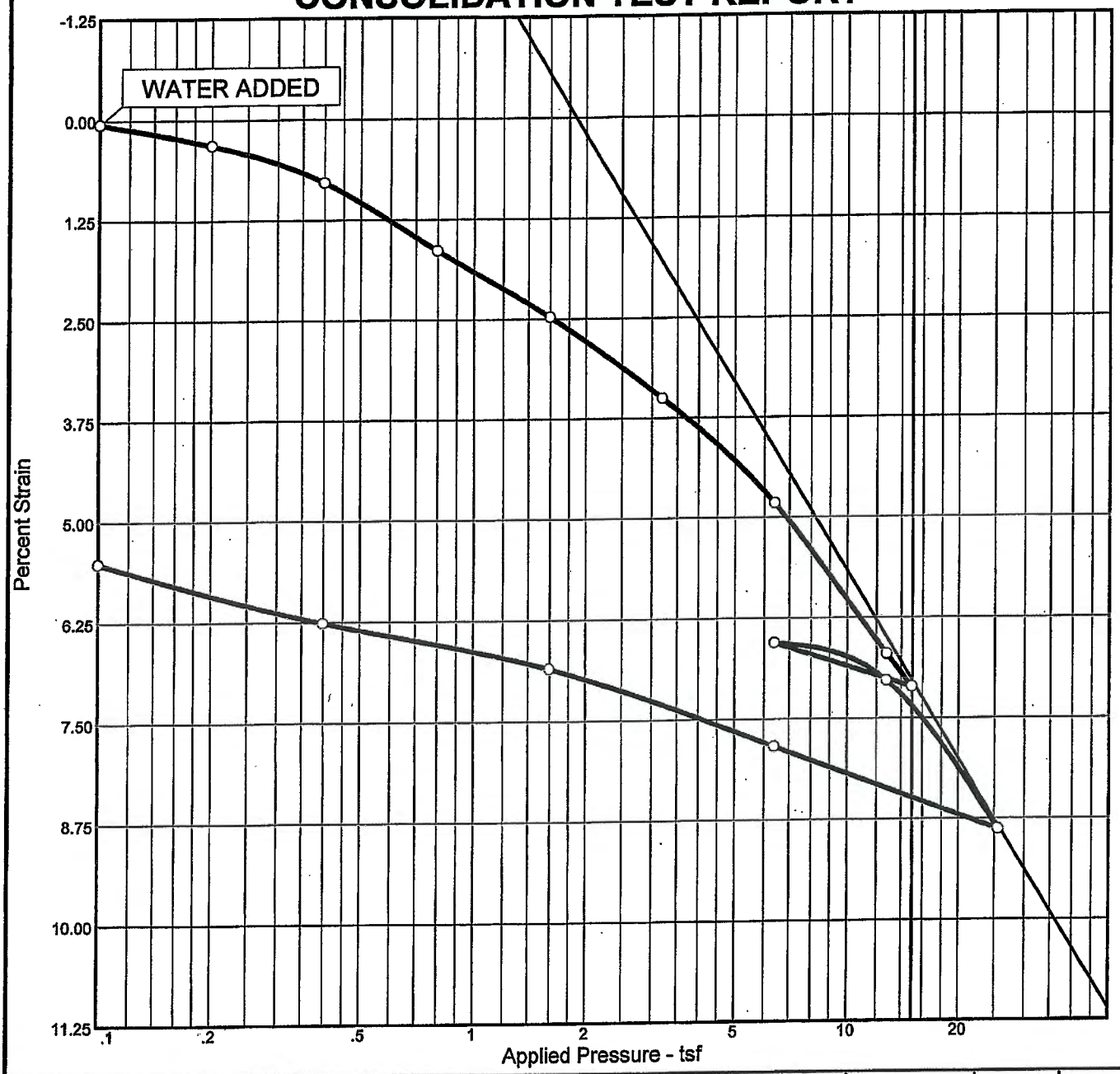


SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_s	Swell Press. (tsf)	Swell %	e_o
100.0 %	37.4 %	83.9	NV	NP	2.70		15.59	0.16	0.03			1.010

MATERIAL DESCRIPTION	USCS	AASHTO

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd
Golder Job No. 063-7079

Source: MW-2 **Sample No.:** MW-2 **Elev./Depth:** 85.0

Remarks:

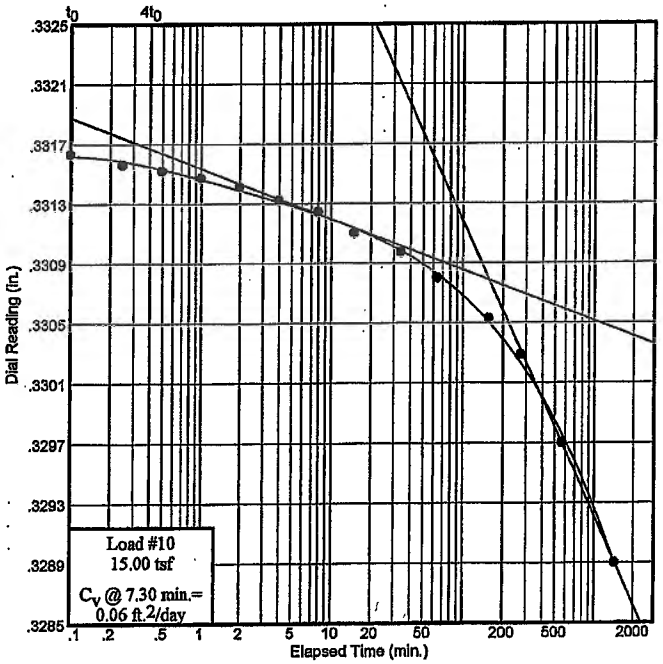
SIERRA TESTING LABS, INC.

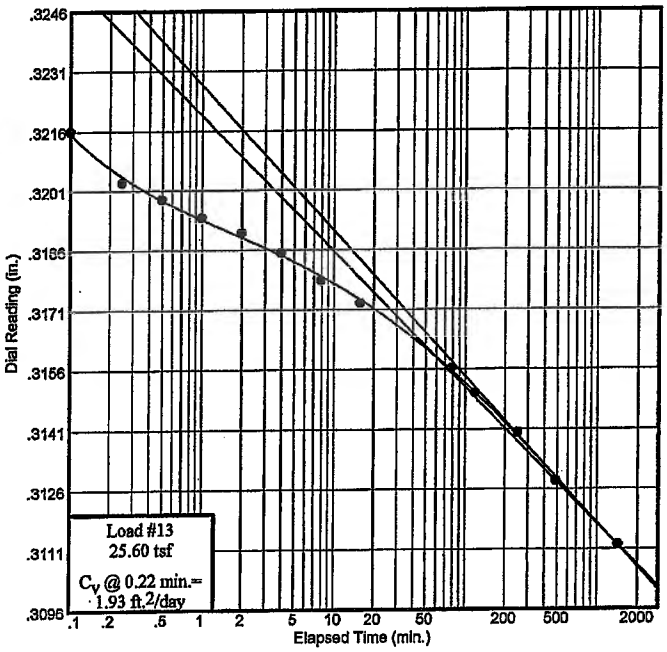
El Dorado Hills, CA

Figure

Dial Reading vs. Time

Project No.: 07-116
Project: Jungo Rd
Golder Job No. 063-7079
Source: MW-2 Sample No.: MW-2 Elev./Depth: 85.0





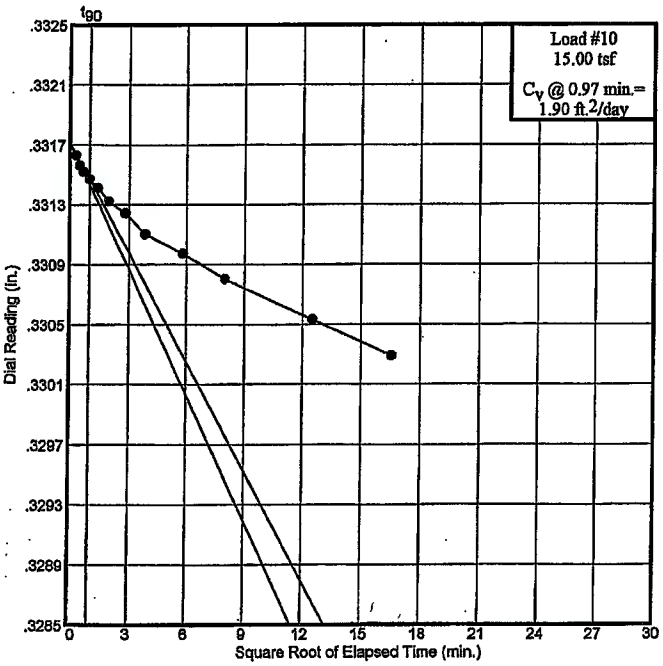
SIERRA TESTING LABS, INC.

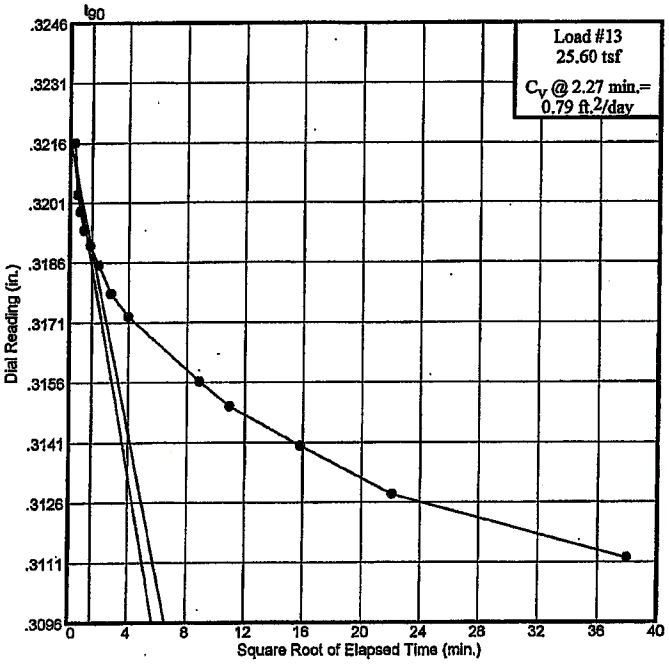
El Dorado Hills, CA

Figure

Dial Reading vs. Time

Project No.: 07-116
Project: Jungo Rd
Golder Job No. 063-7079
Source: MW-2 Sample No.: MW-2 Elev./Depth: 85.0

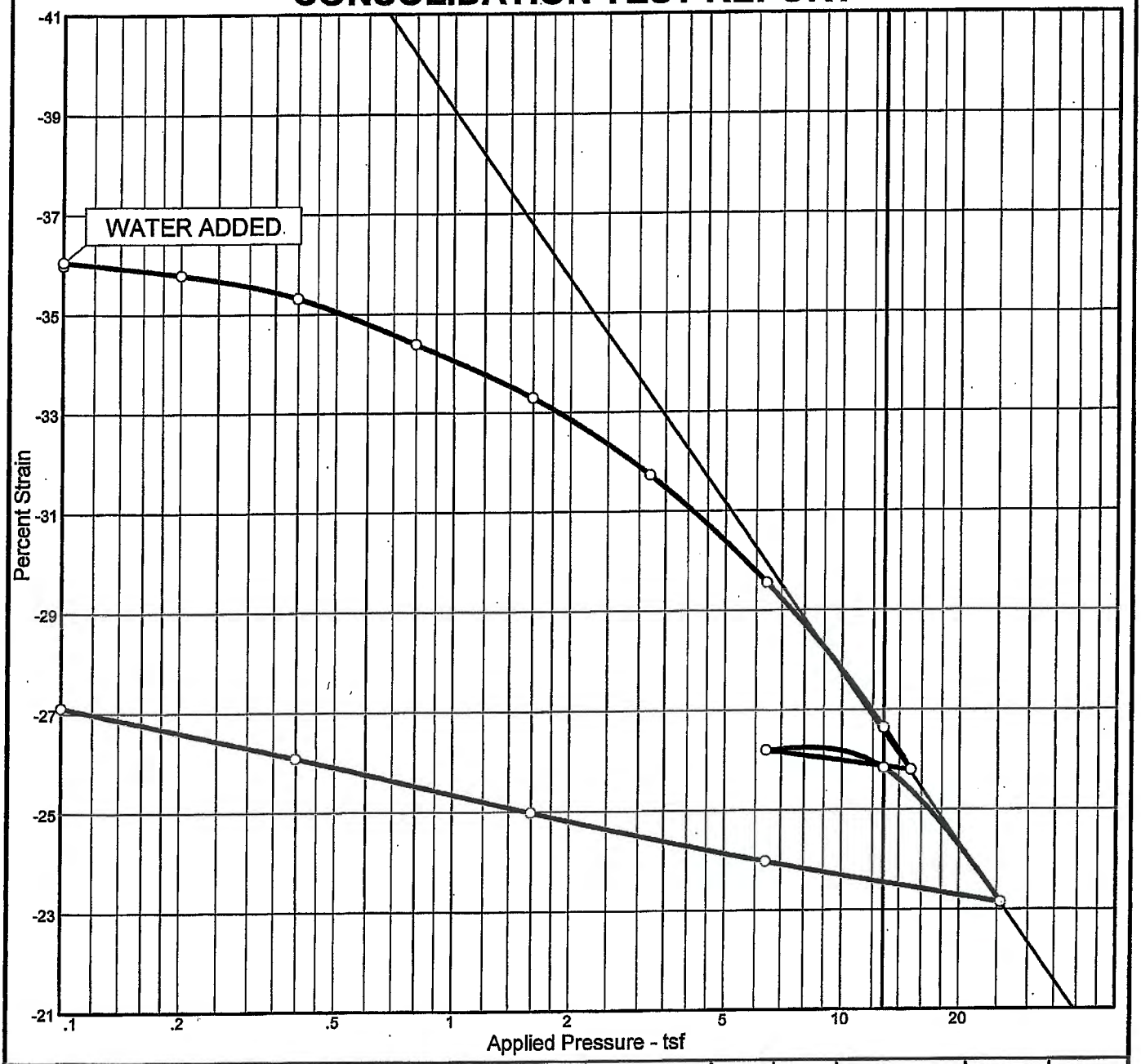




SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Figure

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_s	Swell Press. (tsf)	Swell %	e_o
87.6 %	29.1 %	88.8			2.70		12.20	0.22	0.03	0.12		0.898

MATERIAL DESCRIPTION	USCS	AASHTO

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd
Golder Job No. 063-7079

Source: MW-2 **Sample No.:** MW-2 **Elev./Depth:** 100.0

Remarks:

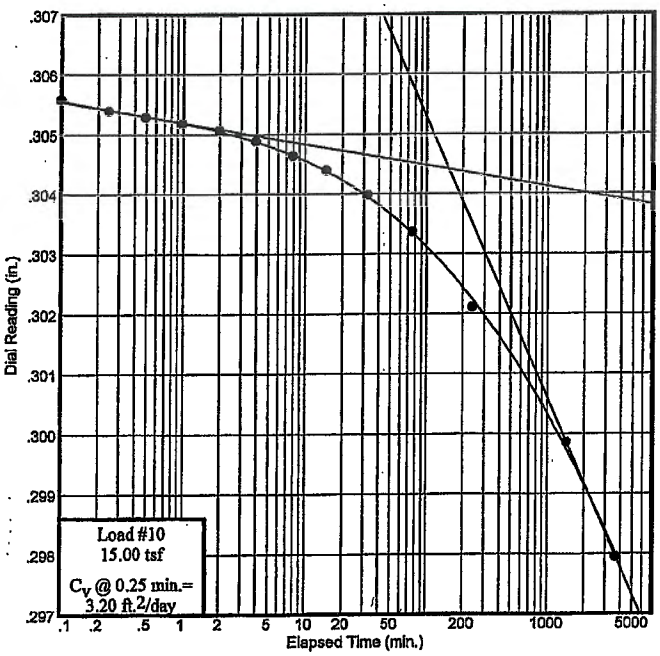
SIERRA TESTING LABS, INC.

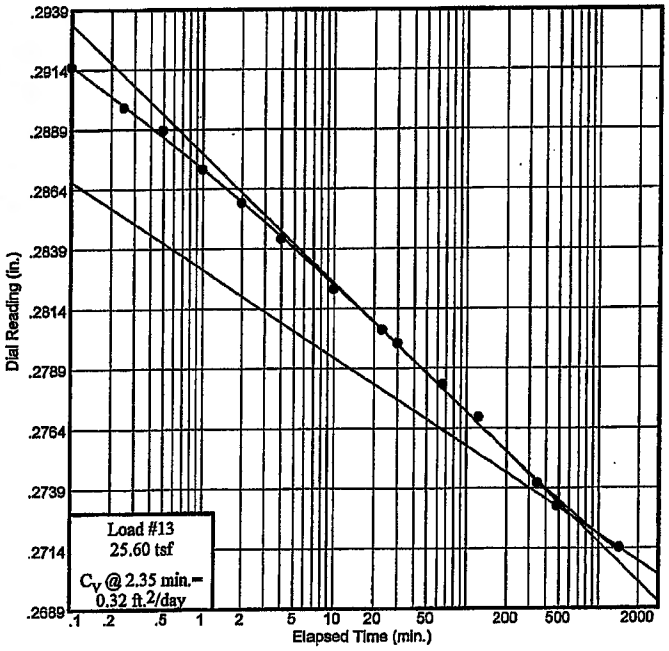
El Dorado Hills, CA

Figure

Dial Reading vs. Time

Project No.: 07-116
Project: Jungo Rd
Golder Job No. 063-7079
Source: MW-2 Sample No.: MW-2 Elev./Depth: 100.0





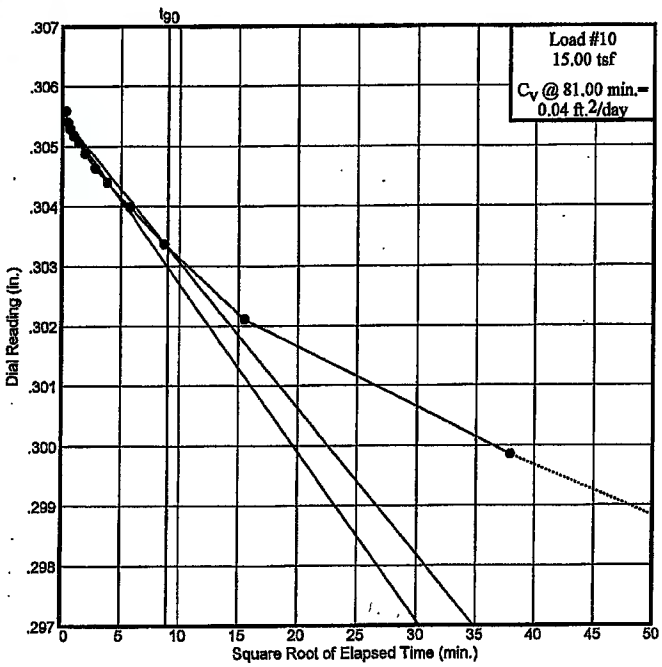
SIERRA TESTING LABS, INC.

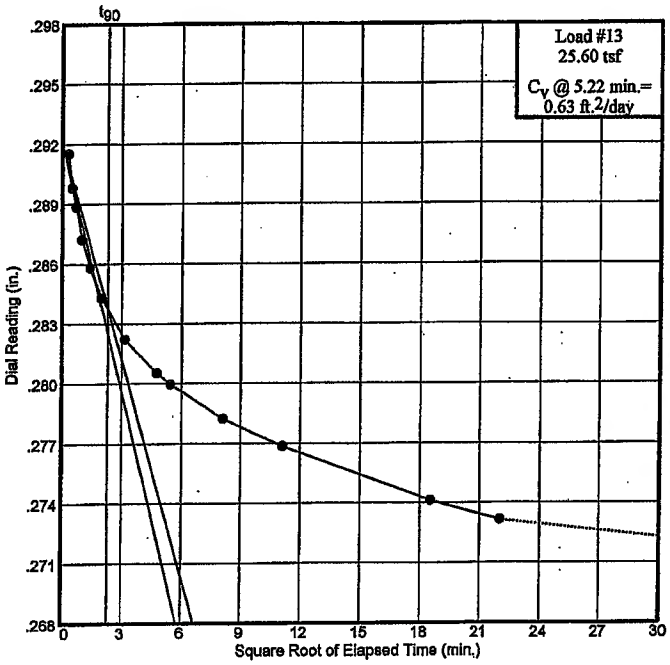
El Dorado Hills, CA

Figure

Dial Reading vs. Time

Project No.: 07-116
Project: Jungo Rd
Golder Job No. 063-7079
Source: MW-2 Sample No.: MW-2 Elev./Depth: 100.0



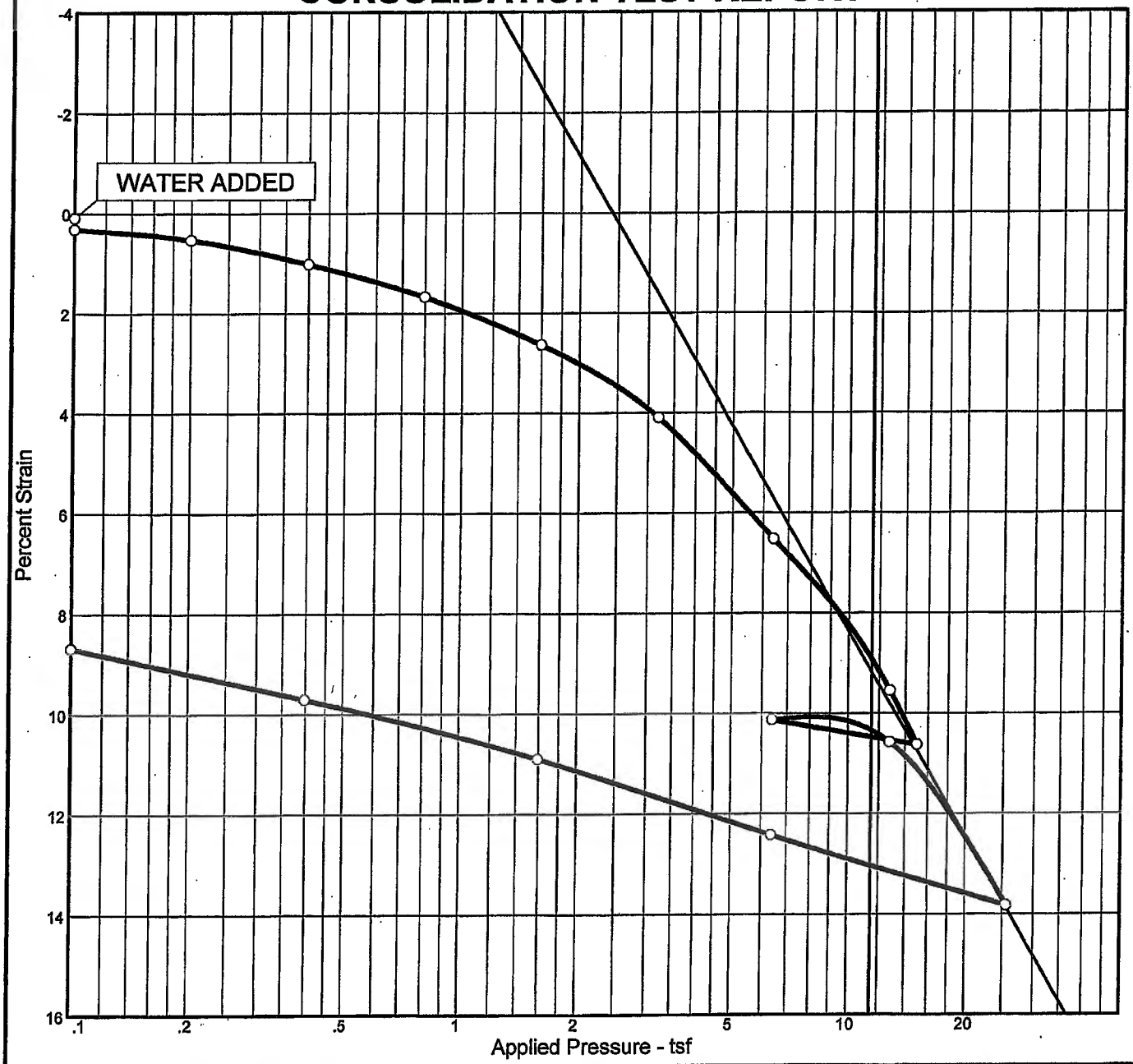


SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_s	Swell Press. (tsf)	Clpse. %	e_o
85.4 %	29.7 %	87.0			2.70		10.55	0.26	0.04		0.2	0.938

MATERIAL DESCRIPTION	USCS	AASHTO

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd
Golder Job No. 063-7079

Source: MW-3 **Sample No.:** MW-3 **Elev./Depth:** 63.0

Remarks:

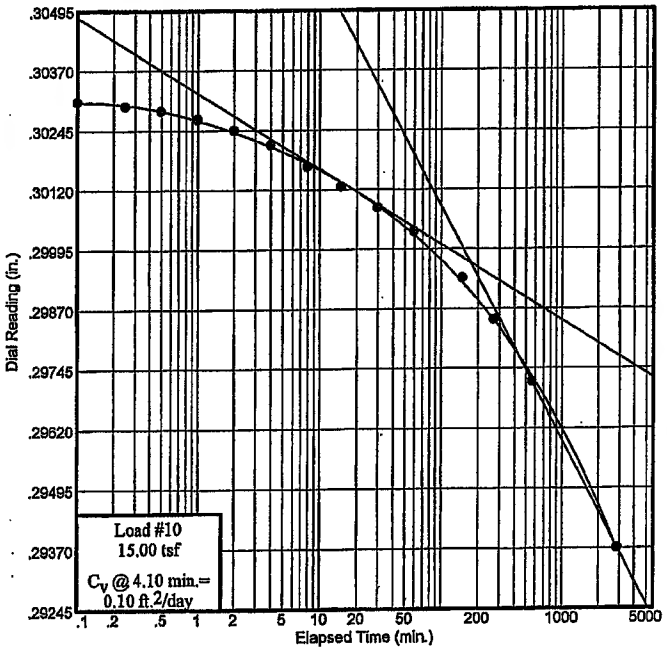
SIERRA TESTING LABS, INC.

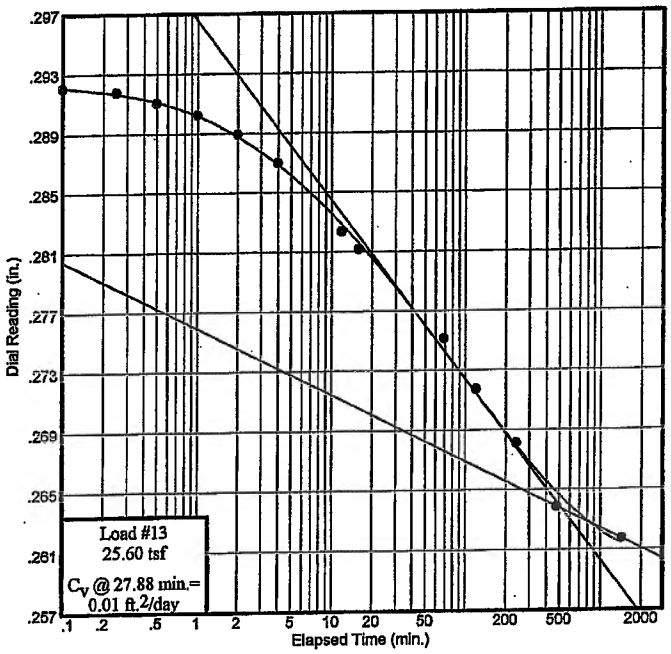
El Dorado Hills, CA

Figure

Dial Reading vs. Time

Project No.: 07-116
Project: Jungo Rd
Golder Job No. 063-7079
Source: MW-3 Sample No.: MW-3 Elev./Depth: 63.0





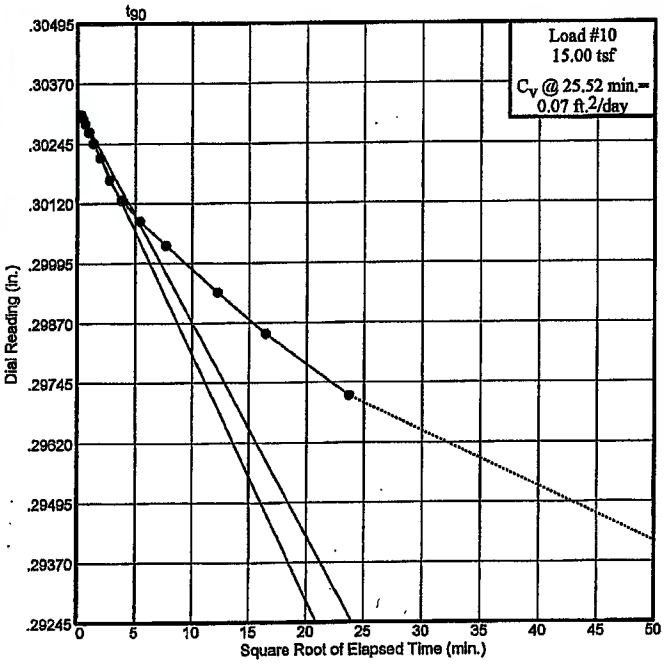
SIERRA TESTING LABS, INC.

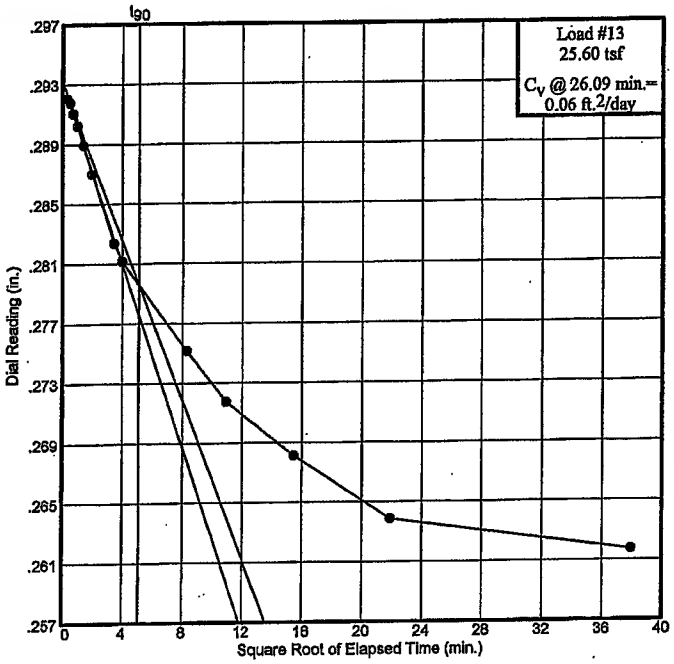
El Dorado Hills, CA

Figure

Dial Reading vs. Time

Project No.: 07-116
Project: Jungo Rd
Golder Job No. 063-7079
Source: MW-3 Sample No.: MW-3 Elev./Depth: 63.0

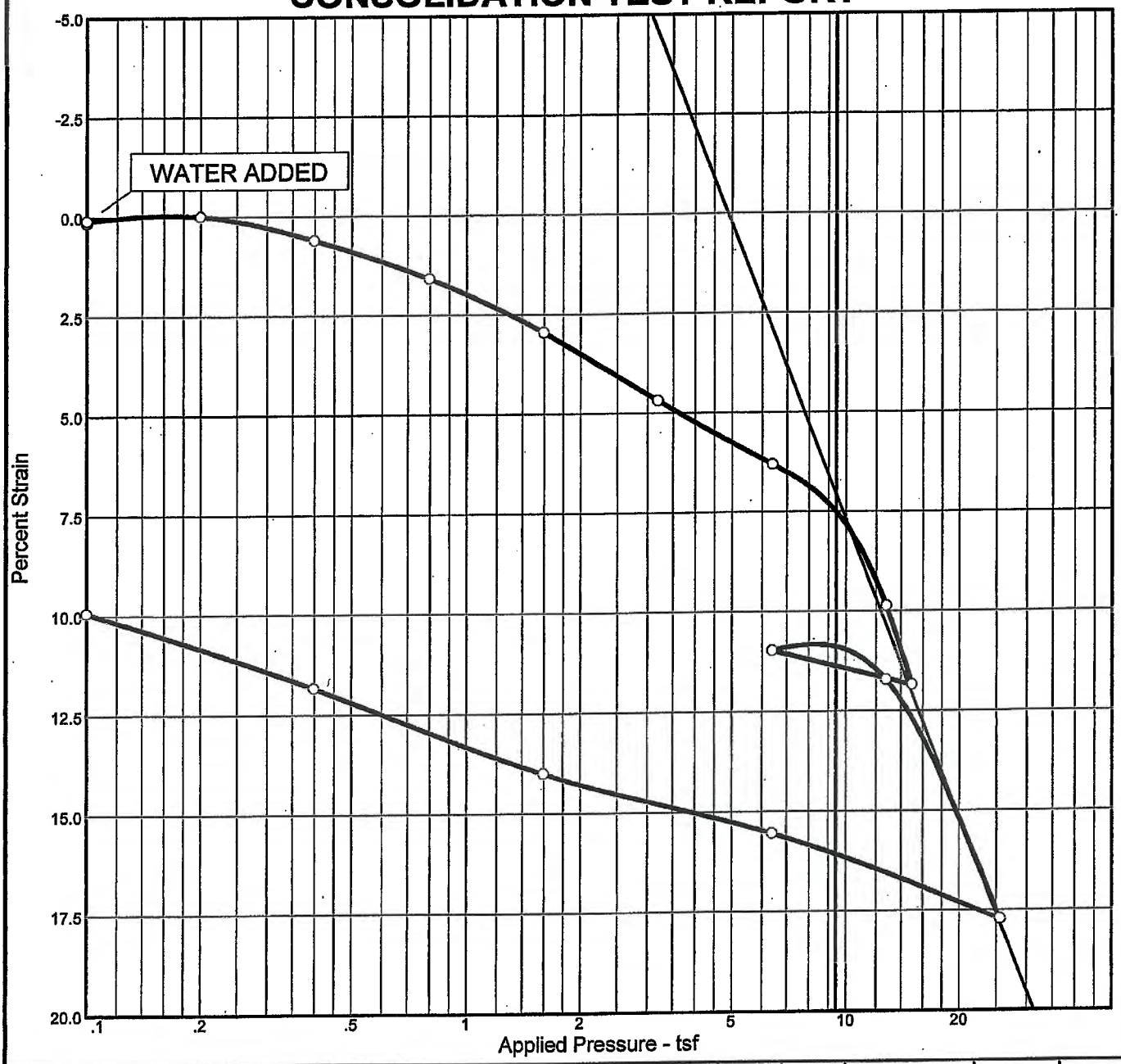




SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Figure

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_s	Swell Press. (tsf)	Swell %	e_o
97.8 %	67.3 %	59.0	103	72	2.70		9.92	0.71	0.09	0.26	0.1	1.858

MATERIAL DESCRIPTION	USCS	AASHTO

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd
Golder Job No. 063-7079

Source: EB **Sample No.:** EB **Elev./Depth:** 85.0

Remarks:

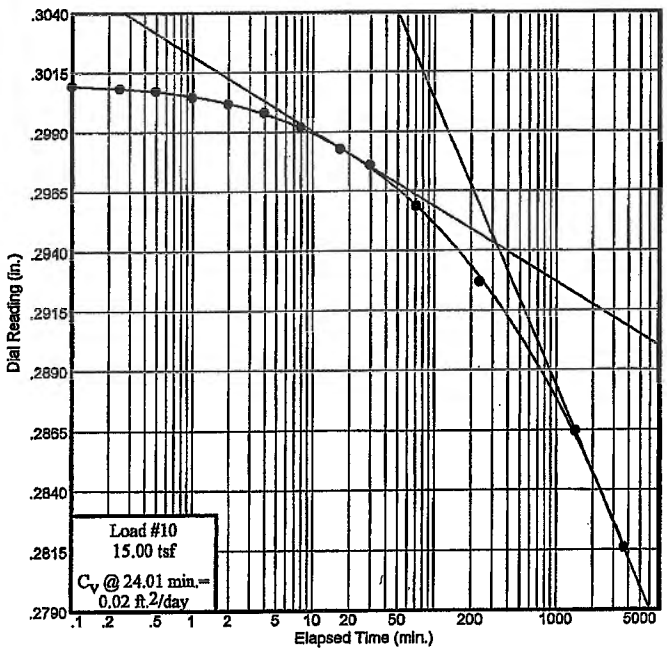
SIERRA TESTING LABS, INC.

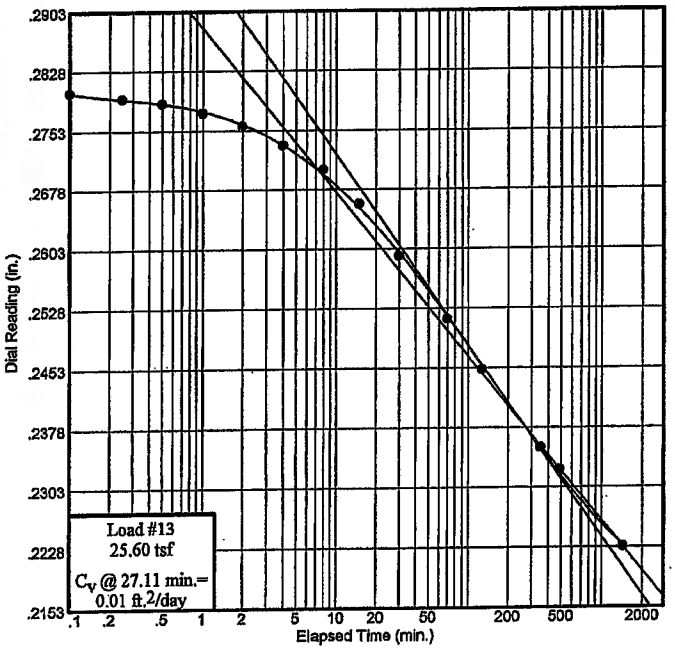
El Dorado Hills, CA

Figure

Dial Reading vs. Time

Project No.: 07-116
Project: Jungo Rd
Golder Job No. 063-7079
Source: EB Sample No.: EB Elev./Depth: 85.0





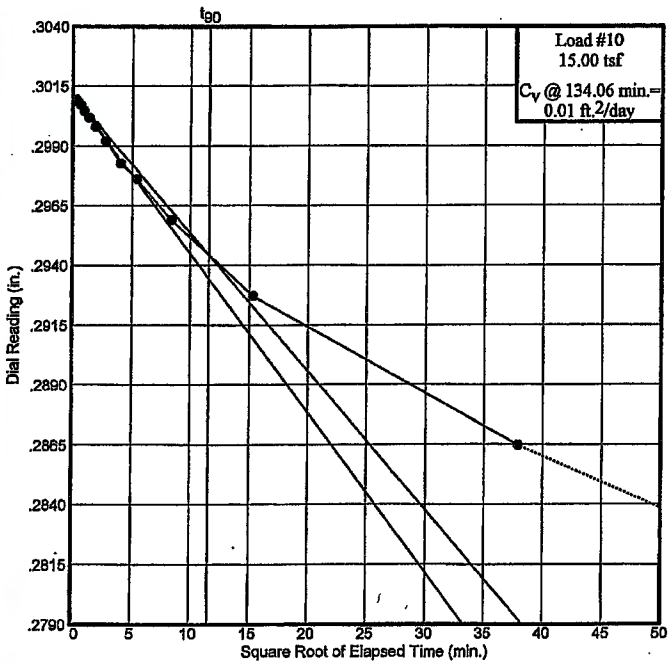
SIERRA TESTING LABS, INC.

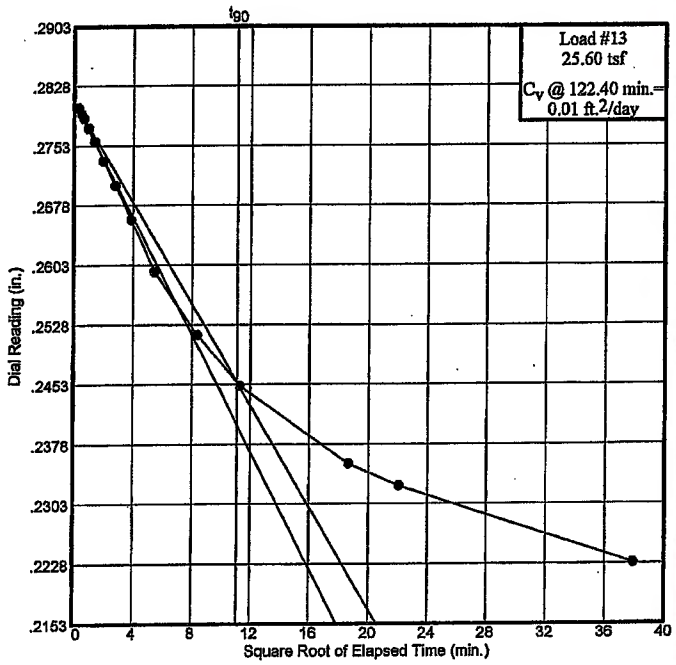
El Dorado Hills, CA

Figure

Dial Reading vs. Time

Project No.: 07-116
Project: Jungo Rd
Golder Job No. 063-7079
Source: EB Sample No.: EB Elev./Depth: 85.0

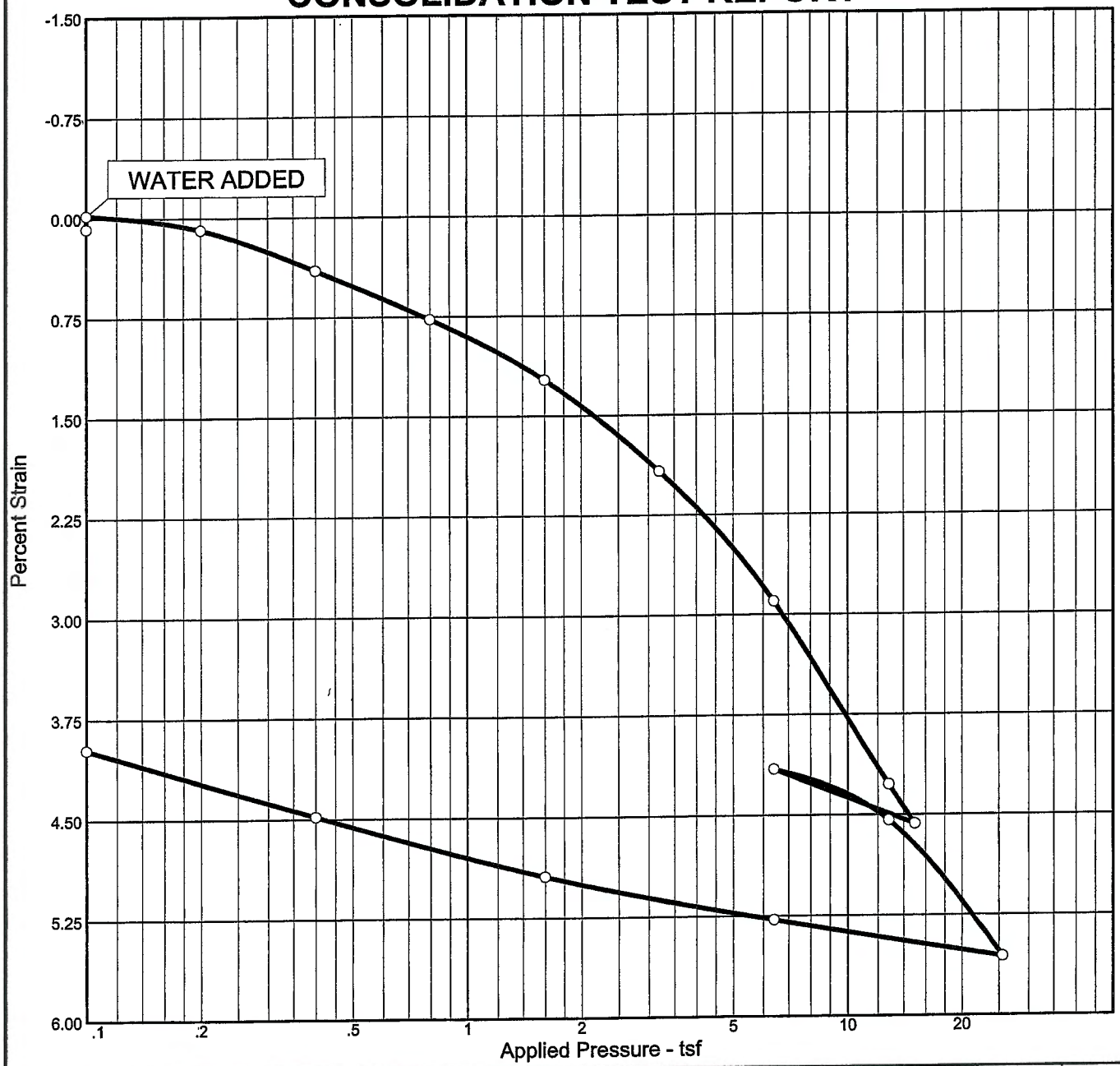




SIERRA TESTING LABS, INC.
El Dorado Hills, CA

Figure

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_s	Swell Press. (tsf)	Swell %	e_o
97.9 %	50.8 %	70.2	61	34	2.70		5.89	0.10	0.02	0.19	0.1	1.400

MATERIAL DESCRIPTION	USCS	AASHTO

Project No. 07-116 **Client:** Golder Associates, Inc.

Project: Jungo Rd
Golder Job No. 063-7079

Source: MW-4 **Sample No.:** MW-4 **Elev./Depth:** 90.0

Remarks:

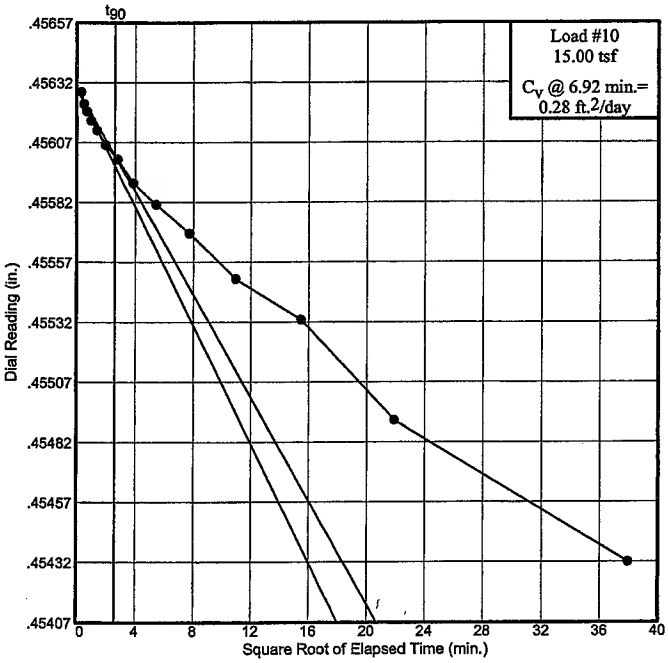
SIERRA TESTING LABS, INC.

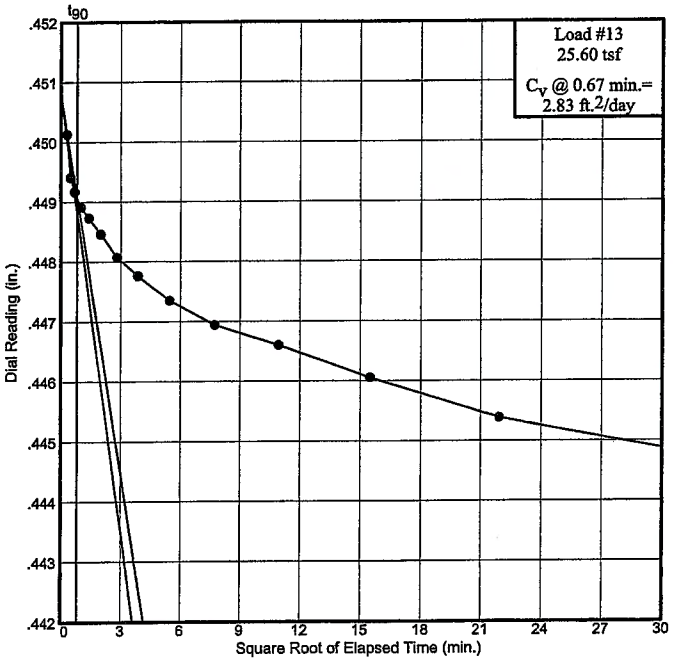
El Dorado Hills, CA

Figure

Dial Reading vs. Time

Project No.: 07-116
Project: Jungo Rd
Golder Job No. 063-7079
Source: MW-4 Sample No.: MW-4 Elev./Depth: 90.0





SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure

APPENDIX C
HISTORICAL GROUNDWATER ELEVATION STUDY

Golder Associates Inc.
2580 Wyandotte Street, Suite G
Mountain View, CA 94043
Telephone: (650) 386-3828
Fax: (650) 386-3815

TECHNICAL MEMORANDUM

TO:	Don Gambelin, Ken Haskell	**DATE:**	May 7, 2007
FR:	Jennifer Panders, Bill Fowler	**OUR REF:**	Jungo Road
RE:	Historical Groundwater Elevations, Desert Valley Basin, NV		

1.0 HISTORICAL EVALUATION OF GROUNDWATER ELEVATIONS IN THE DESERT VALLEY BASIN

As part of the overall hydrogeologic characterization of the Jungo Road site, we evaluated available historical data pertaining to groundwater elevations of the Desert Valley groundwater basin. The purpose of this work was to develop an estimate of highest anticipated groundwater elevation, and resulting groundwater separation, for design of the landfill subgrade.

1.1 Basin Configuration

The project site is located in the southern portion of the Desert Valley groundwater basin (Figures 1a and b). A groundwater divide bisects the Desert Valley basin from east to west. The location of the divide has been shown to migrate over time in response to changes in groundwater elevations, but has generally remained in the central to southern-central area of the basin (Figures 1a and 1b). Groundwater on the northern side of the divide flows to the north toward the Quinn River and Pine Valley. Water on the southern side of the divide flows to the southwest and presumably exits the basin near the Antelope Range. The site is located on the southern side of the divide, where groundwater flows toward the southwest.

1.2 Groundwater Use and Elevation Changes

Prior to 1985, groundwater withdrawal in the Desert Valley basin occurred primarily for agriculture and irrigation, with lesser amounts for domestic and livestock use. In 1985, the Sleeper Mine, located in the northern portion of the valley on the northern side of the groundwater divide, began open-pit mining and associated dewatering. In the early 1990's, a study was conducted by the USGS to evaluate effects of mine dewatering on the groundwater basin. As part of the study, groundwater elevations were measured in spring of 1991 throughout the basin and were compared to historical data. The 1991 measurements demonstrated that groundwater elevations in the basin had been affected by the mine dewatering (Figure 1b). In general, elevations measured in 1991 (while mine dewatering was occurring) were lower than those from "pre-development" (late 1950's to early 60's) conditions (1a).

Specifically, the study found that in the northern area of the basin adjacent to the mine, depths to groundwater were 200 to 300 feet below ground surface (bgs), reflecting a significant decrease in groundwater elevation due to mine dewatering activities. In the central area of the valley, the depth to

groundwater was generally greater than 30 feet. On the southern side of the divide, depths to groundwater were found to increase toward the southwest (from the divide toward the site) to around 70 ft bgs, representing water-level declines of five feet or less in the southern-central part of the valley. Greater declines of five to 20 feet were observed in the very southern portion of the basin, closer to the site location (Figure 1b).

The USGS report proposed that the greater declines observed in the southern area of the valley were not related to mine dewatering activities, but to several consecutive years of below-average precipitation prior to 1991. While precipitation patterns may have contributed to the decline in groundwater elevations in the southwestern part of the valley, it is also possible that other factors, such as the change in the location and elevation of the groundwater divide, may have contributed to the decline.

1.3 Recent Groundwater Elevation Data

Groundwater elevation data from the Nevada Division of Water Resources (NDWR) collected from 1994 through 2005 show that the water levels in wells in the southern portion of the valley near the site have continued to decline since 1991 (Figures 2 and 3). Figure 2 shows the location of the site with respect to locations of surrounding wells with historical records in the NDWR data base. Figure 3 presents a plot of groundwater elevations over time in the southwestern area of the valley. The data shown in the plot comes from wells located approximately 5 to 7 miles from the site location, in up-, side-, and down-gradient directions.

The well data presented in Figure 2 indicate a consistent decline in groundwater elevation from 1989 to 2005 of approximately five to seven feet. The 1989 elevations do not necessarily represent pre-disturbed conditions, as mine dewatering associated with the Sleeper mine began in 1985, and effects may or may not have impacted this area by this time. Data for one well (Site 115) was obtained back to 1975, prior to the Sleeper Mine dewatering, but not necessarily prior to other groundwater development that may have occurred in the southern area of the valley. Using trend lines for two of the wells, a maximum groundwater elevation decline of approximately ten feet since 1980 can be estimated for the southwestern area of the Valley back to 1975. The trend lines show a consistent, gradual decline in groundwater elevations. Elevations in the last three years of the plot appear to be flattening.

1.4 Groundwater Elevation Versus Precipitation

To evaluate the effects of precipitation patterns on groundwater elevations, annual precipitation amounts from Winnemucca were plotted versus groundwater elevations (Figure 4). This plot does not indicate a temporal relationship between precipitation and groundwater elevation, on the contrary, it appears to indicate that annual rainfall does not affect groundwater elevation in the southwestern portion of Desert Valley.

Precipitation records for Winnemucca, Nevada indicate that five of the six years prior to and including 1991 had below average precipitation. Prior to 1995, eight years had below average precipitation, one year was average, and one year was above average. Looking at groundwater elevations over this time period, elevations generally fell about 2 to 4 feet. However, following the below-average rainfall years of the late 1980's and early 1990's, the precipitation data demonstrates several above-average rainfall years occurring in the late 1990's (1996, 1997, 1999, and 2001). The groundwater elevation data do not reflect the increased precipitation, rather they continue to decline an additional two to three feet. Therefore, in this portion of the basis, basin development and long-

term groundwater use patterns (e.g., groundwater extraction for irrigation) appear to be a more significant factor in groundwater elevation change than annual precipitation.

1.5 Groundwater Flow Model

The USGS report included a mathematical hydrologic flow model that simulated pre-development conditions. The model was used to evaluate basin response to groundwater development. Continued mine dewatering through 1998 was one scenario evaluated with the flow model. This scenario happens to correlate with mine activities, as major dewatering operations at the Sleeper Mine ceased in 1997. The model predicted that, by extending the pumping period to 1998, the area of water level decline would expand, mostly farther south of the mine than to the north. After a 100-year recovery period, the model predicts that water levels in the area of the mine will almost recover to pre-development conditions.

1.6 Summary

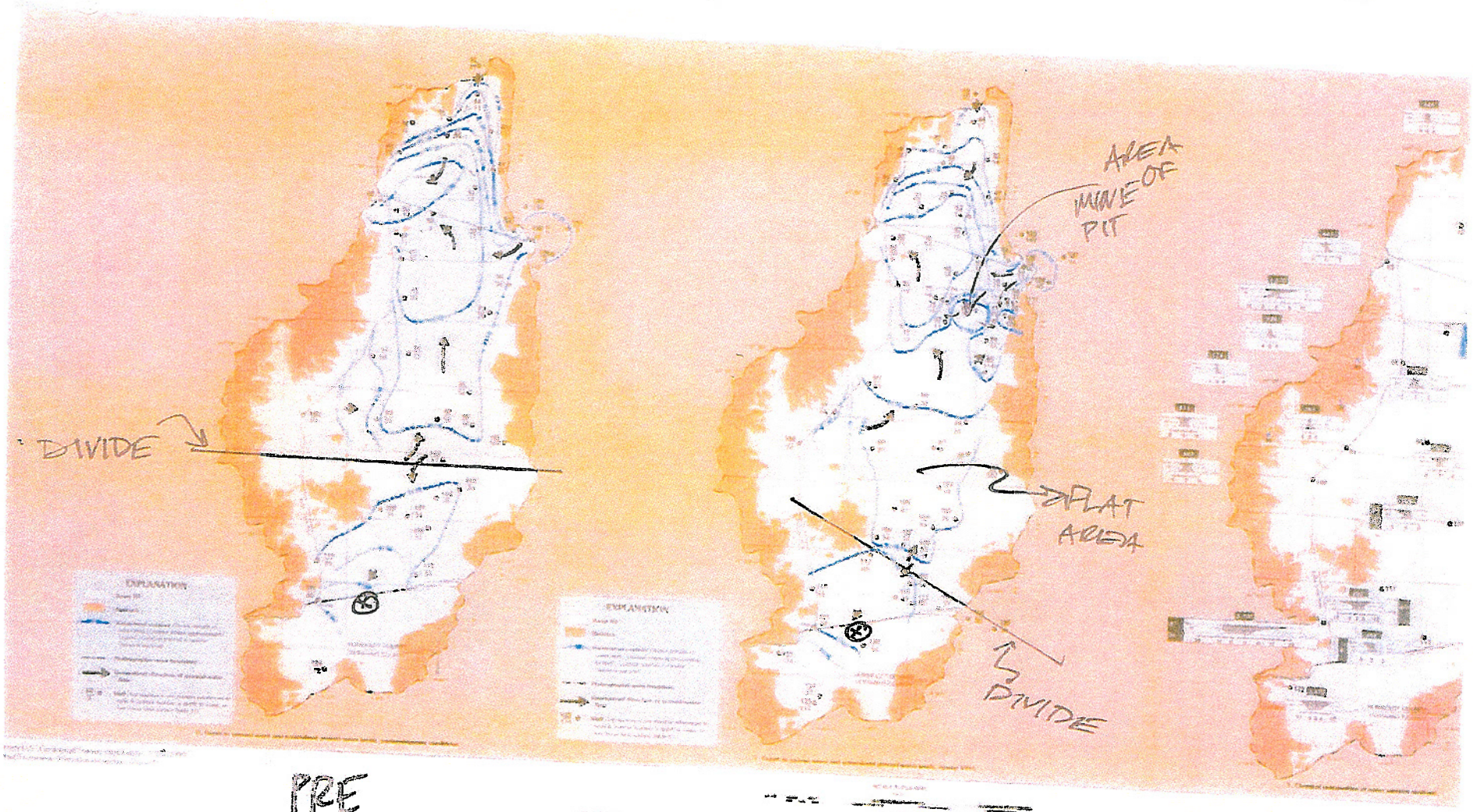
The consistent downward trend in groundwater elevations near the site since 1975 are attributed to overall withdrawal of groundwater in the Desert Valley basin. Major sources of groundwater withdrawal include former dewatering activities in the northern portion of the basin associated with the Sleeper Mine, and more local groundwater withdrawal for agricultural usage. As such, with continued agricultural groundwater use, groundwater elevations in the vicinity of the site are not likely to exceed pre-development levels (i.e., approximately 1975 levels) and indeed may not rise beyond present day levels. Current depth to groundwater at the site is approximately 58 to 60 feet bgs. Therefore, assuming a return to 1975 groundwater levels, the highest anticipated groundwater levels at the site are estimated at approximately 50 feet bgs.

References

1 Nevada Division of Water Resources (driller well logs, water-level database)

2 USGS Water-Resources Inv. Report 95-4119. *Groundwater Conditions and Effect of Mine Dewatering in Desert Valley, Humboldt and Pershing Counties, Northwestern Nevada, 1962-1991.* David L. Berger.

3 USGS Scientific Investigations Report 2005-5291. Evaluation of Precipitation Estimates from PRISM for the 1961-90 and 1971-2000 Data Sets, Nevada.

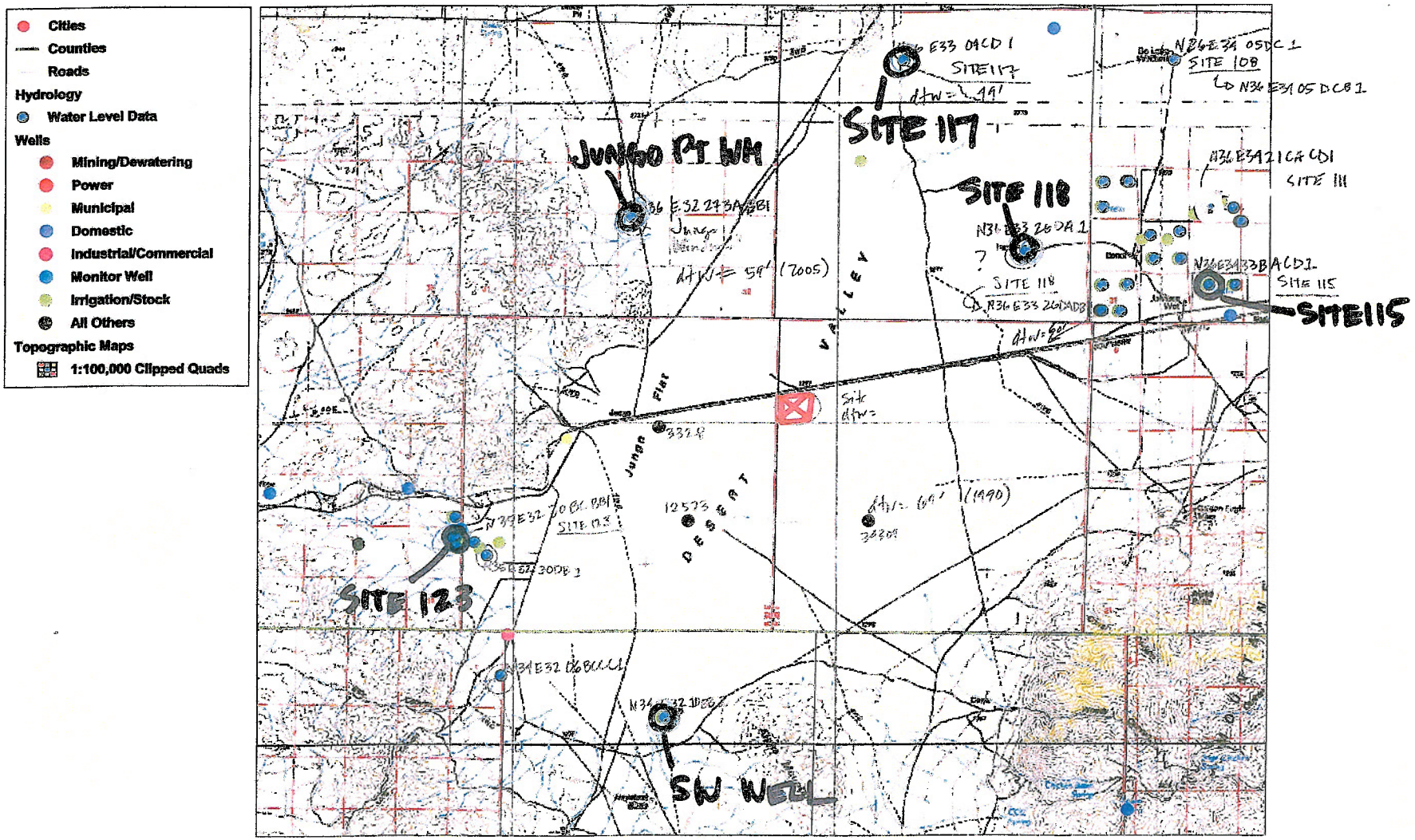


PRE

POST

FIG 1

State of Nevada Division of Water Resources



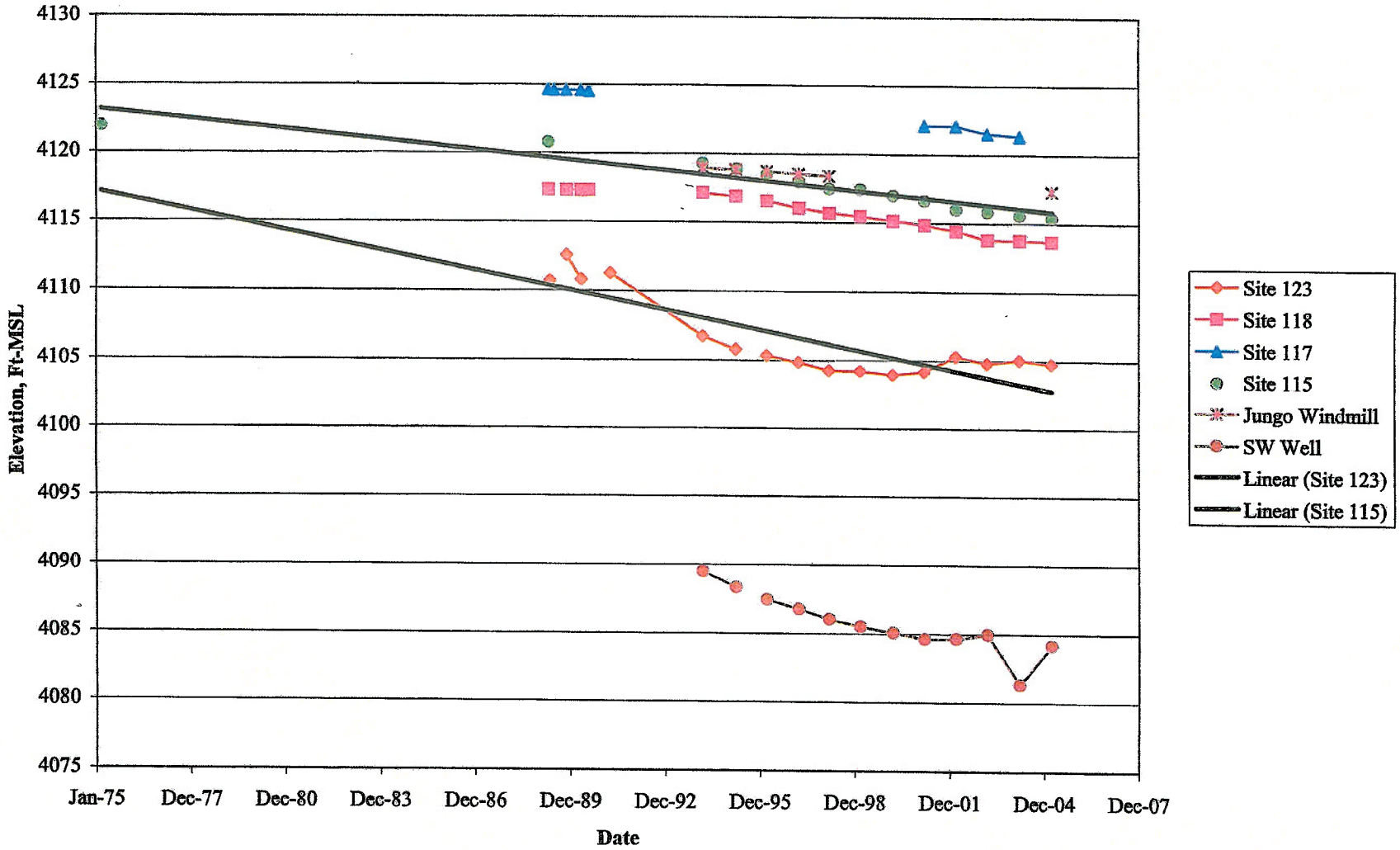
WELL LOCATIONS

FIG. 2

http://webmap.water.nv.gov/mwf/ndwr.mwf

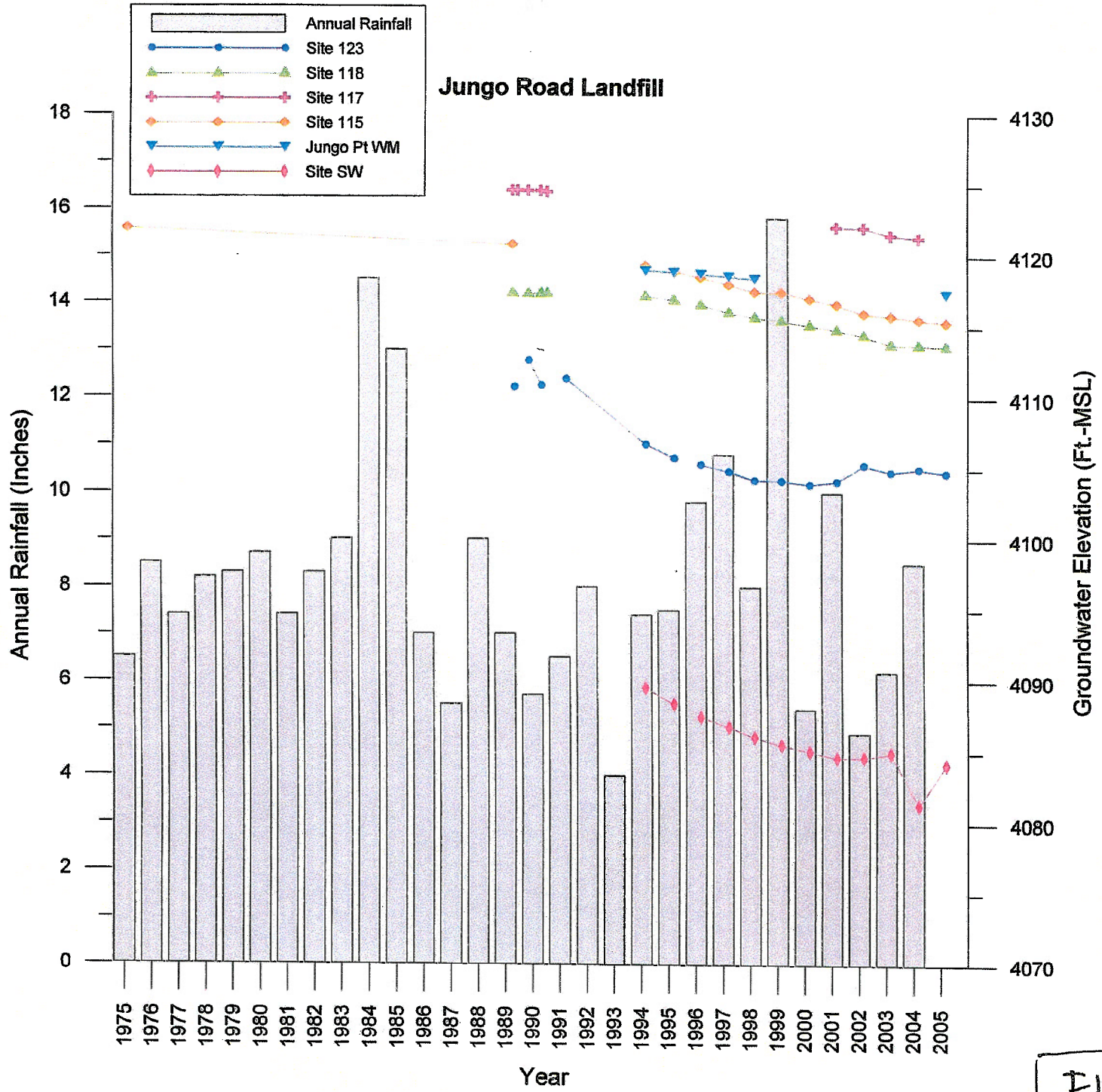
Thursday, April 05, 2007 1:56 PM

Groundwater Elevations



G:\Projects\063-7079-100 (Jungo Road)\Research\basin 31 levels.xls{Chart with trends}

FIG. 3


Jungo Road Landfill
Annual Rainfall
Site 123
Site 118
Site 117
Site 115
Jungo Pt WM
Site SW
Annual Rainfall (Inches)
Groundwater Elevation (Ft.-MSL)
Year
0
2
4
6
8
10
12
14
16
18
4070
4080
4090
4100
4110
4120
4130
1975
1976
1977
1978
1979
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1981
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1983
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1985
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1987
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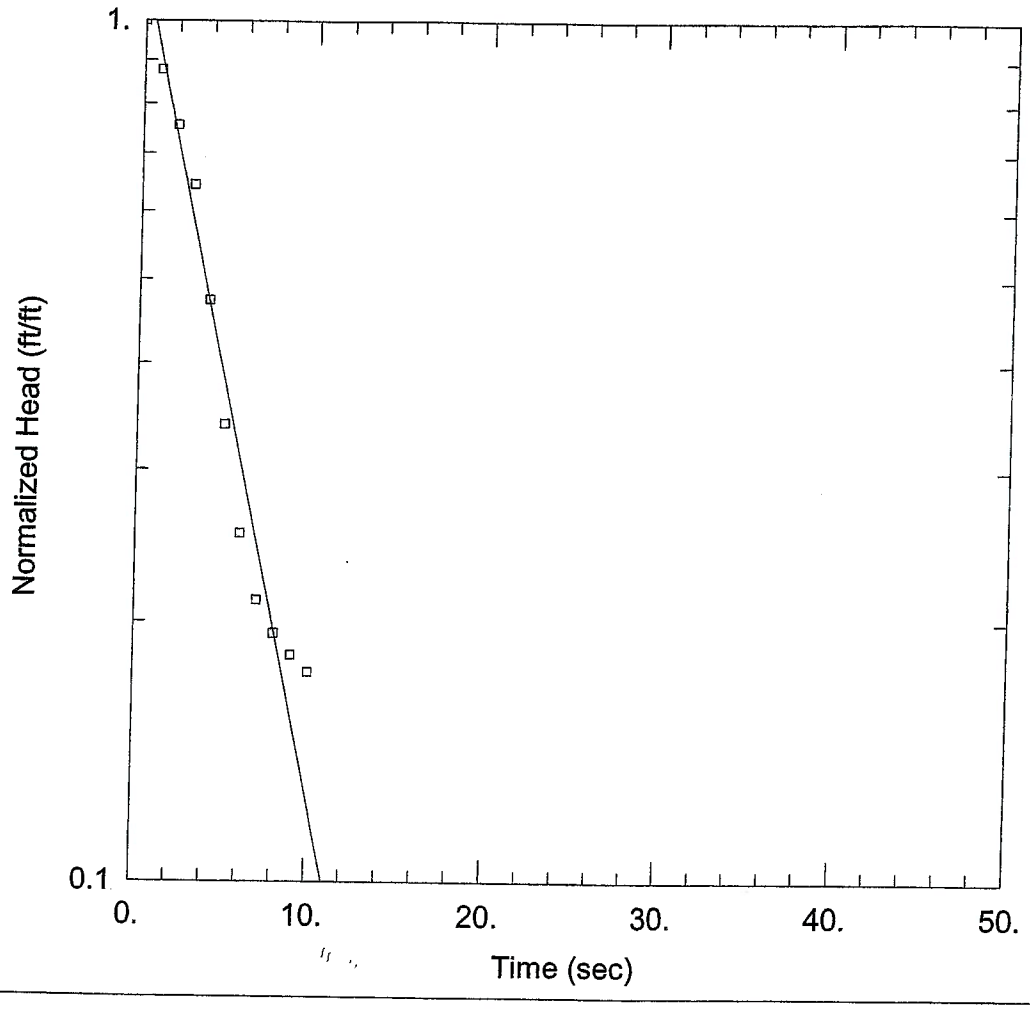
2001
2002
2003
2004
2005

FIG 4

APPENDIX D
SLUG TEST DATA



WELL TEST ANALYSIS

Data Set: N:\Projects\063-7079 (Norcal - Winnemucca Project)\Slug Test Data\MW-1 OUT 4-12-07.aqt
Date: 04/12/07 Time: 11:57:43

PROJECT INFORMATION

Company: Golder Associates, Inc
Client: Nor Cal
Project: 063-7079
Location: Winnemuca, NV
Test Well: MW-1
Test Date: 2/01/07

AQUIFER DATA

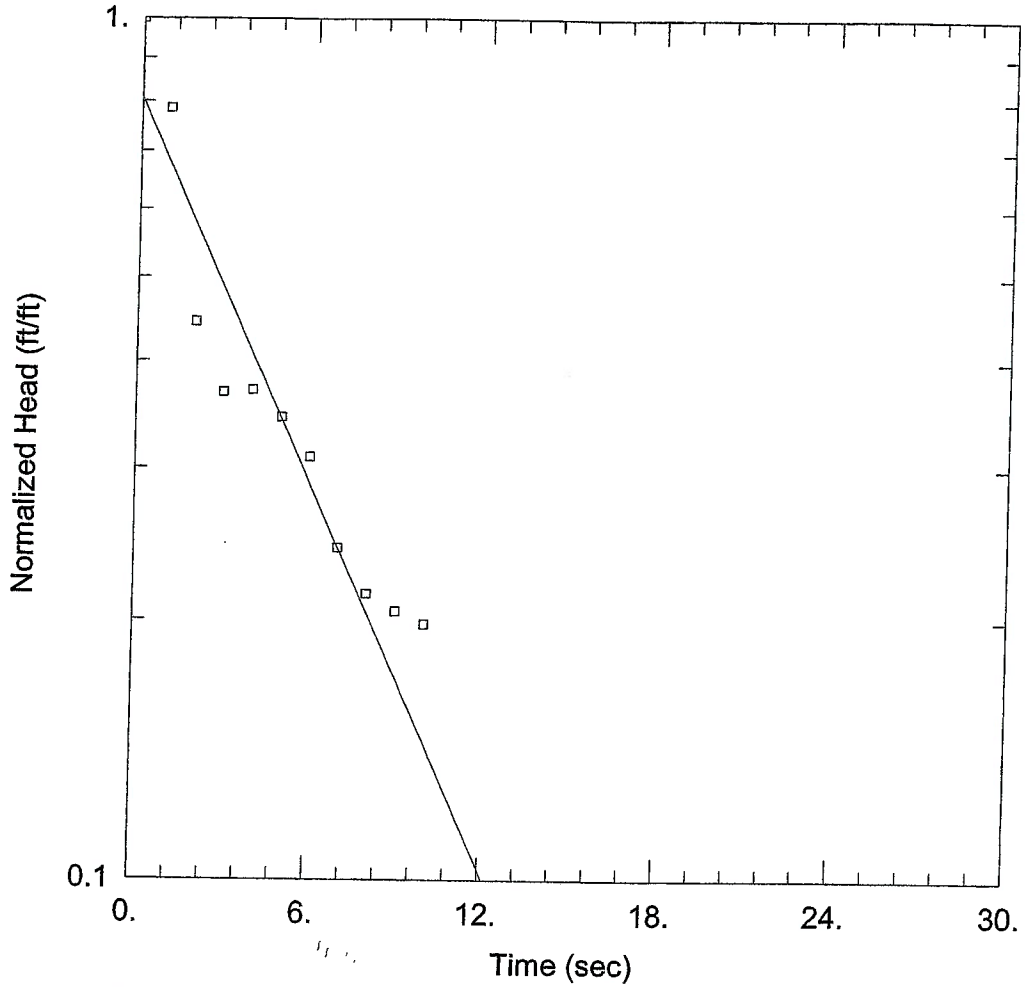
Saturated Thickness: 12.52 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-1)

Initial Displacement: 3.242 ft
Total Well Penetration Depth: 18.72 ft
Casing Radius: 0.083 ft
Static Water Column Height: 18.72 ft
Screen Length: 18.72 ft
Well Radius: 0.33 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.000159 cm/sec
y0 = 3.664 ft



WELL TEST ANALYSIS

Data Set: N:\Projects\063-7079 (Norcal - Winnemucca Project)\Slug Test Data\MW-2 OUT 4-12-07.aqt
Date: 04/12/07 Time: 11:56:27

PROJECT INFORMATION

Company: Golder Associates, Inc
Client: Nor Cal
Project: 063-7079
Location: Winnemuca, NV
Test Well: MW-2
Test Date: 2/01/07

AQUIFER DATA

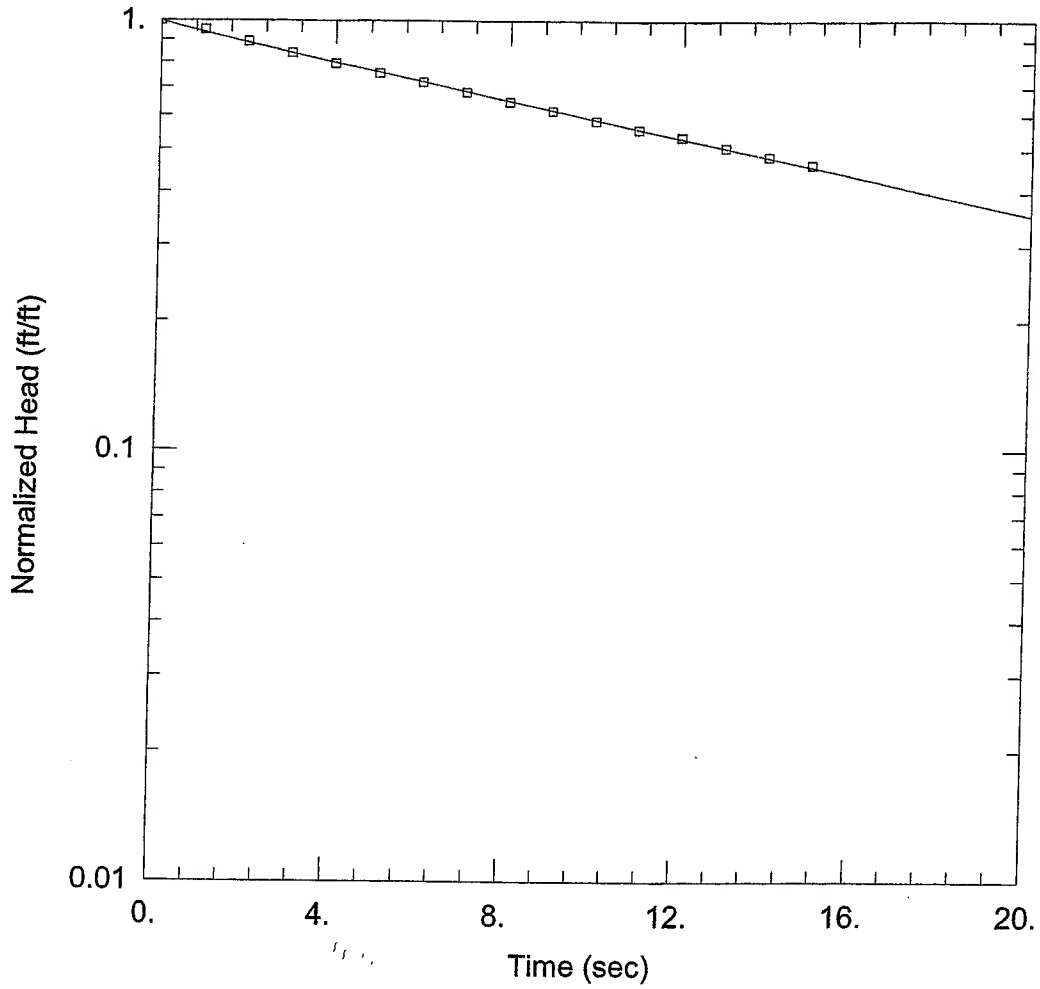
Saturated Thickness: 18.62 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-2)

Initial Displacement: 3.138 ft
Total Well Penetration Depth: 19.72 ft
Casing Radius: 0.083 ft
Static Water Column Height: 19.72 ft
Screen Length: 19.72 ft
Well Radius: 0.333 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0001193 cm/sec
y0 = 2.528 ft



WELL TEST ANALYSIS

Data Set: N:\Projects\063-7079 (Norcal - Winnemucca Project)\Slug Test Data\MW-3 OUT 4-12-07.aqt
Date: 04/12/07 Time: 11:56:56

PROJECT INFORMATION

Company: Golder Associates, Inc
Client: Nor Cal
Project: 063-7079
Location: Winnemuca, NV
Test Well: MW-3
Test Date: 2/01/07

AQUIFER DATA

Saturated Thickness: 12.36 ft

WELL DATA (MW-3)

Initial Displacement: 3.253 ft
Total Well Penetration Depth: 15.16 ft
Casing Radius: 0.083 ft

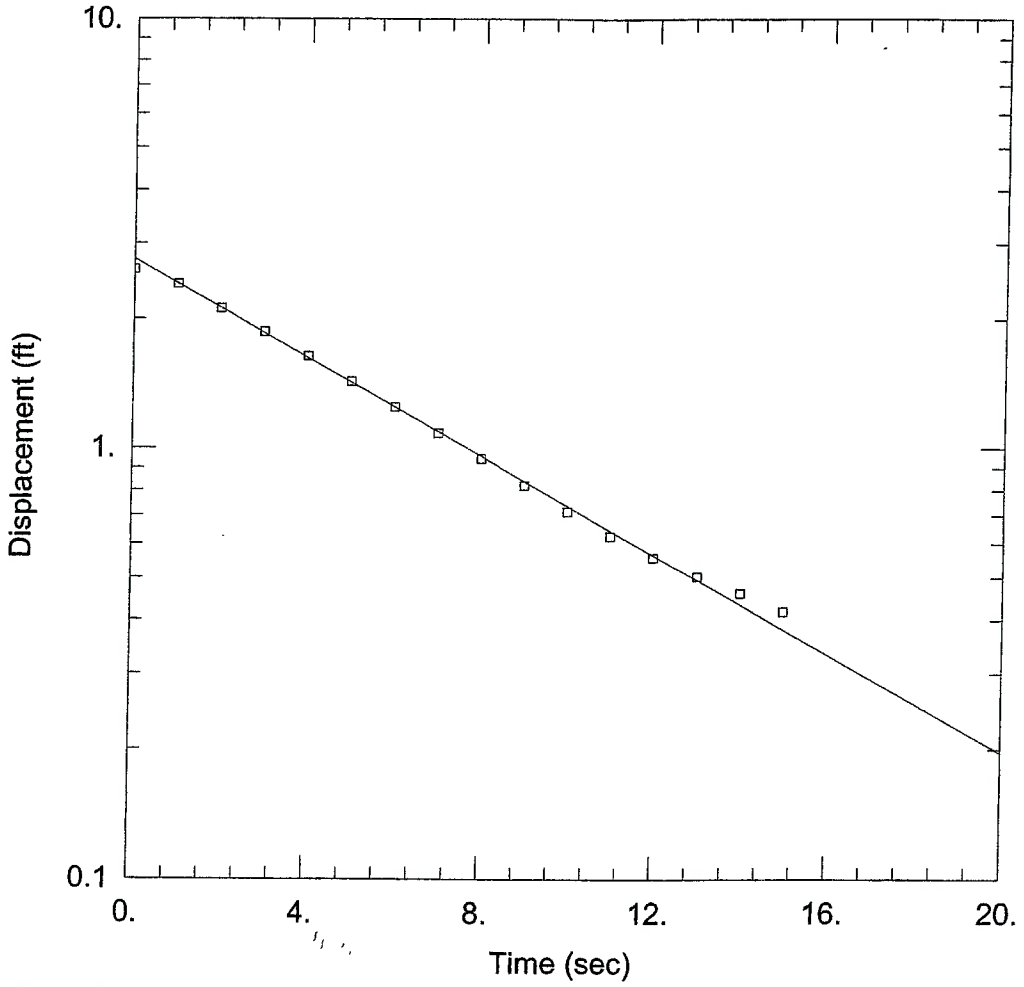
Static Water Column Height: 15.16 ft
Screen Length: 10. ft
Well Radius: 0.333 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.0001081 cm/sec
Kz/Kr = 1

Ss = 1.697E-7 ft^{-1}



WELL TEST ANALYSIS

Data Set: N:\Projects\063-7079 (Norcal - Winnemucca Project)\Slug Test Data\MW-4 OUT 4-12-07.aqt
Date: 04/12/07 Time: 11:57:23

PROJECT INFORMATION

Company: Golder Associates, Inc
Client: Nor Cal
Project: 063-7079
Location: Winnemuca, NV
Test Well: MW-4
Test Date: 2/01/07

AQUIFER DATA

Saturated Thickness: 16.75 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-4)

Initial Displacement: 2.606 ft
Total Well Penetration Depth: 19.85 ft
Casing Radius: 0.083 ft
Static Water Column Height: 19.85 ft
Screen Length: 19.85 ft
Well Radius: 0.333 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 9.133E-5 cm/sec
y0 = 2.756 ft

APPENDIX E
FOUNDATION SELTTLEMENT CALCULATIONS

SUBJECT – Foundation Settlement for Jungo Disposal Site		
Job No. 063-7079-100	Made by AG Checked KK Reviewed by KGH	Date 10/17/07 Sheet 1/1

OBJECTIVES

Evaluate total settlement for the foundation under refuse fill loading.

METHODOLOGY AND ASSUMPTIONS

1. A preliminary and simple 1-D consolidation model was used to estimate settlement beneath the landfill. The 1-D model likely exaggerates the average differential loading experienced at depth between the sump and slope crest (and computed differential settlements).

2. Consolidation settlement includes primary and secondary settlement.

3. The model evaluates a hypothetical 250 to 275-foot soil column of interlayered silty sands, silty clays, and relatively compressible tuffaceous clays. The model assumes approximately 11% of the soil column is compressible tuff, 30% silty clay and the remaining a silty sand/clean sand with occasional silt.

4. Use consolidation model for the clays based on laboratory data to estimate primary and secondary compression values.

5. Consider elastic settlement for the sands in the upper 150 feet using modulus of subgrade reaction values of between 300 to 500 ksf for medium dense sands (J. Bowles, Foundation Analysis and Design, Table 2-7). Elastic settlement of sandy soils assumed to be negligible below depths of 150 feet.

6. The unit weight of refuse is 70 pcf. This is likely high due to the extensive use of ADC.

RESULTS AND CONCLUSION

The results of the foundation analyses are summarized below:

1) Settlement at the center of the landfill is estimated to be 9 to 10 feet (see attached sheet)
2) Settlement at the crest of the slope is estimated to be 7 feet
3) Settlement at the sump is estimated to be 4.5 feet
4) The resulting minimum post-settlement grades along the bottom are between 0.2 and 0.8%.
5) The critical settlement area is the portion of the floor between the sump and the side-slope crest of the final fill slope.

Settlement
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Depth below original ground surface = 0 ft
Height of Refuse = 195 ft

Depth below Surface (ft)	Depth below Water Table (ft)	Material Type	Unit Weight (pcf)	σ_{vo}' (psf)	Es (ksf)	C_c	C_{ce}	C_r	C_{re}	C_α	Max. Past Preconsolidation Pressure, σ_p' (psf)	Initial Void Ratio, e_o	Vertical Stress Due to Load, $\Delta\sigma_v$ (psf)	Primary Settlement (in.)	Secondary Settlement (in.)	Total Consol Settlement (ft.)	Elastic Settlement (ft)	Total Settlement (ft.)
1	0		110	55.0	300.0	0.000	0.000	0.000	0.000	0	55		13650.0	0.000	0	0.000	0.091	0.091
3	0		110	275.0	300.0	0.000	0.000	0.000	0.000	0	275		13633.6	0.000	0	0.000	0.091	0.091
5	0		110	495.0	300.0	0.000	0.000	0.000	0.000	0	495		13622.7	0.000	0	0.000	0.091	0.091
7	0		110	715.0	300.0	0.000	0.000	0.000	0.000	0	715		13611.9	0.000	0	0.000	0.091	0.091
9	0		110	935.0	300.0	0.000	0.000	0.000	0.000	0	935		13601.0	0.000	0	0.000	0.091	0.091
11	0		110	1155.0	300.0	0.000	0.000	0.000	0.000	0	1155		13590.1	0.000	0	0.000	0.091	0.091
13	0		110	1375.0	300.0	0.000	0.000	0.000	0.000	0	1375		13579.3	0.000	0	0.000	0.091	0.091
15	0	SM-SW	110	1595.0	300.0	0.000	0.000	0.000	0.000	0	1595		13568.5	0.000	0	0.000	0.090	0.090
17	0		110	1815.0	300.0	0.000	0.000	0.000	0.000	0	1815		13557.7	0.000	0	0.000	0.090	0.090
19	0		110	2035.0	300.0	0.000	0.000	0.000	0.000	0	2035		13546.8	0.000	0	0.000	0.090	0.090
21	0		110	2255.0	300.0	0.000	0.000	0.000	0.000	0	2255		13536.1	0.000	0	0.000	0.090	0.090
23	0		110	2475.0	300.0	0.000	0.000	0.000	0.000	0	2475		13525.3	0.000	0	0.000	0.090	0.090
25	0		110	2695.0	300.0	0.000	0.000	0.000	0.000	0	2695		13514.5	0.000	0	0.000	0.090	0.090
27	0		110	2915.0	300.0	0.000	0.000	0.000	0.000	0	2915		13503.8	0.000	0	0.000	0.090	0.090
29	0		110	3135.0	300.0	0.000	0.000	0.000	0.000	0	3135		13493.0	0.000	0	0.000	0.090	0.090
31	0		110	3355.0	300.0	0.000	0.000	0.000	0.000	0	3355		13482.3	0.000	0	0.000	0.090	0.090
33	0		110	3575.0	300.0	0.000	0.000	0.000	0.000	0	3575		13471.6	0.000	0	0.000	0.090	0.090
35	0		110	3795.0	300.0	0.000	0.000	0.000	0.000	0	3795		13460.9	0.000	0	0.000	0.090	0.090
37	0		110	4015.0		0.220	0.110	0.030	0.015	0.011	4015	1.000	13450.2	1.686	0.112	1.798		0.150
39	0		110	4235.0		0.220	0.110	0.030	0.015	0.011	4235	1.000	13439.5	1.638	0.112	1.750		0.146
41	0		110	4455.0		0.220	0.110	0.030	0.015	0.011	4455	1.000	13428.9	1.594	0.112	1.706		0.142
43	0	CL	110	4675.0		0.220	0.110	0.030	0.015	0.011	4675	1.000	13418.2	1.552	0.112	1.664		0.139
45	0		110	4895.0		0.220	0.110	0.030	0.015	0.011	4895	1.000	13407.6	1.512	0.112	1.624		0.135
47	0		110	5115.0		0.220	0.110	0.030	0.015	0.011	5115	1.000	13397.0	1.475	0.112	1.587		0.132
49	0		110	5335.0		0.220	0.110	0.030	0.015	0.011	5335	1.000	13386.3	1.439	0.112	1.551		0.129
51	0		115	5565.0	300.0	0.000	0.000	0.000	0.000	0	5565		13375.7	0.000	0	0.000		0.000
53	0		115	5795.0	300.0	0.000	0.000	0.000	0.000	0	5795		13365.2	0.000	0	0.000	0.089	0.089
55	0		115	6025.0	300.0	0.000	0.000	0.000	0.000	0	6025		13354.6	0.000	0	0.000	0.089	0.089
57	0		115	6255.0	300.0	0.000	0.000	0.000	0.000	0	6255		13344.0	0.000	0	0.000	0.089	0.089
59	1		115	6360.2	300.0	0.000	0.000	0.000	0.000	0	6360		13333.5	0.000	0	0.000	0.089	0.089
61	3		115	6465.4	300.0	0.000	0.000	0.000	0.000	0	6465		13322.9	0.000	0	0.000	0.089	0.089
63	5		115	6570.6	300.0	0.000	0.000	0.000	0.000	0	6571		13312.4	0.000	0	0.000	0.089	0.089
65	7		115	6675.8	300.0	0.000	0.000	0.000	0.000	0	6676		13301.9	0.000	0	0.000	0.089	0.089
67	9	SM-SW	115	6781.0	300.0	0.000	0.000	0.000	0.000	0	6781		13291.4	0.000	0	0.000	0.089	0.089
69	11		115	6886.2	300.0	0.000	0.000	0.000	0.000	0	6886		13280.9	0.000	0	0.000	0.089	0.089
71	13		115	6991.4	300.0	0.000	0.000	0.000	0.000	0	6991		13270.4	0.000	0	0.000	0.088	0.088
73	15		115	7096.6	300.0	0.000	0.000	0.000	0.000	0	7097		13260.0	0.000	0	0.000	0.088	0.088
75	17		115	7201.8	300.0	0.000	0.000	0.000	0.000	0	7202		13249.5	0.000	0	0.000	0.088	0.088
77	19		115	7307.0	300.0	0.000	0.000	0.000	0.000	0	7307		13239.1	0.000	0	0.000	0.088	0.088
79	21		115	7412.2	300.0	0.000	0.000	0.000	0.000	0	7412		13228.7	0.000	0	0.000	0.088	0.088
81	23		115	7517.4	300.0	0.000	0.000	0.000	0.000	0	7517		13218.3	0.000	0	0.000	0.088	0.088
83	25		100	7592.6		0.660	0.230	0.030	0.010	0.033	7593	1.870	13207.9	2.416	0.234	2.650		0.221
85	27		100	7667.8		0.660	0.230	0.030	0.010	0.033	7668	1.870	13197.5	2.399	0.234	2.634		0.219
87	29		100	7743.0		0.660	0.230	0.030	0.010	0.033	7743	1.870	13187.1	2.384	0.234	2.618		0.218
89	31		100	7818.2		0.660	0.230	0.030	0.010	0.033	7818	1.870	13176.7	2.368	0.234	2.602		0.217
91	33	CH	100	7893.4		0.660	0.230	0.030	0.010	0.033	7893	1.870	13166.4	2.352	0.234	2.587		0.216
93	35	(Tuff)	100	7968.6		0.660	0.230	0.030	0.010	0.033	7969	1.870	13156.0	2.337	0.234	2.571		0.214
95	37		100	8043.8		0.660	0.230	0.030	0.010	0.033	8044	1.870	13145.7	2.322	0.234	2.556		0.213
97	39		100	8119.0		0.660	0.230	0.030	0.010	0.033	8119	1.870	13135.4	2.307	0.234	2.541		0.212
99	41		100	8194.2		0.660	0.230	0.030	0.010	0.033	8194	1.870	13125.1	2.292	0.234	2.526		0.211
101	43		115	8299.4		0.220	0.110	0.030	0.015	0.011	8299	1.000	13114.8	1.087	0.112	1.199		0.100
103	45		115	8404.6		0.220	0.110	0.030	0.015	0.011	8405	1.000	13104.5	1.077	0.112	1.190		0.099
105	47		115	8509.8		0.220	0.110	0.030	0.015	0.011	8510	1.000	13094.3	1.068	0.112	1.180		0.098
107	49	CL-CH	115	8615.0		0.220	0.110	0.030	0.015	0.011	8615	1.000	13084.0	1.059	0.112	1.171		0.098
109	51		115	8720.2		0.220	0.110	0.030	0.015	0.011	8720	1.000	13073.8	1.050	0.112	1.162		0.097
111	53		115	8825.4		0.220	0.110	0.030	0.015	0.011	8825	1.000	13063.5	1.041	0.112	1.154		0.096
113	55		115	8930.6		0.220	0.110	0.030	0.015	0.011	8931	1.000	13053.3	1.033	0.112	1.145		0.095

Settlement
Center of Landfill

PR/3

115	57		115	9035.8	500.0	0.000	0.000	0.000	0.000	0	9036		13043.1	0.000	0	0.000	0.052	0.052
117	59		115	9141.0	500.0	0.000	0.000	0.000	0.000	0	9141		13032.9	0.000	0	0.000	0.052	0.052
119	61		115	9246.2	500.0	0.000	0.000	0.000	0.000	0	9246		13022.7	0.000	0	0.000	0.052	0.052
121	63		115	9351.4	500.0	0.000	0.000	0.000	0.000	0	9351		13012.6	0.000	0	0.000	0.052	0.052
123	65		115	9456.6	500.0	0.000	0.000	0.000	0.000	0	9457		13002.4	0.000	0	0.000	0.052	0.052
125	67	SM-SW	115	9561.8	500.0	0.000	0.000	0.000	0.000	0	9562		12992.3	0.000	0	0.000	0.052	0.052
127	69		115	9667.0	500.0	0.000	0.000	0.000	0.000	0	9667		12982.1	0.000	0	0.000	0.052	0.052
129	71		115	9772.2	500.0	0.000	0.000	0.000	0.000	0	9772		12972.0	0.000	0	0.000	0.052	0.052
131	73		115	9877.4	500.0	0.000	0.000	0.000	0.000	0	9877		12961.9	0.000	0	0.000	0.052	0.052
133	75		115	9982.6	500.0	0.000	0.000	0.000	0.000	0	9983		12951.8	0.000	0	0.000	0.052	0.052
135	77		115	10087.8		0.180	0.100	0.020	0.011	0.009	10088	0.800	12941.7	0.860	0.102	0.962		0.080
137	79		115	10193.0		0.180	0.100	0.020	0.011	0.009	10193	0.800	12931.6	0.854	0.102	0.956		0.080
139	81		115	10298.2		0.180	0.100	0.020	0.011	0.009	10298	0.800	12921.6	0.847	0.102	0.949		0.079
141	83		115	10403.4		0.180	0.100	0.020	0.011	0.009	10403	0.800	12911.5	0.841	0.102	0.943		0.079
143	85	CL-CH	115	10508.6		0.180	0.100	0.020	0.011	0.009	10509	0.800	12901.5	0.835	0.102	0.937		0.078
145	87		115	10613.8		0.180	0.100	0.020	0.011	0.009	10614	0.800	12891.5	0.829	0.102	0.931		0.078
147	89		115	10719.0		0.180	0.100	0.020	0.011	0.009	10719	0.800	12881.4	0.823	0.102	0.925		0.077
149	91		115	10824.2		0.180	0.100	0.020	0.011	0.009	10824	0.800	12871.4	0.817	0.102	0.919		0.077
151	93		115	10929.4		0.180	0.100	0.020	0.011	0.009	10929	0.800	12861.4	0.811	0.102	0.913		0.076
153	95		115	11034.6		0.180	0.100	0.020	0.011	0.009	11035	0.800	12851.5	0.805	0.102	0.907		0.076
155	97		115	11139.8		0.000	0.000	0.000	0.000	0	11140		12841.5	0.000	0	0.000		0.000
157	99		115	11245.0		0.000	0.000	0.000	0.000	0	11245		12831.5	0.000	0	0.000		0.000
159	101		115	11350.2		0.000	0.000	0.000	0.000	0	11350		12821.6	0.000	0	0.000		0.000
161	103		115	11455.4		0.000	0.000	0.000	0.000	0	11455		12811.6	0.000	0	0.000		0.000
163	105		115	11560.6		0.000	0.000	0.000	0.000	0	11561		12801.7	0.000	0	0.000		0.000
165	107		115	11665.8		0.000	0.000	0.000	0.000	0	11666		12791.8	0.000	0	0.000		0.000
167	109		115	11771.0		0.000	0.000	0.000	0.000	0	11771		12781.9	0.000	0	0.000		0.000
169	111		115	11876.2		0.000	0.000	0.000	0.000	0	11876		12772.0	0.000	0	0.000		0.000
171	113	SM-SW	115	11981.4		0.000	0.000	0.000	0.000	0	11981		12762.1	0	0	0	0	0.000
173	115		115	12086.6		0.000	0.000	0.000	0.000	0	12087		12752.3	0	0	0		0.000
175	117		115	12191.8		0.000	0.000	0.000	0.000	0	12192		12742.4	0	0	0		0.000
177	119		115	12297.0		0.000	0.000	0.000	0.000	0	12297		12732.6	0	0	0		0.000
179	121		115	12402.2		0.000	0.000	0.000	0.000	0	12402		12722.7	0	0	0		0.000
181	123		115	12507.4		0.000	0.000	0.000	0.000	0	12507		12712.9	0	0	0		0.000
183	125		115	12612.6		0.000	0.000	0.000	0.000	0	12613		12703.1	0	0	0		0.000
185	127		115	12717.8		0.000	0.000	0.000	0.000	0	12718		12693.3	0	0	0		0.000
187	129		115	12823.0		0.150	0.083	0.010	0.006	0.0075	12823	0.800	12683.5	0.597	0.085	0.682		0.057
189	131		115	12928.2		0.150	0.083	0.010	0.006	0.0075	12928	0.800	12673.8	0.593	0.085	0.678		0.057
191	133		115	13033.4		0.150	0.083	0.010	0.006	0.0075	13033	0.800	12664.0	0.590	0.085	0.675		0.056
193	135		115	13138.6		0.150	0.083	0.010	0.006	0.0075	13139	0.800	12654.2	0.586	0.085	0.671		0.056
195	137		115	13243.8		0.150	0.083	0.010	0.006	0.0075	13244	0.800	12644.5	0.582	0.085	0.667		0.056
197	139		115	13349.0		0.150	0.083	0.010	0.006	0.0075	13349	0.800	12634.8	0.579	0.085	0.663		0.055
199	141		115	13454.2		0.150	0.083	0.010	0.006	0.0075	13454	0.800	12625.0	0.575	0.085	0.660		0.055
201	143	CL-CH	115	13559.4		0.150	0.083	0.010	0.006	0.0075	13559	0.800	12615.3	0.571	0.085	0.656		0.055
203	145		115	13664.6		0.150	0.083	0.010	0.006	0.0075	13665	0.800	12605.6	0.568	0.085	0.653		0.054
205	147		115	13769.8		0.150	0.083	0.010	0.006	0.0075	13770	0.800	12596.0	0.564	0.085	0.649		0.054
207	149		115	13875.0		0.150	0.083	0.010	0.006	0.0075	13875	0.800	12586.3	0.561	0.085	0.646		0.054
209	151		115	13980.2		0.150	0.083	0.010	0.006	0.0075	13980	0.800	12576.6	0.557	0.085	0.642		0.054
211	153		115	14085.4		0.150	0.083	0.010	0.006	0.0075	14085	0.800	12567.0	0.554	0.085	0.639		0.053
213	155		115	14190.6		0.150	0.083	0.010	0.006	0.0075	14191	0.800	12557.3	0.551	0.085	0.636		0.053
215	157		115	14295.8		0.150	0.083	0.010	0.006	0.0075	14296	0.800	12547.7	0.547	0.085	0.632		0.053
217	159		115	14401.0		0.000	0.000	0.000	0.000	0	14401		12538.1	0.000	0	0.000		0.000
219	161		115	14506.2		0.000	0.000	0.000	0.000	0	14506		12528.5	0.000	0	0.000		0.000
221	163		115	14611.4		0.000	0.000	0.000	0.000	0	14611		12518.9	0.000	0	0.000		0.000
223	165		115	14716.6		0.000	0.000	0.000	0.000	0	14717		12509.3	0.000	0	0.000		0.000
225	167		115	14821.8		0.000	0.000	0.000	0.000	0	14822		12499.7	0.000	0	0.000		0.000
227	169		115	14927.0		0.000	0.000	0.000	0.000	0	14927		12490.2	0.000	0	0.000		0.000
229	171		115	15032.2		0.000	0.000	0.000	0.000	0	15032		12480.6	0.000	0	0.000		0.000
231	173		115	15137.4		0.000	0.000	0.000	0.000	0	15137		12471.1	0.000	0	0.000		0.000
233	175		115	15242.6		0.000	0.000	0.000	0.000	0	15243		12461.5	0.000	0	0.000		0.000
235	177		115	15347.8		0.000	0.000	0.000	0.000	0	15348		12452.0	0.000	0	0.000		0.000
237	179	SM-SW	115	15453.0		0.000	0.000	0.000	0.000	0	15453		12442.5	0.000	0	0.000		0.000
239	181		115	15558.2		0.000	0.000	0.000	0.000	0	15558		12433.0	0.000	0	0.000		0.000
241	183		115	15663.4		0.000	0.000	0.000	0.000	0	15663		12423.5	0.000	0	0.000		0.000
243	185		115	15768.6		0.000	0.000	0.000	0.000	0	15769		12414.0	0.000	0	0.000		0.000
245	187		115	15873.8		0.000	0.000	0.000	0.000	0	15874		12404.6	0.000	0	0.000		0.000

Settlement
Center of Landfill p. 3/3

247	189		115	15979.0		0.000	0.000	0.000	0.000	0	15979		12395.1	0.000	0	0.000		0.000
249	191		115	16084.2		0.000	0.000	0.000	0.000	0	16084		12385.7	0.000	0	0.000		0.000
251	193		115	16189.4		0.000	0.000	0.000	0.000	0	16189		12376.2	0.000	0	0.000		0.000
253	195		115	16294.6		0.000	0.000	0.000	0.000	0	16295		12366.8	0.000	0	0.000		0.000
255	197		115	16399.8		0.000	0.000	0.000	0.000	0	16400		12357.4	0.000	0	0.000		0.000
257	199		115	16505.0		0.000	0.000	0.000	0.000	0	16505		12348.0	0.000	0	0.000		0.000
259	201		115	16610.2		0.000	0.000	0.000	0.000	0	16610		12338.6	0.000	0	0.000		0.000
261	203		100	16685.4		0.400	0.154	0.030	0.012	0.02	16685	1.600	12329.2	0.887	0.157	1.044		0.087
263	205		100	16760.6		0.400	0.154	0.030	0.012	0.02	16761	1.600	12319.9	0.884	0.157	1.040		0.087
265	207	CH	100	16835.8		0.400	0.154	0.030	0.012	0.02	16836	1.600	12310.5	0.880	0.157	1.037		0.086
267	209	(Tuff)	100	16911.0		0.400	0.154	0.030	0.012	0.02	16911	1.600	12301.2	0.877	0.157	1.033		0.086
269	211		100	16986.2		0.400	0.154	0.030	0.012	0.02	16986	1.600	12291.8	0.873	0.157	1.030		0.086
271	213		100	17061.4		0.400	0.154	0.030	0.012	0.02	17061	1.600	12282.5	0.870	0.157	1.026		0.086
273	215		115	17166.6		0.000	0.000	0.000	0.000	0	17167		12273.2	0.000	0	0.000		0.000
275	217		115	17271.8		0.000	0.000	0.000	0.000	0	17272		12263.9	0.000	0	0.000		0.000
											0		13650.0					
											0							
													TOTAL	61.7	6.9	5.7	3.5	9.2

Settlement
Crest of Landfill p. 1/3

Depth below original ground surface = 24 ft
Height of Refuse = 118 ft

Depth below Surface (ft)	Depth below Water Table (ft)	Material Type	Unit Weight (pcf)	σ_{vo}' (psf)	Es (ksf)	C_c	C_{ce}	C_r	C_{re}	C_α	Max. Past Preconsolidation Pressure, σ_p' (psf)	Initial Void Ratio, e_o	Vertical Stress Due to Load, $\Delta\sigma_v$ (psf)	Primary Settlement (in.)	Secondary Settlement (in.)	Total Consol Settlement (in.)	Elastic Settlement (ft)	Total Settlement (ft.)
1	0		110	55.0	300.0	0.000	0.000	0.000	0.000	0	2815		8260.0	0.000	0	0.000	0.055	0.055
3	0		110	275.0	300.0	0.000	0.000	0.000	0.000	0	3035		8250.1	0.000	0	0.000	0.055	0.055
5	0	SM-SW	110	495.0	300.0	0.000	0.000	0.000	0.000	0	3255		8243.5	0.000	0	0.000	0.055	0.055
7	0		110	715.0	300.0	0.000	0.000	0.000	0.000	0	3475		8236.9	0.000	0	0.000	0.055	0.055
9	0		110	935.0	300.0	0.000	0.000	0.000	0.000	0	3695		8230.3	0.000	0	0.000	0.055	0.055
11	0		110	1155.0		0.220	0.110	0.020	0.010	0.011	3915	1.000	8223.8	2.401	0.112	2.513		0.209
13	0		110	1375.0		0.220	0.110	0.020	0.010	0.011	4135	1.000	8217.2	2.227	0.112	2.339		0.195
15	0		110	1595.0		0.220	0.110	0.020	0.010	0.011	4355	1.000	8210.7	2.082	0.112	2.194		0.183
17	0	CL-CH	110	1815.0		0.220	0.110	0.020	0.010	0.011	4575	1.000	8204.1	1.959	0.112	2.071		0.173
19	0		110	2035.0		0.220	0.110	0.020	0.010	0.011	4795	1.000	8197.6	1.852	0.112	1.964		0.164
21	0		110	2255.0		0.220	0.110	0.020	0.010	0.011	5015	1.000	8191.1	1.758	0.112	1.870		0.156
23	0		110	2475.0		0.220	0.110	0.020	0.010	0.011	5235	1.000	8184.5	1.674	0.112	1.786		0.149
25	0		115	2705.0	300.0	0.000	0.000	0.000	0.000	0	5465		8178.0	0.000	0	0.000		0.000
27	0		115	2935.0	300.0	0.000	0.000	0.000	0.000	0	5695		8171.5	0.000	0	0.000	0.054	0.054
29	0		115	3165.0	300.0	0.000	0.000	0.000	0.000	0	5925		8165.0	0.000	0	0.000	0.054	0.054
31	0		115	3395.0	300.0	0.000	0.000	0.000	0.000	0	6155		8158.5	0.000	0	0.000	0.054	0.054
33	1		115	3500.2	300.0	0.000	0.000	0.000	0.000	0	6260		8152.0	0.000	0	0.000	0.054	0.054
35	3		115	3605.4	300.0	0.000	0.000	0.000	0.000	0	6365		8145.6	0.000	0	0.000	0.054	0.054
37	5		115	3710.6	300.0	0.000	0.000	0.000	0.000	0	6471		8139.1	0.000	0	0.000	0.054	0.054
39	7		115	3815.8	300.0	0.000	0.000	0.000	0.000	0	6576		8132.6	0.000	0	0.000	0.054	0.054
41	9	SM-SW	115	3921.0	300.0	0.000	0.000	0.000	0.000	0	6681		8126.2	0.000	0	0.000	0.054	0.054
43	11		115	4026.2	300.0	0.000	0.000	0.000	0.000	0	6786		8119.7	0.000	0	0.000	0.054	0.054
45	13		115	4131.4	300.0	0.000	0.000	0.000	0.000	0	6891		8113.3	0.000	0	0.000	0.054	0.054
47	15		115	4236.6	300.0	0.000	0.000	0.000	0.000	0	6997		8106.9	0.000	0	0.000	0.054	0.054
49	17		115	4341.8	300.0	0.000	0.000	0.000	0.000	0	7102		8100.5	0.000	0	0.000	0.054	0.054
51	19		115	4447.0	300.0	0.000	0.000	0.000	0.000	0	7207		8094.0	0.000	0	0.000	0.054	0.054
53	21		115	4552.2	300.0	0.000	0.000	0.000	0.000	0	7312		8087.6	0.000	0	0.000	0.054	0.054
55	23		115	4657.4	300.0	0.000	0.000	0.000	0.000	0	7417		8081.2	0.000	0	0.000	0.054	0.054
57	25		100	4732.6		0.660	0.230	0.080	0.028	0.033	7493	1.870	8074.8	2.386	0.234	2.621		0.218
59	27		100	4807.8		0.660	0.230	0.080	0.028	0.033	7568	1.870	8068.5	2.361	0.234	2.596		0.216
61	29		100	4883.0		0.660	0.230	0.080	0.028	0.033	7643	1.870	8062.1	2.337	0.234	2.571		0.214
63	31		100	4958.2		0.660	0.230	0.080	0.028	0.033	7718	1.870	8055.7	2.313	0.234	2.547		0.212
65	33	CH	100	5033.4		0.660	0.230	0.080	0.028	0.033	7793	1.870	8049.4	2.290	0.234	2.524		0.210
67	35	(Tuff)	100	5108.6		0.660	0.230	0.080	0.028	0.033	7869	1.870	8043.0	2.267	0.234	2.501		0.208
69	37		100	5183.8		0.660	0.230	0.080	0.028	0.033	7944	1.870	8036.7	2.244	0.234	2.479		0.207
71	39		100	5259.0		0.660	0.230	0.080	0.028	0.033	8019	1.870	8030.3	2.222	0.234	2.456		0.205
73	41		100	5334.2		0.660	0.230	0.080	0.028	0.033	8094	1.870	8024.0	2.200	0.234	2.435		0.203
75	43		115	5439.4		0.220	0.110	0.030	0.015	0.011	8199	1.000	8017.7	1.039	0.112	1.151		0.096
77	45		115	5544.6		0.220	0.110	0.030	0.015	0.011	8305	1.000	8011.4	1.025	0.112	1.137		0.095
79	47		115	5649.8		0.220	0.110	0.030	0.015	0.011	8410	1.000	8005.0	1.012	0.112	1.124		0.094
81	49	CL-CH	115	5755.0		0.220	0.110	0.030	0.015	0.011	8515	1.000	7998.7	0.999	0.112	1.111		0.093
83	51		115	5860.2		0.220	0.110	0.030	0.015	0.011	8620	1.000	7992.4	0.986	0.112	1.098		0.092
85	53		115	5965.4		0.220	0.110	0.030	0.015	0.011	8725	1.000	7986.2	0.974	0.112	1.086		0.091
87	55		115	6070.6		0.220	0.110	0.030	0.015	0.011	8831	1.000	7979.9	0.962	0.112	1.074		0.090
89	57		115	6175.8	500.0	0.000	0.000	0.000	0.000	0	8936		7973.6	0.000	0	0.000	0.032	0.032
91	59		115	6281.0	500.0	0.000	0.000	0.000	0.000	0	9041		7967.3	0.000	0	0.000	0.032	0.032
93	61		115	6386.2	500.0	0.000	0.000	0.000	0.000	0	9146		7961.1	0.000	0	0.000	0.032	0.032
95	63		115	6491.4	500.0	0.000	0.000	0.000	0.000	0	9251		7954.8	0.000	0	0.000	0.032	0.032
97	65		115	6596.6	500.0	0.000	0.000	0.000	0.000	0	9357		7948.6	0.000	0	0.000	0.032	0.032
99	67	SM-SW	115	6701.8	500.0	0.000	0.000	0.000	0.000	0	9462		7942.4	0.000	0	0.000	0.032	0.032
101	69		115	6807.0	500.0	0.000	0.000	0.000	0.000	0	9567		7936.1	0.000	0	0.000	0.032	0.032
103	71		115	6912.2	500.0	0.000	0.000	0.000	0.000	0	9672		7929.9	0.000	0	0.000	0.032	0.032
105	73		115	7017.4	500.0	0.000	0.000	0.000	0.000	0	9777		7923.7	0.000	0	0.000	0.032	0.032
107	75		115	7122.6	500.0	0.000	0.000	0.000	0.000	0	9883		7917.5	0.000	0	0.000	0.032	0.032
109	77		115	7227.8		0.180	0.100	0.020	0.011	0.009	9988	0.800	7911.3	0.771	0.102	0.873		0.073
111	79		115	7333.0		0.180	0.100	0.020	0.011	0.009	10093	0.800	7905.1	0.762	0.102	0.864		0.072
113	81		115	7438.2		0.180	0.100	0.020	0.011	0.009	10198	0.800	7898.9	0.754	0.102	0.856		0.071

Settlement
Crest of Landfill p. 2/3

115	83		115	7543.4		0.180	0.100	0.020	0.011	0.009	10303	0.800	7892.8	0.746	0.102	0.848		0.071
117	85	CL	115	7648.6		0.180	0.100	0.020	0.011	0.009	10409	0.800	7886.6	0.739	0.102	0.841		0.070
119	87		115	7753.8		0.180	0.100	0.020	0.011	0.009	10514	0.800	7880.4	0.731	0.102	0.833		0.069
121	89		115	7859.0		0.180	0.100	0.020	0.011	0.009	10619	0.800	7874.3	0.723	0.102	0.825		0.069
123	91		115	7964.2		0.180	0.100	0.020	0.011	0.009	10724	0.800	7868.1	0.716	0.102	0.818		0.068
125	93		115	8069.4		0.180	0.100	0.020	0.011	0.009	10829	0.800	7862.0	0.709	0.102	0.811		0.068
127	95		115	8174.6		0.180	0.100	0.020	0.011	0.009	10935	0.800	7855.9	0.702	0.102	0.804		0.067
129	97		115	8279.8		0.000	0.000	0.000	0.000	0	11040		7849.7	0.000	0	0.000		0.000
131	99		115	8385.0		0.000	0.000	0.000	0.000	0	11145		7843.6	0.000	0	0.000		0.000
133	101		115	8490.2		0.000	0.000	0.000	0.000	0	11250		7837.5	0.000	0	0.000		0.000
135	103		115	8595.4		0.000	0.000	0.000	0.000	0	11355		7831.4	0.000	0	0.000		0.000
137	105		115	8700.6		0.000	0.000	0.000	0.000	0	11461		7825.3	0.000	0	0.000		0.000
139	107		115	8805.8		0.000	0.000	0.000	0.000	0	11566		7819.2	0.000	0	0.000		0.000
141	109		115	8911.0		0.000	0.000	0.000	0.000	0	11671		7813.1	0.000	0	0.000		0.000
143	111		115	9016.2		0.000	0.000	0.000	0.000	0	11776		7807.1	0.000	0	0.000		0.000
145	113	SM-SW	115	9121.4		0.000	0.000	0.000	0.000	0	11881		7801.0	0.000	0	0.000		0.000
147	115		115	9226.6		0.000	0.000	0.000	0.000	0	11987		7794.9	0.000	0	0.000		0.000
149	117		115	9331.8		0.000	0.000	0.000	0.000	0	12092		7788.9	0.000	0	0.000		0.000
151	119		115	9437.0		0.000	0.000	0.000	0.000	0	12197		7782.8	0.000	0	0.000		0.000
153	121		115	9542.2		0.000	0.000	0.000	0.000	0	12302		7776.8	0.000	0	0.000		0.000
155	123		115	9647.4		0.000	0.000	0.000	0.000	0	12407		7770.7	0.000	0	0.000		0.000
157	125		115	9752.6		0.000	0.000	0.000	0.000	0	12513		7764.7	0.000	0	0.000		0.000
159	127		115	9857.8		0.000	0.000	0.000	0.000	0	12618		7758.7	0.000	0	0.000		0.000
161	129		115	9963.0		0.150	0.083	0.010	0.006	0.0075	12723	0.800	7752.7	0.500	0.085	0.585		0.049
163	131		115	10068.2		0.150	0.083	0.010	0.006	0.0075	12828	0.800	7746.7	0.496	0.085	0.581		0.048
165	133		115	10173.4		0.150	0.083	0.010	0.006	0.0075	12933	0.800	7740.7	0.491	0.085	0.576		0.048
167	135		115	10278.6		0.150	0.083	0.010	0.006	0.0075	13039	0.800	7734.7	0.487	0.085	0.572		0.048
169	137		115	10383.8		0.150	0.083	0.010	0.006	0.0075	13144	0.800	7728.7	0.483	0.085	0.568		0.047
171	139		115	10489.0		0.150	0.083	0.010	0.006	0.0075	13249	0.800	7722.7	0.479	0.085	0.564		0.047
173	141		115	10594.2		0.150	0.083	0.010	0.006	0.0075	13354	0.800	7716.8	0.475	0.085	0.560		0.047
175	143	CL-CH	115	10699.4		0.150	0.083	0.010	0.006	0.0075	13459	0.800	7710.8	0.471	0.085	0.556		0.046
177	145		115	10804.6		0.150	0.083	0.010	0.006	0.0075	13565	0.800	7704.8	0.468	0.085	0.553		0.046
179	147		115	10909.8		0.150	0.083	0.010	0.006	0.0075	13670	0.800	7698.9	0.464	0.085	0.549		0.046
181	149		115	11015.0		0.150	0.083	0.010	0.006	0.0075	13775	0.800	7692.9	0.460	0.085	0.545		0.045
183	151		115	11120.2		0.150	0.083	0.010	0.006	0.0075	13880	0.800	7687.0	0.456	0.085	0.541		0.045
185	153		115	11225.4		0.150	0.083	0.010	0.006	0.0075	13985	0.800	7681.1	0.453	0.085	0.538		0.045
187	155		115	11330.6		0.150	0.083	0.010	0.006	0.0075	14091	0.800	7675.2	0.449	0.085	0.534		0.045
189	157		115	11435.8		0.150	0.083	0.010	0.006	0.0075	14196	0.800	7669.2	0.446	0.085	0.531		0.044
191	159		115	11541.0		0.000	0.000	0.000	0.000	0	14301		7663.3	0.000	0	0.000		0.000
193	161		115	11646.2		0.000	0.000	0.000	0.000	0	14406		7657.4	0.000	0	0.000		0.000
195	163		115	11751.4		0.000	0.000	0.000	0.000	0	14511		7651.5	0.000	0	0.000		0.000
197	165		115	11856.6		0.000	0.000	0.000	0.000	0	14617		7645.7	0.000	0	0.000		0.000
199	167		115	11961.8		0.000	0.000	0.000	0.000	0	14722		7639.8	0.000	0	0.000		0.000
201	169		115	12067.0		0.000	0.000	0.000	0.000	0	14827		7633.9	0.000	0	0.000		0.000
203	171		115	12172.2		0.000	0.000	0.000	0.000	0	14932		7628.0	0.000	0	0.000		0.000
205	173		115	12277.4		0.000	0.000	0.000	0.000	0	15037		7622.2	0.000	0	0.000		0.000
207	175		115	12382.6		0.000	0.000	0.000	0.000	0	15143		7616.3	0.000	0	0.000		0.000
209	177		115	12487.8		0.000	0.000	0.000	0.000	0	15248		7610.5	0.000	0	0.000		0.000
211	179	SM-SW	115	12593.0		0.000	0.000	0.000	0.000	0	15353		7604.6	0.000	0	0.000		0.000
213	181		115	12698.2		0.000	0.000	0.000	0.000	0	15458		7598.8	0.000	0	0.000		0.000
215	183		115	12803.4		0.000	0.000	0.000	0.000	0	15563		7593.0	0.000	0	0.000		0.000
217	185		115	12908.6		0.000	0.000	0.000	0.000	0	15669		7587.1	0.000	0	0.000		0.000
219	187		115	13013.8		0.000	0.000	0.000	0.000	0	15774		7581.3	0.000	0	0.000		0.000
221	189		115	13119.0		0.000	0.000	0.000	0.000	0	15879		7575.5	0.000	0	0.000		0.000
223	191		115	13224.2		0.000	0.000	0.000	0.000	0	15984		7569.7	0.000	0	0.000		0.000
225	193		115	13329.4		0.000	0.000	0.000	0.000	0	16089		7563.9	0.000	0	0.000		0.000
227	195		115	13434.6		0.000	0.000	0.000	0.000	0	16195		7558.1	0.000	0	0.000		0.000
229	197		115	13539.8		0.000	0.000	0.000	0.000	0	16300		7552.4	0.000	0	0.000		0.000
231	199		115	13645.0		0.000	0.000	0.000	0.000	0	16405		7546.6	0.000	0	0.000		0.000
233	201		115	13750.2		0.000	0.000	0.000	0.000	0	16510		7540.8	0.000	0	0.000		0.000
235	203		100	13825.4		0.400	0.154	0.030	0.012	0.02	16585	1.600	7535.1	0.698	0.157	0.854		0.071
237	205		100	13900.6		0.400	0.154	0.030	0.012	0.02	16661	1.600	7529.3	0.694	0.157	0.851		0.071
239	207	CH	100	13975.8		0.400	0.154	0.030	0.012	0.02	16736	1.600	7523.6	0.691	0.157	0.847		0.071
241	209	(Tuff)	100	14051.0		0.400	0.154	0.030	0.012	0.02	16811	1.600	7517.8	0.687	0.157	0.844		0.070
243	211		100	14126.2		0.400	0.154	0.030	0.012	0.02	16886	1.600	7512.1	0.684	0.157	0.841		0.070

Settlement
Crest of Landfill

p. 3/3

245	213		100	14201.4		0.400	0.154	0.030	0.012	0.02	16961	1.600	7506.4	0.680	0.157	0.837		0.070
247	215		115	14306.6		0.000	0.000	0.000	0.000	0	17067		7500.6	0.000	0	0.000		0.000
249	217		115	14411.8		0.000	0.000	0.000	0.000	0	17172		7494.9	0.000	0	0.000		0.000
													TOTAL	5.0	0.6	5.6	1.4	7.0

Settlement
Landfill Sump

p. 1/3

Depth below original ground surface = 27 ft
Height of Refuse = 62 ft

Depth below Surface (ft)	Depth below Water Table (ft)	Material Type	Unit Weight (pcf)	σ_{vo}' (psf)	Es (ksf)	C_c	C_{ce}	C_r	C_{re}	C_α	Max. Past Preconsolidation Pressure, σ_p' (psf)	Initial Void Ratio, e_o	Vertical Stress Due to Load, $\Delta\sigma_v$ (psf)	Primary Settlement (in.)	Secondary Settlement (in.)	Total Consol Settlement (in.)	Elastic Settlement (ft)	Total Settlement (ft.)
1	0		110	55.0	300.0	0.000	0.000	0.000	0.000	0	3160		4340.0	0.000	0	0.000	0.029	0.029
3	0		110	275.0	300.0	0.000	0.000	0.000	0.000	0	3380		4334.8	0.000	0	0.000	0.029	0.029
5	0	SM-SW	110	495.0	300.0	0.000	0.000	0.000	0.000	0	3600		4331.3	0.000	0	0.000	0.029	0.029
7	0		110	715.0	300.0	0.000	0.000	0.000	0.000	0	3820		4327.9	0.000	0	0.000	0.029	0.029
9	0		110	935.0	300.0	0.000	0.000	0.000	0.000	0	4040		4324.4	0.000	0	0.000	0.029	0.029
11	0		110	1155.0		0.220	0.110	0.020	0.010	0.011	4260	1.000	4321.0	1.784	0.112	1.896		0.158
13	0		110	1375.0		0.220	0.110	0.020	0.010	0.011	4480	1.000	4317.5	1.629	0.112	1.741		0.145
15	0		110	1595.0		0.220	0.110	0.020	0.010	0.011	4700	1.000	4314.1	1.502	0.112	1.614		0.134
17	0	CL-CH	110	1815.0		0.220	0.110	0.020	0.010	0.011	4920	1.000	4310.6	1.395	0.112	1.507		0.126
19	0		110	2035.0		0.220	0.110	0.020	0.010	0.011	5140	1.000	4307.2	1.303	0.112	1.415		0.118
21	0		110	2255.0		0.220	0.110	0.020	0.010	0.011	5360	1.000	4303.8	1.224	0.112	1.336		0.111
23	0		110	2475.0		0.220	0.110	0.020	0.010	0.011	5580	1.000	4300.3	1.155	0.112	1.267		0.106
25	0		115	2705.0	300.0	0.000	0.000	0.000	0.000	0	5810		4296.9	0.000	0	0.000		0.000
27	0		115	2935.0	300.0	0.000	0.000	0.000	0.000	0	6040		4293.5	0.000	0	0.000	0.029	0.029
29	0		115	3165.0	300.0	0.000	0.000	0.000	0.000	0	6270		4290.1	0.000	0	0.000	0.029	0.029
31	0		115	3395.0	300.0	0.000	0.000	0.000	0.000	0	6500		4286.7	0.000	0	0.000	0.029	0.029
33	1		115	3500.2	300.0	0.000	0.000	0.000	0.000	0	6605		4283.3	0.000	0	0.000	0.029	0.029
35	3		115	3605.4	300.0	0.000	0.000	0.000	0.000	0	6710		4279.9	0.000	0	0.000	0.029	0.029
37	5		115	3710.6	300.0	0.000	0.000	0.000	0.000	0	6816		4276.5	0.000	0	0.000	0.029	0.029
39	7		115	3815.8	300.0	0.000	0.000	0.000	0.000	0	6921		4273.1	0.000	0	0.000	0.028	0.028
41	9	SM-SW	115	3921.0	300.0	0.000	0.000	0.000	0.000	0	7026		4269.7	0.000	0	0.000	0.028	0.028
43	11		115	4026.2	300.0	0.000	0.000	0.000	0.000	0	7131		4266.3	0.000	0	0.000	0.028	0.028
45	13		115	4131.4	300.0	0.000	0.000	0.000	0.000	0	7236		4262.9	0.000	0	0.000	0.028	0.028
47	15		115	4236.6	300.0	0.000	0.000	0.000	0.000	0	7342		4259.5	0.000	0	0.000	0.028	0.028
49	17		115	4341.8	300.0	0.000	0.000	0.000	0.000	0	7447		4256.2	0.000	0	0.000	0.028	0.028
51	19		115	4447.0	300.0	0.000	0.000	0.000	0.000	0	7552		4252.8	0.000	0	0.000	0.028	0.028
53	21		115	4552.2	300.0	0.000	0.000	0.000	0.000	0	7657		4249.4	0.000	0	0.000	0.028	0.028
55	23		115	4657.4	300.0	0.000	0.000	0.000	0.000	0	7762		4246.1	0.000	0	0.000	0.028	0.028
57	25		100	4732.6		0.660	0.230	0.080	0.028	0.033	7838	1.870	4242.7	1.534	0.234	1.768		0.147
59	27		100	4807.8		0.660	0.230	0.080	0.028	0.033	7913	1.870	4239.4	1.515	0.234	1.750		0.146
61	29		100	4883.0		0.660	0.230	0.080	0.028	0.033	7988	1.870	4236.0	1.497	0.234	1.732		0.144
63	31		100	4958.2		0.660	0.230	0.080	0.028	0.033	8063	1.870	4232.7	1.479	0.234	1.714		0.143
65	33	CH	100	5033.4		0.660	0.230	0.080	0.028	0.033	8138	1.870	4229.3	1.462	0.234	1.696		0.141
67	35	(Tuff)	100	5108.6		0.660	0.230	0.080	0.028	0.033	8214	1.870	4226.0	1.445	0.234	1.679		0.140
69	37		100	5183.8		0.660	0.230	0.080	0.028	0.033	8289	1.870	4222.7	1.428	0.234	1.663		0.139
71	39		100	5259.0		0.660	0.230	0.080	0.028	0.033	8364	1.870	4219.3	1.412	0.234	1.646		0.137
73	41		100	5334.2		0.660	0.230	0.080	0.028	0.033	8439	1.870	4216.0	1.396	0.234	1.630		0.136
75	43		115	5439.4		0.220	0.110	0.030	0.015	0.011	8544	1.000	4212.7	0.658	0.112	0.770		0.064
77	45		115	5544.6		0.220	0.110	0.030	0.015	0.011	8650	1.000	4209.4	0.648	0.112	0.760		0.063
79	47		115	5649.8		0.220	0.110	0.030	0.015	0.011	8755	1.000	4206.0	0.638	0.112	0.750		0.063
81	49	CL-CH	115	5755.0		0.220	0.110	0.030	0.015	0.011	8860	1.000	4202.7	0.629	0.112	0.741		0.062
83	51		115	5860.2		0.220	0.110	0.030	0.015	0.011	8965	1.000	4199.4	0.620	0.112	0.732		0.061
85	53		115	5965.4		0.220	0.110	0.030	0.015	0.011	9070	1.000	4196.1	0.611	0.112	0.723		0.060
87	55		115	6070.6		0.220	0.110	0.030	0.015	0.011	9176	1.000	4192.8	0.602	0.112	0.714		0.060
89	57		115	6175.8	500.0	0.000	0.000	0.000	0.000	0	9281		4189.5	0.000	0	0.000	0.017	0.017
91	59		115	6281.0	500.0	0.000	0.000	0.000	0.000	0	9386		4186.2	0.000	0	0.000	0.017	0.017
93	61		115	6386.2	500.0	0.000	0.000	0.000	0.000	0	9491		4182.9	0.000	0	0.000	0.017	0.017
95	63		115	6491.4	500.0	0.000	0.000	0.000	0.000	0	9596		4179.7	0.000	0	0.000	0.017	0.017
97	65		115	6596.6	500.0	0.000	0.000	0.000	0.000	0	9702		4176.4	0.000	0	0.000	0.017	0.017
99	67	SM-SW	115	6701.8	500.0	0.000	0.000	0.000	0.000	0	9807		4173.1	0.000	0	0.000	0.017	0.017
101	69		115	6807.0	500.0	0.000	0.000	0.000	0.000	0	9912		4169.8	0.000	0	0.000	0.017	0.017
103	71		115	6912.2	500.0	0.000	0.000	0.000	0.000	0	10017		4166.6	0.000	0	0.000	0.017	0.017
105	73		115	7017.4	500.0	0.000	0.000	0.000	0.000	0	10122		4163.3	0.000	0	0.000	0.017	0.017
107	75		115	7122.6	500.0	0.000	0.000	0.000	0.000	0	10228		4160.0	0.000	0	0.000	0.017	0.017
109	77		115	7227.8		0.180	0.100	0.020	0.011	0.009	10333	0.800	4156.8	0.474	0.102	0.575		0.048
111	79		115	7333.0		0.180	0.100	0.020	0.011	0.009	10438	0.800	4153.5	0.468	0.102	0.570		0.047
113	81		115	7438.2		0.180	0.100	0.020	0.011	0.009	10543	0.800	4150.3	0.462	0.102	0.564		0.047

Settlement
Landfill Sump

p. 2/3

115	83		115	7543.4		0.180	0.100	0.020	0.011	0.009	10648	0.800	4147.0	0.457	0.102	0.559		0.047
117	85	CL	115	7648.6		0.180	0.100	0.020	0.011	0.009	10754	0.800	4143.8	0.451	0.102	0.553		0.046
119	87		115	7753.8		0.180	0.100	0.020	0.011	0.009	10859	0.800	4140.6	0.446	0.102	0.548		0.046
121	89		115	7859.0		0.180	0.100	0.020	0.011	0.009	10964	0.800	4137.3	0.441	0.102	0.543		0.045
123	91		115	7964.2		0.180	0.100	0.020	0.011	0.009	11069	0.800	4134.1	0.436	0.102	0.538		0.045
125	93		115	8069.4		0.180	0.100	0.020	0.011	0.009	11174	0.800	4130.9	0.431	0.102	0.533		0.044
127	95		115	8174.6		0.180	0.100	0.020	0.011	0.009	11280	0.800	4127.7	0.426	0.102	0.528		0.044
129	97		115	8279.8		0.000	0.000	0.000	0.000	0	11385		4124.4	0.000	0	0.000		0.000
131	99		115	8385.0		0.000	0.000	0.000	0.000	0	11490		4121.2	0.000	0	0.000		0.000
133	101		115	8490.2		0.000	0.000	0.000	0.000	0	11595		4118.0	0.000	0	0.000		0.000
135	103		115	8595.4		0.000	0.000	0.000	0.000	0	11700		4114.8	0.000	0	0.000		0.000
137	105		115	8700.6		0.000	0.000	0.000	0.000	0	11806		4111.6	0.000	0	0.000		0.000
139	107		115	8805.8		0.000	0.000	0.000	0.000	0	11911		4108.4	0.000	0	0.000		0.000
141	109		115	8911.0		0.000	0.000	0.000	0.000	0	12016		4105.2	0.000	0	0.000		0.000
143	111		115	9016.2		0.000	0.000	0.000	0.000	0	12121		4102.0	0.000	0	0.000		0.000
145	113	SM-SW	115	9121.4		0.000	0.000	0.000	0.000	0	12226		4098.8	0.000	0	0.000		0.000
147	115		115	9226.6		0.000	0.000	0.000	0.000	0	12332		4095.6	0.000	0	0.000		0.000
149	117		115	9331.8		0.000	0.000	0.000	0.000	0	12437		4092.5	0.000	0	0.000		0.000
151	119		115	9437.0		0.000	0.000	0.000	0.000	0	12542		4089.3	0.000	0	0.000		0.000
153	121		115	9542.2		0.000	0.000	0.000	0.000	0	12647		4086.1	0.000	0	0.000		0.000
155	123		115	9647.4		0.000	0.000	0.000	0.000	0	12752		4082.9	0.000	0	0.000		0.000
157	125		115	9752.6		0.000	0.000	0.000	0.000	0	12858		4079.8	0.000	0	0.000		0.000
159	127		115	9857.8		0.000	0.000	0.000	0.000	0	12963		4076.6	0.000	0	0.000		0.000
161	129		115	9963.0		0.150	0.083	0.010	0.006	0.0075	13068	0.800	4073.4	0.298	0.085	0.383		0.032
163	131		115	10068.2		0.150	0.083	0.010	0.006	0.0075	13173	0.800	4070.3	0.295	0.085	0.380		0.032
165	133		115	10173.4		0.150	0.083	0.010	0.006	0.0075	13278	0.800	4067.1	0.292	0.085	0.377		0.031
167	135		115	10278.6		0.150	0.083	0.010	0.006	0.0075	13384	0.800	4064.0	0.289	0.085	0.374		0.031
169	137		115	10383.8		0.150	0.083	0.010	0.006	0.0075	13489	0.800	4060.8	0.287	0.085	0.372		0.031
171	139		115	10489.0		0.150	0.083	0.010	0.006	0.0075	13594	0.800	4057.7	0.284	0.085	0.369		0.031
173	141		115	10594.2		0.150	0.083	0.010	0.006	0.0075	13699	0.800	4054.6	0.281	0.085	0.366		0.031
175	143	CL-CH	115	10699.4		0.150	0.083	0.010	0.006	0.0075	13804	0.800	4051.4	0.279	0.085	0.364		0.030
177	145		115	10804.6		0.150	0.083	0.010	0.006	0.0075	13910	0.800	4048.3	0.276	0.085	0.361		0.030
179	147		115	10909.8		0.150	0.083	0.010	0.006	0.0075	14015	0.800	4045.2	0.274	0.085	0.359		0.030
181	149		115	11015.0		0.150	0.083	0.010	0.006	0.0075	14120	0.800	4042.1	0.272	0.085	0.356		0.030
183	151		115	11120.2		0.150	0.083	0.010	0.006	0.0075	14225	0.800	4038.9	0.269	0.085	0.354		0.030
185	153		115	11225.4		0.150	0.083	0.010	0.006	0.0075	14330	0.800	4035.8	0.267	0.085	0.352		0.029
187	155		115	11330.6		0.150	0.083	0.010	0.006	0.0075	14436	0.800	4032.7	0.264	0.085	0.349		0.029
189	157		115	11435.8		0.150	0.083	0.010	0.006	0.0075	14541	0.800	4029.6	0.262	0.085	0.347		0.029
191	159		115	11541.0		0.000	0.000	0.000	0.000	0	14646		4026.5	0.000	0	0.000		0.000
193	161		115	11646.2		0.000	0.000	0.000	0.000	0	14751		4023.4	0.000	0	0.000		0.000
195	163		115	11751.4		0.000	0.000	0.000	0.000	0	14856		4020.3	0.000	0	0.000		0.000
197	165		115	11856.6		0.000	0.000	0.000	0.000	0	14962		4017.2	0.000	0	0.000		0.000
199	167		115	11961.8		0.000	0.000	0.000	0.000	0	15067		4014.1	0.000	0	0.000		0.000
201	169		115	12067.0		0.000	0.000	0.000	0.000	0	15172		4011.0	0.000	0	0.000		0.000
203	171		115	12172.2		0.000	0.000	0.000	0.000	0	15277		4007.9	0.000	0	0.000		0.000
205	173		115	12277.4		0.000	0.000	0.000	0.000	0	15382		4004.9	0.000	0	0.000		0.000
207	175		115	12382.6		0.000	0.000	0.000	0.000	0	15488		4001.8	0.000	0	0.000		0.000
209	177		115	12487.8		0.000	0.000	0.000	0.000	0	15593		3998.7	0.000	0	0.000		0.000
211	179	SM-SW	115	12593.0		0.000	0.000	0.000	0.000	0	15698		3995.7	0.000	0	0.000		0.000
213	181		115	12698.2		0.000	0.000	0.000	0.000	0	15803		3992.6	0.000	0	0.000		0.000
215	183		115	12803.4		0.000	0.000	0.000	0.000	0	15908		3989.5	0.000	0	0.000		0.000
217	185		115	12908.6		0.000	0.000	0.000	0.000	0	16014		3986.5	0.000	0	0.000		0.000
219	187		115	13013.8		0.000	0.000	0.000	0.000	0	16119		3983.4	0.000	0	0.000		0.000
221	189		115	13119.0		0.000	0.000	0.000	0.000	0	16224		3980.4	0.000	0	0.000		0.000
223	191		115	13224.2		0.000	0.000	0.000	0.000	0	16329		3977.3	0.000	0	0.000		0.000
225	193		115	13329.4		0.000	0.000	0.000	0.000	0	16434		3974.3	0.000	0	0.000		0.000
227	195		115	13434.6		0.000	0.000	0.000	0.000	0	16540		3971.2	0.000	0	0.000		0.000
229	197		115	13539.8		0.000	0.000	0.000	0.000	0	16645		3968.2	0.000	0	0.000		0.000
231	199		115	13645.0		0.000	0.000	0.000	0.000	0	16750		3965.2	0.000	0	0.000		0.000
233	201		115	13750.2		0.000	0.000	0.000	0.000	0	16855		3962.1	0.000	0	0.000		0.000
235	203		100	13825.4		0.400	0.154	0.030	0.012	0.02	16930	1.600	3959.1	0.404	0.157	0.561		0.047
237	205		100	13900.6		0.400	0.154	0.030	0.012	0.02	17006	1.600	3956.1	0.402	0.157	0.558		0.047
239	207	CH	100	13975.8		0.400	0.154	0.030	0.012	0.02	17081	1.600	3953.1	0.399	0.157	0.556		0.046
241	209	(Tuff)	100	14051.0		0.400	0.154	0.030	0.012	0.02	17156	1.600	3950.0	0.397	0.157	0.554		0.046
243	211		100	14126.2		0.400	0.154	0.030	0.012	0.02	17231	1.600	3947.0	0.395	0.157	0.552		0.046

Settlement
Landfill Sump

p. 3/3

245	213		100	14201.4		0.400	0.154	0.030	0.012	0.02	17306	1.600	3944.0	0.393	0.157	0.550		0.046
247	215		115	14306.6		0.000	0.000	0.000	0.000	0	17412		3941.0	0.000	0	0.000		0.000
249	217		115	14411.8		0.000	0.000	0.000	0.000	0	17517		3938.0	0.000	0	0.000		0.000
													TOTAL	3.2	0.6	3.8	0.7	4.5

Post- Settlement Grade Calculations

Sump to Center of Landfill

Initial Elevation Difference	22.7	feet
Final Elevation Difference	18.0	feet
Distance	2271	feet
Post-Settlement Grade	0.79%	

Final Slope Crest to Center of Landfill

Initial Elevation Difference	20.9	feet
Final Elevation Difference	18.7	feet
Distance	2092	feet
Post-Settlement Grade	0.89%	

Sump to Slope Crest

Initial Elevation Difference	3.0	feet
Final Elevation Difference	0.5	feet
Distance	300	feet
Post-Settlement Grade	0.17%	

APPENDIX F
SLOPE STABILITY CALCULATIONS

OBJECTIVES

Evaluate the static and seismic slope stability for proposed base liner design and cover system for various slopes.

METHODOLOGY AND ASSUMPTIONS

1. The program Slide (v. 5.0) was used to calculate the FOS against sliding along the base. Xstabl (v. 5.205) used to calculate the FOS against sliding along the cover.

2. A conservative friction angle of 12 degrees is assumed for the critical interface between textured geomembrane and clay (bentonite admix soil) for the bottom liner. Based on Golder's interface shear strength data base, this value is expected to be conservative for waste depths of 200 feet. Confirmation testing will be completed as part of the admix soil clay to specify materials that meet the required shear strength.

3. Assume a critical interface shear strength of 23 degrees is assumed for the for the final cover system for the textured geomembrane/clay and textured geomembrane/geocomposite interface. Based on Golder's interface shear strength data base, this value is expected to be conservative for normal loads of 200 to 250 psf. Confirmation testing will be completed as part of the final cover design to specify materials that meet the required shear strength.

4. The shear strength of refuse: friction angle of 30 degrees, c = 200 psf.

5. The unit weight of refuse is 70 pcf. This is likely high due to the extensive use of ADC.

6. The peak ground acceleration is 0.28g. A PGA of 0.28 corresponds to bedrock. For thick soil conditions, it is common to reduce the PGA by 10% to account for attenuation. This reduction was conservatively igonored.

7. The simplified procedure of Bray et al. (1998) is used to estimate the permanent seismic deformation for the median and 84th percentile.

RESULTS AND CONCLUSION

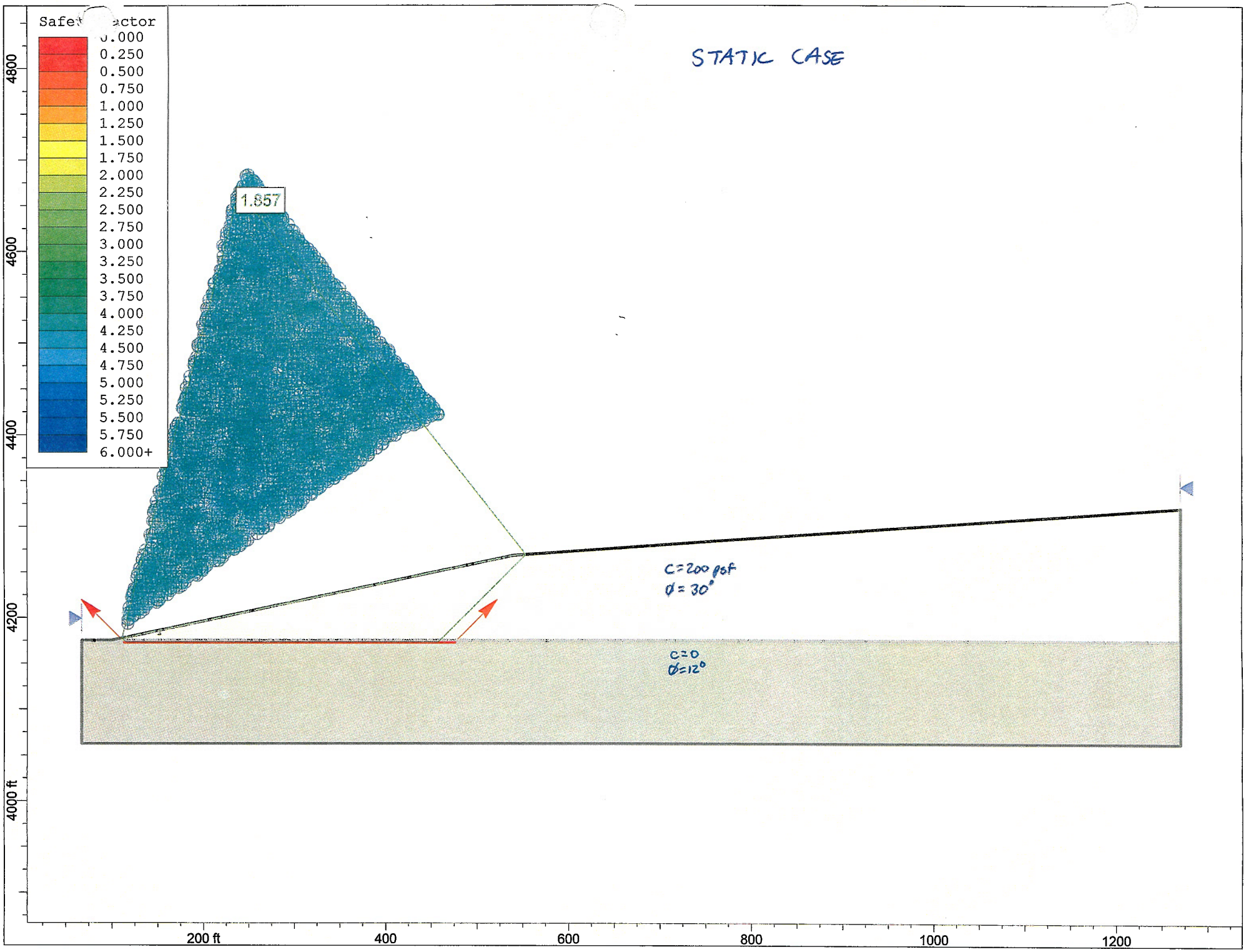
The results of the static and seismic slope stability analyses are summarized below:

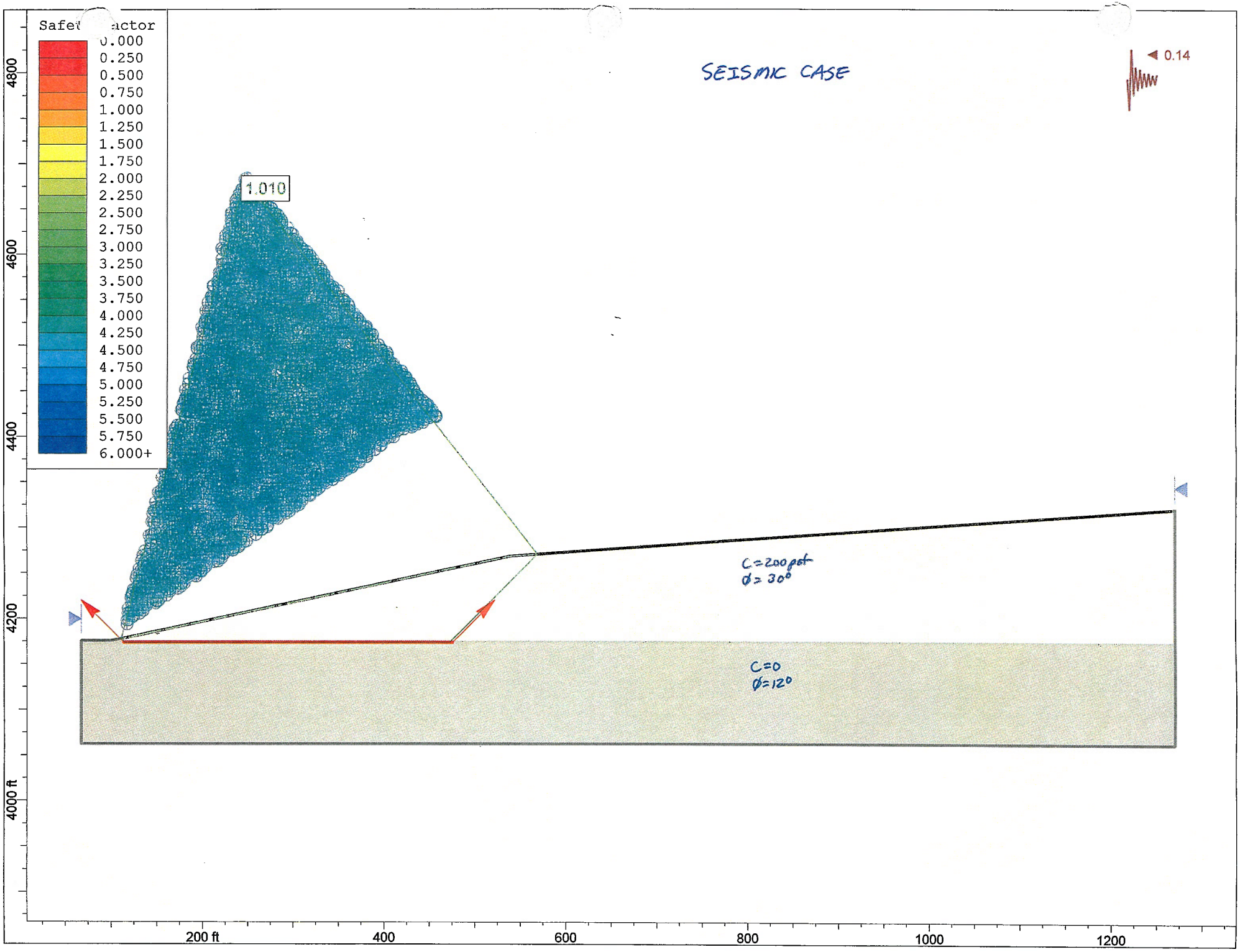
SLOPE STABILITY RESULTS

Interface	Static FS	K_y	Displacement (inch)
Liner System	1.9	.14	< 1 inch (median and 84th percentile)
Cover System	1.7	.15	< 1 inch (median) < 4 inches (84th percentile)

As indicated above, the critical static factor of safety is greater than 1.5, which is a commonly applied criterion of landfill slope stability.

Using the simplified procedure of Bray et. al. (1998), a permanent seismic deformation of less than 2-inches was computed for the design earthquake event for both the cover and liner system. Displacements of less than 6 to 12-inches are generally considered acceptable for liner/cover systems and are not expected to adversely impact the landfill's containment or control systems.


STATIC CASE
Safety Factor
0.000
0.250
0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
2.750
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
1.857
C=200 psf
Ø=30°
C=0
Ø=12°
4800
4600
4400
4200
4000 ft
200 ft
400
600
800
1000
1200


Safety factor
0.000
0.250
0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
2.750
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
SEISMIC CASE
0.14
1.010
C=200 psf
Ø=30°
C=0
Ø=120°
4800
4600
4400
4200
4000 ft
200 ft
400
600
800
1000
1200

Simplified Seismic Design Procedure

Bray, Rathje, Augello, Merry, 1998

Application:	Base Liner
Project:	Jungo Disposal Site
Date:	12/11/2007

Design EQ Event

Mag. =	7	(est)
Ep. Distance =	20	km (est)
MHA =	0.28	g
Waste Depth =	35.0	m (average along slope)
Ky =	0.14	

Determine:

Tm =	0.52	s
D5-95 =	16	s
NRF =	1.11	

Calc:

Sh =	260	m/s
Ts =	0.538	
Ts/Tm =	1.036	

Determine:

MHEA/MHA/NRF =	0.55	Median

Calculate:

MHEA =	0.17094
ky/MHEA =	0.8190008

Determine

U/MHA/D5-95 =	10	mm/s (Median)

Calculate:

Displacement =	0.9	mm
=	0.0	in.

Simplified Seismic Design Procedure

Bray, Rathje, Augello, Merry, 1998

Application:	Base Liner
Project:	Jungo Disposal Site
Date:	12/11/2007

Design EQ Event

Mag. =	7	(est)
Ep. Distance =	20	km (est)
MHA =	0.28	g
Waste Depth =	35.0	m (average along slope)
Ky =	0.14	

Determine:

Tm =	0.52	s
D5-95 =	16	s
NRF =	1.11	

Calc:

Sh =	260	m/s
Ts =	0.538	
Ts/Tm =	1.036	

Determine:

MHEA/MHA/NRF =	0.75	(84th percentile)

Calculate:

MHEA =	0.2331
ky/MHEA =	0.6006006

Determine

U/MHA/D5-95 =	12	mm/s (84th percentile)

Calculate:

Displacement =	1.5	mm
=	0.1	in.

XSTABL File: JLCOV1 12-11-** 6:38

```
*****************************************
*              X S T A B L              *
*                                       *
*        Slope Stability Analysis       *
*               using the               *
*            Method of Slices           *
*                                       *
*         Copyright (C) 1992 Ä 97       *
*   Interactive Software Designs, Inc.  *
*        Moscow, ID 83843, U.S.A.       *
*                                       *
*          All Rights Reserved          *
*                                       *
*  Ver. 5.202                 96 Ä 1318 *
*****************************************
```

Problem Description : GENERIC 4HTO1V COVER - STATIC

SEGMENT BOUNDARY COORDINATES
---

3 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	75.0	100.0	100.0	100.0	1
2	100.0	100.0	300.0	150.0	1
3	300.0	150.0	325.0	150.0	1

3 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	75.0	98.0	100.0	98.0	2
2	100.0	98.0	300.0	148.0	2
3	300.0	148.0	325.0	148.0	2

ISOTROPIC Soil Parameters
---

2 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	110.0	110.0	.0	23.00	.000	.0	0
2	110.0	110.0	.0	23.00	.000	.0	0

A SINGLE FAILURE SURFACE HAS BEEN SPECIFIED FOR ANALYSIS

Trial failure surface specified by
the following 4 coordinate points :

Point No.	x-surf (ft)	y-surf (ft)
1	100.00	100.00
2	110.00	100.00
3	300.00	148.00
4	302.00	150.00

****
SELECTED METHOD OF ANALYSIS: Spencer (1973)
****

****
SUMMARY OF INDIVIDUAL SLICE INFORMATION
****

Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	104.00	100.00	1.00	8.00	.00	14.04	880.
2	109.00	100.00	2.25	2.00	.00	14.04	495.
3	205.00	124.00	2.25	190.00	14.18	14.04	47025.

4	301.00	149.00	1.00	2.00	45.00	.00

220.

ITERATIONS FOR SPENCER'S METHOD

Iter #	Theta	FOS_force	FOS_moment
2	13.8365	1.7181	1.7181

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	117.1	.0	23.00	0.	0.	0.	.00
2	263.5	.0	23.00	0.	0.	0.	.00
3	232.7	.0	23.00	0.	0.	0.	.00
4	76.8	.0	23.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	104.00	117.1	110.0	.0	28.9
2	109.00	263.5	247.5	.0	65.1
3	205.00	232.7	247.5	.0	57.5
4	301.00	76.8	110.0	.0	19.0

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)	Height Ratio
1	108.00	13.84	238.	.99	2.00	.493

	2	110.00	13.84	373.	1.03	2.50
.414						
	3	300.00	13.84	119.	.75	2.00
.377						
	4	302.00	.00	0.	.28	.00
.000						

AVERAGE VALUES ALONG FAILURE SURFACE

Total Normal Stress = 226.42 (psf)
Pore Water Pressure = .00 (psf)
Shear Stress = 55.94 (psf)

Total Length of failure surface = 208.80 feet

For the single specified surface and the assumed angle of the interslice forces, the SPENCER'S (1973) procedure gives a

FACTOR OF SAFETY = 1.718

Total shear strength available along specified failure surface = 200.67E+02 lb

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*****************************************
*              X S T A B L              *
*                                       *
*        Slope Stability Analysis       *
*               using the               *
*            Method of Slices           *
*                                       *
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*        Moscow, ID 83843, U.S.A.       *
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*                                       *
*  Ver. 5.202                 96 Ä 1318 *
*****************************************
```

Problem Description : GENERIC 4HTO1V COVER - SEISMIC

SEGMENT BOUNDARY COORDINATES
---

3 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	75.0	100.0	100.0	100.0	1
2	100.0	100.0	300.0	150.0	1
3	300.0	150.0	325.0	150.0	1

3 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	75.0	98.0	100.0	98.0	2
2	100.0	98.0	300.0	148.0	2
3	300.0	148.0	325.0	148.0	2

ISOTROPIC Soil Parameters
---

2 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	110.0	110.0	.0	23.00	.000	.0	0
2	110.0	110.0	.0	23.00	.000	.0	0

A horizontal earthquake loading coefficient
of .150 has been assigned

A vertical earthquake loading coefficient
of .000 has been assigned

A SINGLE FAILURE SURFACE HAS BEEN SPECIFIED FOR ANALYSIS

Trial failure surface specified by
the following 4 coordinate points :

Point No.	x-surf (ft)	y-surf (ft)
1	100.00	100.00
2	110.00	100.00
3	300.00	148.00
4	302.00	150.00

****
SELECTED METHOD OF ANALYSIS: Spencer (1973)
****

****
SUMMARY OF INDIVIDUAL SLICE INFORMATION
****

Slice x-base y-base height width alpha beta weight

	(ft)	(ft)	(ft)	(ft)		(lb)
1	104.00	100.00	1.00	8.00	.00	14.04
880.						
2	109.00	100.00	2.25	2.00	.00	14.04
495.						
3	205.00	124.00	2.25	190.00	14.18	14.04
47025.						
4	301.00	149.00	1.00	2.00	45.00	.00
220.						

ITERATIONS FOR SPENCER'S METHOD

Iter #	Theta	FOS_force	FOS_moment
2	22.4952	1.0328	1.0310
3	22.0766	1.0327	1.0328

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	124.0	.0	23.00	0.	0.	0.	.00
2	278.9	.0	23.00	0.	0.	0.	.00
3	223.6	.0	23.00	0.	0.	0.	.00
4	62.6	.0	23.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	104.00	124.0	110.0	.0	51.0
2	109.00	278.9	247.5	.0	114.7
3	205.00	223.6	247.5	.0	91.9
4	301.00	62.6	110.0	.0	25.7

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Height Ratio	Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)
.676	1	108.00	22.08	297.	1.35	2.00
.530	2	110.00	22.08	465.	1.32	2.50
.378	3	300.00	22.08	115.	.76	2.00
.000	4	302.00	.00	0.	.06	.00

AVERAGE VALUES ALONG FAILURE SURFACE

Total Normal Stress = 218.12 (psf)
Pore Water Pressure = .00 (psf)
Shear Stress = 89.66 (psf)

Total Length of failure surface = 208.80 feet

For the single specified surface and the assumed angle of the interslice forces, the SPENCER'S (1973) procedure gives a

FACTOR OF SAFETY = 1.033

Total shear strength available along specified failure surface = 193.32E+02 lb

Simplified Seismic Design Procedure

Bray, Rathje, Augello, Merry, 1998

Application:	Cover System
Project:	Jungo Disposal Site
Date:	12/11/07

Design EQ Event

Mag. =	7	
Ep. Distance =	20	km
MHA =	0.16	g
Waste Depth =	35	m (average)
Ky =	0.15	

Determine:

Tm =	0.52	s
D5-95 =	16	s
NRF =	1.11	

Calc:

Sh =	260	m/s
Ts =	0.538	
Ts/Tm =	1.036	

Determine:

MHEA/MHA/NRF =	1	median

Calculate:

MHEA =	0.1776
Side Effects =	0.222
ky/MHEA =	0.6756757

Determine

Displacement =	20.0	mm
=	0.8	in.

Simplified Seismic Design Procedure

Bray, Rathje, Augello, Merry, 1998

Application:	Cover System
Project:	Jungo Disposal Site
Date:	12/11/07

Design EQ Event

Mag. =	7	
Ep. Distance =	20	km
MHA =	0.16	g
Waste Depth =	35	m (average)
Ky =	0.15	

Determine:

Tm =	0.52	s
D5-95 =	16	s
NRF =	1.11	

Calc:

Sh =	260	m/s
Ts =	0.538	
Ts/Tm =	1.036	

Determine:

MHEA/MHA/NRF =	1.25	median

Calculate:

MHEA =	0.222
Side Effects =	0.2775
ky/MHEA =	0.5405405

Determine

Displacement =	100.0	mm
=	3.9	in.

APPENDIX G
LEACHATE GENERATION CALCULATIONS

APPENDIX G

LEACHATE GENERATION CALCULATIONS

OBJECTIVE

Determine the volume of leachate generated during operations and post closure of the landfill, and leachate pipe spacing.

METHODOLOGY

The Hydrologic Evaluation of Landfill Performance (HELP) Model Version 3, developed by the U.S. Army Corps of Engineers, was used to estimate the volume of leachate generated at the landfill. Two profiles were evaluated using the HELP Model to simulate landfill operations and post closure. Each profile and associated HELP Model results are shown in subsequent documentation of Appendix G.

The leachate pipe spacing was determined by solving the following hydraulics equations:

$$Q = ILw \qquad\qquad Q = Kihw$$

Where:

Q = Flow rate
I = Infiltration Rate (calculated from the HELP Model)
L = Length between HDPE drainage pipes
w = Width of the section
K = Permeability of the LCRS layer
i = Gradient (slope of the base grade)
h = Height of sand layer

The leachate pipe spacing calculations are shown in subsequent documentation of Appendix G.

RESULTS SUMMARY

Using the methodology described above, we estimate the average leachate infiltration rate during operations to be 1.0 inches per year and 0.0 during post closure. The leachate piping should be spaced approximately 62,000 feet apart to accommodate this volume leachate.

HELP MODEL RESULTS
OPERATIONS PROFILE

Table 1 - HELP Model Analyses
Leachate Generation Profiles
Jungo Road Landfill
June 2007

Operations Profile

Layer	Top (ft bgs)	Bottom (ft bgs)	Thickness (ft)
Layer 1 - Cover Soil	0.0	0.5	0.5
Layer 2 - Refuse	0.5	50.5	50

Layer 1 - Cover Soil

Parameter	Value	Units
HELP Model Classification	7	-
USDA Classification	FSL	-
Unified Soil Classification System	SM	-
Total Porosity	0.473	vol/vol
Field Capacity	0.222	vol/vol
Wilting Point	0.104	vol/vol
Saturated Hydraulic Conductivity	5.2E-04	cm/sec
Initial Moisture Content	0.12	vol/vol

Layer 2 - Refuse

Parameter	Value	Units
HELP Model Classification	18	-
Unit Weight	900	lb/yd^3
Total Porosity	0.671	vol/vol
Field Capacity	0.292	vol/vol
Wilting Point	0.077	vol/vol
Saturated Hydraulic Conductivity	1.0E-03	cm/sec
Initial Moisture Content	0.2	vol/vol

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.01   (14 OCTOBER 1994)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\PROGRA~1\HELP3\JUNGOF.D4
TEMPERATURE DATA FILE:        C:\PROGRA~1\HELP3\JUNGOF.D7
SOLAR RADIATION DATA FILE:    C:\PROGRA~1\HELP3\JUNGOF.D13
EVAPOTRANSPIRATION DATA:      C:\PROGRA~1\HELP3\6INCH~1.D11
SOIL AND DESIGN DATA FILE:    C:\PROGRA~1\HELP3\JUNGOR.D10
OUTPUT DATA FILE:             C:\PROGRA~1\HELP3\6 EVAP.OUT


TIME:  15:36     DATE:   6/18/2007


******************************************************************************

     TITLE:  Jungo Road Operations

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                  LAYER  1
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   7
          THICKNESS                  =      6.00   INCHES
          POROSITY                   =      0.4730 VOL/VOL
          FIELD CAPACITY             =      0.2220 VOL/VOL
          WILTING POINT              =      0.1040 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.1200 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.520000001000E-03 CM/SEC


                                  LAYER  2
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
```

MATERIAL TEXTURE NUMBER 18

THICKNESS	=	600.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 1.% AND A SLOPE LENGTH OF 2000. FEET.

SCS RUNOFF CURVE NUMBER	=	86.80	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	55.000	ACRES
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.720	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	2.838	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.624	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	120.720	INCHES
TOTAL INITIAL WATER	=	120.720	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM WINNEMUCCA NEVADA

MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	130	
END OF GROWING SEASON (JULIAN DATE)	=	277	
AVERAGE ANNUAL WIND SPEED	=	7.90	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	62.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	42.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	31.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	58.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR WINNEMUCCA NEVADA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.89	0.67	0.67	0.81	0.80	0.92
0.18	0.39	0.34	0.59	0.75	0.86

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR WINNEMUCCA NEVADA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
29.80	35.70	38.70	45.30	54.70	63.50
72.00	68.70	59.60	48.70	37.70	30.40

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR WINNEMUCCA NEVADA

STATION LATITUDE = 40.54 DEGREES

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.22	1641123.000	100.00
RUNOFF	0.051	10105.118	0.62
EVAPOTRANSPIRATION	6.309	1259636.620	76.75
PERC./LEAKAGE THROUGH LAYER 2	0.679607	135683.531	8.27
CHANGE IN WATER STORAGE	1.181	235695.203	14.36
SOIL WATER AT START OF YEAR	120.720	24101742.000	
SOIL WATER AT END OF YEAR	121.901	24337438.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	2.594	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.54	1705011.370	100.00
RUNOFF	0.374	74594.977	4.38
EVAPOTRANSPIRATION	6.219	1241701.370	72.83

PERC./LEAKAGE THROUGH LAYER 2	0.628302	125440.469	7.36
CHANGE IN WATER STORAGE	1.319	263275.937	15.44
SOIL WATER AT START OF YEAR	121.901	24337438.000	
SOIL WATER AT END OF YEAR	123.219	24600714.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-1.404	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.16	1828794.370	100.00
RUNOFF	0.743	148338.437	8.11
EVAPOTRANSPIRATION	6.995	1396489.120	76.36
PERC./LEAKAGE THROUGH LAYER 2	0.724869	144720.125	7.91
CHANGE IN WATER STORAGE	0.697	139244.109	7.61
SOIL WATER AT START OF YEAR	123.219	24600714.000	
SOIL WATER AT END OF YEAR	123.917	24739958.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.030	5918.065	0.32
ANNUAL WATER BUDGET BALANCE	0.0000	2.594	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.31	1659091.750	100.00
RUNOFF	0.015	2988.432	0.18
EVAPOTRANSPIRATION	7.029	1403403.370	84.59

PERC./LEAKAGE THROUGH LAYER 2	0.725677	144881.406	8.73
CHANGE IN WATER STORAGE	0.510	101900.727	6.14
SOIL WATER AT START OF YEAR	123.917	24739958.000	
SOIL WATER AT END OF YEAR	124.457	24847776.000	
SNOW WATER AT START OF YEAR	0.030	5918.065	0.36
SNOW WATER AT END OF YEAR	0.030	5989.500	0.36
ANNUAL WATER BUDGET BALANCE	0.0296	5917.796	0.36

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.48	1693032.250	100.00
RUNOFF	0.457	91277.398	5.39
EVAPOTRANSPIRATION	7.018	1401145.120	82.76
PERC./LEAKAGE THROUGH LAYER 2	0.735129	146768.422	8.67
CHANGE IN WATER STORAGE	0.240	47852.879	2.83
SOIL WATER AT START OF YEAR	124.457	24847776.000	
SOIL WATER AT END OF YEAR	124.726	24901618.000	
SNOW WATER AT START OF YEAR	0.030	5989.500	0.35
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0300	5988.435	0.35

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.38	1473416.870	100.00
RUNOFF	0.340	67793.602	4.60
EVAPOTRANSPIRATION	6.389	1275606.370	86.57
PERC./LEAKAGE THROUGH LAYER 2	0.915343	182748.281	12.40

CHANGE IN WATER STORAGE	-0.264	-52731.961	-3.58
SOIL WATER AT START OF YEAR	124.726	24901618.000	
SOIL WATER AT END OF YEAR	124.462	24848886.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.030	6033.006	0.41
ANNUAL WATER BUDGET BALANCE	0.0000	0.512	0.00

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.52	1501368.250	100.00
RUNOFF	0.235	46935.512	3.13
EVAPOTRANSPIRATION	5.704	1138890.870	75.86
PERC./LEAKAGE THROUGH LAYER 2	0.868778	173451.578	11.55
CHANGE IN WATER STORAGE	0.681	136057.984	9.06
SOIL WATER AT START OF YEAR	124.462	24848886.000	
SOIL WATER AT END OF YEAR	125.174	24990978.000	
SNOW WATER AT START OF YEAR	0.030	6033.006	0.40
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0302	6032.311	0.40

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.43	1483399.620	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	5.756	1149216.000	77.47
PERC./LEAKAGE THROUGH LAYER 2	0.843804	168465.375	11.36

CHANGE IN WATER STORAGE	0.830	165717.484	11.17
SOIL WATER AT START OF YEAR	125.174	24990978.000	
SOIL WATER AT END OF YEAR	126.004	25156696.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.833	0.00

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.18	1433487.120	100.00
RUNOFF	0.303	60497.723	4.22
EVAPOTRANSPIRATION	5.476	1093253.000	76.27
PERC./LEAKAGE THROUGH LAYER 2	0.935104	186693.547	13.02
CHANGE IN WATER STORAGE	0.466	93043.539	6.49
SOIL WATER AT START OF YEAR	126.004	25156696.000	
SOIL WATER AT END OF YEAR	126.454	25246622.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.016	3116.347	0.22
ANNUAL WATER BUDGET BALANCE	0.0000	-0.643	0.00

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.03	2002489.500	100.00
RUNOFF	0.364	72761.234	3.63
EVAPOTRANSPIRATION	7.234	1444261.120	72.12
PERC./LEAKAGE THROUGH LAYER 2	0.877400	175172.812	8.75
CHANGE IN WATER STORAGE	1.554	310292.969	15.50

SOIL WATER AT START OF YEAR	126.454	25246622.000	
SOIL WATER AT END OF YEAR	128.024	25560032.000	
SNOW WATER AT START OF YEAR	0.016	3116.347	0.16
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	1.333	0.00

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ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.76	1549284.000	100.00
RUNOFF	0.178	35459.559	2.29
EVAPOTRANSPIRATION	5.818	1161547.750	74.97
PERC./LEAKAGE THROUGH LAYER 2	1.070154	213656.281	13.79
CHANGE IN WATER STORAGE	0.694	138620.250	8.95
SOIL WATER AT START OF YEAR	128.024	25560032.000	
SOIL WATER AT END OF YEAR	128.443	25643708.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.275	54944.301	3.55
ANNUAL WATER BUDGET BALANCE	0.0000	0.190	0.00

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ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.24	1645116.370	100.00
RUNOFF	0.092	18442.041	1.12
EVAPOTRANSPIRATION	7.670	1531364.120	93.09
PERC./LEAKAGE THROUGH LAYER 2	1.064908	212608.906	12.92
CHANGE IN WATER STORAGE	-0.588	-117298.094	-7.13

SOIL WATER AT START OF YEAR	128.443	25643708.000	
SOIL WATER AT END OF YEAR	128.024	25560062.000	
SNOW WATER AT START OF YEAR	0.275	54944.301	3.34
SNOW WATER AT END OF YEAR	0.107	21291.680	1.29
ANNUAL WATER BUDGET BALANCE	0.0000	-0.690	0.00

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ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.73	1742944.750	100.00
RUNOFF	0.048	9516.784	0.55
EVAPOTRANSPIRATION	7.491	1495529.870	85.80
PERC./LEAKAGE THROUGH LAYER 2	1.053329	210297.156	12.07
CHANGE IN WATER STORAGE	0.138	27600.271	1.58
SOIL WATER AT START OF YEAR	128.024	25560062.000	
SOIL WATER AT END OF YEAR	128.269	25608954.000	
SNOW WATER AT START OF YEAR	0.107	21291.680	1.22
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.762	0.00

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ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
PRECIPITATION	5.62	1122033.250	100.00
RUNOFF	0.002	398.146	0.04
EVAPOTRANSPIRATION	4.125	823598.875	73.40
PERC./LEAKAGE THROUGH LAYER 2	1.054742	210579.328	18.77
CHANGE IN WATER STORAGE	0.438	87456.547	7.79
SOIL WATER AT START OF YEAR	128.269	25608954.000	

SOIL WATER AT END OF YEAR	128.707	25696410.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.333	0.00

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ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.93	1782875.000	100.00
RUNOFF	0.196	39052.891	2.19
EVAPOTRANSPIRATION	7.686	1534517.120	86.07
PERC./LEAKAGE THROUGH LAYER 2	1.033713	206380.719	11.58
CHANGE IN WATER STORAGE	0.015	2924.561	0.16
SOIL WATER AT START OF YEAR	128.707	25696410.000	
SOIL WATER AT END OF YEAR	128.722	25699336.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.333	0.00

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ANNUAL TOTALS FOR YEAR 16

	INCHES	CU. FEET	PERCENT
PRECIPITATION	6.58	1313696.870	100.00
RUNOFF	0.068	13499.408	1.03
EVAPOTRANSPIRATION	5.447	1087533.370	82.78
PERC./LEAKAGE THROUGH LAYER 2	1.140247	227650.328	17.33
CHANGE IN WATER STORAGE	-0.075	-14985.326	-1.14
SOIL WATER AT START OF YEAR	128.722	25699336.000	

SOIL WATER AT END OF YEAR	128.647	25684350.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.881	0.00

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ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT
PRECIPITATION	6.38	1273767.250	100.00
RUNOFF	0.747	149051.875	11.70
EVAPOTRANSPIRATION	4.188	836212.750	65.65
PERC./LEAKAGE THROUGH LAYER 2	1.000532	199756.266	15.68
CHANGE IN WATER STORAGE	0.445	88746.414	6.97
SOIL WATER AT START OF YEAR	128.647	25684350.000	
SOIL WATER AT END OF YEAR	128.963	25747472.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.128	25624.646	2.01
ANNUAL WATER BUDGET BALANCE	0.0000	-0.119	0.00

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ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.64	1724976.250	100.00
RUNOFF	0.737	147156.578	8.53
EVAPOTRANSPIRATION	5.713	1140596.870	66.12
PERC./LEAKAGE THROUGH LAYER 2	1.230544	245678.078	14.24
CHANGE IN WATER STORAGE	0.959	191542.250	11.10
SOIL WATER AT START OF YEAR	128.963	25747472.000	
SOIL WATER AT END OF YEAR	130.051	25964638.000	

SNOW WATER AT START OF YEAR	0.128	25624.646	1.49
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	2.451	0.00

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ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
PRECIPITATION	5.24	1046165.870	100.00
RUNOFF	0.007	1404.073	0.13
EVAPOTRANSPIRATION	5.083	1014751.120	97.00
PERC./LEAKAGE THROUGH LAYER 2	1.109547	221521.031	21.17
CHANGE IN WATER STORAGE	-0.959	-191509.969	-18.31
SOIL WATER AT START OF YEAR	130.051	25964638.000	
SOIL WATER AT END OF YEAR	129.092	25773128.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.381	0.00

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ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.23	1443469.750	100.00
RUNOFF	0.332	66243.469	4.59
EVAPOTRANSPIRATION	5.319	1061928.120	73.57
PERC./LEAKAGE THROUGH LAYER 2	1.066961	213018.672	14.76
CHANGE IN WATER STORAGE	0.512	102280.414	7.09
SOIL WATER AT START OF YEAR	129.092	25773128.000	
SOIL WATER AT END OF YEAR	129.604	25875408.000	

SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.976	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.85	0.49	0.60	0.85	0.71	0.98
	0.16	0.41	0.44	0.61	0.85	0.84
STD. DEVIATIONS	0.46	0.23	0.30	0.57	0.43	0.58
	0.19	0.44	0.54	0.48	0.61	0.45
RUNOFF						
TOTALS	0.137	0.056	0.000	0.002	0.000	0.000
	0.000	0.001	0.002	0.001	0.000	0.064
STD. DEVIATIONS	0.148	0.081	0.000	0.010	0.000	0.001
	0.000	0.002	0.009	0.005	0.000	0.164
EVAPOTRANSPIRATION						
TOTALS	0.544	0.442	0.429	0.718	0.610	0.875
	0.328	0.248	0.309	0.334	0.523	0.774
STD. DEVIATIONS	0.246	0.183	0.186	0.518	0.448	0.620
	0.239	0.242	0.354	0.249	0.324	0.326
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0659	0.0636	0.0909	0.0895	0.0884	0.0628
	0.0595	0.0657	0.0822	0.0916	0.0877	0.0902
STD. DEVIATIONS	0.0280	0.0391	0.0413	0.0260	0.0301	0.0403
	0.0364	0.0343	0.0299	0.0238	0.0358	0.0283

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.78 (1.197)	1553277.2	100.00

RUNOFF	0.264	(0.2510)	52775.86	3.398
EVAPOTRANSPIRATION	6.134	(1.0599)	1224559.00	78.837
PERCOLATION/LEAKAGE THROUGH FROM LAYER 2	0.93793	(0.17142)	187258.625	12.05571
CHANGE IN WATER STORAGE	0.440	(0.6186)	87786.30	5.652

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	1.05	209632.484
RUNOFF	0.607	121146.6480
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.006957	1388.91687
SNOW WATER	1.03	205921.9530

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3235
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0639

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	0.9583	0.1597
2	128.6456	0.2144
SNOW WATER	0.000	

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HELP MODEL RESULTS
POST CLOSURE PROFILE

Table 1 - HELP Model Analyses
Leachate Generation Profiles
Jungo Road Landfill
June 2007

Closed Profile

Layer	Top (ft bgs)	Bottom (ft bgs)	Thickness
Layer 1 - Cover Soil	0	2.0	2.0
Layer 2 - Geocomposite Drainage	2.000	2.021	0.021
Layer 3 - Geomembrane	2.021	2.024	0.003

Layer 1 - Cover Soil

Parameter	Value	Units
HELP Model Classification	7	-
USDA Classification	FSL	-
Unified Soil Classification System	SM	-
Total Porosity	0.473	vol/vol
Field Capacity	0.222	vol/vol
Wilting Point	0.104	vol/vol
Saturated Hydraulic Conductivity	5.2E-04	cm/sec
Initial Moisture Content	0.12	vol/vol

Layer 2 - Geocomposite Drainage

Parameter	Value	Units
HELP Model Classification	34	-
Thickness	0.6	cm
Total Porosity	0.850	vol/vol
Field Capacity	0.010	vol/vol
Wilting Point	0.005	vol/vol
Saturated Hydraulic Conductivity	3.3E+01	cm/sec
Initial Moisture Content	0	vol/vol

Layer 3 - Geomembrane

Parameter	Value	Units
HELP Model Classification	35	-
Material Description	High Density Polyethylene	-
Geomembrane Pinhole Density	1	#/acre
Geomembrane Install Defects	1	#/acre
Geomembrane Placement Quaility	3 - Good	-
Saturated Hydraulic Conductivity	2.0E-13	cm/sec
Initial Moisture Content	0	vol/vol

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.01   (14 OCTOBER 1994)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\PROGRA~1\HELP3\JUNGOF.D4
TEMPERATURE DATA FILE:       C:\PROGRA~1\HELP3\JUNGOF.D7
SOLAR RADIATION DATA FILE:   C:\PROGRA~1\HELP3\JUNGOF.D13
EVAPOTRANSPIRATION DATA:     C:\PROGRA~1\HELP3\JUNGOF.D11
SOIL AND DESIGN DATA FILE:   C:\PROGRA~1\HELP3\CLOSED.D10
OUTPUT DATA FILE:            C:\PROGRA~1\HELP3\CLOSED.OUT


TIME:  12:25     DATE:   6/22/2007


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     TITLE:  Jungo Road Operations

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   7
          THICKNESS                  =     24.00   INCHES
          POROSITY                   =      0.4730 VOL/VOL
          FIELD CAPACITY             =      0.2220 VOL/VOL
          WILTING POINT              =      0.1040 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.1418 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.520000001000E-03 CM/SEC


                                  LAYER  2
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                     TYPE 2 - LATERAL DRAINAGE LAYER
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MATERIAL TEXTURE NUMBER 34

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0129	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	33.0000000000	CM/SEC
SLOPE	=	5.00	PERCENT
DRAINAGE LENGTH	=	1000.0	FEET

LAYER 3

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.04	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 1000. FEET.

SCS RUNOFF CURVE NUMBER	=	87.80	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	55.000	ACRES
EVAPORATIVE ZONE DEPTH	=	18.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.018	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	8.514	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.872	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	3.407	INCHES
TOTAL INITIAL WATER	=	3.407	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM WINNEMUCCA NEVADA

MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	130	
END OF GROWING SEASON (JULIAN DATE)	=	277	
AVERAGE ANNUAL WIND SPEED	=	7.90	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	62.00	%

AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 42.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 31.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 58.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR WINNEMUCCA NEVADA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.89	0.67	0.67	0.81	0.80	0.92
0.18	0.39	0.34	0.59	0.75	0.86

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR WINNEMUCCA NEVADA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
29.80	35.70	38.70	45.30	54.70	63.50
72.00	68.70	59.60	48.70	37.70	30.40

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR WINNEMUCCA NEVADA

STATION LATITUDE = 40.54 DEGREES

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.22	1641123.000	100.00
RUNOFF	0.043	8604.810	0.52
EVAPOTRANSPIRATION	4.377	873960.375	53.25
DRAINAGE COLLECTED FROM LAYER 2	3.8003	758727.312	46.23
PERC./LEAKAGE THROUGH LAYER 3	0.000001	0.269	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0011		
CHANGE IN WATER STORAGE	-0.001	-170.123	-0.01
SOIL WATER AT START OF YEAR	3.407	680241.187	
SOIL WATER AT END OF YEAR	3.406	680071.062	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.432	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.54	1705011.370	100.00
RUNOFF	0.332	66301.727	3.89
EVAPOTRANSPIRATION	5.627	1123415.000	65.89
DRAINAGE COLLECTED FROM LAYER 2	2.3978	478720.437	28.08
PERC./LEAKAGE THROUGH LAYER 3	0.000001	0.270	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0007		
CHANGE IN WATER STORAGE	0.183	36573.238	2.15
SOIL WATER AT START OF YEAR	3.406	680071.062	
SOIL WATER AT END OF YEAR	3.590	716644.312	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.706	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.16	1828794.370	100.00
RUNOFF	0.725	144764.719	7.92
EVAPOTRANSPIRATION	6.389	1275494.870	69.75
DRAINAGE COLLECTED FROM LAYER 2	1.5497	309403.156	16.92
PERC./LEAKAGE THROUGH LAYER 3	0.000001	0.254	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0005		

CHANGE IN WATER STORAGE	0.497	99131.320	5.42
SOIL WATER AT START OF YEAR	3.590	716644.312	
SOIL WATER AT END OF YEAR	4.086	815775.625	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.030	5918.065	0.32
ANNUAL WATER BUDGET BALANCE	0.0000	-0.016	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.31	1659091.750	100.00
RUNOFF	0.015	3030.896	0.18
EVAPOTRANSPIRATION	6.512	1300022.370	78.36
DRAINAGE COLLECTED FROM LAYER 2	2.5198	503070.687	30.32
PERC./LEAKAGE THROUGH LAYER 3	0.000001	0.264	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0007		
CHANGE IN WATER STORAGE	-0.766	-152950.406	-9.22
SOIL WATER AT START OF YEAR	4.086	815775.625	
SOIL WATER AT END OF YEAR	3.350	668743.250	
SNOW WATER AT START OF YEAR	0.030	5918.065	0.36
SNOW WATER AT END OF YEAR	0.030	5989.500	0.36
ANNUAL WATER BUDGET BALANCE	0.0296	5917.947	0.36

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.48	1693032.250	100.00
RUNOFF	0.377	75233.930	4.44
EVAPOTRANSPIRATION	6.338	1265325.250	74.74

DRAINAGE COLLECTED FROM LAYER 2	1.6651	332442.437	19.64
PERC./LEAKAGE THROUGH LAYER 3	0.000002	0.322	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0005		
CHANGE IN WATER STORAGE	0.070	14040.360	0.83
SOIL WATER AT START OF YEAR	3.350	668743.250	
SOIL WATER AT END OF YEAR	3.450	688773.125	
SNOW WATER AT START OF YEAR	0.030	5989.500	0.35
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0300	5989.946	0.35

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.38	1473416.870	100.00
RUNOFF	0.313	62434.750	4.24
EVAPOTRANSPIRATION	5.704	1138860.370	77.29
DRAINAGE COLLECTED FROM LAYER 2	1.6072	320883.156	21.78
PERC./LEAKAGE THROUGH LAYER 3	0.000002	0.331	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0005		
CHANGE IN WATER STORAGE	-0.244	-48761.762	-3.31
SOIL WATER AT START OF YEAR	3.450	688773.125	
SOIL WATER AT END OF YEAR	3.206	640011.375	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.030	6033.006	0.41
ANNUAL WATER BUDGET BALANCE	0.0000	0.026	0.00

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.52	1501368.250	100.00
RUNOFF	0.163	32636.994	2.17
EVAPOTRANSPIRATION	4.770	952271.562	63.43
DRAINAGE COLLECTED FROM LAYER 2	2.4967	498465.437	33.20
PERC./LEAKAGE THROUGH LAYER 3	0.000001	0.259	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0007		
CHANGE IN WATER STORAGE	0.060	11960.419	0.80
SOIL WATER AT START OF YEAR	3.206	640011.375	
SOIL WATER AT END OF YEAR	3.296	658004.812	
SNOW WATER AT START OF YEAR	0.030	6033.006	0.40
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0302	6033.592	0.40

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.43	1483399.620	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	3.003	599638.375	40.42
DRAINAGE COLLECTED FROM LAYER 2	4.2384	846189.125	57.04
PERC./LEAKAGE THROUGH LAYER 3	0.000002	0.382	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0013		
CHANGE IN WATER STORAGE	0.188	37571.605	2.53
SOIL WATER AT START OF YEAR	3.296	658004.812	
SOIL WATER AT END OF YEAR	3.484	695576.375	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.189	0.00

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.18	1433487.120	100.00
RUNOFF	0.209	41720.875	2.91
EVAPOTRANSPIRATION	4.896	977522.250	68.19
DRAINAGE COLLECTED FROM LAYER 2	2.2893	457060.969	31.88
PERC./LEAKAGE THROUGH LAYER 3	0.000002	0.326	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0007		
CHANGE IN WATER STORAGE	-0.214	-42817.863	-2.99
SOIL WATER AT START OF YEAR	3.484	695576.375	
SOIL WATER AT END OF YEAR	3.254	649642.187	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.016	3116.347	0.22
ANNUAL WATER BUDGET BALANCE	0.0000	0.573	0.00

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.03	2002489.500	100.00
RUNOFF	0.236	47064.613	2.35
EVAPOTRANSPIRATION	6.354	1268531.500	63.35
DRAINAGE COLLECTED FROM LAYER 2	2.9912	597193.812	29.82
PERC./LEAKAGE THROUGH LAYER 3	0.000002	0.324	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0009		
CHANGE IN WATER STORAGE	0.449	89699.461	4.48
SOIL WATER AT START OF YEAR	3.254	649642.187	
SOIL WATER AT END OF YEAR	3.719	742458.000	
SNOW WATER AT START OF YEAR	0.016	3116.347	0.16

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.211	0.00

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ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.76	1549284.000	100.00
RUNOFF	0.116	23190.311	1.50
EVAPOTRANSPIRATION	5.687	1135356.250	73.28
DRAINAGE COLLECTED FROM LAYER 2	2.0874	416750.219	26.90
PERC./LEAKAGE THROUGH LAYER 3	0.000001	0.254	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0006		
CHANGE IN WATER STORAGE	-0.130	-26013.189	-1.68
SOIL WATER AT START OF YEAR	3.719	742458.000	
SOIL WATER AT END OF YEAR	3.313	661500.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.275	54944.301	3.55
ANNUAL WATER BUDGET BALANCE	0.0000	0.167	0.00

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ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.24	1645116.370	100.00
RUNOFF	0.078	15648.724	0.95
EVAPOTRANSPIRATION	6.214	1240708.750	75.42
DRAINAGE COLLECTED FROM LAYER 2	1.7515	349691.187	21.26
PERC./LEAKAGE THROUGH LAYER 3	0.000001	0.253	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0005		

CHANGE IN WATER STORAGE	0.196	39067.406	2.37
SOIL WATER AT START OF YEAR	3.313	661500.500	
SOIL WATER AT END OF YEAR	3.678	734220.562	
SNOW WATER AT START OF YEAR	0.275	54944.301	3.34
SNOW WATER AT END OF YEAR	0.107	21291.680	1.29
ANNUAL WATER BUDGET BALANCE	0.0000	0.031	0.00

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ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.73	1742944.750	100.00
RUNOFF	0.047	9305.570	0.53
EVAPOTRANSPIRATION	5.920	1181941.750	67.81
DRAINAGE COLLECTED FROM LAYER 2	2.7284	544726.625	31.25
PERC./LEAKAGE THROUGH LAYER 3	0.000002	0.306	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0008		
CHANGE IN WATER STORAGE	0.035	6970.600	0.40
SOIL WATER AT START OF YEAR	3.678	734220.562	
SOIL WATER AT END OF YEAR	3.819	762482.812	
SNOW WATER AT START OF YEAR	0.107	21291.680	1.22
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.040	0.00

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ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
PRECIPITATION	5.62	1122033.250	100.00
RUNOFF	0.002	494.505	0.04
EVAPOTRANSPIRATION	4.318	862109.125	76.83

DRAINAGE COLLECTED FROM LAYER 2	1.4114	281780.625	25.11
PERC./LEAKAGE THROUGH LAYER 3	0.000001	0.222	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0004		
CHANGE IN WATER STORAGE	-0.112	-22351.850	-1.99
SOIL WATER AT START OF YEAR	3.819	762482.812	
SOIL WATER AT END OF YEAR	3.707	740131.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.625	0.00

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ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.93	1782875.000	100.00
RUNOFF	0.122	24447.889	1.37
EVAPOTRANSPIRATION	6.709	1339459.620	75.13
DRAINAGE COLLECTED FROM LAYER 2	2.3855	476266.531	26.71
PERC./LEAKAGE THROUGH LAYER 3	0.000002	0.340	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0007		
CHANGE IN WATER STORAGE	-0.287	-57299.918	-3.21
SOIL WATER AT START OF YEAR	3.707	740131.000	
SOIL WATER AT END OF YEAR	3.420	682831.062	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.411	0.00

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ANNUAL TOTALS FOR YEAR 16

	INCHES	CU. FEET	PERCENT
PRECIPITATION	6.58	1313696.870	100.00
RUNOFF	0.060	12024.770	0.92
EVAPOTRANSPIRATION	5.140	1026142.060	78.11
DRAINAGE COLLECTED FROM LAYER 2	1.2982	259179.516	19.73
PERC./LEAKAGE THROUGH LAYER 3	0.000001	0.212	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0004		
CHANGE IN WATER STORAGE	0.082	16350.598	1.24
SOIL WATER AT START OF YEAR	3.420	682831.062	
SOIL WATER AT END OF YEAR	3.502	699181.625	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.249	0.00

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ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT
PRECIPITATION	6.38	1273767.250	100.00
RUNOFF	0.392	78288.602	6.15
EVAPOTRANSPIRATION	4.714	941205.625	73.89
DRAINAGE COLLECTED FROM LAYER 2	0.7412	147985.203	11.62
PERC./LEAKAGE THROUGH LAYER 3	0.000001	0.157	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0002		
CHANGE IN WATER STORAGE	0.532	106286.641	8.34
SOIL WATER AT START OF YEAR	3.502	699181.625	
SOIL WATER AT END OF YEAR	3.906	779843.625	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.128	25624.646	2.01
ANNUAL WATER BUDGET BALANCE	0.0000	0.967	0.00

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ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.64	1724976.250	100.00
RUNOFF	0.581	115908.336	6.72
EVAPOTRANSPIRATION	6.364	1270488.000	73.65
DRAINAGE COLLECTED FROM LAYER 2	1.8948	378306.375	21.93
PERC./LEAKAGE THROUGH LAYER 3	0.000001	0.286	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0006		
CHANGE IN WATER STORAGE	-0.199	-39727.035	-2.30
SOIL WATER AT START OF YEAR	3.906	779843.625	
SOIL WATER AT END OF YEAR	3.835	765741.250	
SNOW WATER AT START OF YEAR	0.128	25624.646	1.49
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.267	0.00

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ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
PRECIPITATION	5.24	1046165.870	100.00
RUNOFF	0.001	194.272	0.02
EVAPOTRANSPIRATION	4.258	850158.687	81.26
DRAINAGE COLLECTED FROM LAYER 2	1.5477	308990.906	29.54
PERC./LEAKAGE THROUGH LAYER 3	0.000001	0.212	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0005		
CHANGE IN WATER STORAGE	-0.567	-113177.875	-10.82
SOIL WATER AT START OF YEAR	3.835	765741.250	
SOIL WATER AT END OF YEAR	3.269	652563.375	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.370	0.00

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ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.23	1443469.750	100.00
RUNOFF	0.265	52857.707	3.66
EVAPOTRANSPIRATION	4.735	945329.187	65.49
DRAINAGE COLLECTED FROM LAYER 2	1.4237	284236.031	19.69
PERC./LEAKAGE THROUGH LAYER 3	0.000001	0.280	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0004		
CHANGE IN WATER STORAGE	0.807	161046.328	11.16
SOIL WATER AT START OF YEAR	3.269	652563.375	
SOIL WATER AT END OF YEAR	4.075	813609.687	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.184	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.85	0.49	0.60	0.85	0.71	0.98
	0.16	0.41	0.44	0.61	0.85	0.84
STD. DEVIATIONS	0.46	0.23	0.30	0.57	0.43	0.58
	0.19	0.44	0.54	0.48	0.61	0.45
RUNOFF						

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  TOTALS                  0.109    0.032    0.000    0.002    0.000    0.000
                          0.000    0.000    0.002    0.000    0.000    0.059

  STD. DEVIATIONS         0.114    0.051    0.000    0.007    0.000    0.001
                          0.000    0.002    0.007    0.001    0.000    0.154

EVAPOTRANSPIRATION
------------------
  TOTALS                  0.509    0.422    0.569    0.625    0.584    0.788
                          0.200    0.180    0.200    0.231    0.460    0.633

  STD. DEVIATIONS         0.197    0.141    0.324    0.486    0.469    0.640
                          0.184    0.321    0.203    0.214    0.347    0.266

LATERAL DRAINAGE COLLECTED FROM LAYER  2
----------------------------------------
  TOTALS                  0.0166   0.0424   0.1181   0.1624   0.1958   0.4089
                          0.1513   0.1085   0.2215   0.2441   0.2655   0.2061

  STD. DEVIATIONS         0.0267   0.1161   0.1257   0.2235   0.1707   0.3106
                          0.1405   0.1261   0.3121   0.2983   0.3454   0.1885

PERCOLATION/LEAKAGE THROUGH LAYER  3
-------------------------------------
  TOTALS                  0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                          0.0000   0.0000   0.0000   0.0000   0.0000   0.0000


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              AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
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DAILY AVERAGE HEAD ACROSS LAYER  3
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  AVERAGES                0.0001   0.0002   0.0004   0.0006   0.0007   0.0015
                          0.0005   0.0004   0.0008   0.0008   0.0009   0.0007

  STD. DEVIATIONS         0.0001   0.0004   0.0004   0.0008   0.0006   0.0011
                          0.0005   0.0004   0.0011   0.0010   0.0012   0.0007
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    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   20
-------------------------------------------------------------------------------
                                   INCHES              CU. FEET       PERCENT
                              -------------------   -------------   ---------
 PRECIPITATION                  7.78    (   1.197)    1553277.2     100.00

 RUNOFF                         0.204   (  0.2018)      40707.70      2.621

 EVAPOTRANSPIRATION             5.401   (  0.9920)    1078397.00     69.427

 LATERAL DRAINAGE COLLECTED     2.14126 (  0.85170)    427503.437   27.52267
   FROM LAYER  2
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PERCOLATION/LEAKAGE THROUGH FROM LAYER 3	0.00000 (0.00000)	0.276	0.00002
AVERAGE HEAD ACROSS TOP OF LAYER 3	0.001 (0.000)		
CHANGE IN WATER STORAGE	0.029 (0.3738)	5771.40	0.372

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	1.05	209632.484
RUNOFF	0.608	121473.6720
DRAINAGE COLLECTED FROM LAYER 2	0.44761	89365.36720
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000000	0.00299
AVERAGE HEAD ACROSS LAYER 3	0.048	
SNOW WATER	1.03	205921.9530

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2220
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1000

****

****

FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	4.0716	0.1697
2	0.0035	0.0141
3	0.0000	0.0000
SNOW WATER	0.000	

****
****

LEACHATE PIPE SPACING CALCULATIONS

JUNGO BASE LINER LCRS CALCULATIONS

Case 1: Base Liner

Imingement Rate	74.4	gpad (equal to 1-inch per year)		
Drainage Grade (toward pipes)	0.02			
Gravel Perm	1	cm/s =	2,835	ft/day
Flow Path Length	550	ft		
Predicted max. head	0.002	feet		

Computed FS = 451 for a 12-inch thick layer

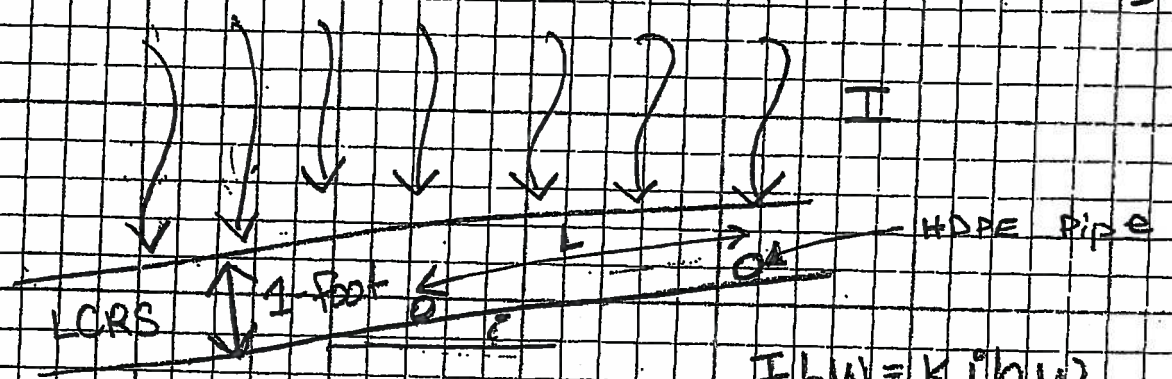
Case 1: Side-Slope Liner

Imingement Rate	74.4	gpad (equal to 1-inch per year)		
Drainage Grade	0.33			
Geocomposite Drainage Perm	5.00E-03	cm/s =	14	ft/day
Flow Path Length	90	ft		
Predicted max. head	0.004	feet		

Computed FS = 48 for a 1/4 inch thick geocomposite layer

Golder Associates	SUBJECT Leachate Pipe Spacing		
	Job No. 013-7079-100 Ref.	Made by AAH Checked Reviewed	Date 5/1/07 Sheet 1 of 2

Objective: Determine leachate pipe spacing



$ILW = Kihw$

I- infiltration rate

L= length between HDPE Drainage Pipes

i- gradient = slope of the base grade

K- Permeability of the LCRS Layer

W- width of the section

h- height liquid in sand layer

I- calculated from HELP model = 1.0 in/year

i= from base grade drawings = 1%

K =

Table 6-1
Darcy's Coefficient of Permeability

Soil Type	Average Grain Size, mm	Range of *k* Coefficient, cm/s	Order of Magnitude of *k*, cm/s
Clean gravel	4–7	2.5–4.0	1
Fine gravel	2–4	1.0–3.5	1
Coarse, clean sand	0.5	0.01–1.0	10^{-1}
Mixed sand	0.1–0.3	0.005–0.01	10^{-2}
Fine sand	0.1	0.001–0.05	10^{-3}
Silty sand	0.02–0.1	0.0001–0.002	10^{-4}
Silt	0.002–0.02	0.00001–0.0005	10^{-5}
Clay	0.002	10^{-9}–10^{-6}	10^{-7}

Table From: Second Edition Practical Hydraulic By: Andrew L. Simon page 132

Golder Associates	SUBJECT Leachate Pipe Spacing		
	Job No. Ref. 063.7079.100	Made by AAH Checked Reviewed	Date 5/1/07 Sheet 2 of 2

K = assume fine gravel = 1.0 cm/sec

$h_{allowable}$ = 0.5 ft

Calculations $\quad I L \cancel{w} = K i h \cancel{w}$

$$\frac{1.0\,in}{year}(L) = \frac{1.0\,cm}{sec}(0.01)(0.5\,ft)$$

Convert Units

$$\frac{1.0\,in}{year} \Big| \frac{1\,year}{365\,days} \Big| \frac{1\,ft}{12\,inch} = 2.28\times10^{-4}\ ft/day$$

$$\frac{1.0\,cm}{sec} \Big| \frac{60\,sec}{1\,min} \Big| \frac{60\,min}{1\,hr} \Big| \frac{24\,hr}{1\,day} \Big| \frac{1\,in}{2.54\,cm} \Big| \frac{1\,ft}{12\,in} = 2834\ ft/day$$

$$\left(2.28\times10^{-4}\frac{ft}{day}\right)L = \left(2834\frac{ft}{day}\right)(0.01)(0.5\,ft) =$$

62149 ft

$$L = 62{,}000\ ft$$

Golder Associates	SUBJECT FOS calculations		
	Job No. 063-7079-100 Ref.	Made by HMK Checked HSD. Reviewed KGH	Date 3/25/11 Sheet 1 of 3

Over time, drainage grades may reduce due to settlement. The objective is to calculate the factor of safety (FOS) of the maximum permissible flow (ϕ_{max}) versus the calculated flow (ϕ_{pred}) over various drainage grades (i)

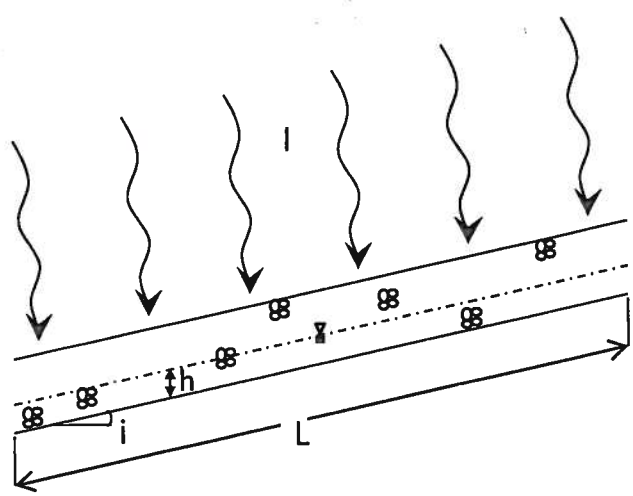
$\phi_{max} = K i h$ (over unit area)

where K = permeability of gravel layer (1 cm/s)
i = floor grade (examine 0.2% to 2%)
h = leachate head (use maximum allowable, 1ft)

$\phi_{pred} = I L$ (over unit area)

where I = Infiltration rate (calculated as 1 in/yr in the HELP model)
L = Maximum flow length (550 ft designed)

$$FOS = \frac{\phi_{max}}{\phi_{pred}}$$



Golder Associates	SUBJECT FOS calculations		
	Job No. 063-7079-100 Ref.	Made by HMK Checked H.G.D. Reviewed KGH	Date 3/25/11 Sheet 2 of 3

$Q_{max} = Kih = \left(1 \frac{cm}{s}\right)(i)(1\ ft)$

Convert units:

$K = \left(1 \frac{cm}{s}\right)\left(\frac{ft}{30.48\ cm}\right) = 0.033 \frac{ft}{s}$

$Q_{max} = 0.033\, i \frac{ft^2}{s}$

$Q_{pred} = IL = \left(1 \frac{in}{yr}\right)(550\ ft)$

Convert units:

$I = \left(1 \frac{in}{yr}\right)\left(\frac{ft}{12\ in}\right)\left(\frac{yr}{365\ d}\right)\left(\frac{d}{86{,}400\ s}\right)$

$I = 2.6 \times 10^{-9} \frac{ft}{s}$

$Q_{pred} = \left(2.6 \times 10^{-9} \frac{ft}{s}\right)(550\ ft)$

$Q_{pred} = 1.4 \times 10^{-6} \frac{ft^2}{s}$

$FOS = \frac{Q_{max}}{Q_{pred}} = \frac{0.033\, i}{1.4 \times 10^{-6}} =$

$FOS = 22{,}706\, i$

Golder Associates	SUBJECT FOS		
	Job No. 013-7079-100 Ref.	Made by HMK Checked MCD Reviewed MJG	Date 3/25/11 Sheet 3 of 3

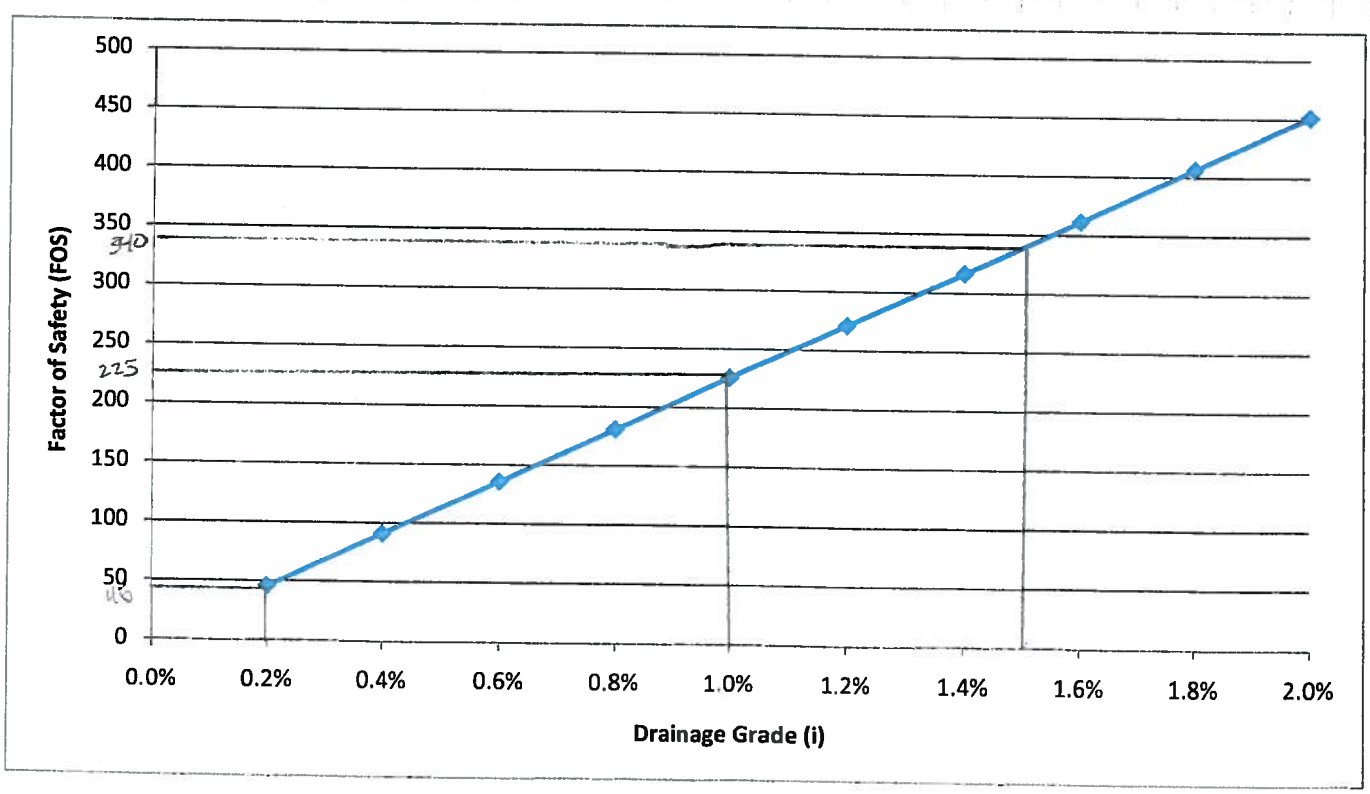
Examine FOS for a range of potential i's

$0.2\% \le i \le 2\%$

FOS = 22,706 i

i (%)	FOS	Max predicted head (hmax)
0.2	45.1	0.02
0.4	90.3	0.01
0.6	135.4	0.007
0.8	180.6	0.006
1.0	225.7	0.004
1.2	270.9	0.004
1.4	316.0	0.003
1.6	361.2	0.003
1.8	406.3	0.002
2.0	451.5	0.002

A plot of i vs FOS was generated in Microsoft Exel:



Golder Associates	SUBJECT Pipe capacity		
	Job No. 063-7079-100 Ref.	Made by HMK Checked HAD. Reviewed KGH	Date 3/25/11 Sheet 1 of 3

Objective: Calculate hydraulic capacity of a 6-inch HDPE pipe for a range of grades (i)

i = grade = $0.1\% \le i \le 1\%$

Compare these capacities with the maximum expected leachate generation.

Use the Manning equation to determine the hydraulic capacity.

Assume pipes are flowing full

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

where

n = Manning's roughness coefficient (use 0.01)
A = Cross-sectional area of flow (ft^2) ($\pi D^2/4$)
R = Hydraulic radius (ft)
S = Slope = i ($0.1\% \le i \le 1\%$)

With full flowing pipes Mannings equation reduces to:

$$Q = \frac{1.49}{n}\left(\frac{\pi D^2}{4}\right)\frac{\left(\frac{\pi D^2}{4}\right)^{2/3}}{(\pi D)}(S)^{1/2}$$

$$Q = \frac{1.49}{n}\left(\frac{\pi D^2}{4}\right)\left(\frac{D}{4}\right)^{2/3}(S)^{1/2}$$

D = diameter of pipe = 6 inches = 0.5 ft

Golder Associates	SUBJECT Pipe capacity		
	Job No 063-7079 Ref.	Made by HMK Checked HGO Reviewed	Date 3/25/11 Sheet 2 of 3

Calculate pipe capacity

$$Q_{pipe} = \frac{1.49}{0.01}\left(\frac{\pi (0.5\,ft)^2}{4}\right)\left(\frac{0.5\,ft}{4}\right)^{2/3}(s)^{1/2}$$

$$Q_{pipe} = 7.314\ s$$

For various slopes (i, s)

i (%)	Q_{pipe} (cfs)	FOS (Q_{pipe}/Q_{max})
0.1	0.23	36.5
0.2	0.33	52.4
0.3	0.40	63.5
0.4	0.46	73.0
0.5	0.52	82.5
0.6	0.57	90.5
0.7	0.61	96.8
0.8	0.65	103.2
0.9	0.69	109.5
1.0	0.73	115.9

Calculate Q_{max}

$Q_{max} = IA$

where I = Impingement rate (1 in/yr from HELP model)
A = Maximum cell area (55 acres)

Convert units

$$I = 1\ \frac{in}{yr}\left(\frac{ft}{12\,in}\right)\left(\frac{yr}{365\,d}\right)\left(\frac{d}{86{,}400\,s}\right)$$

$$I = 2.64 \times 10^{-9}\ \frac{ft}{s}$$

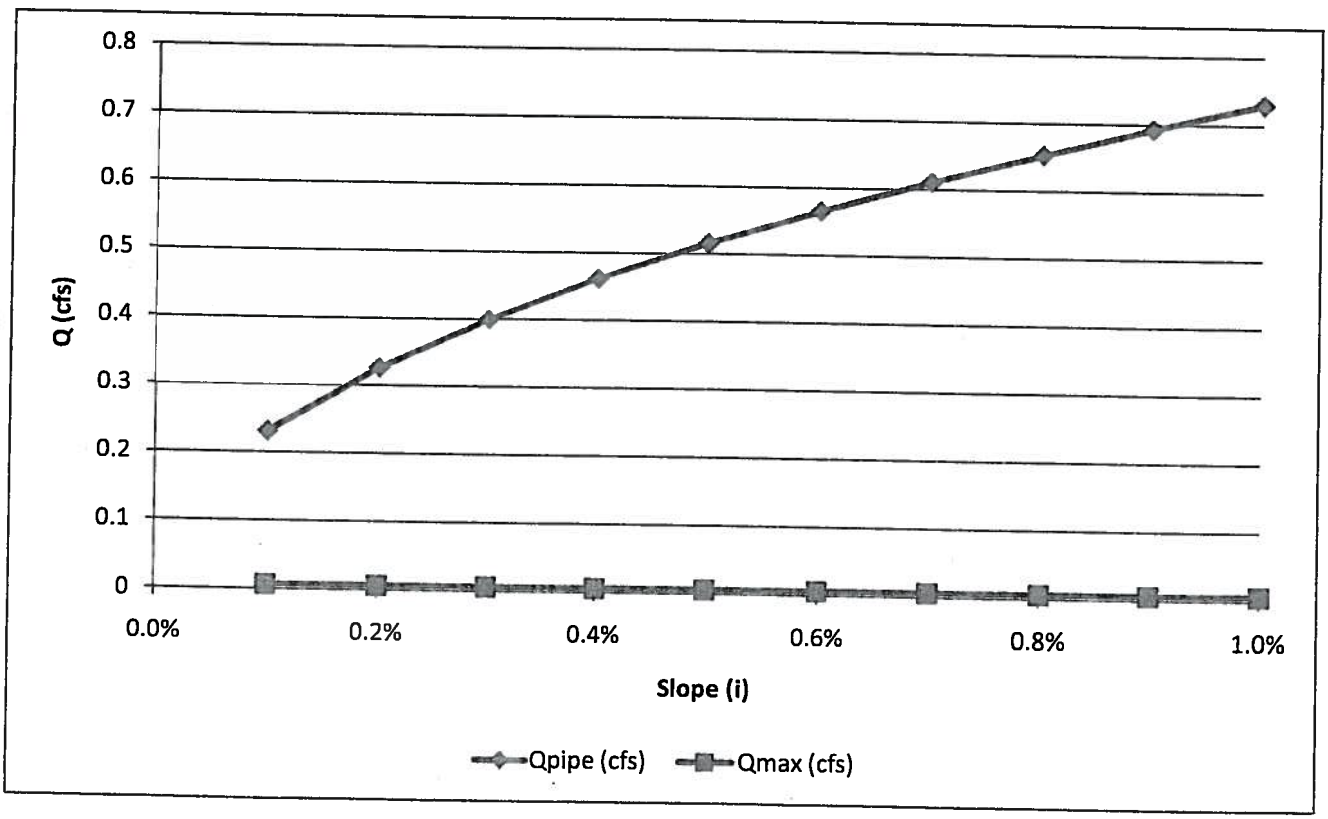
$$A = 55\ acres\left(43{,}560\ \frac{ft^2}{acre}\right)$$

$$A = 2.40 \times 10^{6}\ ft^2$$

$$Q_{max} = 0.0063\ cfs$$

Golder Associates	SUBJECT Pipe capacity		
	Job No. 063-7079-006 Ref.	Made by HMK Checked HGO. Reviewed KGH	Date 3/25/14 Sheet 3 of 3

Below is a graph illustrating Qpipe vs i
Qmax is also shown



Golder Associates	SUBJECT Head on Liner Calculations		
	Job No. 063-7079-106 Ref.	Made by HMK Checked HGO Reviewed KGH	Date 3/25/11 Sheet 1 of 14

Objective: Calculate estimated head on the liner with varying grades. Use the maximum estimated head to calculate pipe spacing.

head will be calculated using three methods:

1) Giroud's Method

from:
"Giroud, J.P., Gross, B.A., and Darasse, J. (1992) Flow in leachate collection layers, steady-state condition." Geosyntec Consultants Rep.

2) The Mound Method

from:
United States Environmental Protection Agency (EPA) ~~Soti~~ (1993) "Solid Waste Disposal Facility Criteria Technical Manual" Revised April 13, 1998

3) Moore's Method

from:
United States Environmental Protection Agency (EPA) (1983) "Landfill and surface impoundment performance evaluation." Rep. No. SW-869, Revised Ed., Office of Solid Waste and Emergency Response, Washington, D.C.

Golder Associates	SUBJECT Head on liner Calcs - Giroud		
	Job No. 063-7079-100 Ref.	Made by HMK Checked HGO Reviewed KGH	Date 3/25/11 Sheet 2 of 14

1) Calculate head using Giroud's Method:

$$h_{max} = \frac{jL\left[\left(\frac{4I}{K} + S^2\right)^{1/2} - S\right]}{2\cos\delta}$$

where h_{max} = maximum liquid head
L = horizontal drainage distance (550 ft)
I = inflow rate (1 inch/year)
K = hydraulic conductivity of drainage layer (1 cm/s)
S = slope of drainage layer ($S = \tan\delta$) $0.1\% \le S \le 1\%$
δ = slope angle of drainage layer

$$j = 1 - 0.12\exp\left\{-\left[\log\left(\frac{1.6I}{KS^2}\right)^{5/8}\right]^2\right\}$$

Convert units

$$I = 1\,\frac{\text{inch}}{\text{year}}\left(\frac{\text{ft}}{12\,\text{inch}}\right)\left(\frac{\text{yr}}{365\,\text{d}}\right)\left(\frac{\text{d}}{86400\,\text{s}}\right)$$

$$\underline{I = 2.6 \times 10^{-9}\ \text{ft/s}}$$

$$K = 1\,\frac{\text{cm}}{\text{s}}\left(\frac{\text{ft}}{30.48\,\text{cm}}\right) =$$

$$\underline{K = 0.033\ \text{ft/s}}$$

$0.001 \le S \le 0.01$

Calculations were performed using the attached Excel spreadsheet.

The maximum head calculated at a drainage grade of 0.1% was 0.04 ft. This is below the maximum allowable head of 1 ft.

checked HGO

Giroud's Method

Input Parameters		
L	550	ft
I (qh)	2.64248E-09	ft/s
k	0.033	ft/s
i	ranges	

1. Calculate maximum head (hmax) using the design flow length of 550 feet

$$h_{max} = \frac{jL\left[\left(\frac{4I}{k} + S^2\right)^{1/2} - S\right]}{}$$

$$j = 1 - 0.12\exp\left\{-\left[\log\left(\frac{1.6I}{kS^2}\right)^{5/8}\right]^2\right\}$$

Calculation table

i (%)	j	hmax (ft) (Assuming 550 ft flow length)
0.10%	0.9119291145	0.038
0.20%	0.9497016439	0.021
0.30%	0.9682143138	0.014
0.40%	0.9783584918	0.011
0.50%	0.9844687841	0.009
0.60%	0.9884117166	0.007
0.70%	0.9910906727	0.006
0.80%	0.9929850463	0.005
0.90%	0.9943680457	0.005
1.00%	0.9954044114	0.004

checked HAD.

2. Calculate the flow length assuming a maximum allowable head of 1-foot

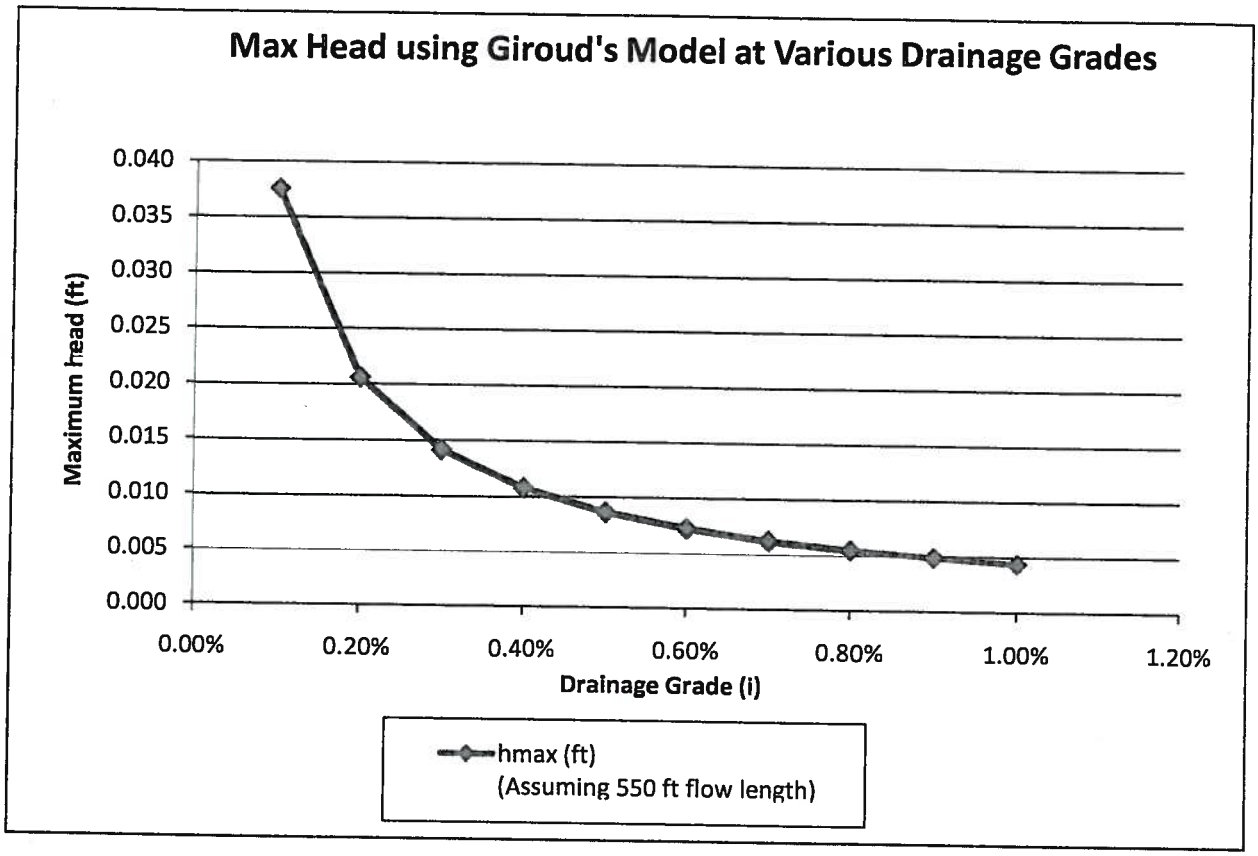
hmax	1.0	ft

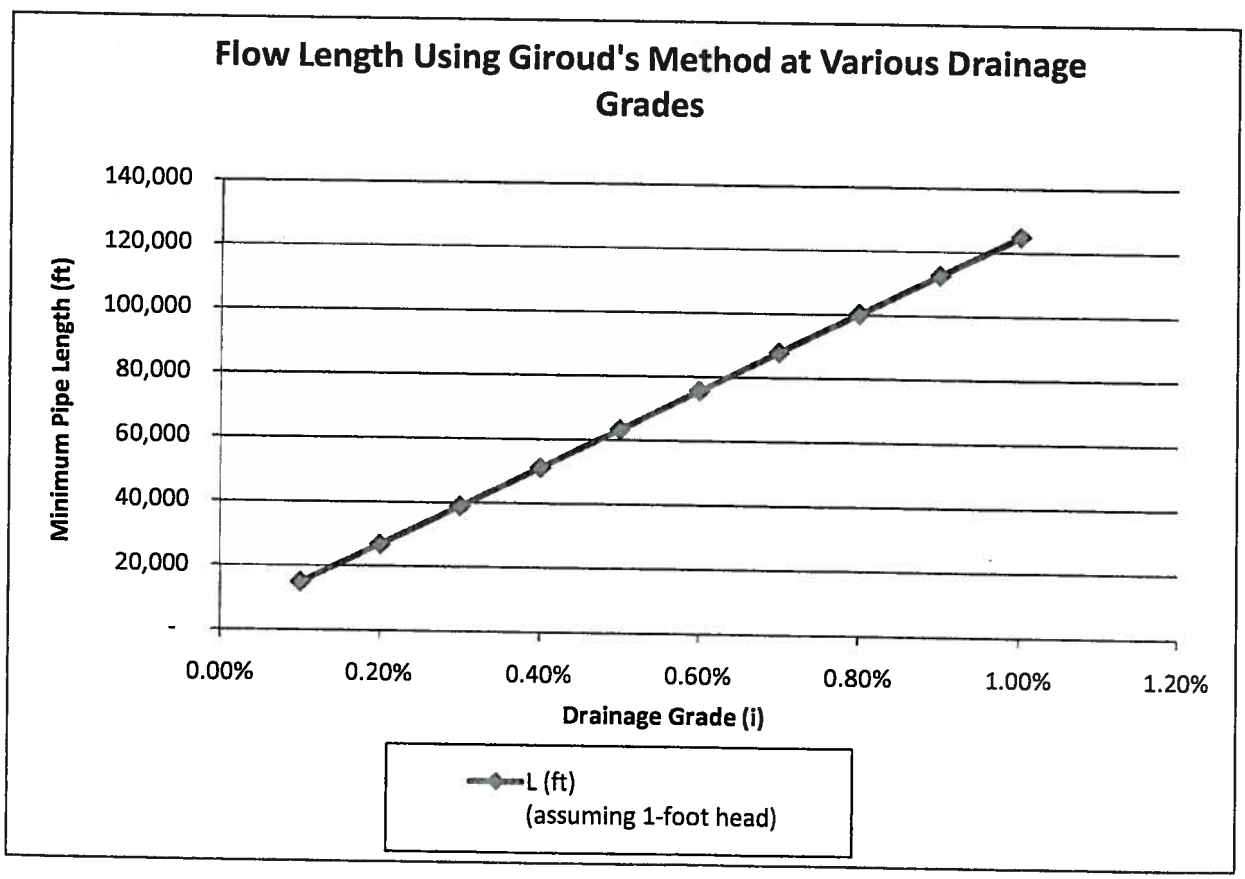
L = hmax/(j((4I/k+S^2)^(1/2)-S)/(2cosa))

Calculation table

i (%)	j	L (ft) (assuming 1-foot head)
0.10%	0.91	14,637
0.20%	0.95	26,666
0.30%	0.97	38,816
0.40%	0.98	51,022
0.50%	0.98	63,268
0.60%	0.99	75,545
0.70%	0.99	87,846
0.80%	0.99	100,165
0.90%	0.99	112,499
1.00%	1.00	124,845

checked: HGU.


Max Head using Giroud's Model at Various Drainage Grades
Maximum head (ft)
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
0.00%
0.20%
0.40%
0.60%
0.80%
1.00%
1.20%
Drainage Grade (i)
hmax (ft)
(Assuming 550 ft flow length)


Flow Length Using Giroud's Method at Various Drainage Grades
Minimum Pipe Length (ft)
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
0.00%
0.20%
0.40%
0.60%
0.80%
1.00%
1.20%
Drainage Grade (i)
L (ft)
(assuming 1-foot head)

Golder Associates	SUBJECT Head on liner calcs - Mound		
	Job No. 063-7079-100 Ref.	Made by HMK Checked HGD Reviewed	Date 3/25/11 Sheet 7 of 14

2) Calculate head using the EPA Mound model:

$$h_{max} = \frac{L\sqrt{C}}{2}\left[\frac{\tan^2\alpha}{C} + 1 - \frac{\tan\alpha}{C}\sqrt{\tan^2\alpha + C}\right]$$

where h_{max} = maximum liquid head
L = horizontal drainage distance (550 ft)
I = Inflow rate (1 in/yr = 2.6×10^{-7} ft/s)
K = hydraulic conductivity of drainage layer (1 cm/s = 0.033 ft/s)
α = Slope angle of drainage layer
$C = I/K$

Calculations were performed using the attached Microsoft Excel spreadsheet for a range of slopes ($S = \tan\alpha$)

$$0.1\% \le S \le 1\%$$

The maximum head calculated at a drainage grade of 0.1% was 0.04 ft with a flow length L = 550 ft

The minimum pipe spacing L was calculated using the maximum allowable head of 1 ft. This minimum pipe spacing at 0.1% grade was 13,827

checked : HGW

EPA Mounds Model

Input Parameters		
k	0.033	ft/s
q	2.64E-09	ft/s
i	1	percent
alpha	0.05729387	degrees
alpha	0.01	radians
L	550	ft

c	q/k	
c	8.05E-08	
L/c	6.83E+09	

1. Calculate the maximum head (hmax) using the design flow length of 550 feet

$$h_{max} = \frac{L\sqrt{c}}{2}\left[\frac{\tan^2\alpha}{c} + 1 - \frac{\tan\alpha}{c}\sqrt{\tan^2\alpha + c}\right]$$

i (%)	hmax (ft) (Assume 550 ft flow length)
0.10%	0.04
0.20%	0.04
0.30%	0.04
0.40%	0.04
0.50%	0.04
0.60%	0.04
0.70%	0.04
0.80%	0.04
0.90%	0.04
1.00%	0.04

checked: Hao

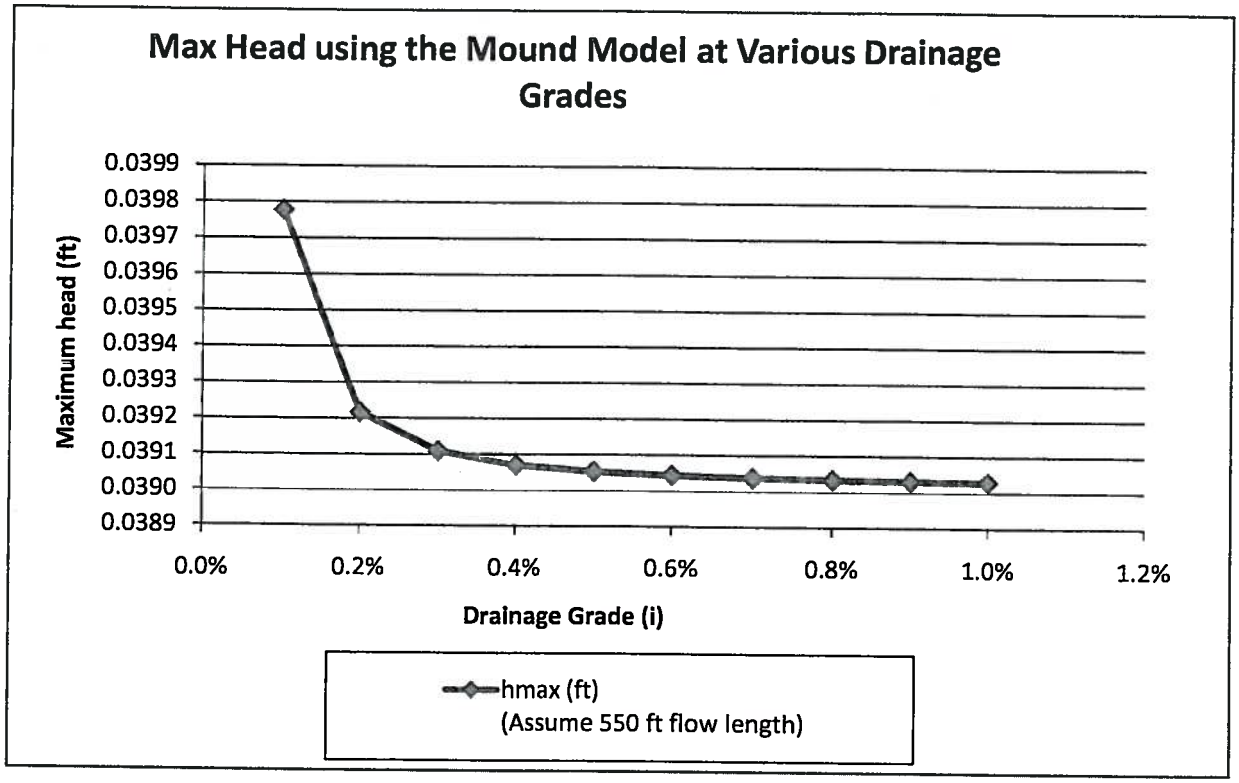
2. Calculate the flow length assuming a maximum allowable head of 1-foot

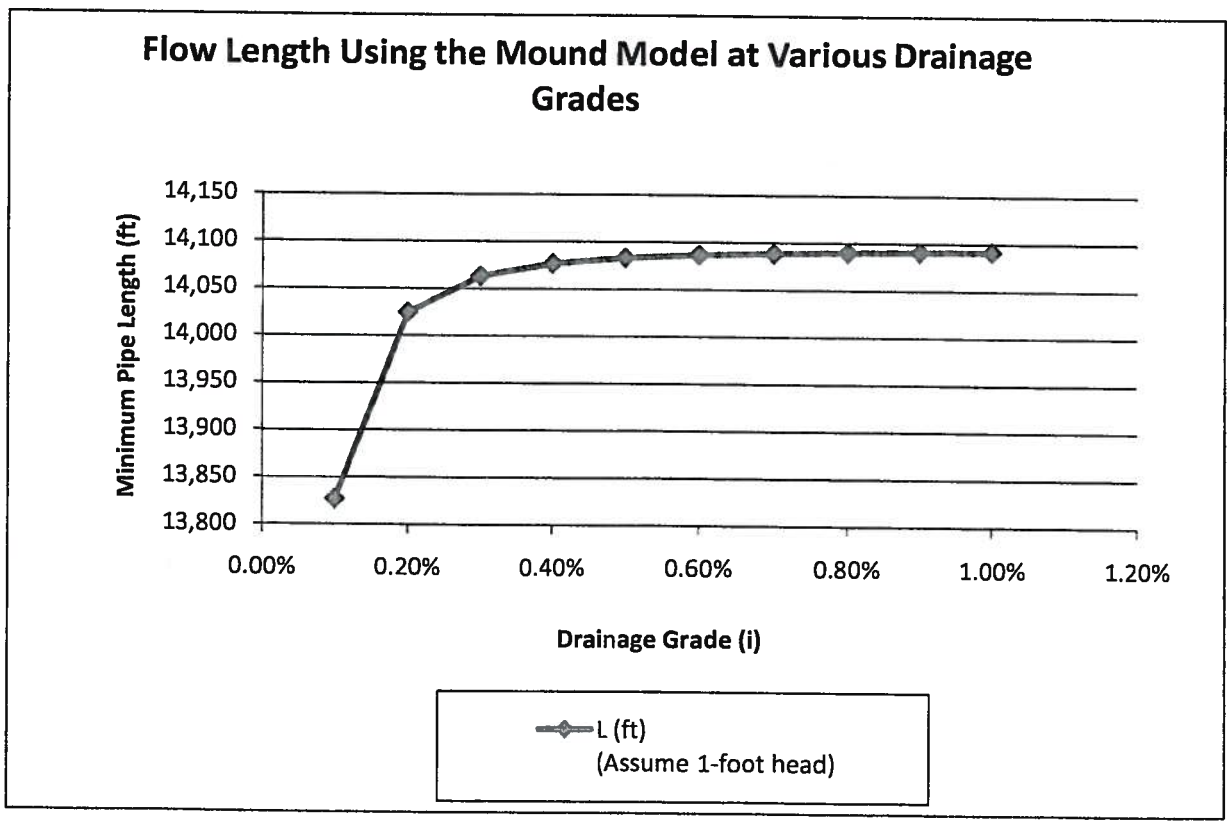
hmax 1 ft

i (%)	L (ft) (Assume 1-foot head)
0.10%	13,827
0.20%	14,024
0.30%	14,063
0.40%	14,077
0.50%	14,083
0.60%	14,087
0.70%	14,089
0.80%	14,090
0.90%	14,091
1.00%	14,092

$$L = h_{max} \times 2 \left(\sqrt{c} \times \left[\frac{\tan^2 \alpha}{c} + 1 - \frac{\tan \alpha}{c} \sqrt{\tan^2 \alpha + c} \right] \right)$$

checked: FMB


Max Head using the Mound Model at Various Drainage Grades
Maximum head (ft)
0.0399
0.0398
0.0397
0.0396
0.0395
0.0394
0.0393
0.0392
0.0391
0.0390
0.0389
0.0%
0.2%
0.4%
0.6%
0.8%
1.0%
1.2%
Drainage Grade (i)
hmax (ft)
(Assume 550 ft flow length)


Flow Length Using the Mound Model at Various Drainage Grades
Minimum Pipe Length (ft)
14,150
14,100
14,050
14,000
13,950
13,900
13,850
13,800
0.00%
0.20%
0.40%
0.60%
0.80%
1.00%
1.20%
Drainage Grade (i)
L (ft)
(Assume 1-foot head)

Golder Associates	SUBJECT Head on Liner Calcs - Moore 1983		
	Job No. 063-7079-100 Ref.	Made by HMK Checked HWD Reviewed KGH	Date 3/25/11 Sheet 11 of 14

3) Calculate Head using Moore's 1983 Method:

$$h_{max} = L\left[(r/K + S^2)^{1/2} - S\right]$$

where: h_{max} = maximum liquid head
$r = I$ = Inflow rate = (1 in/yr = 2.6×10^{-9} ft/s)
K = hydraulic conductivity of drainage layer (1cm/s)
S = Slope of drainage layer ($S = \tan\theta$)
L = horizontal drainage distance

The calculations were performed using the attached Microsoft Excel spreadsheet for a range of drainage grades:

$$0.1\% \le S \le 1\%$$

Using the maximum drainage distance of 550 ft, the maximum liquid head was calculated at a drainage grade of 0.1% to be 0.02 ft.

~~Ust~~ Rearranging the equation to solve for min pipe spacing:

$$L = \frac{h_{max}}{\left[(r/K + S^2)^{1/2} - S\right]}$$

A maximum allowable head of 1 ft was used. Minimum pipe spacing was calculated at a drainage grade of 0.1% to be 25,321 ft

checked: HAD

Moore's 1983 Method

Input Parameters		
k	0.033	ft/s
I	2.64E-09	ft/s
i	1	percent
alpha	0.05729387	degrees
alpha	0.01	radians
L	550	ft

1. Calculate the maximum head (hmax) using the design flow length of 550 feet

$$h_{\max} = L\left[\left(\frac{I}{k} + S^2\right)^2\right]^{1/2} - S$$

i (%)	hmax (ft) (Assume 550 ft flow length)
0.10%	0.0217210920424
0.20%	0.0110194501992
0.30%	0.0073666518468
0.40%	0.0055303712814
0.50%	0.0044262957455
0.60%	0.0036894858115
0.70%	0.0031628850425
0.80%	0.0027677906824
0.90%	0.0024604207091
1.00%	0.0022144831565

Checked: HGD

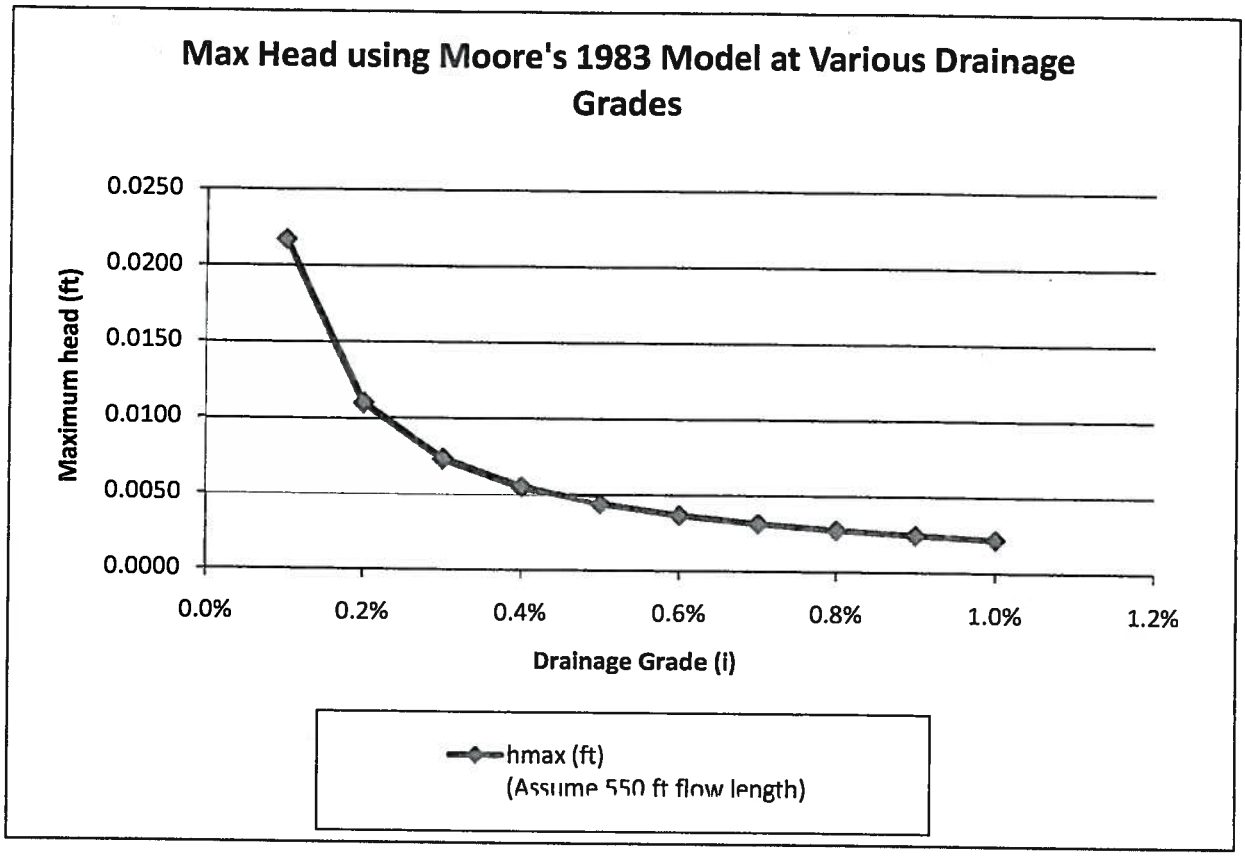
2. Calculate the flow length assuming a maximum allowable head of 1-foot

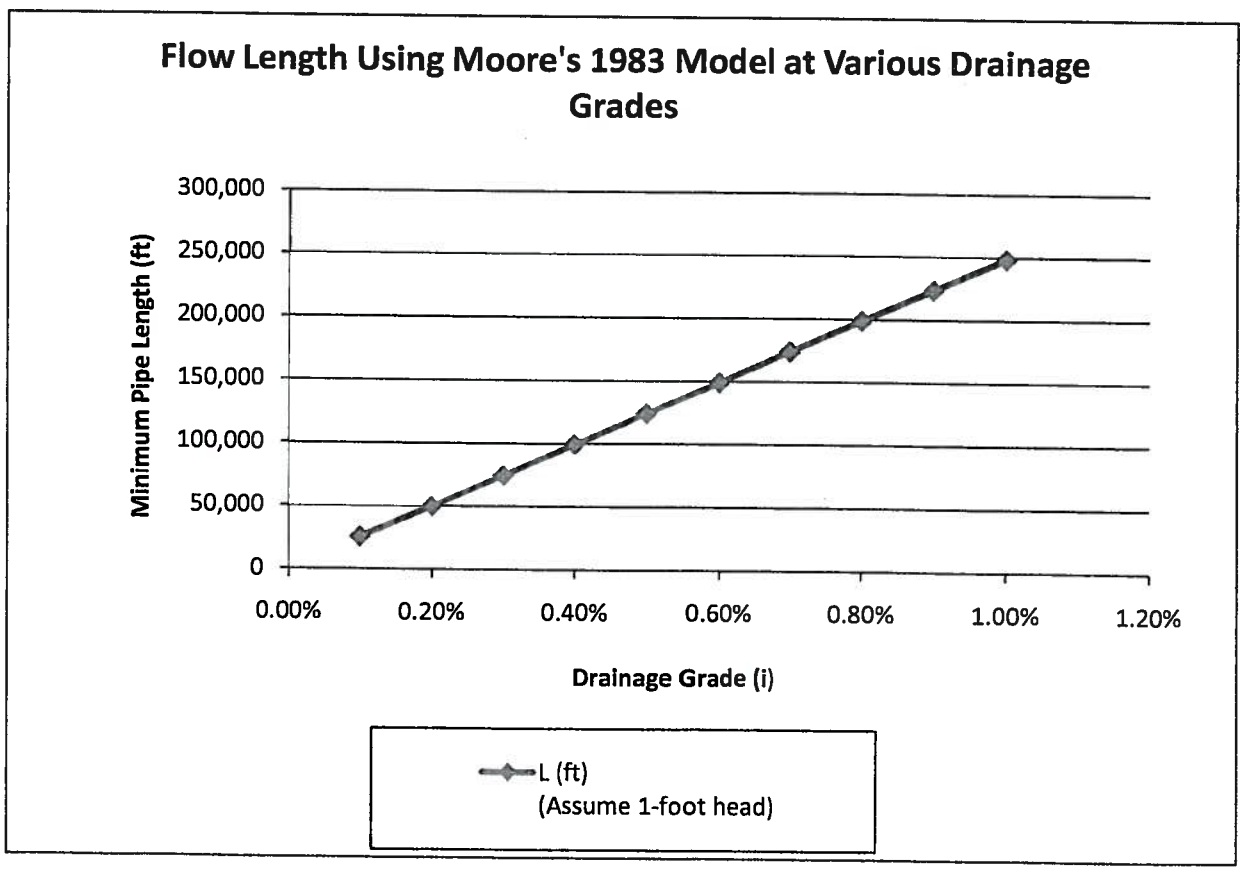
hmax 1.0 ft.

L = hmax/([(r/k+S2)^(1/2)-S])

i (%)	L (ft) (Assume 1-foot head)
0.10%	25,321
0.20%	49,912
0.30%	74,661
0.40%	99,451
0.50%	124,257
0.60%	149,072
0.70%	173,892
0.80%	198,714
0.90%	223,539
1.00%	248,365

checked: HAD


Max Head using Moore's 1983 Model at Various Drainage Grades
Maximum head (ft)
0.0250
0.0200
0.0150
0.0100
0.0050
0.0000
0.0%
0.2%
0.4%
0.6%
0.8%
1.0%
1.2%
Drainage Grade (i)
hmax (ft)
(Assume 550 ft flow length)


Flow Length Using Moore's 1983 Model at Various Drainage Grades
Minimum Pipe Length (ft)
300,000
250,000
200,000
150,000
100,000
50,000
0
0.00%
0.20%
0.40%
0.60%
0.80%
1.00%
1.20%
Drainage Grade (i)
L (ft)
(Assume 1-foot head)

APPENDIX H
COVER EROSION CALCULATIONS

COVER SOIL EROSION CALCULATIONS

OBJECTIVE

Determine soil loss potential of the cover soil due to water erosion.

METHODOLOGY

Soil loss potential at the proposed site for the Jungo Road Landfill due to water erosion was evaluated using the Revised Universal Soil Equation (RUSLE), developed by the U.S. Department of Agriculture, which considers soil and vegetation type as well as physical and climatic features of the landfill area.

The RUSLE can be used to evaluate landfill cover soil loss. This equation may be stated as:

A = R K LS C P, Where

A = Average annual soil loss, in tons per acre per year

R = Rainfall and runoff erosivity index

K = Soil erodibility factor

LS = Hill slope length and steepness factor

C = Cover-management factor

The results of the analysis are shown in Table 1.

The RUSLE factors for proposed site for the Jungo Road Landfill were assigned as follows:

R = 10 Index for the Nevada area, which best represents weather conditions at the site.

K = 0.42 It is assumed that the textural class of the final cover material will be of a "silt loam" based on the average grain size distribution curve of the proposed final cover material and will contain less than 2.0 % organic.

LS = 1.64 Calculated using the following equation:

$$LS = [\frac{L}{72.6}\cos(\tan^{-1} s)]^{1/2}[\frac{\sin(\tan^{-1} s)}{\sin(5.143)}]^{1.4}$$

C = 1.0 "C" represents the effects of plants, soil cover, soil biomass (roots and incorporated residue), and soil-disturbing activities on soil loss. A value of 1.0 a conservative value associated with no vegetative cover.

P = 1.0 "P" accounts for reduction of erosion due to land management practices and is conservatively assumed to be 1.0 (highest value) or the entire landfill site.

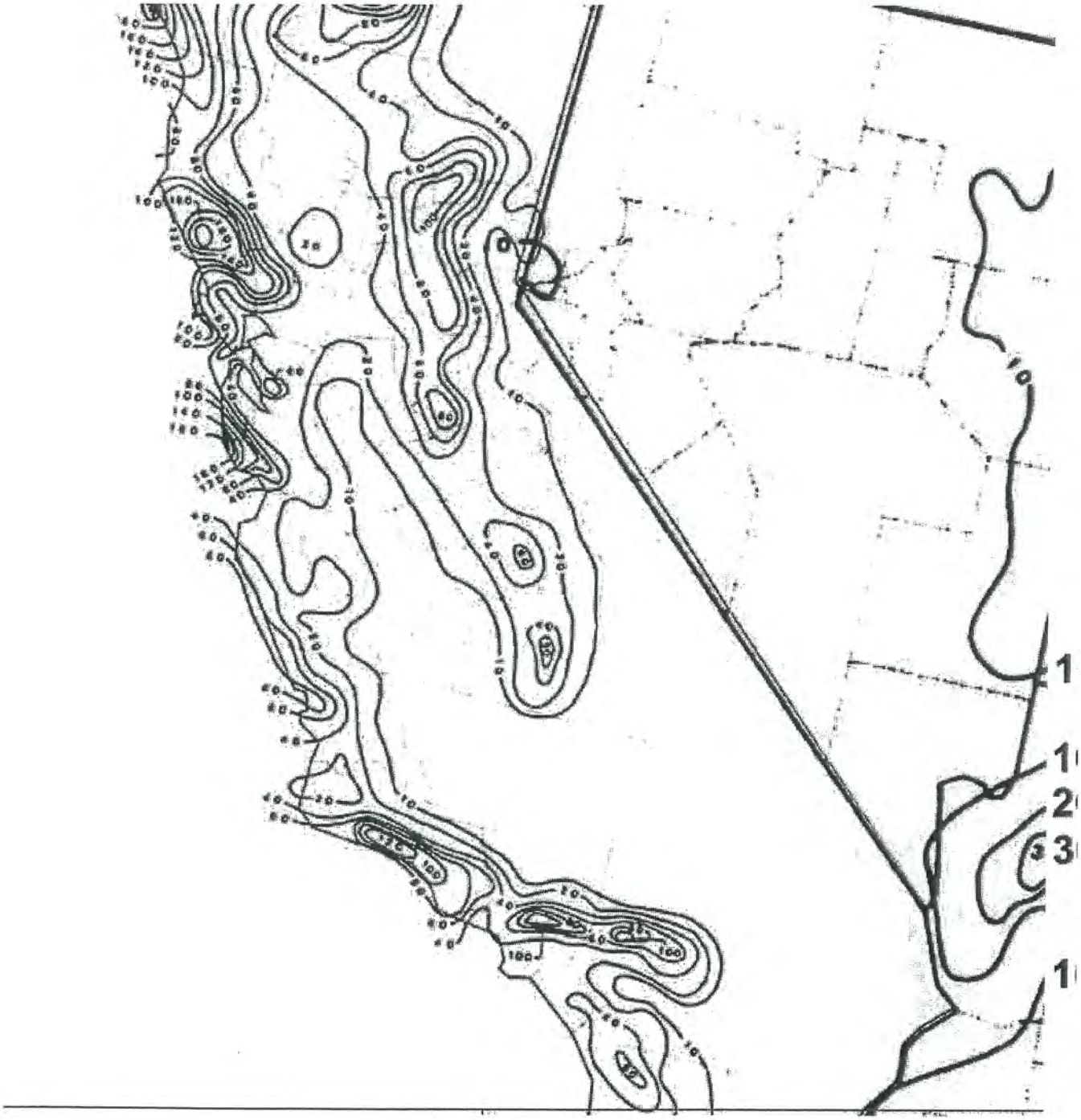
RESULTS SUMMARY

Using the values listed above, we estimate the average soil loss depth due to water erosion to be 0.032 inch per year and 0.95 inches over a 30 years period

TABLE- 1
SOIL LOSS ESTIMATES
JUNGO ROAD

Approx. Area (acres)	Avg. Slope Length (ft)	Average gradient (%)	R	K	LS	C	P	Soil Loss (tons/acre/year)	Soil Loss (tons/sq. ft/year)	Soil Loss (tons/year)	Soil Loss (CY/year)	Soil Loss (inches/year)
640	1000	5	10	0.42	1.64	1	1	6.87	0.00016	4395.15	2713.06	0.0315
								30 year cover loss (inch):				0.9459

Notes:
C=1.0 assumes no vegetative cover



Attachment 2

APPROXIMATE VALUES OF FACTOR K
USDA TEXTURAL CLASSES

Texture class	Organic matter content ≤0.5% K	2% K	4% K
Sand	0.05	0.03	0.02
Fine sand	.16	.14	.10
Very fine sand	.42	.36	.28
Loamy sand	.12	.10	.08
Loamy fine sand	.24	.20	.16
Loamy very fine sand	.44	.38	.30
Sandy loam	.27	.24	.19
Fine sandy loam	.35	.30	.24
Very fine sandy loam	.47	.41	.33
Loam	.38	.34	.29
Silt loam	.48	.42	.33
Silt	.60	.52	.42
Sandy clay loam	.27	.25	.21
Clay loam	.28	.25	.21
Silty clay loam	.37	.32	.26
Sandy clay	.14	.13	.12
Silty clay	.25	.23	.19
Clay	0.13 to 0.29		

The values shown are estimated averages of broad ranges of specific-soil values. When a texture is near the borderline of two texture classes, use the average of the two K values.

Reference: Lutton, R. J., et al, 1979. Design and Construction of Covers for Solid Waste Landfills, EPA 600/2-79-165. August, 1979.

Type of Mulch	Mulch Rate (tons/acre)	Land Slope (%)	Max Length (ft)	C Factor
None	0	all	-	1.0
Poor grass	-	-	-	0.01
Good grass	-	-	-	0.004
GECB		* consult manufacturer		
Straw/hay	1.0	1-5	200	0.20
Straw/hay	1.0	6-10	100	0.20
Straw/hay	1.5	1-5	300	0.12
Straw/hay	1.5	6-10	150	0.12
Straw/hay	1.5	1-5	400	0.06
Straw/hay	2.0	6-10	200	0.06
Straw/hay	2.0	11-15	150	0.07
Straw/hay	2.0	16-20	100	0.11
Straw/hay	2.0	21-25	75	0.14
Straw/hay	2.0	26-33	50	0.17
Straw/hay	2.0	34-50	35	0.20
Crushed stone	135	<16	200	0.05
Crushed stone	135	16-20	150	0.05
Crushed stone	135	21-33	100	0.05
Crushed stone	135	34-50	75	0.05
Crushed stone	240	<21	300	0.02
Crushed stone	240	21-33	200	0.02
Crushed stone	240	34-50	150	0.02
Wood chips	7	<16	75	0.08
Wood chips	7	16-20	50	0.08
Wood chips	12	<16	150	0.05
Wood chips	12	16-20	100	0.05
Wood chips	12	21-33	75	0.05
Wood chips	25	<16	200	0.02
Wood chips	25	16-20	150	0.02
Wood chips	25	21-33	100	0.02
Wood chips	25	34-50	75	0.02

COVER SOIL WIND EROSION CALCULATIONS

OBJECTIVE

Determine soil loss potential of the cover soil for the final cover resulting from wind erosion.

METHODOLOGY

Soil loss potential at the proposed site for the Jungo Disposal Site due to wind erosion was evaluated using Single-Event Wind Erosion Evaluation Program 1.0 (SWEEP), which is a part of the Wind Erosion Prediction System (WEPS), developed by the United States Department of Agriculture, Natural Resource Conservation Service (NRCS), which considers soil and vegetation type as well as physical and climatic features of the landfill area. WEPS is a process-based, continuous, daily time-step model that simulates weather, field conditions, and erosion. The SWEEP processes hourly wind data and additional input parameters and determines the daily wind soil erosion.

SWEEEP INPUT PARAMETERS

The SWEEP input parameters include:

- Site boundary area including barriers;
- Soil type and characteristics;
- Soil surface characteristics;
- Vegetative (Biomass) characteristics; and,
- Wind Input Parameters.

The SWEEP input data screens are attached to this section of the Appendix.

Site Boundary
The boundary was input as a square parcel 1500 m by 1500 m with no barriers.

Soil Characteristics
Golder reviewed the NRCS Custom Soil Resource Report for the Humbolt County to determine the soil characteristics for the Site. The Site consists of two soil types: Soil 831 Boton-Playas and Soil 990 Playas. Soil Type 831 Boton Plays is the primary soil type at the Site and is used in this analysis. NRCS developed soil templates to use with the WEPS and SWEEP programs. Golder input the soil template for the Soil 831 Boton-Playas into the SWEEP program.

Soil Surface Characteristics
Upon review with NRCS representatives, the surface crust density of 1.8 Mg/m^3 and crust stability of 2.65 J/kg are applicable input parameters for the Boton-Playas soil type. However, the SWEEP model was run with assuming no surface crust is present on-site to simulate the final cover suface.

The allamaras random roughness coefficient was assumed to be 4 mm, simulating a relatively smooth ground surface without any larger particles on the surface. The ridge thickness and spacing was input as 10 mm; although, the ridge height is 0.

All other surface soil input parameters are zero.

Vegetative Cover Characteristics

The Vegetative Cover input variables for SWEEP are: average crop height, crop stem area index, leaf area index, and row spacing. The kind of vegetative cover used this analysis are desert grasses. The applicable vegetative cover variables for desert grasses are listed below.

- Average Crop Height = 6-inches = 0.15 m
- Crop Stem Index (CSI) = Stem diameter (m) x stem height (m) x stem population (#/m^2)
  = 0.006 m x 0.15 m x 10 plants/m^2
  = 0.01
- Leaf Area Index (LAI) = 0.2 - 0.4 (varies seasonally)
- Row Spacing = 0 (not planted in rows)

Residue vegetative cover was conservatively ignored in this analysis.

Daily Wind Input Parameters

Wind data from May 2008 to May 2009 was reviewed. Based upon soil input parameters, SWEEP estimates a threshold wind speed. The threshold value is the minimum wind speed that causes wind soil erosion, which is 11 m/s for the Jungo Disposal Site.

Maximum Wind Speed data is shown on Figure 1. The days with maximum wind speeds above 11 m/s were segregated into three categories, as shown in Table 1.

Table 1 – Wind Speed Categories

Category #	Wind Speed	Number of Days
1	11 m/s to 12 m/s	8
2	12 m/s to 13 m/s	5
3	>= 13 m/s	3

Hourly wind data for one day from each category was entered input into SWEEP. The SWEEP results for the day were multiplied by the number of days in each category to calculate the annual wind erosion for each category. The total annual wind erosion was determined by adding the annual wind erosion for each category together.

CALCULATIONS

One SWEEP analysis was performed for each wind speed category. SWEEP analyses were performed with three types of vegetative cover scenarios:

1. No Vegetative Cover (for comparison purposes only);
2. LAI = 0.2;
3. LAI = 0.3.

RESULTS SUMMARY

The daily SWEEP output results for the vegetative cover scenario LAI = 0.2 are attached in this appendix. The annual soil erosion rates are shown in Table 2.

Table 2 – SWEEP Analysis Results

Category #	Annual Wind Erosion (tons per acre per year)		
	No Vegetative Cover	LAI = 0.20	LAI = 0.30
1	57	0	0
2	78	31	0
3	48	32	0
TOTAL	**183**	**63**	**0**
TOTAL (inches/year)	**0.84**	**0.29**	**0**

Using the SWEEP analysis and assuming the LAI = 0.2 occurs 50% of the year; we estimate the soil loss resulting from wind erosion to be 25 tons/acre/year or 0.15 inches/year. Additionally, wind erosion soil loss was also estimated for the worst case scenario with no vegetative cover. The worst case scenario wind soil erosion is 183 tons/acre/year or 0.84 inches/year. However, the worst case scenario wind erosion rates are not applicable to the Site because the Site will be vegetated with desert grasses.

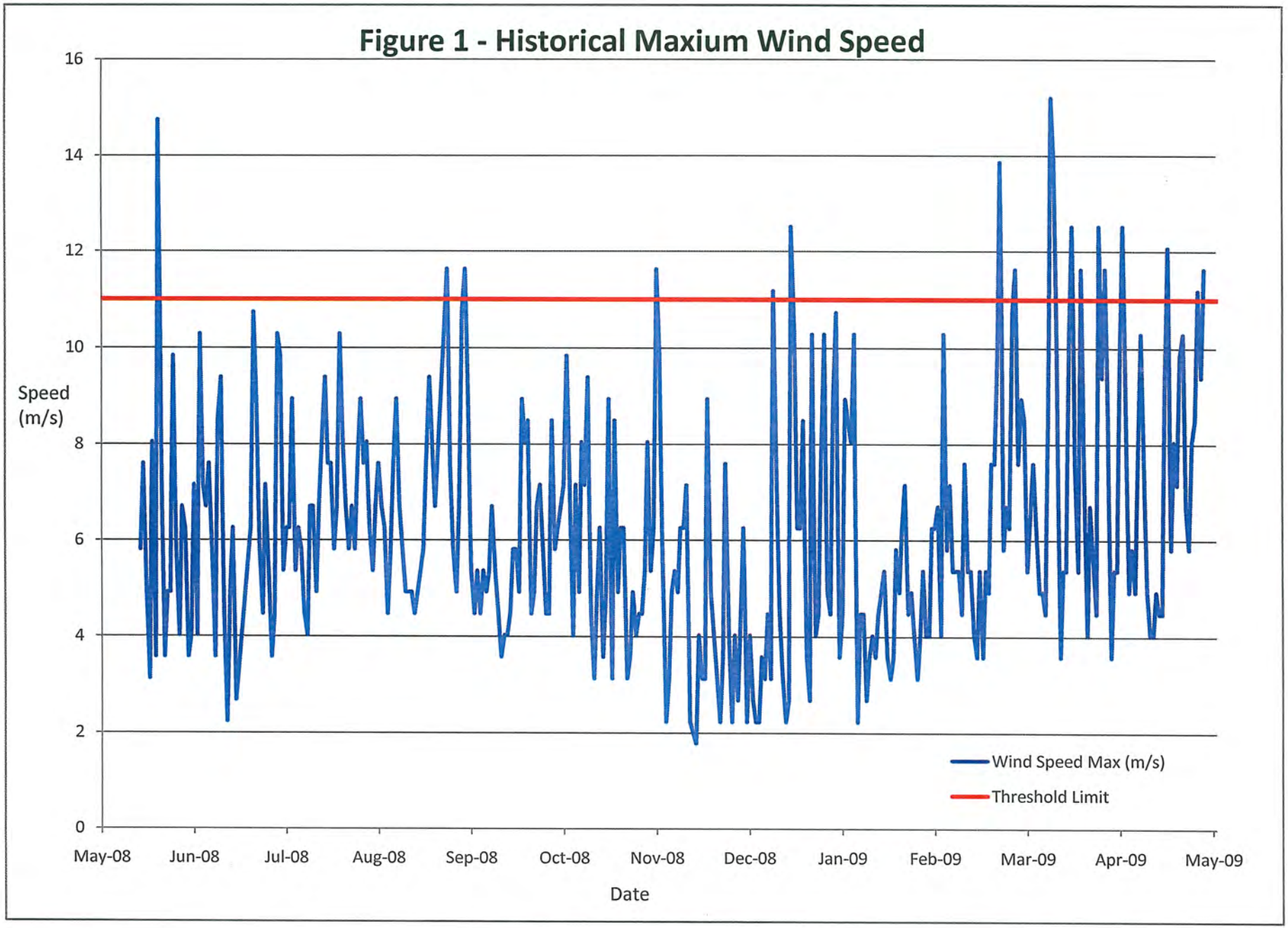
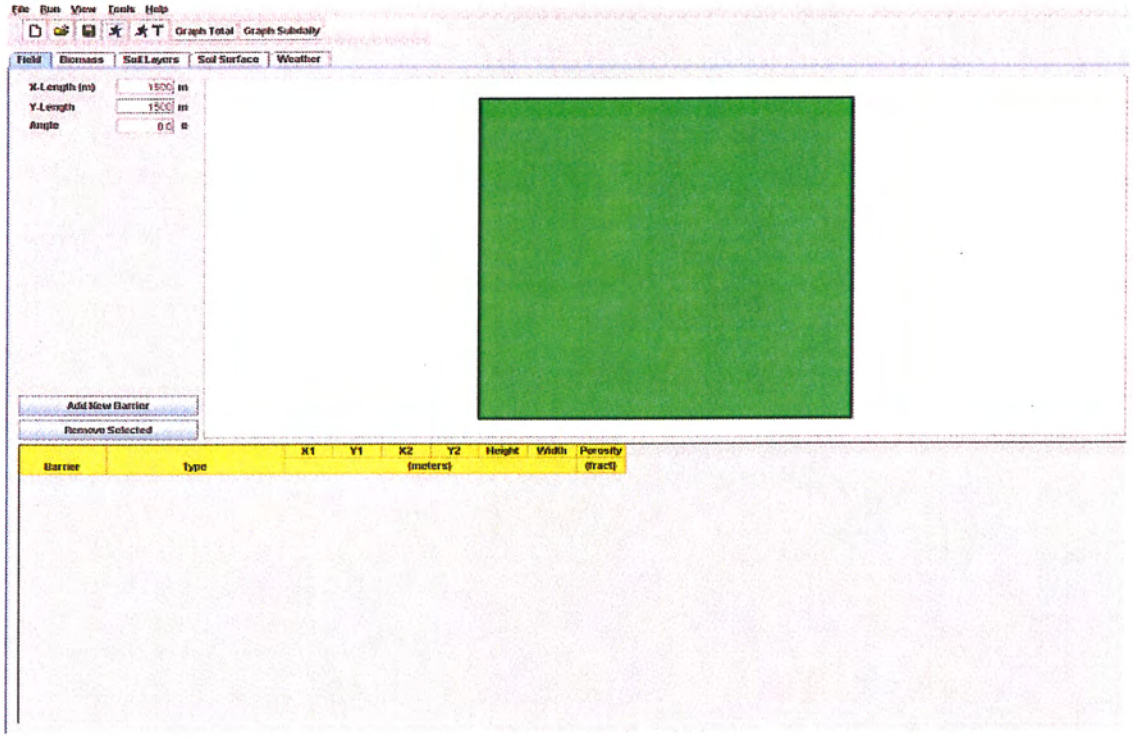


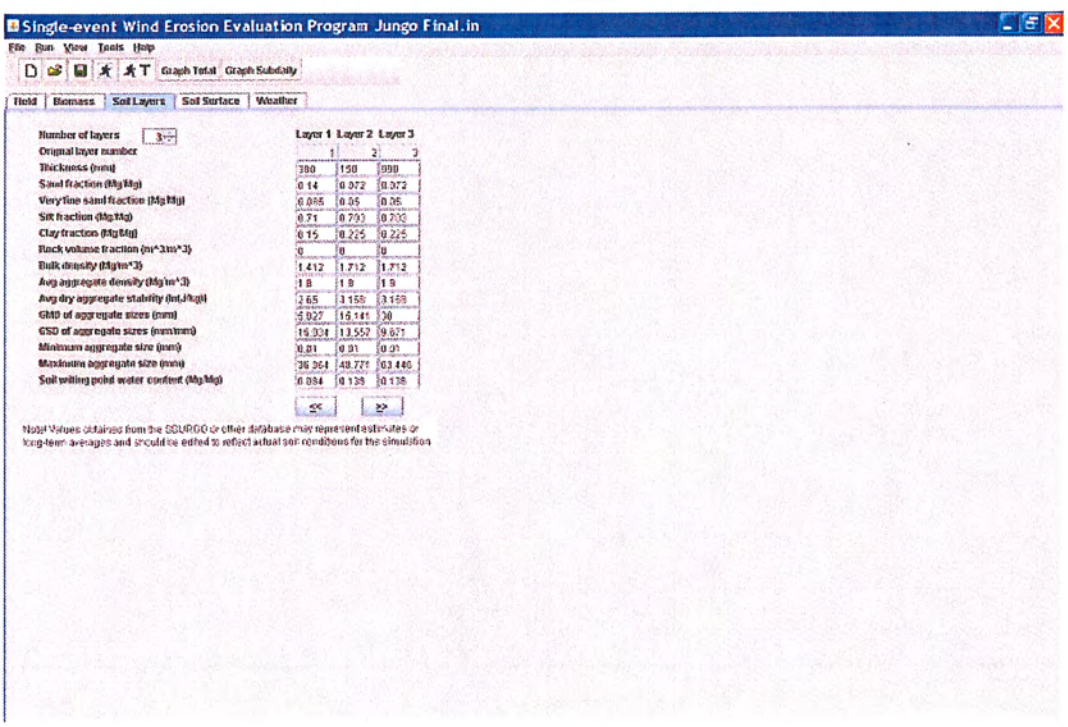
Figure 1 - Historical Maxium Wind Speed
16
14
12
10
8
6
4
2
0
Speed (m/s)
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Date
Wind Speed Max (m/s)
Threshold Limit

SWEEP INPUT PARAMETERS

Site Boundary

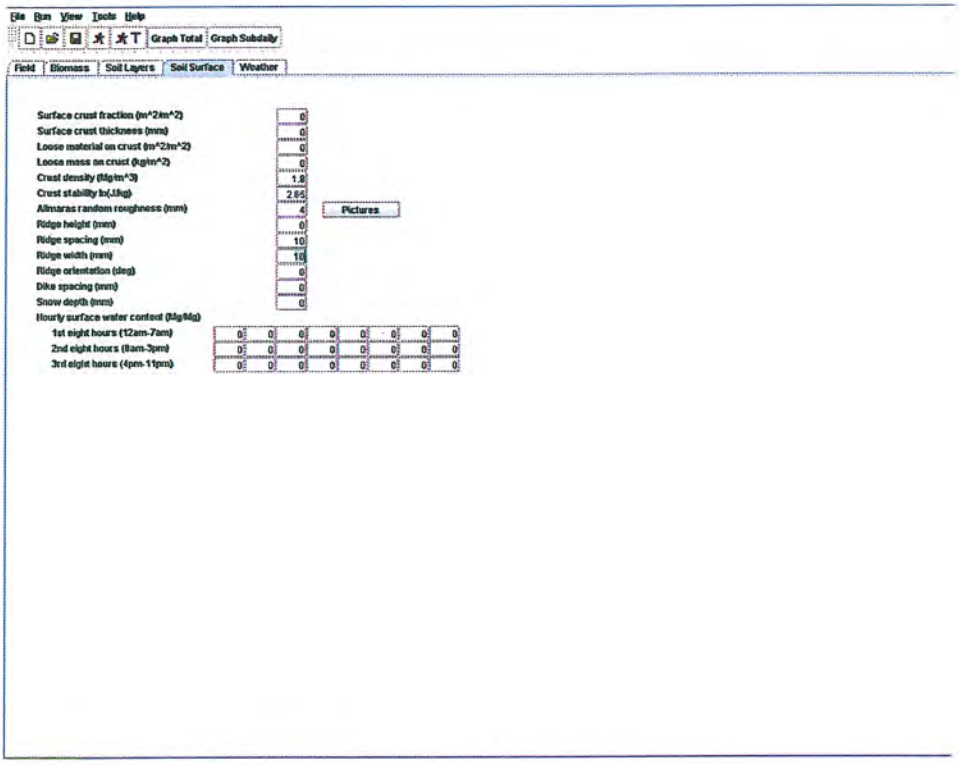


Soil Characteristics

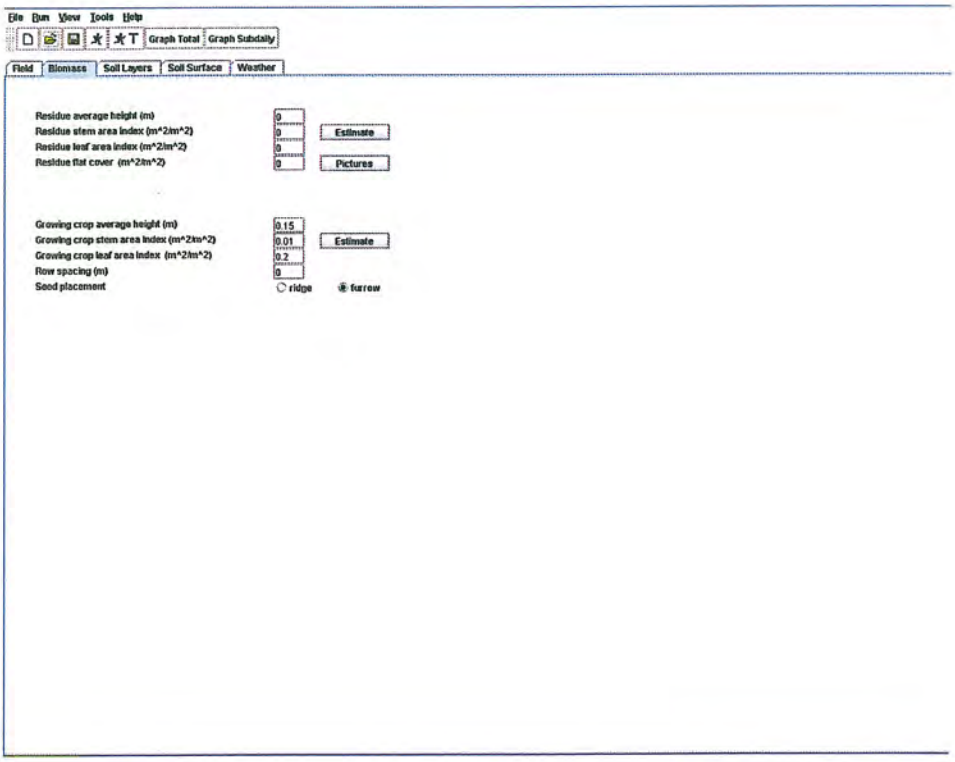


SWEEP INPUT PARAMETERS

Soil Surface Characteristics

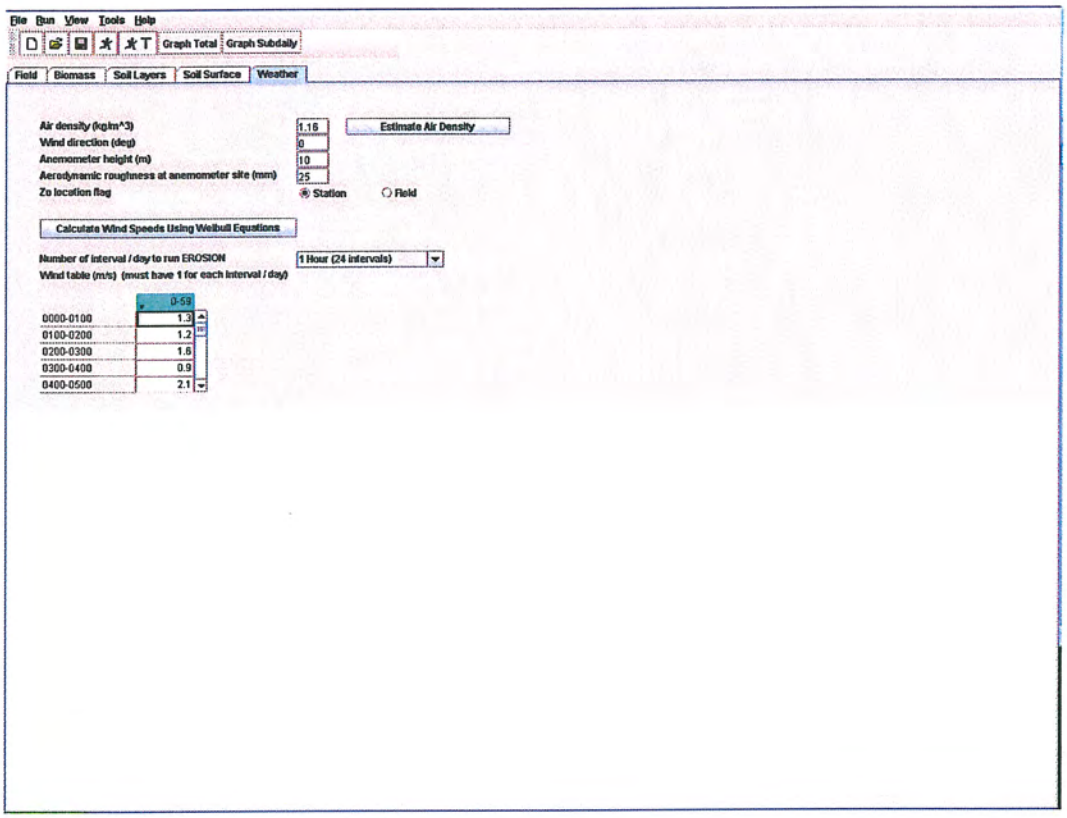


Vegetative Cover Characteristics



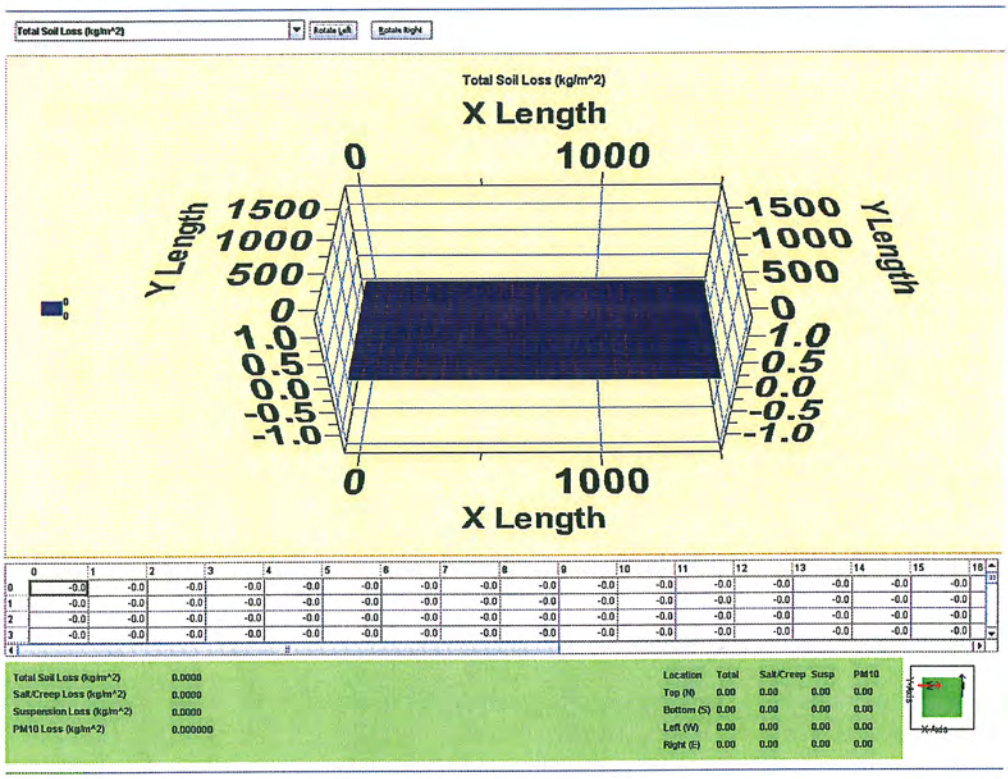
SWEEP INPUT PARAMETERS

Daily Wind Input Parameters

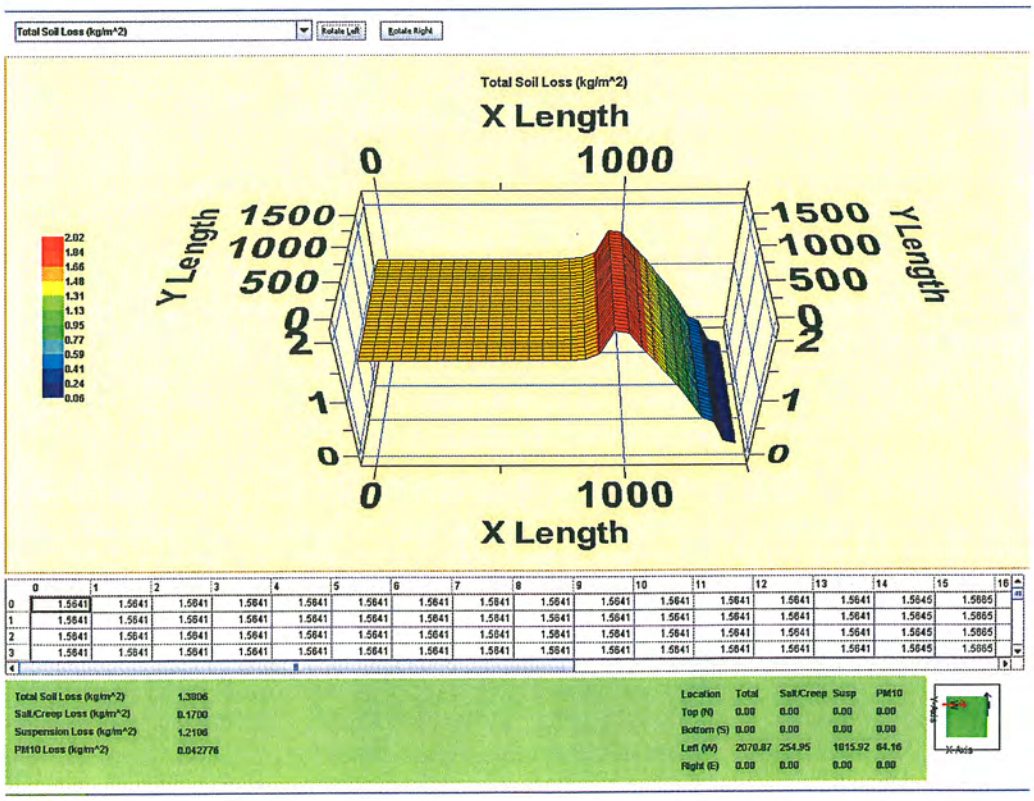


SWEEP DAILY WIND EROSION OUTPUT
Vegetative Cover Scenario LAI = 0.2

Wind Speed Category 1

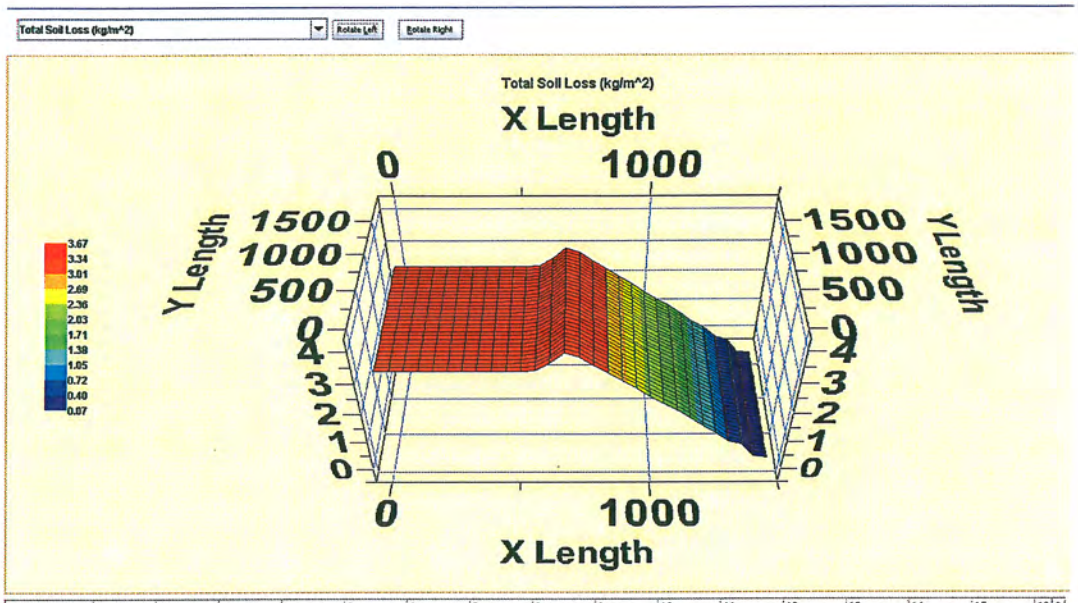


Wind Speed Category 2

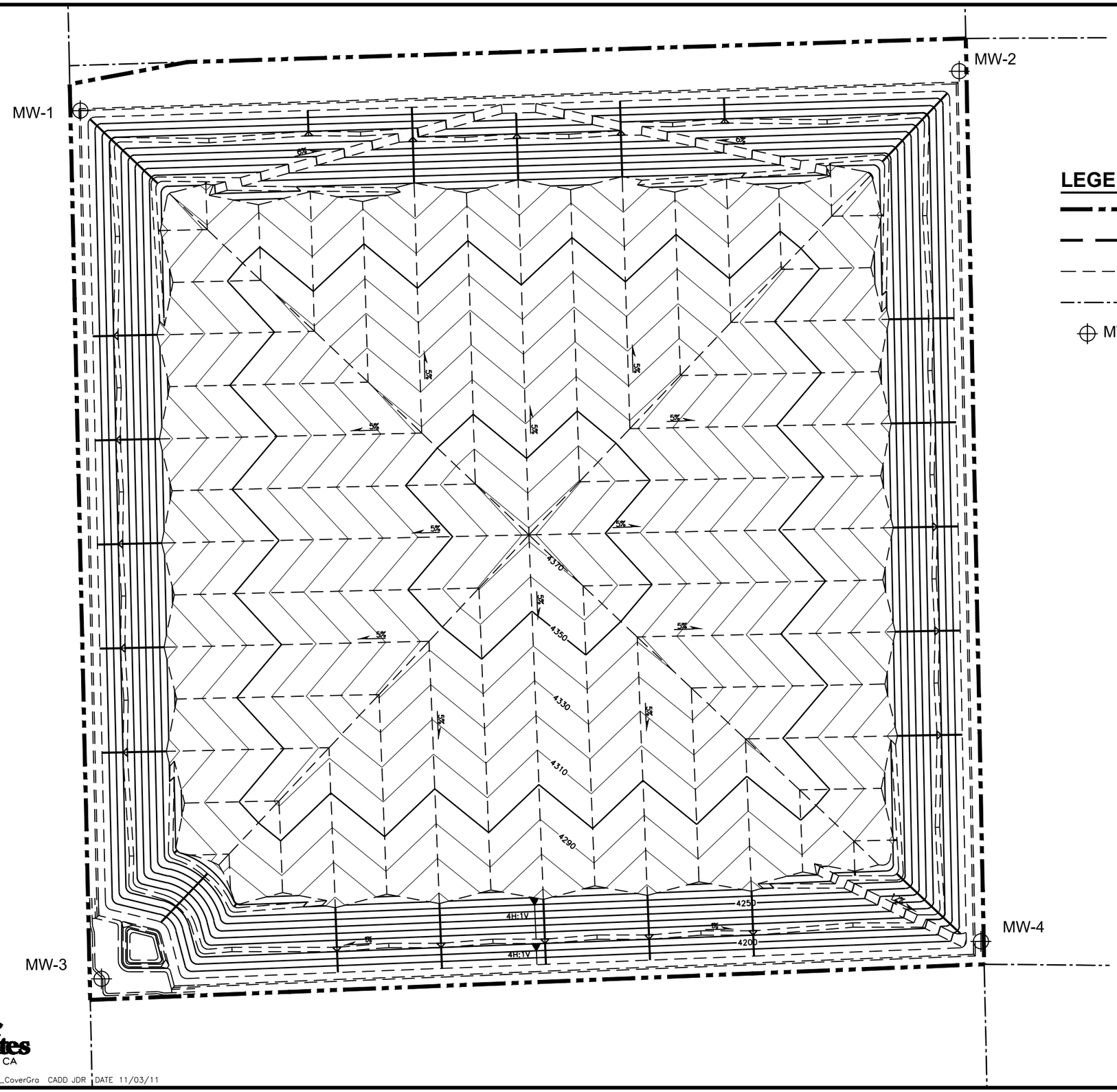


SWEEP DAILY WIND EROSION OUTPUT
Vegetative Cover Scenario LAI = 0.2

Wind Speed Category 3



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0744	3.0751	3.0796	3.1144	3.3422	3.6678	3.5319	3.2784	
1	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0744	3.0751	3.0796	3.1144	3.3422	3.6678	3.5319	3.2784	
2	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0744	3.0751	3.0796	3.1144	3.3422	3.6678	3.5319	3.2784	
3	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0743	3.0744	3.0751	3.0796	3.1144	3.3422	3.6678	3.5319	3.2784	



LEGEND

- PROPERTY BOUNDARY
- LIMIT OF LANDFILL
- LIMIT OF PROPOSED RAILYARD
- LIMIT OF SECTION
- MW-2 MONITORING WELL LOCATION AND ID

600 0 600
SCALE FEET

Golder Associates
Sacramento, CA

LANDFILL FINAL COVER GRADING PLAN

FIGURE 12

PROJECT No. 0637079 FILE No. F12_CoverGra CADD JDR DATE 11/03/11

Drawing file: 0637079100_F12_CoverGrade.dwg Nov 03, 2011 – 4:47pm

APPENDIX I
POSTCLOSURE SETTLEMENT CALCULATIONS

APPENDIX I

POSTCLOSURE SETTLEMENT CALCULATIONS

OBJECTIVE

Evaluate the post settlement cover grades to ensure minimum drainage grades are maintained.

ASSUMPTIONS

1. Primary settlements are complete.
2. Secondary Compression Index = 0.05 (conservative value, typical 0.02 to 0.04)
3. Average time after primary settlement is complete is 6 years (1/2 of phase A life). Evaluate cover settlement for a 30 year time period (post closure minimum 30 year). t_2 = 36 years.

METHODOLOGY

Secondary Settlement can be estimated using the soil consolidation equation:

$$\Delta s = C_a H \log(\frac{t_1}{t_2})$$

Where

Δs = Secondary settlement

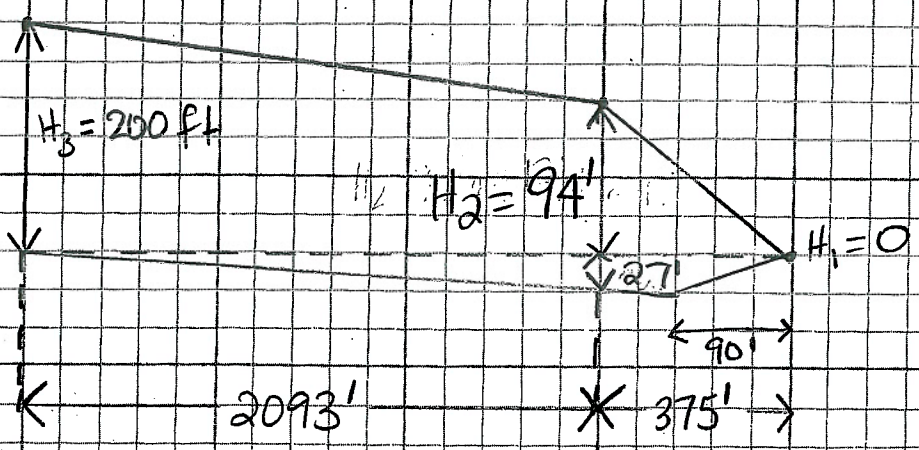
C_a = Secondary Compression Index = 0.05

H = Height of refuse = varies

t_1 = Time to end of primary settlement = 6 years

t_2 = Total time = 36 years

Golder Associates	SUBJECT Cover Settlement Calcs		
	Job No. Ref. 063.7079	Made by AAH Checked Reviewed	Date 3/19/08 Sheet 1 of 1



CROSS SECTION
(NOT TO SCALE)

POST SETTLEMENT GRADES

@ H_1: $\Delta S = 0$

@ H_2: $\Delta S = (0.05)(94+27)\log(36/6) = 4.71$ ft

@ H_3: $\Delta S = (0.05)(200)\log(36/6) = 7.78$ ft

FINAL GRADES

$$H_3 \text{ to } H_2 = \frac{(200-7.78)-(94-4.71)}{2093} = 4.9\%$$

$$H_2 \text{ to } H_1 = \frac{(94-4.71)-0}{375} = 23.8\%$$

APPENDIX J
PRELIMINARY SURFACE WATER CALCULATIONS

Subject	Jungo Landfill	Made by	PM	Job	063-7079300
25-Year 24hr Retention		Checked by		Date	4/2/09
Hydrologic & Hydraulics		Approved by		Sheet	1 of 2

OBJECTIVE:
Retention basins and perimeter channels for the proposed Jungo Landfill are required to retain the 24-hour 25-year storm event. All runoff from the drainage configuration shall be routed to the proposed retention basin located on the southwest section of the proposed landfill and the perimeter channel. The perimeter channel shall also serve to provide retention capacity.

METHOD:
The 24-hour rainfall event for the 25-Year storm event was used for evaluating the volume required to retain the 25-year storm on-site in a proposed retention basin. The 24-hour precipitations for the 25-year and 100-year storm events were derived from the Point Precipitation Frequency Estimates from NOAA Atlas 14 (Reference Attachment). The surface water parameters as described below were used to model the proposed Jungo Landfill. Attachment A presents the watershed delineation map for sub-basins used for the HEC-HMS modeling program. Basin areas and curve numbers (CNs) were entered into HEC-HMS modeling software (USACE) and routed to calculate the volumes

ASSUMPTIONS:
- The 24-hour rainfall event for the 25-year storm equals 1.62 inches. Ref. Attachment A.
- SCS Type II rainfall synthetic distribution.
- Landfill final cover SCS Curve Numbers (CN):

Location	Soil Type	Hydrologic Soil Group	Assumed Cover	SCS CN
Landfill Final Cover	Silty Sand	C	Herbaceous: fair cover	81

- Run-off from active operations will be directed to interior basins that will be pumped and discharged to a lined basin for temporary storage.
- Run-off from inactive areas will be directed to perimeter ditch that will discharge water to SW unlined basin. The perimeter ditch will also serve to store run-off.

CALCULATIONS:
The HEC-HMS modeling software (USACE) was used to calculate the proposed 25-year volume at the proposed retention pond and 100-year peak flows at design points. The calculated run-off for the proposed 640-acre (1 square mile) site for final build-out (plus RR yard area) is 0.38 inches for the 25-year 24-hour storm. The volume of stormwater from 0.38-inches over the site conveyed to the proposed retention basin is 20.20 acre-feet.

The capacity of the basins and perimeter trench are as follows:

- Unlined Basin w/ one foot of freeboard: 6.8 ac-ft
- Unlined Basin with no freeboard: 7.6 ac-ft
- Perimeter Ditch w/ one foot of freeboard: 37.5 ac-ft
- Perimeter Ditch w/ one foot of freeboard: 54.2 ac-ft
- Lined Basin with w/two foot of freeboard: 6.3 ac-ft

Combined perimeter ditch and unlined basin with one foot of freeboard is 44 ac-ft (more than 2 time the run-off from 25-yr storm).

Assuming similar percent of run-off for operational conditions, the lined basin can accommodate storm-water run-off from 200-acre area under 25-year storm event (6.3 ac-feet/(0.38in/12in/ft)). Maximum operational run-off directed to the basin is expected to be only approximately 87 acres – see attached development plan at end of year 50 as an example.

CONCLUSIONS/RESULTS:

The proposed basins have sufficient capacity to accommodate two 25-yr, 24-hour storms back-to-back without discharging. This applies to the run-on/run-off control basin and unlined basin.

REFERENCES:

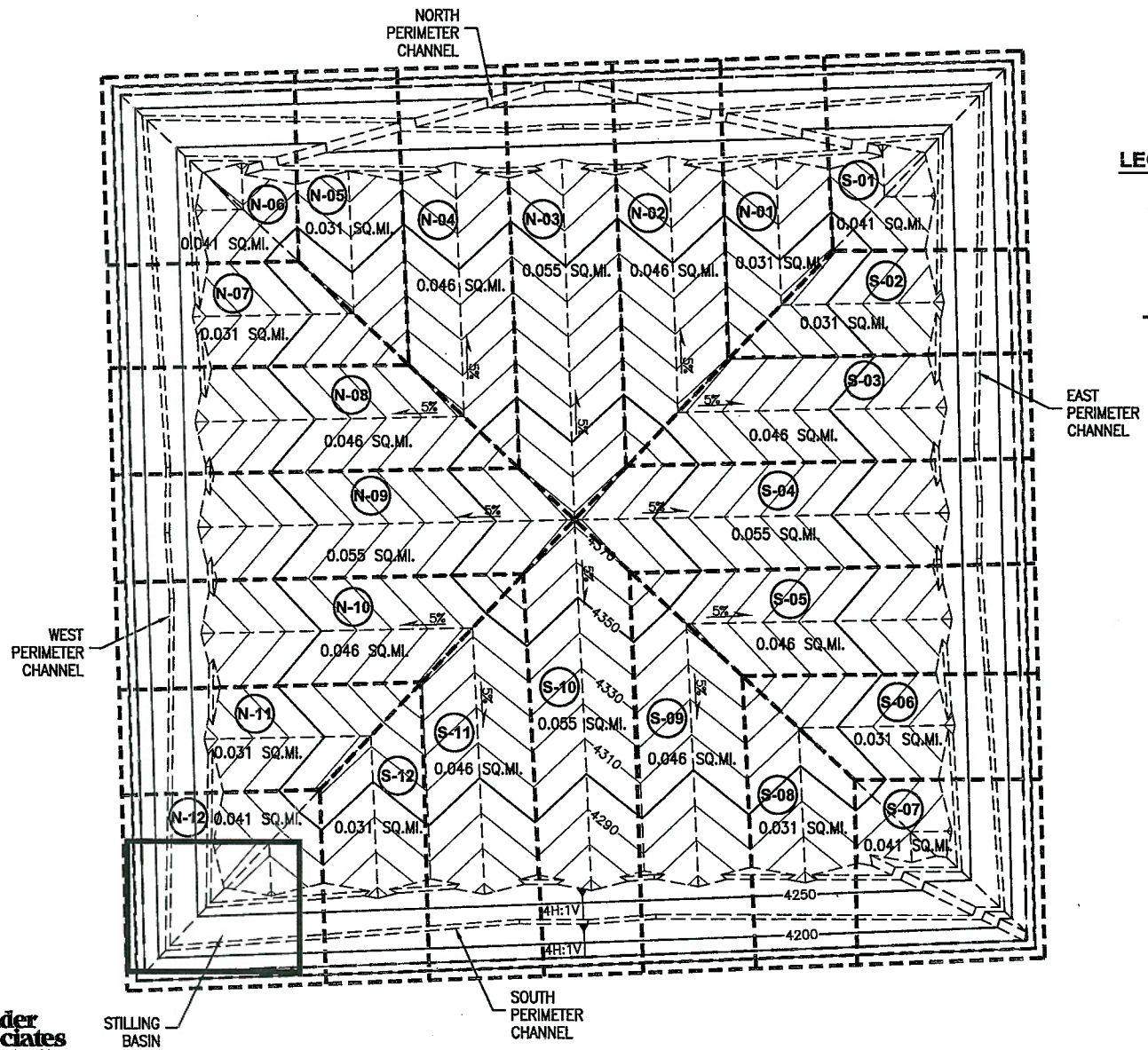
HEC-HMS Hydrologic Modeling System [computer software] US Army Corps of Engineers Version 3.1.0

Bentley FlowMaster [computer software] 2005 Bentley Systems Inc. Service Pack 3

Natural Resource Conservation Service. 1986. Technical Release 55: Urban Hydrology for Small Watersheds. United States Department of Agriculture.

Ernest F. Brater and Horace H. King 1976. Handbook of Hydraulics, 6th edition. McGraw-Hill Inc.

U.S Department of Commerce, National Oceanic and Atmospheric Administration, U.S. Army Corps of Engineers. 1999. *Hydrometeorological Report No. 59* Probable Maximum Precipitation for California.



LEGEND

N-12	HYDROLOGY SUB–BASIN
0.055 SQ.MI.	SUB–BASIN AREA
- - - - - -	HYDROLOGY BASIN BOUNDARY

600 0 600
SCALE FEET

Golder Associates
Sacramento, CA

HYDROLOGIC BASIN MAP

FIGURE 1

PROJECT No. 063-7079 FILE No. Fig 1 CADD PM DATE 04/06/09

Drawing file: Hydro-basins.dwg Apr 06, 2009 – 12:00pm

TABLE 1
SUBBASIN SUMMARY TABLE

Jungo Landfill - Hydrology
Project Number: 063-7079300

Date:	4/2/09
By:	PM
Chkd:	
Apprvd:	

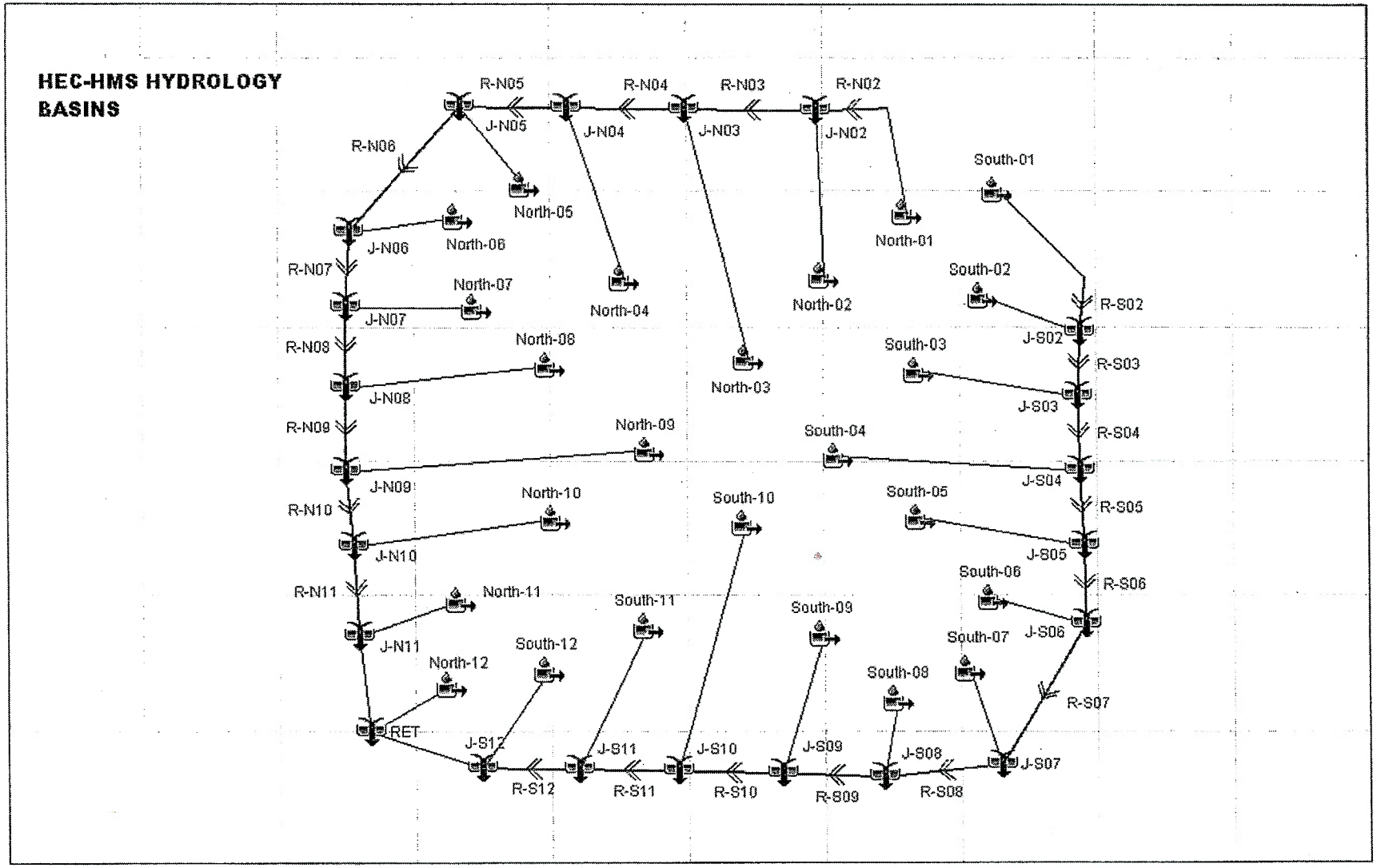
Design Storm 25-year - Recurrance Interval

Storm Duration (hours)	25-year - Depth (inches)	Storm Distribution
24	1.62	II

Subbasin ID	Subbasin Area (ft^2)	Subbasin Area (acres)	Subbasin Area (sq mile)	CN = 81 Covered Landfill HSG C (acres)	Composite SCS Curve No.	$S = \frac{1000}{CN} - 10$	Unit Runoff Q (in)	Runoff Volume (ac-ft)	Runoff Volume (ft^3)
North-01	864,230	19.84	0.0310	19.84	CN = 81	2.35	0.38	0.63	27,281
North-02	1,282,406	29.44	0.0460	29.44	CN = 81	2.35	0.38	0.93	40,481
North-03	1,533,312	35.20	0.0550	35.20	CN = 81	2.35	0.38	1.11	48,401
North-04	1,282,406	29.44	0.0460	29.44	CN = 81	2.35	0.38	0.93	40,481
North-05	864,230	19.84	0.0310	19.84	CN = 81	2.35	0.38	0.63	27,281
North-06	1,143,014	26.24	0.0410	26.24	CN = 81	2.35	0.38	0.83	36,081
North-07	864,230	19.84	0.0310	19.84	CN = 81	2.35	0.38	0.63	27,281
North-08	1,282,406	29.44	0.0460	29.44	CN = 81	2.35	0.38	0.93	40,481
North-09	1,533,312	35.20	0.0550	35.20	CN = 81	2.35	0.38	1.11	48,401
North-10	1,282,406	29.44	0.0460	29.44	CN = 81	2.35	0.38	0.93	40,481
North-11	864,230	19.84	0.0310	19.84	CN = 81	2.35	0.38	0.63	27,281
North-12	1,143,014	26.24	0.0410	26.24	CN = 81	2.35	0.38	0.83	36,081
South-01	1,143,014	26.24	0.0410	26.24	CN = 81	2.35	0.38	0.83	36,081
South-02	864,230	19.84	0.0310	19.84	CN = 81	2.35	0.38	0.63	27,281
South-03	1,282,406	29.44	0.0460	29.44	CN = 81	2.35	0.38	0.93	40,481
South-04	1,533,312	35.20	0.0550	35.20	CN = 81	2.35	0.38	1.11	48,401
South-05	1,282,406	29.44	0.0460	29.44	CN = 81	2.35	0.38	0.93	40,481
South-06	864,230	19.84	0.0310	19.84	CN = 81	2.35	0.38	0.63	27,281
South-07	1,143,014	26.24	0.0410	26.24	CN = 81	2.35	0.38	0.83	36,081
South-08	864,230	19.84	0.0310	19.84	CN = 81	2.35	0.38	0.63	27,281
South-09	1,282,406	29.44	0.0460	29.44	CN = 81	2.35	0.38	0.93	40,481
South-10	1,533,312	35.20	0.0550	35.20	CN = 81	2.35	0.38	1.11	48,401
South-11	1,282,406	29.44	0.0460	29.44	CN = 81	2.35	0.38	0.93	40,481
South-12	864,230	19.84	0.0310	19.84	CN = 81	2.35	0.38	0.63	27,281
Total:	27,878,400	640.00	1.00					20.20	880,027

TOTAL RUNOFF TO RETENTION POND: **20.20 AC-FT**

HEC-HMS Basin Model Schematic



Attachment A
HEC-HMS Screen Captures and Inputs

Sub Basin Area	
Subbasin	Area (mi^2)
North-01	0.0280
North-02	0.0430
North-03	0.0520
North-04	0.0430
North-05	0.0280
North-06	0.0380
North-07	0.0280
North-08	0.0430
North-09	0.0520
North-10	0.0430
North-11	0.0280
North-12	0.0380
South-01	0.0380
South-02	0.0280
South-03	0.0430
South-04	0.0520
South-05	0.0430
South-06	0.0280
South-07	0.0380
South-08	0.0280
South-09	0.0430
South-10	0.0520
South-11	0.0430
South-12	0.0280

Loss SCS Curve Number			
Subbasin	Initial Abstraction (in)	Curve Number	Impervious (%)
North-01	0.2	81	0
North-02	0.2	81	0
North-03	0.2	81	0
North-04	0.2	81	0
North-05	0.2	81	0
North-07	0.2	81	0
North-08	0.2	81	0
North-09	0.2	81	0
North-10	0.2	81	0
North-11	0.2	81	0
South-02	0.2	81	0
South-03	0.2	81	0
South-04	0.2	81	0
South-05	0.2	81	0
South-06	0.2	81	0
South-08	0.2	81	0
South-09	0.2	81	0
South-10	0.2	81	0
South-11	0.2	81	0
South-12	0.2	81	0

Transform SCS Unit Hydrograph	
Subbasin	Lag Time (min)
North-06	7.2
North-12	7.2
South-01	7.2
South-07	7.2

Routing Kinematic Wave Channel								
Reach	Length (ft)	Slope (ft/ft)	Manning's n	subreaches	Shape	Diameter (ft)	Width (ft)	Side Slope (xH:1V)
R-N02	600	0.005	0.030	2	Trapezoid		10	4
R-N03	600	0.005	0.030	2	Trapezoid		10	4
R-N04	600	0.005	0.030	2	Trapezoid		10	4
R-N05	600	0.005	0.030	2	Trapezoid		10	4
R-N06	1850	0.005	0.030	2	Trapezoid		10	4
R-N07	600	0.005	0.030	2	Trapezoid		10	4
R-N08	600	0.005	0.030	2	Trapezoid		10	4
R-N09	600	0.005	0.030	2	Trapezoid		10	4
R-N10	600	0.005	0.030	2	Trapezoid		10	4
R-N11	600	0.005	0.030	2	Trapezoid		10	4
R-S02	600	0.005	0.030	2	Trapezoid		10	4
R-S03	600	0.005	0.030	2	Trapezoid		10	4
R-S04	600	0.005	0.030	2	Trapezoid		10	4
R-S05	600	0.005	0.030	2	Trapezoid		10	4
R-S06	600	0.005	0.030	2	Trapezoid		10	4
R-S07	1850	0.005	0.030	2	Trapezoid		10	4
R-S08	600	0.005	0.030	2	Trapezoid		10	4
R-S09	600	0.005	0.030	2	Trapezoid		10	4
R-S10	600	0.005	0.030	2	Trapezoid		10	4
R-S11	600	0.005	0.030	2	Trapezoid		10	4
R-S12	600	0.005	0.030	2	Trapezoid		10	4

Attachment B
Time of Concentration and Mannings Flow Coefficients

TR-55 (1986)

Sheet Flow Travel time (SCS Upland Method)

$$T_t = \frac{0.007\,(n'\,L)^{0.8}}{(P_2)^{0.5}\,s^{0.4}}$$

Where: T_t = travel time (hr); n' = roughness coefficient; L = flow length (ft);

P_2 = 2-yr storm depth (inches); s = slope (ft/ft)

flow velocity = $L/(60T_t)$

Flow Type	Surface Type	roughness n	Surface Description	Short Description
Sheet/Overland Flow	A	0.011	Smooth surfaces (concrete, asphalt, gravel, bare soil)	Smooth
	B	0.05	Fallow (no residue)	Fallow
	C	0.06	Cultivated soils: Residue cover <= 20%	Cover<20%
	D	0.17	Cultivated soils: Residue cover > 20%	Cover>20%
	E	0.15	Grass: Short grass prairie	Short Grass
	F	0.24	Grass: Dense grasses	Dense Grass
	G	0.41	Grass: Bermuda grass	Bermuda Grass
	H	0.13	Range (natural)	Range
	I	0.40	Woods: Light underbrush	Light woods
	J	0.80	Woods: Heavy underbrush	Heavy Woods

Shallow Concentrated Flow Velocity (SCS Upland Method)

$v = mS^{0.5}$

Where: v = velocity (fps); m = roughness coeffient; S = slope (ft/ft)

Flow Type	Surface Type	Roughness m	Surface Description	Short Description
Shallow Conc. Flow	P	20.3282	Paved Surfaces	Paved
	U	16.1345	Unpaved Surfaces	Unpaved

Channel Flow Velocity (Mannings Velocity)

$v = 1.49/n\ Rh^{2/3}S^{1/2}$

Where: v = velocity (fps); n = roughness coeffient; Rh = Hydraulic Radius (ft), S = slope (ft/ft)

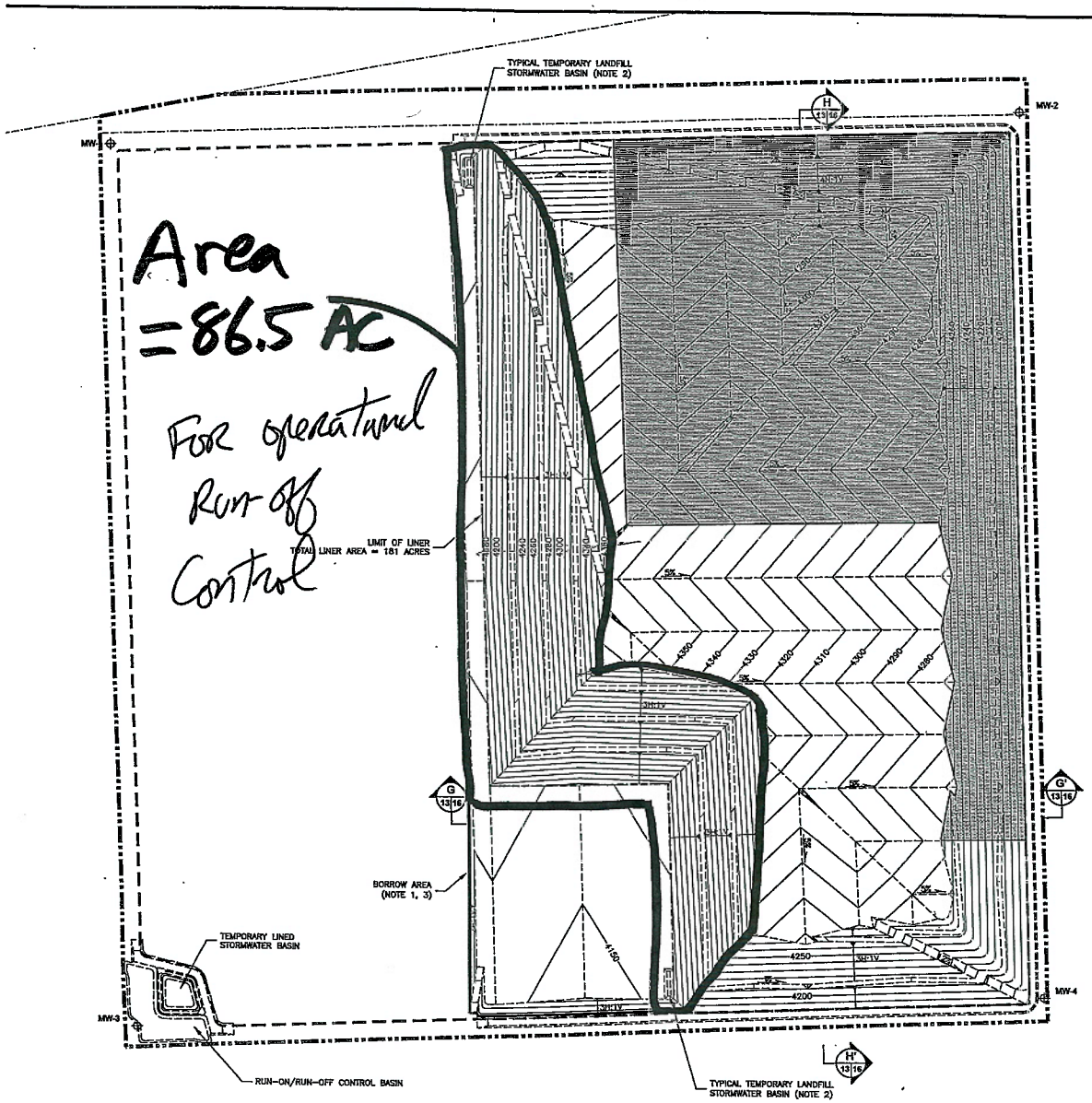
Lining Type	Mannings n for Depth	Mannings n for Velocity	Material	Maximum Velocity	Maximum Shear Stress
A	0.026	0.026	ACB	25	
B	0.016	0.016	Asphalt	25	
C	0.024	0.022	CSP	50	
E	0.025	0.022	Earth-lined	3	
G	0.035	0.030	Grass-lined	7	
I	0.017	0.013	Ductile Iron	50	
P	0.012	0.009	Plastic	25	
R	0.040	0.035	Riprap	15	
T	0.035	0.030	Turf Reinf.	10	1.5
Z	0.060	0.005	Other	25	

Attachment C
NOAA Precipitation Frequencies from Atlas 14

Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.09	0.13	0.16	0.22	0.27	0.34	0.39	0.50	0.62	0.71	0.80	0.92	1.06	1.18	1.46	1.70	2.05	2.33
2	0.11	0.17	0.20	0.28	0.34	0.43	0.49	0.63	0.79	0.90	1.01	1.16	1.33	1.49	1.84	2.15	2.59	2.96
5	0.15	0.23	0.28	0.38	0.47	0.56	0.63	0.81	1.01	1.15	1.28	1.47	1.69	1.90	2.34	2.72	3.29	3.75
10	0.19	0.28	0.35	0.47	0.58	0.69	0.76	0.96	1.19	1.34	1.50	1.72	1.96	2.20	2.71	3.16	3.81	4.34
25	0.24	0.37	0.46	0.62	0.77	0.87	0.94	1.16	1.44	1.62	1.79	2.05	2.33	2.62	3.20	3.73	4.49	5.09
50	0.30	0.46	0.57	0.76	0.94	1.03	1.09	1.33	1.64	1.83	2.01	2.31	2.62	2.94	3.57	4.16	4.98	5.64
100	0.37	0.56	0.69	0.93	1.15	1.22	1.28	1.50	1.84	2.06	2.25	2.57	2.90	3.26	3.94	4.59	5.48	6.17
200	0.44	0.67	0.83	1.12	1.39	1.45	1.50	1.71	2.06	2.29	2.49	2.85	3.20	3.58	4.30	5.01	5.96	6.69
500	0.56	0.86	1.06	1.43	1.77	1.82	1.85	2.07	2.35	2.61	2.82	3.22	3.59	4.01	4.77	5.57	6.57	7.34
1000	0.68	1.03	1.28	1.72	2.13	2.16	2.17	2.39	2.62	2.86	3.07	3.50	3.89	4.33	5.12	5.98	7.01	7.81

* These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting forces estimates near zero to appear as zero.



Area
= 86.5 AC

For operational
Run-off
Control

LEGEND

- PROPERTY BOUNDARY
- LIMIT OF LANDFILL
- LIMIT OF LINER
- BORROW AREA
- CLOSED PORTION OF LANDFILL
- MW-1 APPROXIMATE LOCATION OF MONITORING WELLS
- 14% GRADE INDICATOR
- 3H:1V SLOPE INDICATOR
- A 3/8 DRAWING DETAIL

NOTES

1. BORROW AREA GRADES SHOWN REPRESENT THE MAXIMUM EXCAVATIO ELEVATIONS) OF SOIL REMOVAL PRIOR TO SUBSEQUENT LINER SYSTI
2. TEMPORARY LANDFILL STORMWATER BASIN WILL COLLECT STORMWATE THE ACTIVE DISPOSAL AREA. THE WATER IN THIS BASIN WILL BE P ROUTED TO THE TEMPORARY LINED STORMWATER BASIN WHERE IT W AND TESTED. IF IT IS FREE OF WASTE CONSTITUENTS, THE WATER DISCHARGED TO THE UNLINED RUN-ON/RUN-OFF CONTROL BASIN.
3. STORMWATER RUN-OFF WITHIN THE BORROW AREA WILL BE ROUTED TOPOGRAPHIC LOW POINT WITHIN THE BORROW AREA WHERE IT WILL IT EVAPORATES OR INFILTRATES INTO THE SUBSURFACE SOILS.

SCALE 300 0 300 FEET

REV	DATE	DES	REVISION DESCRIPTION
1	5/08	KGH	REVISED DEVELOPMENT SEQUENCE

PROJECT
JUNGO ROAD LANDFILL CONCEPTUAL
WINNEMUCCA, HUMBOLDT COUNTY, I

TITLE
CELL DEVELOPMENT PL
END OF YEAR 50

Golder Associates
Sacramento, CA

PROJECT No. 083-7079-100			FILE
DESIGN	KGH	10/01/07	SCA
CADD	JDR	03/05/08	
CHECK	KGH	03/06/08	
REVIEW	REK	03/08/08	

Appendix A: Design Use Values of Manning's n

channel material	n
clean, uncoated cast iron	0.013–0.015
clean, coated cast iron	0.012–0.014
dirty, tuberculated cast iron	0.015–0.035
riveted steel	0.015–0.017
lock-bar and welded	0.012–0.013
galvanized iron	0.015–0.017
brass and glass	0.009–0.013
wood stave	
small diameter	0.011–0.012
large diameter	0.012–0.013
concrete	
with rough joints	0.016–0.017
dry mix, rough forms	0.015–0.016
wet mix, steel forms	0.012–0.014
very smooth, finished	0.011–0.012
vitrified sewer	0.013–0.015
common-clay drainage tile	0.012–0.014
asbestos	0.011
planed timber	0.011
canvas	0.012
unplaned timber	0.014
brick	0.016
rubble masonry	0.017
smooth earth	0.018
firm gravel	0.023
corrugated metal pipe	0.022 — down-drains
natural channels, good condition	0.025 — vegetated ditches
natural channels with stones and weeds	0.035
very poor natural channels	0.060

Source: Lindberg, 1986, Civil Engineering

MEMORANDUM

Date: April 1, 2011
To: Rick Kiel, P.E.
From: Ken Haskell, P.E. (California)
Nagesh Koragappa, P.E., G.E. (California)

Project No.: 063-7079-200
Company: Golder Associates Inc.

RE: UPDATED DESIGN SEISMIC GROUND MOTIONS AND SEISMIC IMPACT EVALUATION FOR THE PROPOSED JUNGO DISPOSAL SITE, HUMBOLDT COUNTY, NEVADA

This memorandum summarizes the updated design seismic ground motions and seismic impact evaluations for the proposed Jungo Disposal Site (JDS). An updated seismic hazards assessment was completed to reflect the latest predicted seismic ground motions that were developed after Golder Associates Inc. (Golder) completed the initial seismic characterization for the JDS.

In addition, this memorandum summarizes the results of updated permanent seismic displacement calculations and the results of our initial liquefaction evaluation. These analyses were completed to address the Nevada Division of Environmental Protection's (NDEP's) comments dated February 2, 2011.

1.0 UPDATED SEISMIC HAZARD CHARACTERIZATION

The Jungo Disposal Site is located within a seismic impact zone, which is defined as a location that has a 10 percent or greater probability of experiencing a seismically induced peak ground acceleration (PGA) in bedrock of 0.1g or greater in a 250-year period.

Using the 2002 United States Geological Survey (USGS) database for an earthquake event with a 10 percent probability of exceedance in a 250-year period, Golder initially estimated that the design bedrock PGA was 0.28g at the JDS. This design event, which is specified by Federal Subtitle D regulations and the Nevada Administrative Code, has an associated return period of 2,475 years.

In 2008, the USGS seismic ground motion database was updated to include the latest, state-of-the-art relationships between earthquake magnitude, distance from the epicenter, and peak bedrock accelerations. Using the 2008 USGS seismic hazard mapping, the revised estimated design bedrock PGA for this site is 0.25g, which is approximately 10 percent lower than that originally estimated by Golder and previously used to assess the seismic impacts on the liner system.

2.0 UPDATED PERMANENT SEISMIC DISPLACEMENT ESTIMATES

2.1 Review of Previous Analyses

The previous versions of the Report of Design included estimated permanent seismic displacements along the base liner using a PGA of 0.28g. Potential attenuation of ground motions within the thick soil profile below the JDS were conservatively ignored. Using the simplified approach by Bray et. al. (1998), Golder estimated that the permanent seismically induced displacements would be less than 1 inch (0.8

inch) along the base liner. The currently accepted practice for landfill liner design generally limit permanent displacements to 6 to 12 inches along landfill base liners. Permanent displacements within 6 to 12 inches are not expected to adversely compromise the liner integrity, leachate collection and removal system, or other environmental controls. The estimated permanent displacement of 0.8 inch is well below the more stringent displacement criterion on 6-inches.

2.2 Updated Analyses

Following the completion of the updated seismic ground motion estimates, more rigorous seismic slope stability analyses were performed to confirm that predicted seismic deformations would be well within the accepted criterion of 6 to 12 inches or less. These procedures consisted of the following:

- Selecting of three spectrum-compatible acceleration time histories for site response analyses and considered the revised design PGA of 0.25g. Attachment A includes a more detailed description of the development of these acceleration time histories.
- Applying a yield acceleration of 0.14g as determined from the previous pseudo-static slope stability analyses. Yield accelerations are primarily a function of the landfill geometry and liner shear strengths and are not affected by the seismic ground motions.
- Performing seismic response analyses using the SHAKE91 computer program (Idriss and Sun, 1992) to estimate the average horizontal equivalent acceleration (HEA) time histories within the critical failure surfaces associated with the critical yield acceleration value.
- Performing Newmark-type displacement analyses using the computer program DISPLMT (Houston et al., 1987), which involves the double-integration of the average HEA values that exceed the yield acceleration value, to estimate the potential magnitude of seismically induced permanent displacement along the liner system.

Figures 1 through 3 show the results of seismic displacements for each of the three representative time histories that were analyzed. On each figure there are four graphical plots as follows:

- The first plot (uppermost) is the spectrally matched input acceleration time history.
- The second plot is the computed horizontal equivalent acceleration (HEA) with time. Permanent displacements only occur if the HEA exceeds the yield acceleration, which is also shown on this plot. The magnitude of the computed displacement depends on the relative amount that the HEA exceeds the yield acceleration with respect to magnitude, time, and number of cycles.
- The third plot shows the relative velocity with time.
- The final plot is the computed displacement as a function of time.

As shown in these figures, the computed HEA does not exceed the yield acceleration in Figure 2, and therefore, the estimated permanent seismic displacement is zero. For Figures 1 and 3, the computed HEA slightly exceeds the yield acceleration for one to 4 cycles, and therefore results in very small displacements of 0.4 to 0.6-inches.

Attachment A includes additional technical discussion of the SHAKE91 computer program and the computation of the permanent displacements. The results of SHAKE91 and displacement analysis are included in Attachment B.

2.3 Base Liner Seismic Impact Evaluations

Permanent seismically induced displacements computed using the more rigorous seismic analyses described in Sections 2.2 provided similar results to previously estimated by Golder. In both cases, the computed permanent seismic displacements are relatively small (less than one inch). The computed displacements using the updated design PGA of 0.25g and more rigorous analyses resulted in estimated permanent seismically-induced displacements ranging from 0 to 0.6 inches for the various representative acceleration time histories, which is more than a factor of 10 times lower than the maximum allowable permanent seismically-induced displacement of 6 to 12 inches.

Golder considers the estimated permanent seismically-induced displacements of 0.6-inch or less to be negligible for the JDS.

NDEP (February 2, 2011 comments) stated that the seismic impact evaluation should consider the maximum seismically-induced displacement and not just the permanent seismically-induced displacement. In terms of assessing impacts on the landfill liner systems, it is the permanent seismically-induced displacements that are of concern and critical to the performance of the liner system. Therefore, the accepted performance criteria for landfill liners are based on permanent seismically-induced displacements.

2.4 Other Considerations

NDEP (February 2, 2011 comments) asked that the seismic impact evaluation include the addition of seismically-induced strains to settlement induced strains.

Accepted industry standards for textured high-density polyethylene geomembranes (GRI-GM13) specifies that these materials include a minimum elongation at yield of 12 percent and elongation at break of 120 percent. Elongation at yield represents the maximum strain under which the liner performs elastically. Prudent design standards limits strains below the yield strains.

Golder's previous analyses computed maximum strains are less than 2.3 percent, which is more than 5 times lower than the yield strain specified by GRI-GM13. The addition of negligible strains due to seismically-induced permanent displacements to the above relatively low settlement induced strains will result in overall strains that are well below the maximum yield strain for textured HDPE geomembranes.

3.0 LIQUEFACTION POTENTIAL

3.1 Preliminary Liquefaction Evaluation

Liquefaction is a condition where seismic ground motions cause excessive pore pressures in soils that result in a loss in shear strength. Liquefaction can result in slope instability and/or settlement. Liquefaction is most likely to occur for (1) loose sands/silts, (2) shallow groundwater conditions, and (3) strong ground motions. At the JDS, groundwater is relatively deep at 60 feet below the ground surface and the sands and silts below the liner are considered dense base on the standard penetration test blow counts measured during the subsurface explorations.

Golder previously indicated that liquefaction was unlikely due to depth of groundwater at the JDS. In addition, the relatively high density of the sand/silts relative to the design ground motions were unlikely to result in a significant liquefaction potential.

As requested by NDEP (February 2, 2011 comments), Golder has performed a preliminary liquefaction analysis using the standard penetration (N) values recoded on the logs for the existing testing boring EB and monitoring wells MW-1 through MW-4 The liquefaction analysis has been performed for N values recorded in the upper 100 feet although the "RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities" (U.S.EPA, 1995) states that liquefaction is generally not likely to occur more than 50 feet below the ground surface. Because clayey soils are generally considered non-liquefiable, the analysis has been limited to clean and low plasticity sandy and silty soils.

The liquefaction analysis has been performed using the latest procedure developed at the University of California, Berkeley ("Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential" by Cetin et al., 2004). The deterministic approach presented in Cetin et al (2004) has been used to compute factors of safety against liquefaction potential with depth using the cyclic resistance of the soil.

Although liquefaction is a phenomenon associated with saturated or nearly-saturated (> 85% saturation) granular soils, factors of safety were computed for N values measured both above and below the ground water table. To be conservative, it is assumed that the landfill base is 15 feet below existing ground surface and no waste is present above the base line. The free-field peak ground acceleration (PGA) 0.312g was used (which is higher than the peak acceleration 0.25g in bedrock), which was estimated based on SHAKE91 analysis performed using the three acceleration time histories and a conservative soil column height of 200 feet. The fines contents (percent by weight of particles passing the No. 200 sieve) were estimated based on the available laboratory grain-size analysis test results and soil descriptions in the boring logs.

The results of the liquefaction analysis are presented in Appendix C. The analysis shows that liquefaction is unlikely during the design PGA having a 10 percent probability of exceedance in 250 years (i.e., a return period of 2,475 years).

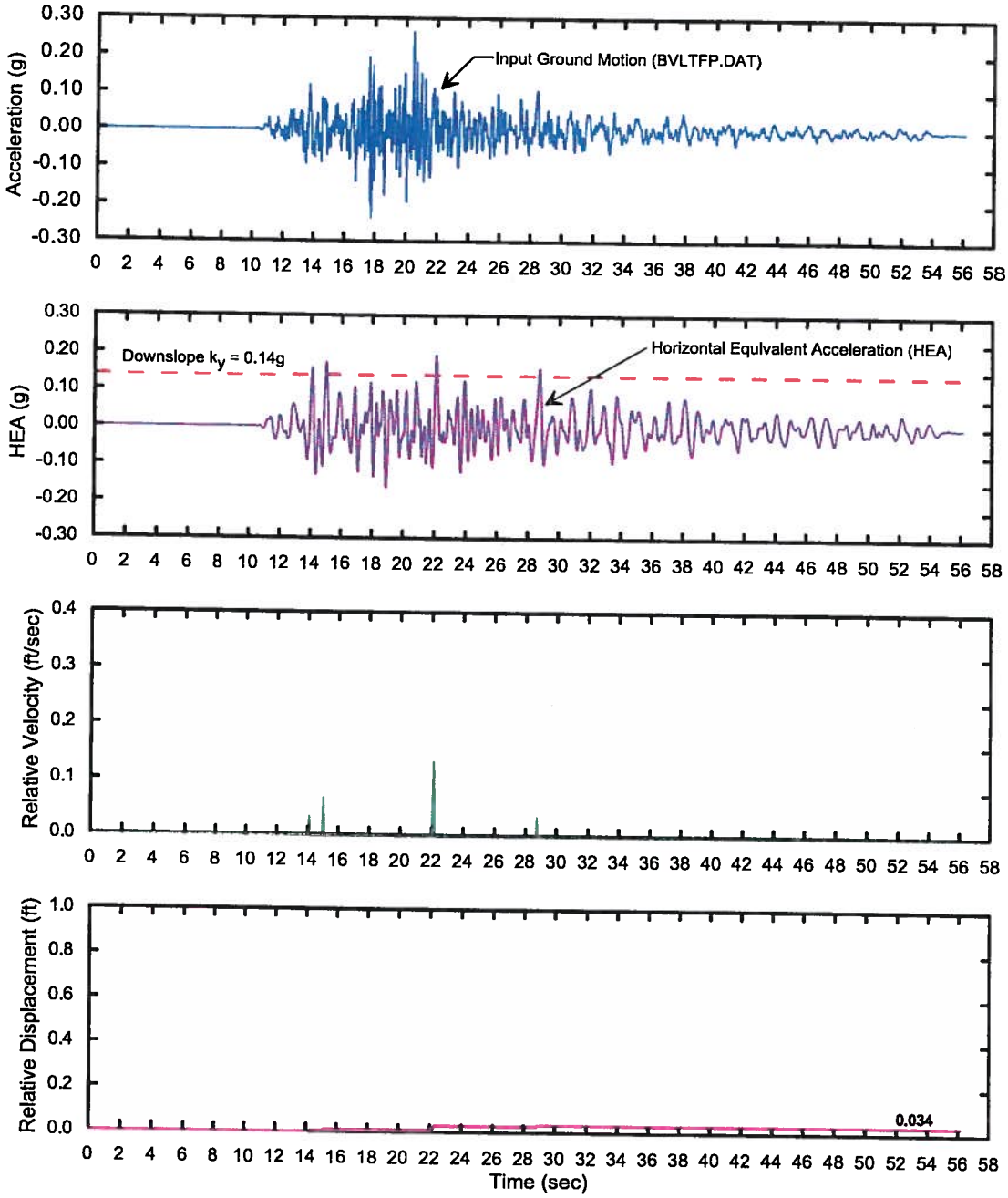
It should be noted that the liquefaction analysis discussed above should be considered preliminary and conservative because the afore-mentioned test boring EB and monitoring wells MW-1 through MW-4 were drilled using a hollow stem auger (HSA). Typically, N values measured within HSA borings below the ground water table are typical lower because the soil at the bottom of the drill hole tend to loosen or flow up because of the unbalanced pore pressure (i.e., the pore pressure inside the borehole would be lower than that outside creating a hydraulic gradient). Therefore, N values measured for liquefaction analyses are typically measured using mud rotary drilling where the hydraulic head inside the drill hole is maintained by filling the bore hole with bentonite slurry. During the design of the various operational modules of the Jungo Landfill, additional test borings will be performed using the mud-rotary technique to conduct more detailed liquefaction analysis in the future.

3.2 References

Cetin, K.O, Seed, R.B., Kiureghian, A.D., Tokimatsu, K., Harder, L.F., Kayen, R.E., and Moss, R.E.S. (2004). "Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential," *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 130, No. 12, December 2004.

U.S.EPA (1995). "RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities", dated April.

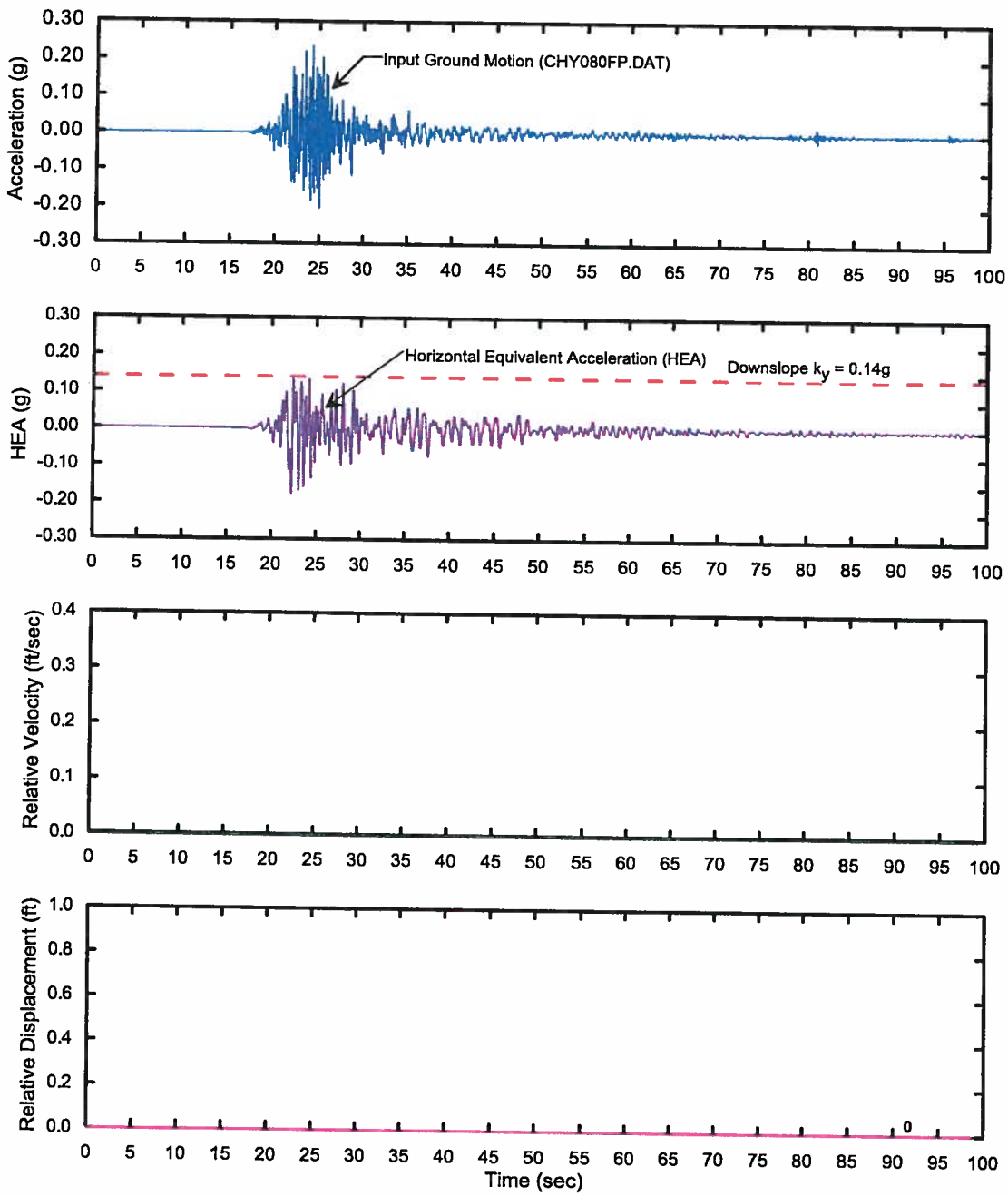
Attachments: Figures 1 through 3
Attachment A – Technical Summary of Seismic Analyses
Attachment B – SHAKE91 and DSIPLMT Results
Attachment C – Liquefaction Calculation Summary



Golder Associates

Jungo Landfill
Seismic Slope Stability
Permanent Displacement Analysis
Time History = BVLTFP.DAT

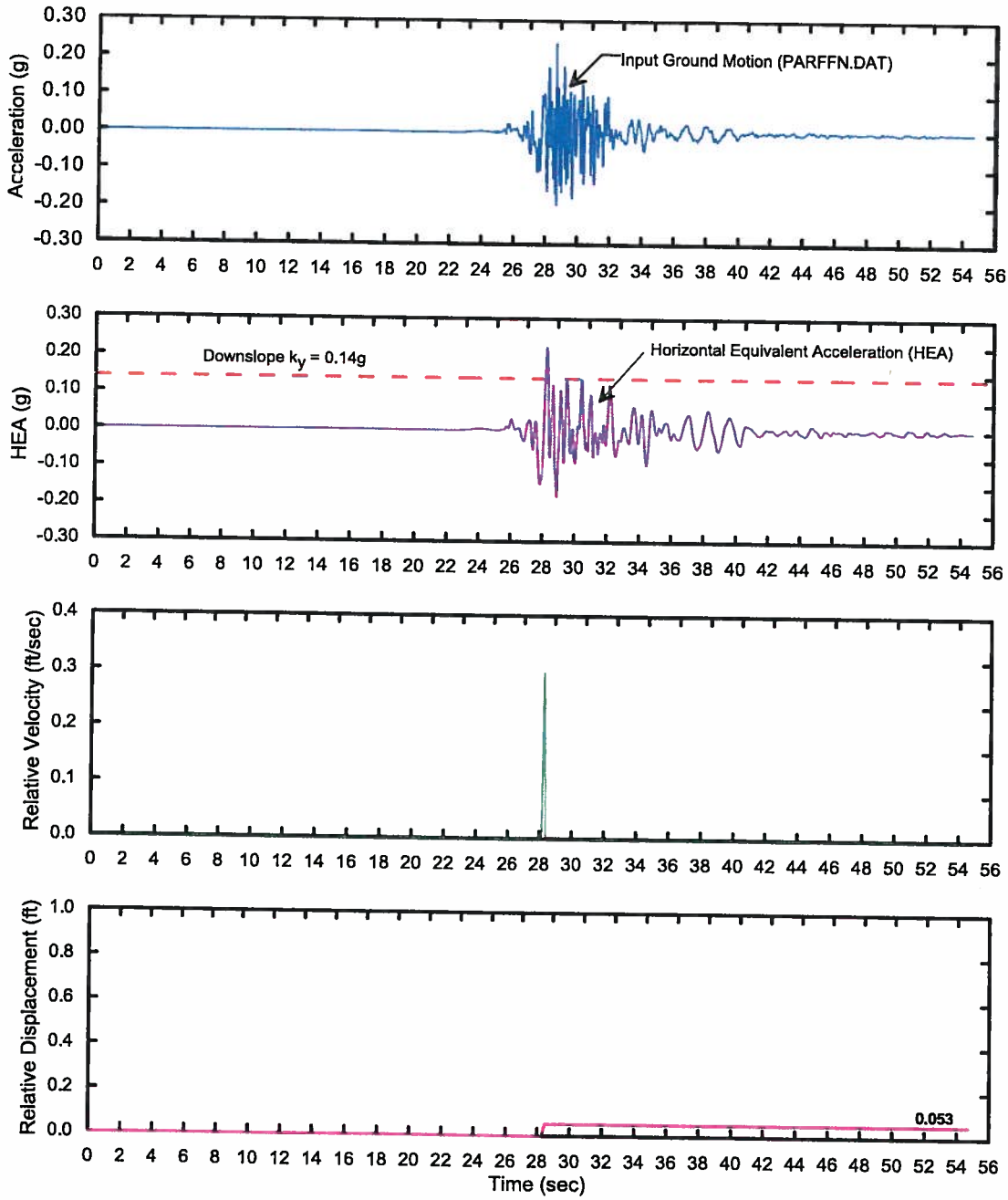
Design: NK	Check:	Date: March 2011	Figure. 1



Golder Associates

Jungo Landfill
Seismic Slope Stability
Permanent Displacement Analysis
Time History = CHY080FP.DAT

Design: NK	Check:	Date: March 2011	Figure: 2



Golder Associates

Jungo Landfill
Seismic Slope Stability
Permanent Displacement Analysis
Time History = PARFFN.DAT

Design: NK	Check:	Date: March 2011	Figure: 3

ATTACHMENT A
TECHNICAL SUMMARY OF SEISMIC ANALYSES

The methods used to complete the seismic evaluations were briefly reviewed in Section 2.0 of the Technical Memorandum. The following sections include a more detailed discussion of the methods and assumptions used in these analyses.

1.0 SPECTRAL ACCELERATION MATCHING

The U.S. Geological Survey (1996 updated in 2008) has developed a probabilistic seismic hazard model for the United States. The U.S. Geological Survey model, and interactive ground motion disaggregation, allow for the listing of peak ground acceleration (PGA) for various probabilities of being exceeded, or return periods, and the associated earthquake modal magnitude and distance from the site. Table 1 provides a list of the PGAs on weak rock ($V_{S,30}$ = 760m/s) and associated mean earthquake magnitudes derived from the interactive disaggregation of PGAs at the Jungo Landfill site.

TABLE 1
PROBABILISTIC SEISMIC HAZARD ANALYSIS RESULTS FOR PEAK GROUND ACCELERATION (PGA) AT THE JDS (U.S. GEOLOGICAL SURVEY, 2008)

Probability of Being Exceeded (Return Period)	PGA (g)	Mean Earthquake Magnitude
2% in 50 Years (2,475 yrs)	0.25	6.2
5% in 50 Years (975 yrs)	0.16	6.2
10% in 50 Years (475 yrs)	0.10	6.2
25% in 50 Years (224 yrs)	0.07	6.2
50% in 75 Years (108 yrs)	0.03	6.2

The specific steps performed in the selection of representative in acceleration time histories and spectral matching are summarized below.

1.1 Disaggregation of PSHA

The first step to develop spectrally matched acceleration time histories is to disaggregate the PSHA model to identify the earthquake magnitude-distance pairs (scenario events) that contribute to the seismic hazard for the chosen return period and frequency. The mean magnitude earthquake event with a return period of 2,475-years is a moment magnitude (M) 6.2 earthquake located at a distance of 12 km (USGS, 2008).

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1.2 Selection of Acceleration Time Histories

We reviewed available acceleration time history records from strike-slip, reverse, and oblique-reverse mechanism earthquakes that met the magnitude-distance criteria listed in above. These earthquake mechanisms were selected because of the need to have records from a range of moderate earthquakes at relatively close source-to-site distances, the selected acceleration time history records are shown in Table 2.

TABLE 2
SELECTED TIME HISTORY FOR M 6.2 EARTHQUAKE

Motion No.	Earthquake Name (Date)	Magnitude (M)	PGA (g)	Station	Distance (km)	Vs (m/sec)
EQ1	Irpinia Italy (1980)	6.2	0.11	Rinero in Vulture	25	665
EQ2	Chi Chi Taiwan – 04 (1999)	6.2	0.12	CHY080	12.5	680
EQ3	Parkfield (1966)	6.2	0.30	Temblor	16	530

1.3 Spectral Matching

Spectral matching is a procedure used to develop an acceleration time history that closely matches a smooth design response spectrum (target spectrum). The spectral matching procedure begins with selection of a recorded acceleration time history (seed) from an earthquake whose characteristics reasonably represent the earthquake expected at the site. The objective of the spectral matching procedure is to reduce the individual spectral peaks and valleys of the seed acceleration time history while preserving the non-stationary characteristics of the seed time history as much as possible Abrahamson (1992).

The matching procedure is involves adding and subtracting elementary wavelets to and from the seed acceleration time history. Each wavelet is intended to match the design response spectrum at one period. Matching is done either period by period or in groups of periods. Several iterations are required to get reasonable convergence between the spectrally-matched acceleration time history and the design response spectrum. Spectral matching can be undertaken in either the time-domain or frequency domain. Full details of the method are presented in Lilhanand and Tseng (1988) and Abrahamson (1992).

For this study, spectral matching was accomplished using the computer program RSPMATCH which has been incorporated into the EZ-FRISK 7.51 software developed by Risk Engineering Inc. RSPMATCH is based on the on the time-domain matching method developed by Lilhanand and Tseng (1988) and

modified by Abrahamson (1992). In this study, the spectral matching was conducted in groups of periods. The goal of the spectral matching was to produce an acceleration time history with an acceleration response spectrum within about 10% (or less) of the target acceleration response spectrum. The computer program is run iteratively until the computed acceleration response spectrum is within a user specified percentage of the target acceleration response spectrum. Because the solution is not unique (i.e., there are an infinite number of motions that will produce the target spectrum), the motion was integrated to calculate the velocity and displacement time histories. The acceleration, velocity, and displacement time histories were checked to ensure that the solution is reasonable. This check was made to verify that the spectrally matched motion had a reasonable duration and there was no residual displacement.

Because the design acceleration response spectrum was developed for a bedrock site ($V_{S,30}$ = 760 m/sec), the spectrally matched motions can be considered "rock" motions.

1.4 Discussion of Spectral Matching

The seed motions used for spectral matching include actual recorded and synthetic acceleration time histories that are available from readily available worldwide databases. There are a number of parameters that must be considered when selecting recorded acceleration time histories for spectral matching. These include earthquake magnitude, sense of earthquake motions (normal, reverse, and strike-slip), site-to-source distance, shear wave velocity at the recording station, and PGA of the recorded motion. Ideally, recorded time histories that closely match each of these parameters at the site would be selected for spectral matching. However, because of the limited database of world-wide recorded acceleration time histories some of these parameters may have to be relaxed. By far, the most important parameter in spectral matching is the earthquake magnitude because the magnitude is directly related to the duration of strong shaking. This is consistent with the recommendations of Bommer and Acevedo (2004) who show that distance has little influence on spectral shape. They recommend a small window in terms of magnitude but broad limits in terms of distance. Similarly, Watson-Lamprey and Abrahamson (2006) found that spectrally matched acceleration time histories with scale factors of over 10 on PGA are acceptable. The sense of earthquake movement can affect the peak ground acceleration and the spectral accelerations, but this is accounted for in the attenuation relationships used in the probabilistic seismic hazard analysis (PSHA).

Because the spectral matching solution is not unique, the acceleration, velocity and displacement time histories were checked for the spectrally matched motions to verify that the duration of strong shaking was adequate and that residual displacement was zero. If the displacement or acceleration time history was not adequate, the spectral matching was repeated until adequate results were achieved. For each spectrally matched motion, the residual displacement was less than 0.1 centimeters (cm).

2.0 ESTIMATES OF THE PERMANENT DISPLACEMENTS

2.1 Seismic Response Analysis

SHAKE91 analyzes the seismic response of a 1-dimensional soil column; therefore, its use is ideal where the ground surfaces are relatively flat. For sloping ground surfaces, the state of practice is to use an approximation to estimate the average response of the 2-D slope failure mass. This approximation involves performing SHAKE91 analysis on one or more soil/waste columns taken across the critical failure mass identified by the pseudo-static slope stability analysis. It should be noted that the computed HEA time history based on just one waste column is conservative. In other words, averaging of HEA values from more than one waste column taken across the critical failure mass typically results in lower HEA values because of averaging of the spatial incoherence (i.e., at any instant of time, the acceleration values at different points within the critical failure surface have different magnitudes). Also, HEA values estimated based on SHAKE91 are typically conservative compared to those obtained from a 2-D site-response analysis (e.g., QUAD4M).

To be conservative, only one SHAKE column was used along each cross section analyzed. The shear stress time history output files from the SHAKE91 analyses is used to compute the time history of the horizontal equivalent acceleration (HEA) within the failure mass using the following equation (Bray et al., 1998):

$$\mathrm{HEA}\,(t) = \left[\frac{\tau(t)}{\sigma_v}\right] g$$

where, $\tau(t)$ = shear stress at the elevation of the failure plane at time t
σv = total vertical stress at the elevation of the failure plane
g = acceleration due to gravity

The various waste parameters used in SHAKE91 analyses were obtained from the following references:

- Unit weight with depth -- Zekkos et. al (2006a)
- Shear wave velocity with depth -- Kavazanjian et al. (1996)
- Modulus reduction and damping curves -- Zekkos et al. (2006b)

The shear strain dependent modulus reduction and damping values used for waste are summarized in Tables 3 and 4, respectively.

TABLE 3
SHEAR MODULUS REDUCTION AND DAMPING CURVES FOR WASTE

Shear Strain, γ (%)	G/G_{max} Matasovic and Kavazanjian (1998)	G/G_{max} Zekkos et al. (2006b)
0.0001	1.000	0.998
0.0003	1.000	0.996
0.001	1.000	0.990
0.003	0.990	0.975
0.01	0.980	0.936
0.03	0.950	0.856
0.1	0.850	0.690
0.3	0.675	0.475
1	0.330	0.252
3	0.128	0.121
8	0.050	0.058

TABLE 4
DAMPING CURVES FOR WASTE

Shear Strain, γ (%)	Damping Matasovic and Kavazanjian (1998)	Damping Zekkos et al. (2006b)
0.0001	1.8	4.0
0.0003	2.0	4.1
0.001	3.0	4.1
0.003	4.0	4.2
0.01	6.0	4.5
0.03	8.8	5.2
0.1	13.0	7.2
0.3	17.2	10.5
1	21.8	14.0
3	24.8	23.5
8	27.0	28.0

The time history of the horizontal shear stress corresponding to the elevation of the failure surface is first computed using the SHAKE program and saved in to a computer file. This file was then imported to a spreadsheet and the shear stress at each time step was divided by the weight (which is the same as the vertical stress in a 1-dimensional analysis) above the failure surface to obtain the time history of the HEA of the failure block overlying the failure plane within the waste column. As noted in Bray et al. (1998), this method of computing average acceleration of 1-dimensional soil columns was originally conceived by Seed and Martin in 1966.

Separate seismic response analyses were performed using each of the three acceleration time histories.

2.2 Permanent Displacement Analysis

The computer program DISPLMT developed by Houston et al. (1987) was used to predict the likely magnitude of seismically-induced permanent displacements. DISPLMT performs numerical double integration of the HEA values that are in excess of the yield acceleration values.

The results of the permanent displacement analyses using DISPLMT are presented graphically in Figures 1 through 3 included in the Technical Memorandum. Each of these figures indicate that the HEA values only exceed the corresponding yield acceleration values in a few brief instances in time. Therefore, the estimated permanent displacements are relatively small and range from 0 to 0.05 feet (0 to 0.6 inches).

3.0 REFERENCES

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ATTACHMENT B

SHAKE91 AND DISPLACMENT RESULTS

```
*****************************************************
* SHAKE  --   A COMPUTER PROGRAM FOR EARTHQUAKE RESPONSE  *
*             ANALYSIS OF HORIZONTALLY LAYERED SITES      *
*             by: Per B. Schnabel & John Lysmer -- 1970   *
* ---------------------------------------------------- *
* shake85     IBM-PC version of SHAKE                     *
*             by: S.S. (Willie) Lai, January 1985         *
* ---------------------------------------------------- *
* shake88   : New modulus reduction curves for clays added*
*             using results from Sun et al (1988)         *
*             by: J. I. Sun & Ramin Golesorkhi            *
*             February 26, 1988                           *
* ---------------------------------------------------- *
* SHAKE90/91: Adjust last iteration; Input now is either  *
*             Gmax or max Vs; up to 13 material types can *
*             be specified by user; up to 50 Layers can   *
*             be specified; object motion can be read in  *
*             from a separate file and can have user      *
*             specified format; Different periods for     *
*             response spectral calculations; options     *
*             are renumbered; and general cleanup         *
*             by: J. I. Sun, I. M. Idriss & P. Dirrim     *
*             June 1990 - February 1991                   *
* ---------------------------------------------------- *
* SHAKE91   : General cleanup and finalization of input/  *
*             output format ... etc                       *
*             by: I. M. Idriss                            *
*             December 1991                               *
*************************************************************
 MAX. NUMBER OF TERMS IN FOURIER TRANSFORM =     32768
 NECESSARY LENGTH OF BLANK COMMON X        =    204819
    Option NO.    1   is started.

1******   OPTION  1  ***  READ RELATION BETWEEN SOIL PROPERTIES AND STRAIN

 **********************
  MATERIAL TYPE NO. 1
 **********************

 CURVE NO.  1:      #1 modulus for clay (seed & sun 1989) upper range
 CURVE NO.  2:        damping for clay (Idriss 1990) -


     CURVE NO. 1              CURVE NO. 2
 ===================      ==================
   STRAIN    G/Gmax         STRAIN    DAMPING
 --------   -------        --------  --------
   0.0001     1.000         0.0001      0.24
   0.0003     1.000         0.0003      0.42
```

0.0010	1.000	0.0010	0.80
0.0030	0.981	0.0030	1.40
0.0100	0.941	0.0100	2.80
0.0300	0.847	0.0300	5.10
0.1000	0.656	0.1000	9.80
0.3000	0.438	0.3000	15.50
1.0000	0.238	1.0000	21.00
3.0000	0.144	3.1600	25.00
10.0000	0.110	10.0000	28.00

****
MATERIAL TYPE NO. 2
****

CURVE NO. 3: #2 modulus for sand (seed & idriss 1970) - upper Range
CURVE NO. 4: damping for sand (Idriss 1990) - (about LRng from SI

CURVE NO. 3

STRAIN	G/Gmax
0.0001	1.000
0.0003	1.000
0.0010	0.990
0.0030	0.960
0.0100	0.850
0.0300	0.640
0.1000	0.370
0.3000	0.180
1.0000	0.080
3.0000	0.050
10.0000	0.035

CURVE NO. 4

STRAIN	DAMPING
0.0001	0.24
0.0003	0.42
0.0010	0.80
0.0030	1.40
0.0100	2.80
0.0300	5.10
0.1000	9.80
0.3000	15.50
1.0000	21.00
3.0000	25.00
10.0000	28.00

****
MATERIAL TYPE NO. 3
****

CURVE NO. 5: #3 ATTENUATION OF ROCK AVERAGE
CURVE NO. 6: DAMPING IN ROCK

CURVE NO. 5

STRAIN	G/Gmax
0.0001	1.000
0.0003	1.000
0.0010	0.988

CURVE NO. 6

STRAIN	DAMPING
0.0001	0.40
0.0010	0.80
0.0100	1.50

0.0030	0.952	0.1000	3.00
0.0100	0.900	1.0000	4.60
0.0300	0.810	0.0000	0.00
0.1000	0.725	0.0000	0.00
1.0000	0.550	0.0000	0.00

****
MATERIAL TYPE NO. 4
****

CURVE NO. 7: #4 modulus for waste (Zekkos et al., 2006)
CURVE NO. 8: damping for waste (Zekkos et al., 2006)

CURVE NO. 7

STRAIN	G/Gmax
0.0001	1.000
0.0003	0.996
0.0010	0.990
0.0030	0.975
0.0100	0.936
0.0300	0.856
0.1000	0.690
0.3000	0.475
1.0000	0.252
3.0000	0.121
8.0000	0.058

CURVE NO. 8

STRAIN	DAMPING
0.0001	4.00
0.0003	4.10
0.0010	4.10
0.0030	4.20
0.0100	4.50
0.0300	5.20
0.1000	7.20
0.3000	10.50
1.0000	14.00
3.0000	23.50
10.0000	28.00

****
MATERIAL TYPE NO. 7
****

CURVE NO. 13: #7 modulus for clay PI=1-10 (Sun et al., 1988)
CURVE NO. 14: damping for clay (Dobry & Vucetic Curve, 4/9/91)

CURVE NO.13

STRAIN	G/Gmax
0.0001	1.000
0.0010	0.974
0.0032	0.915
0.0100	0.786
0.0316	0.574
0.1000	0.312
0.3000	0.160

CURVE NO.14

STRAIN	DAMPING
0.0001	1.75
0.0010	1.75
0.0032	2.80
0.0100	4.90
0.0316	9.01
0.1000	3.45
0.3160	18.10

```
    1.0000      0.060          1.0000      22.00
    3.1600      0.020          3.1600      24.55
   10.0000      0.006         10.0000      26.50
     Option NO.     1   has been concluded.
     Option NO.     2   is started.

1******   OPTION  2  ***  READ SOIL PROFILE
 NEW SOIL PROFILE NO.   1       IDENTIFICATION  Jungo Landfill; BVLTFP.DAT
 NUMBER OF LAYERS                   18          DEPTH TO BEDROCK        260.00
```

NO.	TYPE	THICKNESS (ft)	DEPTH (ft)	Tot. PRESS. (ksf)	MODULUS (ksf)	DAMPING	UNIT WT. (kcf)	SHEAR VEL (fps)
1	4	10.00	5.00	0.34	657.	0.050	0.067	562.0
2	4	10.00	15.00	1.02	755.	0.050	0.071	585.0
3	4	10.00	25.00	1.75	850.	0.050	0.074	608.0
4	4	10.00	35.00	2.51	955.	0.050	0.077	632.0
5	4	10.00	45.00	3.29	1053.	0.050	0.079	655.0
6	4	10.00	55.00	4.08	1142.	0.050	0.080	678.0
7	2	10.00	65.00	5.08	3019.	0.050	0.120	900.0
8	2	15.00	77.50	6.58	3363.	0.050	0.120	950.0
9	7	15.00	92.50	8.38	3727.	0.050	0.120	1000.0
10	2	15.00	107.50	10.22	3144.	0.050	0.125	900.0
11	2	15.00	122.50	12.09	3882.	0.050	0.125	1000.0
12	1	20.00	140.00	14.28	5590.	0.050	0.125	1200.0
13	2	20.00	160.00	16.78	4697.	0.050	0.125	1100.0
14	2	20.00	180.00	19.33	5814.	0.050	0.130	1200.0
15	2	20.00	200.00	21.93	6308.	0.050	0.130	1250.0
16	2	20.00	220.00	24.53	6823.	0.050	0.130	1300.0
17	2	30.00	245.00	27.78	6823.	0.050	0.130	1300.0
18	BASE				36335.	0.050	0.130	3000.0

```
  PERIOD = 1.02 FROM AVERAGE SHEAR VELOCITY =   1015.


  FREQUENCY    AMPLITUDE
 MAXIMUM AMPLIFICATION =  15.72
 FOR FREQUENCY         =   1.24 C/SEC.
     PERIOD            =   0.81 SEC.
     Option NO.     2   has been concluded.
     Option NO.     3   is started.

1******   OPTION  3  ***  READ INPUT MOTION

  FILE NAME FOR INPUT MOTION = BVLTFP.DAT
    NO. OF INPUT ACC. POINTS = 19355
   NO. OF POINTS USED IN FFT = 32768
        NO. OF HEADING LINES =     5
      NO. OF POINTS PER LINE =     8
  TIME STEP FOR INPUT MOTION = 0.0029
```

```
  FORMAT FOR OF TIME HISTORY = (8F9.6)


  READING INPUT MOTION FROM ----> BVLTFP.DAT
  FORMAT OF INPUT MOTION USED --> (8F9.6)

 ***** H E A D E R
PEER NGA Rotated Accelerogram (November 1, 2007)
#Misfit: 0.0837993
File Type: Accelerations (g)
File Type: Accelerations (g)
NPTS= 19355 , DT= 0.0029 SEC
 **  FIRST & LAST 5 LINES OF INPUT MOTION *****

     1  0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
     2  0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
     3  0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
     4  0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
     5  0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
   ........ INPUT MOTION READ NOT ECHOED...........
  2416  0.000010 0.000011 0.000012 0.000013 0.000013 0.000014 0.000015 0.000016
  2417  0.000017 0.000018 0.000019 0.000020 0.000021 0.000022 0.000023 0.000023
  2418 -0.000024 0.000025 0.000026 0.000027 0.000028 0.000029 0.000030 0.000031
  2419  0.000032 0.000033 0.000034 0.000035 0.000036 0.000037 0.000038 0.000039
  2420  0.000040 0.000041 0.000042 0.000000 0.000000 0.000000 0.000000 0.000000

 MAXIMUM ACCELERATION =  0.26326
 AT TIME              = 20.47 SEC
 THE VALUES WILL BE MULTIPLIED BY A FACTOR =  0.950
 TO GIVE NEW MAXIMUM ACCELERATION          =  0.25000
 MEAN SQUARE FREQUENCY =       4.57 C/SEC.
  MAX ACCELERATION =    0.25956 FOR FREQUENCIES REMOVED ABOVE     100.00 C/SEC.
     Option NO.    3   has been concluded.
     Option NO.    4   is started.
1******   OPTION  4  ***  READ WHERE OBJECT MOTION IS GIVEN
   OBJECT MOTION IN LAYER NUMBER  18 OUTCROPPING
     Option NO.    4   has been concluded.
     Option NO.    5   is started.

1******   OPTION  5  ***  OBTAIN STRAIN COMPATIBLE SOIL PROPERTIES
  MAXIMUM NUMBER OF ITERATIONS                =     6
  FACTOR FOR UNIFORM STRAIN IN TIME DOMAIN    =   0.65


+              ITERATION NUMBER  1
     EARTHQUAKE   - BVLTFP.DAT
     SOIL PROFILE - Jungo Landfill; BVLTFP.DAT
```

ITERATION NUMBER 1

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01291	0.047	0.050	-7.2	602.9	657.2	-9.0	1.000
2	4	15.0	0.02965	0.052	0.050	3.7	646.6	754.6	-16.7	1.000
3	4	25.0	0.04168	0.057	0.050	13.0	688.7	849.5	-23.4	1.000
4	4	35.0	0.05205	0.061	0.050	18.2	745.0	955.1	-28.2	1.000
5	4	45.0	0.05536	0.062	0.050	19.6	812.1	1052.6	-29.6	1.000
6	4	55.0	0.05233	0.061	0.050	18.4	890.0	1142.1	-28.3	1.000
7	2	65.0	0.02063	0.043	0.050	-15.8	2148.0	3018.6	-40.5	1.000
8	2	77.5	0.02148	0.044	0.050	-13.6	2367.5	3363.4	-42.1	1.000
9	7	92.5	0.02152	0.076	0.050	34.5	2402.8	3726.7	-55.1	1.000
10	2	107.5	0.02657	0.048	0.050	-3.2	2085.3	3144.4	-50.8	1.000
11	2	122.5	0.02295	0.045	0.050	-10.1	2683.2	3882.0	-44.7	1.000
12	1	140.0	0.01801	0.040	0.050	-24.0	4978.9	5590.1	-12.3	1.000
13	2	160.0	0.02411	0.046	0.050	-7.7	3202.6	4697.2	-46.7	1.000
14	2	180.0	0.02112	0.044	0.050	-14.5	4110.6	5813.7	-41.4	1.000
15	2	200.0	0.02058	0.043	0.050	-16.0	4491.7	6308.2	-40.4	1.000
16	2	220.0	0.01986	0.042	0.050	-18.0	4904.5	6823.0	-39.1	1.000
17	2	245.0	0.02071	0.043	0.050	-15.6	4850.1	6823.0	-40.7	1.000

+ ITERATION NUMBER 2
1

EARTHQUAKE - BVLTFP.DAT
SOIL PROFILE - Jungo Landfill; BVLTFP.DAT

ITERATION NUMBER 2

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01244	0.046	0.047	-0.5	604.7	602.9	0.3	0.917
2	4	15.0	0.03259	0.053	0.052	2.7	637.3	646.6	-1.5	0.857
3	4	25.0	0.04586	0.059	0.057	2.7	677.5	688.7	-1.7	0.811
4	4	35.0	0.05726	0.063	0.061	2.5	732.5	745.0	-1.7	0.780
5	4	45.0	0.06219	0.064	0.062	3.0	795.2	812.1	-2.1	0.772
6	4	55.0	0.06402	0.065	0.061	5.2	858.3	890.0	-3.7	0.779
7	2	65.0	0.02900	0.050	0.043	14.2	1951.4	2148.0	-10.1	0.712
8	2	77.5	0.02842	0.050	0.044	11.8	2187.3	2367.5	-8.2	0.704
9	7	92.5	0.03068	0.089	0.076	14.2	2159.5	2402.8	-11.3	0.645
10	2	107.5	0.04054	0.063	0.048	22.8	1800.2	2085.3	-15.8	0.663
11	2	122.5	0.03509	0.057	0.045	20.5	2347.9	2683.2	-14.3	0.691
12	1	140.0	0.02078	0.043	0.040	6.9	4910.5	4978.9	-1.4	0.891
13	2	160.0	0.03479	0.057	0.046	18.2	2850.3	3202.6	-12.4	0.682

14	2	180.0	0.02806	0.050	0.044	12.0	3795.2	4110.6	-8.3	0.707
15	2	200.0	0.02599	0.048	0.043	10.2	4210.1	4491.7	-6.7	0.712
16	2	220.0	0.02371	0.046	0.042	8.0	4673.6	4904.5	-4.9	0.719
17	2	245.0	0.02409	0.046	0.043	6.8	4652.6	4850.1	-4.2	0.711

+
1

ITERATION NUMBER 3

EARTHQUAKE - BVLTFP.DAT
SOIL PROFILE - Jungo Landfill; BVLTFP.DAT

ITERATION NUMBER 3

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01175	0.046	0.046	-0.8	607.4	604.7	0.5	0.920
2	4	15.0	0.03140	0.053	0.053	-1.2	641.2	637.3	0.6	0.845
3	4	25.0	0.04421	0.058	0.059	-1.0	681.8	677.5	0.6	0.797
4	4	35.0	0.05471	0.062	0.063	-1.2	738.5	732.5	0.8	0.767
5	4	45.0	0.06001	0.064	0.064	-0.9	800.4	795.2	0.6	0.755
6	4	55.0	0.06307	0.064	0.065	-0.4	860.6	858.3	0.3	0.751
7	2	65.0	0.03065	0.052	0.050	3.0	1917.5	1951.4	-1.8	0.646
8	2	77.5	0.03009	0.051	0.050	2.5	2150.2	2187.3	-1.7	0.650
9	7	92.5	0.03337	0.087	0.089	-1.8	2092.9	2159.5	-3.2	0.579
10	2	107.5	0.04522	0.067	0.063	6.4	1723.0	1800.2	-4.5	0.572
11	2	122.5	0.03823	0.060	0.057	5.5	2273.4	2347.9	-3.3	0.605
12	1	140.0	0.01988	0.042	0.043	-2.2	4931.6	4910.5	0.4	0.878
13	2	160.0	0.03646	0.059	0.057	3.1	2800.7	2850.3	-1.8	0.607
14	2	180.0	0.02816	0.050	0.050	0.2	3791.2	3795.2	-0.1	0.653
15	2	200.0	0.02548	0.048	0.048	-0.9	4234.3	4210.1	0.6	0.667
16	2	220.0	0.02276	0.045	0.046	-1.9	4726.8	4673.6	1.1	0.685
17	2	245.0	0.02646	0.048	0.046	4.1	4530.5	4652.6	-2.7	0.682

+
1

ITERATION NUMBER 4

EARTHQUAKE - BVLTFP.DAT
SOIL PROFILE - Jungo Landfill; BVLTFP.DAT

ITERATION NUMBER 4

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01157	0.046	0.046	-0.2	608.2	607.4	0.1	0.924
2	4	15.0	0.03090	0.052	0.053	-0.5	642.9	641.2	0.3	0.850
3	4	25.0	0.04360	0.058	0.058	-0.4	683.4	681.8	0.2	0.803
4	4	35.0	0.05384	0.062	0.062	-0.4	740.6	738.5	0.3	0.773

5	4	45.0	0.05897	0.063	0.064	-0.5	802.9	800.4	0.3	0.760
6	4	55.0	0.06241	0.064	0.064	-0.3	862.3	860.6	0.2	0.754
7	2	65.0	0.03106	0.052	0.052	1.0	1908.4	1917.5	-0.5	0.635
8	2	77.5	0.03064	0.052	0.051	1.3	2136.7	2150.2	-0.6	0.639
9	7	92.5	0.03444	0.086	0.087	-1.8	2066.1	2092.9	-1.3	0.562
10	2	107.5	0.04690	0.068	0.067	2.1	1697.3	1723.0	-1.5	0.548
11	2	122.5	0.03908	0.061	0.060	1.4	2254.3	2273.4	-0.8	0.586
12	1	140.0	0.01956	0.042	0.042	-0.8	4939.3	4931.6	0.2	0.882
13	2	160.0	0.03659	0.059	0.059	0.2	2797.0	2800.7	-0.1	0.596
14	2	180.0	0.02779	0.049	0.050	-0.6	3805.8	3791.2	0.4	0.652
15	2	200.0	0.02498	0.047	0.048	-0.9	4258.1	4234.3	0.6	0.671
16	2	220.0	0.02222	0.045	0.045	-1.1	4758.4	4726.8	0.7	0.693
17	2	245.0	0.02740	0.049	0.048	1.5	4485.0	4530.5	-1.0	0.664

+ ITERATION NUMBER 5
1

EARTHQUAKE - BVLTFP.DAT
SOIL PROFILE - Jungo Landfill; BVLTFP.DAT

ITERATION NUMBER 5

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01153	0.046	0.046	-0.1	608.3	608.2	0.0	0.925
2	4	15.0	0.03075	0.052	0.052	-0.2	643.4	642.9	0.1	0.852
3	4	25.0	0.04343	0.058	0.058	-0.1	683.9	683.4	0.1	0.804
4	4	35.0	0.05363	0.062	0.062	-0.1	741.1	740.6	0.1	0.775
5	4	45.0	0.05862	0.063	0.063	-0.2	803.8	802.9	0.1	0.763
6	4	55.0	0.06217	0.064	0.064	-0.1	862.9	862.3	0.1	0.755
7	2	65.0	0.03118	0.053	0.052	0.3	1905.7	1908.4	-0.1	0.632
8	2	77.5	0.03085	0.052	0.052	0.5	2131.6	2136.7	-0.2	0.635
9	7	92.5	0.03490	0.085	0.086	-0.8	2054.8	2066.1	-0.6	0.554
10	2	107.5	0.04754	0.069	0.068	0.8	1687.7	1697.3	-0.6	0.540
11	2	122.5	0.03932	0.062	0.061	0.4	2249.0	2254.3	-0.2	0.581
12	1	140.0	0.01947	0.042	0.042	-0.2	4941.5	4939.3	0.0	0.884
13	2	160.0	0.03652	0.059	0.059	-0.1	2799.2	2797.0	0.1	0.595
14	2	180.0	0.02760	0.049	0.049	-0.3	3813.6	3805.8	0.2	0.655
15	2	200.0	0.02477	0.047	0.047	-0.4	4268.2	4258.1	0.2	0.675
16	2	220.0	0.02210	0.045	0.045	-0.2	4765.1	4758.4	0.1	0.697
17	2	245.0	0.02776	0.049	0.049	0.6	4467.7	4485.0	-0.4	0.657

+ ITERATION NUMBER 6
1

EARTHQUAKE - BVLTFP.DAT
SOIL PROFILE - Jungo Landfill; BVLTFP.DAT

ITERATION NUMBER 6

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01151	0.046	0.046	0.0	608.4	608.3	0.0	0.926
2	4	15.0	0.03070	0.052	0.052	0.0	643.5	643.4	0.0	0.853
3	4	25.0	0.04338	0.058	0.058	0.0	684.0	683.9	0.0	0.805
4	4	35.0	0.05358	0.062	0.062	0.0	741.2	741.1	0.0	0.776
5	4	45.0	0.05850	0.063	0.063	-0.1	804.1	803.8	0.0	0.764
6	4	55.0	0.06208	0.064	0.064	0.0	863.1	862.9	0.0	0.756
7	2	65.0	0.03122	0.053	0.053	0.1	1905.0	1905.7	0.0	0.631
8	2	77.5	0.03092	0.052	0.052	0.2	2129.7	2131.6	-0.1	0.634
9	7	92.5	0.03511	0.085	0.085	-0.3	2049.9	2054.8	-0.2	0.551
10	2	107.5	0.04779	0.069	0.069	0.3	1684.0	1687.7	-0.2	0.537
11	2	122.5	0.03938	0.062	0.062	0.1	2247.7	2249.0	-0.1	0.579
12	1	140.0	0.01945	0.042	0.042	-0.1	4942.2	4941.5	0.0	0.884
13	2	160.0	0.03645	0.059	0.059	-0.1	2801.2	2799.2	0.1	0.596
14	2	180.0	0.02751	0.049	0.049	-0.1	3817.0	3813.6	0.1	0.656
15	2	200.0	0.02469	0.047	0.047	-0.1	4272.1	4268.2	0.1	0.677
16	2	220.0	0.02209	0.045	0.045	0.0	4765.9	4765.1	0.0	0.698
17	2	245.0	0.02791	0.049	0.049	0.2	4461.0	4467.7	-0.2	0.655

VALUES IN TIME DOMAIN

LAYER	TYPE	THICKNESS FT	DEPTH FT	MAX STRAIN PRCNT	MAX STRESS PSF	TIME SEC
1	4	10.0	5.0	0.01771	107.76	18.90
2	4	10.0	15.0	0.04723	303.87	18.90
3	4	10.0	25.0	0.06673	456.37	18.07
4	4	10.0	35.0	0.08242	610.84	18.06
5	4	10.0	45.0	0.09000	723.38	22.08
6	4	10.0	55.0	0.09551	824.13	22.08
7	2	10.0	65.0	0.04803	915.23	22.07
8	2	15.0	77.5	0.04757	1014.06	22.06
9	7	15.0	92.5	0.05401	1109.90	15.01
10	2	15.0	107.5	0.07353	1240.95	28.66
11	2	15.0	122.5	0.06058	1362.42	28.64
12	1	20.0	140.0	0.02992	1478.30	28.62
13	2	20.0	160.0	0.05607	1569.49	28.61
14	2	20.0	180.0	0.04232	1614.07	28.59
15	2	20.0	200.0	0.03799	1621.38	28.58
16	2	20.0	220.0	0.03398	1619.38	14.51
17	2	30.0	245.0	0.04294	1918.24	14.53

PERIOD = 1.24 FROM AVERAGE SHEAR VELOCITY = 835.

```
 FREQUENCY    AMPLITUDE
MAXIMUM AMPLIFICATION =  14.00
FOR FREQUENCY         =   1.00 C/SEC.
    PERIOD            =   1.00 SEC.
    Option NO.    5   has been concluded.
    Option NO.    6   is started.

1******   OPTION  6  ***  COMPUTE MOTION IN NEW SUBLAYERS

  EARTHQUAKE -BVLTFP.DAT
 SOIL DEPOSIT - Jungo Landfill; BVLTFP.DAT
    LAYER           DEPTH        MAX. ACC.          TIME      MEAN SQ. FR.         ACC. RATIO       TH SAVED
                     FT            G                SEC          C/SEC              QUIET ZONE       ACC. RECORD
    WITHIN            0.0        0.32169          20.79          2.61                0.000                 0
    WITHIN           10.0        0.28528          18.89          2.31                0.000                 0
    WITHIN           20.0        0.26925          18.05          2.03                0.000                 0
    WITHIN           30.0        0.22545          22.08          2.07                0.000                 0
    WITHIN           40.0        0.19054          14.98          2.19                0.000                 0
    WITHIN           50.0        0.17718          17.85          2.38                0.000                 0
    WITHIN           60.0        0.21215          20.91          2.52                0.000                 0
    WITHIN           70.0        0.18833          20.90          2.40                0.000                 0
    WITHIN           85.0        0.16550          21.33          2.28                0.000                 0
    WITHIN          100.0        0.14786          20.63          2.55                0.000                 0
    WITHIN          115.0        0.16059          17.76          2.98                0.000                 0
    WITHIN          130.0        0.15903          17.74          3.15                0.000                 0
    WITHIN          150.0        0.14897          17.73          2.93                0.000                 0
    WITHIN          170.0        0.14701          21.05          3.56                0.000                 0
    Option NO.    6   has been concluded.
    Option NO.    6   is started.

1******   OPTION  6  ***  COMPUTE MOTION IN NEW SUBLAYERS

  EARTHQUAKE -BVLTFP.DAT
 SOIL DEPOSIT - Jungo Landfill; BVLTFP.DAT
    LAYER           DEPTH        MAX. ACC.          TIME      MEAN SQ. FR.         ACC. RATIO       TH SAVED
                     FT            G                SEC          C/SEC              QUIET ZONE       ACC. RECORD
    WITHIN          190.0        0.17191          20.53          3.66                0.000                 0
    WITHIN          210.0        0.17177          20.51          3.92                0.000                 0
    WITHIN          230.0        0.17208          20.49          4.18                0.000                 0
    WITHIN          260.0        0.19518          20.47          4.54                0.000                 0
    OUTCR.          260.0        0.25956          20.47          4.57                0.000                 0
    Option NO.    6   has been concluded.
    Option NO.    7   is started.

1******   OPTION  7  ***  COMPUTE STRESS/STRAIN HISTORY

 COMPUTE STRESS OR STRAIN HISTORY AT THE TOP OF  LAYER    7
 SCALE FOR PLOTTING     0.0000
IDENTIFICATION - -- Stress at the top of layer
```

```
 COMPUTE STRESS OR STRAIN HISTORY AT THE TOP OF  LAYER    7
 SCALE FOR PLOTTING     0.0000
IDENTIFICATION - -- Strain not saved
    Option NO.    7   has been concluded.
```

```
*****************************************************
* SHAKE  --   A COMPUTER PROGRAM FOR EARTHQUAKE RESPONSE  *
*             ANALYSIS OF HORIZONTALLY LAYERED SITES      *
*             by: Per B. Schnabel & John Lysmer -- 1970   *
* ---------------------------------------------------- *
* shake85     IBM-PC version of SHAKE                     *
*             by: S.S. (Willie) Lai, January 1985         *
* ---------------------------------------------------- *
* shake88   : New modulus reduction curves for clays added*
*             using results from Sun et al (1988)         *
*             by: J. I. Sun & Ramin Golesorkhi            *
*             February 26, 1988                           *
* ---------------------------------------------------- *
* SHAKE90/91: Adjust last iteration; Input now is either  *
*             Gmax or max Vs; up to 13 material types can *
*             be specified by user; up to 50 Layers can   *
*             be specified; object motion can be read in  *
*             from a separate file and can have user      *
*             specified format; Different periods for     *
*             response spectral calculations; options     *
*             are renumbered; and general cleanup         *
*             by: J. I. Sun, I. M. Idriss & P. Dirrim     *
*             June 1990 - February 1991                   *
* ---------------------------------------------------- *
* SHAKE91   : General cleanup and finalization of input/  *
*             output format ... etc                       *
*             by: I. M. Idriss                            *
*             December 1991                               *
*************************************************************
 MAX. NUMBER OF TERMS IN FOURIER TRANSFORM =     32768
 NECESSARY LENGTH OF BLANK COMMON X        =    204819
    Option NO.    1   is started.

1******   OPTION  1  ***  READ RELATION BETWEEN SOIL PROPERTIES AND STRAIN

 **********************
  MATERIAL TYPE NO. 1
 **********************

 CURVE NO.  1:      #1 modulus for clay (seed & sun 1989) upper range
 CURVE NO.  2:        damping for clay (Idriss 1990) -


     CURVE NO. 1              CURVE NO. 2
 ===================      ==================
   STRAIN    G/Gmax         STRAIN    DAMPING
 --------  -------        --------  --------
   0.0001     1.000         0.0001      0.24
   0.0003     1.000         0.0003      0.42
```

0.0010	1.000	0.0010	0.30
0.0030	0.981	0.0030	1.40
0.0100	0.941	0.0100	2.30
0.0300	0.847	0.0300	5.10
0.1000	0.656	0.1000	9.30
0.3000	0.438	0.3000	15.50
1.0000	0.238	1.0000	21.00
3.0000	0.144	3.1600	25.00
10.0000	0.110	10.0000	28.00

****
MATERIAL TYPE NO. 2
****

CURVE NO. 3: #2 modulus for sand (seed & idriss 1970) - upper Range
CURVE NO. 4: damping for sand (Idriss 1990) - (about LRng from SI

CURVE NO. 3

STRAIN	G/Gmax
0.0001	1.000
0.0003	1.000
0.0010	0.990
0.0030	0.960
0.0100	0.850
0.0300	0.640
0.1000	0.370
0.3000	0.180
1.0000	0.080
3.0000	0.050
10.0000	0.035

CURVE NO. 4

STRAIN	DAMPING
0.0001	0.24
0.0003	0.42
0.0010	0.80
0.0030	1.40
0.0100	2.80
0.0300	5.10
0.1000	9.80
0.3000	15.50
1.0000	21.00
3.0000	25.00
10.0000	28.00

****
MATERIAL TYPE NO. 3
****

CURVE NO. 5: #3 ATTENUATION OF ROCK AVERAGE
CURVE NO. 6: DAMPING IN ROCK

CURVE NO. 5

STRAIN	G/Gmax
0.0001	1.000
0.0003	1.000
0.0010	0.988

CURVE NO. 6

STRAIN	DAMPING
0.0001	0.40
0.0010	0.80
0.0100	1.50

0.0030	0.952	0.1000	3.00
0.0100	0.900	1.0000	4.60
0.0300	0.810	0.0000	0.00
0.1000	0.725	0.0000	0.00
1.0000	0.550	0.0000	0.00

****
MATERIAL TYPE NO. 4
****

CURVE NO. 7: #4 modulus for waste (Zekkos et al., 2006)
CURVE NO. 8: damping for waste (Zekkos et al., 2006)

CURVE NO. 7

STRAIN	G/Gmax
0.0001	1.000
0.0003	0.996
0.0010	0.990
0.0030	0.975
0.0100	0.936
0.0300	0.856
0.1000	0.690
0.3000	0.475
1.0000	0.252
3.0000	0.121
8.0000	0.058

CURVE NO. 8

STRAIN	DAMPING
0.0001	4.00
0.0003	4.10
0.0010	4.10
0.0030	4.20
0.0100	4.50
0.0300	5.20
0.1000	7.20
0.3000	10.50
1.0000	14.00
3.0000	23.50
10.0000	28.00

****
MATERIAL TYPE NO. 7
****

CURVE NO. 13: #7 modulus for clay PI=1-10 (Sun et al., 1988)
CURVE NO. 14: damping for clay (Dobry & Vucetic Curve, 4/9/91)

CURVE NO.13

STRAIN	G/Gmax
0.0001	1.000
0.0010	0.974
0.0032	0.915
0.0100	0.786
0.0316	0.574
0.1000	0.312
0.3000	0.160

CURVE NO.14

STRAIN	DAMPING
0.0001	1.75
0.0010	1.75
0.0032	2.80
0.0100	4.90
0.0316	9.01
0.1000	3.45
0.3160	18.10

```
    1.0000     0.060         1.0000     22.00
    3.1600     0.020         3.1600     24.55
   10.0000     0.006        10.0000     26.50
     Option NO.    1   has been concluded.
     Option NO.    2   is started.

1******   OPTION  2  ***  READ SOIL PROFILE
 NEW SOIL PROFILE NO.   1      IDENTIFICATION  Jungo Landfill; CHY080FP.DAT
 NUMBER OF LAYERS                   18          DEPTH TO BEDROCK        260.00
```

NO.	TYPE	THICKNESS (ft)	DEPTH (ft)	Tot. PRESS. (ksf)	MODULUS (ksf)	DAMPING	UNIT WT. (kcf)	SHEAR VEL (fps)
1	4	10.00	5.00	0.34	657.	0.050	0.067	562.0
2	4	10.00	15.00	1.02	755.	0.050	0.071	585.0
3	4	10.00	25.00	1.75	850.	0.050	0.074	608.0
4	4	10.00	35.00	2.51	955.	0.050	0.077	632.0
5	4	10.00	45.00	3.29	1053.	0.050	0.079	655.0
6	4	10.00	55.00	4.08	1142.	0.050	0.080	678.0
7	2	10.00	65.00	5.08	3019.	0.050	0.120	900.0
8	2	15.00	77.50	6.58	3363.	0.050	0.120	950.0
9	7	15.00	92.50	8.38	3727.	0.050	0.120	1000.0
10	2	15.00	107.50	10.22	3144.	0.050	0.125	900.0
11	2	15.00	122.50	12.09	3882.	0.050	0.125	1000.0
12	1	20.00	140.00	14.28	5590.	0.050	0.125	1200.0
13	2	20.00	160.00	16.78	4697.	0.050	0.125	1100.0
14	2	20.00	180.00	19.33	5814.	0.050	0.130	1200.0
15	2	20.00	200.00	21.93	6308.	0.050	0.130	1250.0
16	2	20.00	220.00	24.53	6823.	0.050	0.130	1300.0
17	2	30.00	245.00	27.78	6823.	0.050	0.130	1300.0
18	BASE				36335.	0.050	0.130	3000.0

```
  PERIOD = 1.02 FROM AVERAGE SHEAR VELOCITY =   1015.


  FREQUENCY    AMPLITUDE
 MAXIMUM AMPLIFICATION =  15.72
 FOR FREQUENCY         =   1.24 C/SEC.
     PERIOD            =   0.81 SEC.
     Option NO.    2   has been concluded.
     Option NO.    3   is started.

1******   OPTION  3  ***  READ INPUT MOTION

  FILE NAME FOR INPUT MOTION = CHY080FP.DAT
    NO. OF INPUT ACC. POINTS = 22080
   NO. OF POINTS USED IN FFT = 32768
        NO. OF HEADING LINES =     5
      NO. OF POINTS PER LINE =     8
  TIME STEP FOR INPUT MOTION = 0.0050
```

```
  FORMAT FOR OF TIME HISTORY = (8F9.6)


  READING INPUT MOTION FROM ----> CHY080FP.DAT
  FORMAT OF INPUT MOTION USED --> (8F9.6)

 ***** H E A D E R
PEER NGA Rotated Accelerogram (November 1, 2007)
#Misfit: 0.0706782
File Type: Accelerations (g)
File Type: Accelerations (g)
NPTS= 22081 , DT= 0.005 SEC
 **  FIRST & LAST 5 LINES OF INPUT MOTION *****

     1 -0.000001-0.000001-0.000001-0.000001-0.000001-0.000001-0.000001-0.000001
     2 -0.000001-0.000001-0.000001-0.000001-0.000001-0.000001-0.000001-0.000001
     3 -0.000001-0.000001-0.000001-0.000001-0.000001-0.000001-0.000001-0.000001
     4 -0.000001-0.000001-0.000001-0.000001-0.000001-0.000001-0.000001-0.000001
     5 -0.000001-0.000001-0.000001-0.000001-0.000001-0.000002-0.000002-0.000002
   ........ INPUT MOTION READ NOT ECHOED...........
  2756  0.000030 0.000030 0.000030 0.000030 0.000030 0.000030 0.000030 0.000031
  2757  0.000031 0.000031 0.000031 0.000031 0.000031 0.000031 0.000031 0.000031
  2758  0.000032 0.000032 0.000032 0.000032 0.000032 0.000032 0.000032 0.000032
  2759  0.000033 0.000033 0.000033 0.000033 0.000033 0.000033 0.000033 0.000033
  2760  0.000033 0.000033 0.000034 0.000034 0.000034 0.000034 0.000034 0.000034

 MAXIMUM ACCELERATION =  0.23357
 AT TIME              = 24.18 SEC
 THE VALUES WILL BE MULTIPLIED BY A FACTOR =  1.070
 TO GIVE NEW MAXIMUM ACCELERATION          =  0.25000
 MEAN SQUARE FREQUENCY =       5.68 C/SEC.
  MAX ACCELERATION =    0.25000 FOR FREQUENCIES REMOVED ABOVE     100.00 C/SEC.
     Option NO.    3   has been concluded.
     Option NO.    4   is started.
1******   OPTION  4  ***  READ WHERE OBJECT MOTION IS GIVEN
   OBJECT MOTION IN LAYER NUMBER  18 OUTCROPPING
     Option NO.    4   has been concluded.
     Option NO.    5   is started.

1******   OPTION  5  ***  OBTAIN STRAIN COMPATIBLE SOIL PROPERTIES
  MAXIMUM NUMBER OF ITERATIONS                =     6
  FACTOR FOR UNIFORM STRAIN IN TIME DOMAIN    =   0.65


+              ITERATION NUMBER  1
     EARTHQUAKE   - CHY080FP.DAT
     SOIL PROFILE - Jungo Landfill; CHY080FP.DAT
```

ITERATION NUMBER 1

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01652	0.048	0.050	-3.7	591.1	657.2	-11.2	1.000
2	4	15.0	0.04133	0.057	0.050	12.8	612.6	754.6	-23.2	1.000
3	4	25.0	0.05565	0.062	0.050	19.7	654.8	849.5	-29.7	1.000
4	4	35.0	0.06026	0.064	0.050	21.4	725.8	955.1	-31.6	1.000
5	4	45.0	0.05945	0.063	0.050	21.1	801.7	1052.6	-31.3	1.000
6	4	55.0	0.05956	0.063	0.050	21.1	869.6	1142.1	-31.3	1.000
7	2	65.0	0.02535	0.047	0.050	-5.3	2029.2	3018.6	-48.8	1.000
8	2	77.5	0.02561	0.048	0.050	-4.8	2254.2	3363.4	-49.2	1.000
9	7	92.5	0.02545	0.082	0.050	39.3	2287.8	3726.7	-62.9	1.000
10	2	107.5	0.03244	0.054	0.050	7.5	1957.4	3144.4	-60.6	1.000
11	2	122.5	0.02778	0.049	0.050	-1.2	2541.6	3882.0	-52.7	1.000
12	1	140.0	0.02045	0.043	0.050	-16.3	4918.0	5590.1	-13.7	1.000
13	2	160.0	0.02717	0.049	0.050	-2.2	3095.3	4697.2	-51.8	1.000
14	2	180.0	0.02361	0.046	0.050	-8.7	3987.0	5813.7	-45.8	1.000
15	2	200.0	0.02292	0.045	0.050	-10.2	4361.8	6308.2	-44.6	1.000
16	2	220.0	0.02306	0.045	0.050	-9.9	4709.8	6823.0	-44.9	1.000
17	2	245.0	0.02497	0.047	0.050	-6.0	4605.8	6823.0	-48.1	1.000

+ ITERATION NUMBER 2
1

EARTHQUAKE - CHY080FP.DAT
SOIL PROFILE - Jungo Landfill; CHY080FP.DAT

ITERATION NUMBER 2

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01652	0.048	0.048	0.0	591.1	591.1	0.0	0.899
2	4	15.0	0.04583	0.059	0.057	2.9	601.8	612.5	-1.8	0.812
3	4	25.0	0.06464	0.065	0.062	3.8	637.3	654.3	-2.8	0.771
4	4	35.0	0.06987	0.066	0.064	3.7	706.3	725.3	-2.8	0.760
5	4	45.0	0.06700	0.065	0.063	3.0	784.4	801.7	-2.2	0.762
6	4	55.0	0.06901	0.066	0.063	3.7	846.4	869.5	-2.7	0.761
7	2	65.0	0.03276	0.054	0.047	12.8	1872.4	2029.2	-8.4	0.672
8	2	77.5	0.03324	0.055	0.048	13.3	2075.2	2254.2	-8.6	0.670
9	7	92.5	0.03521	0.085	0.082	3.0	2047.5	2287.3	-11.7	0.614
10	2	107.5	0.04498	0.067	0.054	19.1	1726.8	1957.4	-13.4	0.622
11	2	122.5	0.03823	0.060	0.049	18.3	2273.4	2541.5	-11.8	0.655
12	1	140.0	0.02311	0.046	0.043	5.6	4859.7	4918.0	-1.2	0.880
13	2	160.0	0.04340	0.065	0.049	25.2	2617.3	3095.3	-18.3	0.659

14	2	180.0	0.03838	0.061	0.046	24.1	3399.7	3987.0	-17.3	0.686
15	2	200.0	0.03864	0.061	0.045	25.5	3679.4	4361.3	-18.5	0.691
16	2	220.0	0.03831	0.061	0.045	24.9	3992.5	4709.3	-18.0	0.690
17	2	245.0	0.04214	0.064	0.047	26.6	3846.9	4605.3	-19.7	0.675

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+                ITERATION NUMBER  3
1
     EARTHQUAKE    - CHY080FP.DAT
     SOIL PROFILE - Jungo Landfill; CHY080FP.DAT
```

ITERATION NUMBER 3

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01427	0.047	0.048	-2.0	598.1	591.1	1.2	0.899
2	4	15.0	0.04017	0.057	0.059	-3.8	615.6	601.3	2.2	0.798
3	4	25.0	0.05679	0.063	0.065	-3.4	652.5	637.3	2.3	0.750
4	4	35.0	0.06092	0.064	0.066	-3.6	724.3	706.3	2.5	0.739
5	4	45.0	0.05771	0.063	0.065	-3.9	806.1	784.4	2.7	0.745
6	4	55.0	0.06000	0.064	0.066	-3.7	868.5	846.4	2.5	0.741
7	2	65.0	0.03003	0.051	0.054	-6.6	1931.2	1872.4	3.0	0.620
8	2	77.5	0.03144	0.053	0.055	-4.1	2117.2	2075.2	2.0	0.617
9	7	92.5	0.03652	0.083	0.085	-2.1	2016.5	2047.5	-1.5	0.549
10	2	107.5	0.04922	0.070	0.067	5.0	1663.3	1726.3	-3.8	0.549
11	2	122.5	0.04391	0.066	0.060	8.2	2152.8	2273.4	-5.6	0.586
12	1	140.0	0.02390	0.046	0.046	1.5	4843.6	4859.7	-0.3	0.869
13	2	160.0	0.05262	0.073	0.065	10.3	2414.3	2617.3	-8.4	0.557
14	2	180.0	0.04552	0.067	0.061	9.9	3177.1	3399.7	-7.0	0.585
15	2	200.0	0.04553	0.067	0.061	9.5	3447.2	3679.4	-6.7	0.583
16	2	220.0	0.04415	0.066	0.061	8.4	3775.6	3992.5	-5.7	0.585
17	2	245.0	0.04804	0.069	0.064	7.4	3646.3	3846.9	-5.5	0.564

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+                ITERATION NUMBER  4
1
     EARTHQUAKE    - CHY080FP.DAT
     SOIL PROFILE - Jungo Landfill; CHY080FP.DAT
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ITERATION NUMBER 4

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01360	0.047	0.047	-0.6	600.4	598.1	0.4	0.910
2	4	15.0	0.03785	0.056	0.057	-1.8	621.7	615.5	1.0	0.816
3	4	25.0	0.05353	0.062	0.063	-1.6	659.4	652.5	1.1	0.768
4	4	35.0	0.05733	0.063	0.064	-1.6	732.3	724.3	1.1	0.758

5	4	45.0	0.05368	0.062	0.063	-2.0	816.6	806.1	1.3	0.766
6	4	55.0	0.05571	0.062	0.064	-2.0	880.2	868.5	1.3	0.760
7	2	65.0	0.02900	0.050	0.051	-1.5	1951.5	1931.2	1.0	0.640
8	2	77.5	0.03117	0.052	0.053	-0.6	2123.6	2117.2	0.3	0.629
9	7	92.5	0.03766	0.082	0.083	-1.8	1990.4	2016.5	-1.3	0.541
10	2	107.5	0.05149	0.072	0.070	2.4	1631.6	1663.3	-1.9	0.529
11	2	122.5	0.04638	0.068	0.066	3.1	2105.2	2152.3	-2.3	0.555
12	1	140.0	0.02391	0.046	0.046	0.0	4843.3	4843.5	0.0	0.866
13	2	160.0	0.05687	0.076	0.073	4.0	2332.5	2414.3	-3.5	0.514
14	2	180.0	0.04838	0.070	0.067	3.4	3097.6	3177.1	-2.6	0.546
15	2	200.0	0.04804	0.069	0.067	3.0	3371.1	3447.2	-2.3	0.546
16	2	220.0	0.04602	0.068	0.066	2.4	3712.1	3775.5	-1.7	0.553
17	2	245.0	0.04987	0.071	0.069	2.1	3589.0	3646.3	-1.6	0.534

+ ITERATION NUMBER 5
1

EARTHQUAKE - CHY080FP.DAT
SOIL PROFILE - Jungo Landfill; CHY080FP.DAT

ITERATION NUMBER 5

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01336	0.047	0.047	-0.2	601.3	600.4	0.1	0.914
2	4	15.0	0.03698	0.055	0.056	-0.7	624.2	621.7	0.4	0.824
3	4	25.0	0.05224	0.061	0.062	-0.7	662.2	659.4	0.4	0.776
4	4	35.0	0.05601	0.062	0.063	-0.6	735.4	732.3	0.4	0.767
5	4	45.0	0.05236	0.061	0.062	-0.7	820.2	816.5	0.4	0.776
6	4	55.0	0.05510	0.062	0.062	-0.3	881.9	880.2	0.2	0.771
7	2	65.0	0.02880	0.050	0.050	-0.3	1955.4	1951.5	0.2	0.646
8	2	77.5	0.03126	0.053	0.052	0.2	2121.4	2123.5	-0.1	0.631
9	7	92.5	0.03837	0.081	0.082	-1.1	1974.5	1990.4	-0.8	0.534
10	2	107.5	0.05263	0.073	0.072	1.2	1616.1	1631.5	-1.0	0.519
11	2	122.5	0.04743	0.069	0.068	1.3	2085.8	2105.2	-0.9	0.542
12	1	140.0	0.02388	0.046	0.046	-0.1	4843.9	4843.3	0.0	0.866
13	2	160.0	0.05878	0.077	0.076	1.7	2297.7	2332.5	-1.5	0.497
14	2	180.0	0.04946	0.071	0.070	1.2	3068.9	3097.5	-0.9	0.533
15	2	200.0	0.04886	0.070	0.069	0.9	3347.2	3371.1	-0.7	0.534
16	2	220.0	0.04653	0.068	0.068	0.6	3695.0	3712.1	-0.5	0.544
17	2	245.0	0.05034	0.071	0.071	0.5	3574.7	3589.0	-0.4	0.526

+ ITERATION NUMBER 6
1

EARTHQUAKE - CHY080FP.DAT
SOIL PROFILE - Jungo Landfill; CHY080FP.DAT

ITERATION NUMBER 6

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01328	0.047	0.047	-0.1	601.5	601.3	0.0	0.915
2	4	15.0	0.03666	0.055	0.055	-0.3	625.1	624.2	0.1	0.827
3	4	25.0	0.05176	0.061	0.061	-0.3	663.3	662.2	0.2	0.780
4	4	35.0	0.05550	0.062	0.062	-0.2	736.6	735.4	0.2	0.770
5	4	45.0	0.05192	0.061	0.061	-0.2	821.4	820.2	0.1	0.779
6	4	55.0	0.05504	0.062	0.062	0.0	882.1	881.9	0.0	0.772
7	2	65.0	0.02878	0.050	0.050	0.0	1956.0	1955.4	0.0	0.648
8	2	77.5	0.03135	0.053	0.053	0.2	2119.4	2121.4	-0.1	0.631
9	7	92.5	0.03873	0.080	0.081	-0.6	1966.7	1974.5	-0.4	0.530
10	2	107.5	0.05320	0.073	0.073	0.6	1608.4	1616.1	-0.5	0.514
11	2	122.5	0.04787	0.069	0.069	0.5	2077.7	2085.8	-0.4	0.537
12	1	140.0	0.02387	0.046	0.046	0.0	4844.0	4843.9	0.0	0.867
13	2	160.0	0.05965	0.078	0.077	0.7	2282.2	2297.7	-0.7	0.489
14	2	180.0	0.04987	0.071	0.071	0.5	3058.2	3068.9	-0.4	0.528
15	2	200.0	0.04912	0.070	0.070	0.3	3339.8	3347.2	-0.2	0.531
16	2	220.0	0.04665	0.068	0.068	0.1	3691.3	3695.0	-0.1	0.542
17	2	245.0	0.05041	0.071	0.071	0.1	3572.5	3574.7	-0.1	0.524

VALUES IN TIME DOMAIN

LAYER	TYPE	THICKNESS FT	DEPTH FT	MAX STRAIN PRCNT	MAX STRESS PSF	TIME SEC
1	4	10.0	5.0	0.02043	122.86	22.39
2	4	10.0	15.0	0.05640	352.04	22.39
3	4	10.0	25.0	0.07964	527.37	22.39
4	4	10.0	35.0	0.08538	627.86	22.39
5	4	10.0	45.0	0.07987	655.11	22.39
6	4	10.0	55.0	0.08467	746.70	22.19
7	2	10.0	65.0	0.04427	865.64	22.18
8	2	15.0	77.5	0.04823	1023.18	22.17
9	7	15.0	92.5	0.05959	1176.53	22.16
10	2	15.0	107.5	0.08185	1322.77	22.14
11	2	15.0	122.5	0.07365	1536.10	22.11
12	1	20.0	140.0	0.03673	1779.11	22.08
13	2	20.0	160.0	0.09177	2108.56	22.07
14	2	20.0	180.0	0.07672	2354.54	22.06
15	2	20.0	200.0	0.07557	2529.33	22.04
16	2	20.0	220.0	0.07177	2651.77	22.02
17	2	30.0	245.0	0.07756	2772.52	21.99

PERIOD = 1.32 FROM AVERAGE SHEAR VELOCITY = 786.

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  FREQUENCY    AMPLITUDE
 MAXIMUM AMPLIFICATION =  10.68
 FOR FREQUENCY         =   0.92 C/SEC.
     PERIOD            =   1.09 SEC.
     Option NO.    5   has been concluded.
     Option NO.    6   is started.

1******   OPTION  6  ***  COMPUTE MOTION IN NEW SUBLAYERS

   EARTHQUAKE -CHY080FP.DAT
  SOIL DEPOSIT - Jungo Landfill; CHY080FP.DAT
     LAYER           DEPTH        MAX. ACC.          TIME      MEAN SQ. FR.         ACC. RATIO       TH SAVED
                      FT            G                 SEC          C/SEC             QUIET ZONE       ACC. RECORD
     WITHIN            0.0        0.37502          22.39           2.80                0.000                 0
     WITHIN           10.0        0.34163          22.39           2.49                0.000                 0
     WITHIN           20.0        0.25297          22.39           2.08                0.000                 0
     WITHIN           30.0        0.19361          22.15           2.17                0.000                 0
     WITHIN           40.0        0.18002          22.15           2.47                0.000                 0
     WITHIN           50.0        0.17042          22.52           2.60                0.000                 0
     WITHIN           60.0        0.23194          22.51           2.70                0.000                 0
     WITHIN           70.0        0.23686          22.51           2.61                0.000                 0
     WITHIN           85.0        0.19650          22.50           2.37                0.000                 0
     WITHIN          100.0        0.17008          22.03           2.65                0.000                 0
     WITHIN          115.0        0.17249          22.59           3.15                0.000                 0
     WITHIN          130.0        0.18242          22.60           3.25                0.000                 0
     WITHIN          150.0        0.16618          23.98           3.05                0.000                 0
     WITHIN          170.0        0.17109          23.51           3.81                0.000                 0
     Option NO.    6   has been concluded.
     Option NO.    6   is started.

1******   OPTION  6  ***  COMPUTE MOTION IN NEW SUBLAYERS

   EARTHQUAKE -CHY080FP.DAT
  SOIL DEPOSIT - Jungo Landfill; CHY080FP.DAT
     LAYER           DEPTH        MAX. ACC.          TIME      MEAN SQ. FR.         ACC. RATIO       TH SAVED
                      FT            G                 SEC          C/SEC             QUIET ZONE       ACC. RECORD
     WITHIN          190.0        0.17474          23.48           4.05                0.000                 0
     WITHIN          210.0        0.18147          23.47           4.29                0.000                 0
     WITHIN          230.0        0.19367          23.44           4.67                0.000                 0
     WITHIN          260.0        0.19312          24.18           5.52                0.000                 0
     OUTCR.          260.0        0.25000          24.18           5.68                0.000                 0
     Option NO.    6   has been concluded.
     Option NO.    7   is started.

1******   OPTION  7  ***  COMPUTE STRESS/STRAIN HISTORY

  COMPUTE STRESS OR STRAIN HISTORY AT THE TOP OF  LAYER    7
  SCALE FOR PLOTTING     0.0000
 IDENTIFICATION - -- Stress at the top of layer
```

```
 COMPUTE STRESS OR STRAIN HISTORY AT THE TOP OF  LAYER    7
 SCALE FOR PLOTTING     0.0000
IDENTIFICATION - -- Strain not saved
    Option NO.    7   has been concluded.
```

```
*****************************************************
* SHAKE  --   A COMPUTER PROGRAM FOR EARTHQUAKE RESPONSE  *
*             ANALYSIS OF HORIZONTALLY LAYERED SITES      *
*             by: Per B. Schnabel & John Lysmer -- 1970   *
* ---------------------------------------------------- *
* shake85     IBM-PC version of SHAKE                     *
*             by: S.S. (Willie) Lai, January 1985         *
* ---------------------------------------------------- *
* shake88   : New modulus reduction curves for clays added*
*             using results from Sun et al (1988)         *
*             by: J. I. Sun & Ramin Golesorkhi            *
*             February 26, 1988                           *
* ---------------------------------------------------- *
* SHAKE90/91: Adjust last iteration; Input now is either  *
*             Gmax or max Vs; up to 13 material types can *
*             be specified by user; up to 50 Layers can   *
*             be specified; object motion can be read in  *
*             from a separate file and can have user      *
*             specified format; Different periods for     *
*             response spectral calculations; options     *
*             are renumbered; and general cleanup         *
*             by: J. I. Sun, I. M. Idriss & P. Dirrim     *
*             June 1990 - February 1991                   *
* ---------------------------------------------------- *
* SHAKE91   : General cleanup and finalization of input/  *
*             output format ... etc                       *
*             by: I. M. Idriss                            *
*             December 1991                               *
*************************************************************
 MAX. NUMBER OF TERMS IN FOURIER TRANSFORM =     32768
 NECESSARY LENGTH OF BLANK COMMON X        =    204819
    Option NO.    1   is started.

1******   OPTION  1  ***  READ RELATION BETWEEN SOIL PROPERTIES AND STRAIN

 **********************
  MATERIAL TYPE NO. 1
 **********************

 CURVE NO.  1:      #1 modulus for clay (seed & sun 1989) upper range
 CURVE NO.  2:        damping for clay (Idriss 1990) -


     CURVE NO. 1              CURVE NO. 2
 ===================      ==================
   STRAIN    G/Gmax         STRAIN    DAMPING
 --------   -------        --------  --------
   0.0001     1.000         0.0001      0.24
   0.0003     1.000         0.0003      0.42
```

0.0010	1.000	0.0010	0.80
0.0030	0.981	0.0030	1.40
0.0100	0.941	0.0100	2.80
0.0300	0.847	0.0300	5.10
0.1000	0.656	0.1000	9.80
0.3000	0.438	0.3000	15.50
1.0000	0.238	1.0000	21.00
3.0000	0.144	3.1600	25.00
10.0000	0.110	10.0000	28.00

****
MATERIAL TYPE NO. 2
****

CURVE NO. 3: #2 modulus for sand (seed & idriss 1970) - upper Range
CURVE NO. 4: damping for sand (Idriss 1990) - (about LRng from SI

CURVE NO. 3

STRAIN	G/Gmax
0.0001	1.000
0.0003	1.000
0.0010	0.990
0.0030	0.960
0.0100	0.850
0.0300	0.640
0.1000	0.370
0.3000	0.180
1.0000	0.080
3.0000	0.050
10.0000	0.035

CURVE NO. 4

STRAIN	DAMPING
0.0001	0.24
0.0003	0.42
0.0010	0.80
0.0030	1.40
0.0100	2.80
0.0300	5.10
0.1000	9.80
0.3000	15.50
1.0000	21.00
3.0000	25.00
10.0000	28.00

****
MATERIAL TYPE NO. 3
****

CURVE NO. 5: #3 ATTENUATION OF ROCK AVERAGE
CURVE NO. 6: DAMPING IN ROCK

CURVE NO. 5

STRAIN	G/Gmax
0.0001	1.000
0.0003	1.000
0.0010	0.988

CURVE NO. 6

STRAIN	DAMPING
0.0001	0.40
0.0010	0.80
0.0100	1.50

0.0030	0.952	0.1000	3.00
0.0100	0.900	1.0000	4.60
0.0300	0.810	0.0000	0.00
0.1000	0.725	0.0000	0.00
1.0000	0.550	0.0000	0.00

****
MATERIAL TYPE NO. 4
****

CURVE NO. 7: #4 modulus for waste (Zekkos et al., 2006)
CURVE NO. 8: damping for waste (Zekkos et al., 2006)

CURVE NO. 7

STRAIN	G/Gmax
0.0001	1.000
0.0003	0.996
0.0010	0.990
0.0030	0.975
0.0100	0.936
0.0300	0.856
0.1000	0.690
0.3000	0.475
1.0000	0.252
3.0000	0.121
8.0000	0.058

CURVE NO. 8

STRAIN	DAMPING
0.0001	4.00
0.0003	4.10
0.0010	4.10
0.0030	4.20
0.0100	4.50
0.0300	5.20
0.1000	7.20
0.3000	10.50
1.0000	14.00
3.0000	23.50
10.0000	28.00

****
MATERIAL TYPE NO. 7
****

CURVE NO. 13: #7 modulus for clay PI=1-10 (Sun et al., 1988)
CURVE NO. 14: damping for clay (Dobry & Vucetic Curve, 4/9/91)

CURVE NO.13

STRAIN	G/Gmax
0.0001	1.000
0.0010	0.974
0.0032	0.915
0.0100	0.786
0.0316	0.574
0.1000	0.312
0.3000	0.160

CURVE NO.14

STRAIN	DAMPING
0.0001	1.75
0.0010	1.75
0.0032	2.30
0.0100	4.90
0.0316	9.01
0.1000	3.45
0.3160	18.10

```
    1.0000      0.060          1.0000      22.00
    3.1600      0.020          3.1600      24.55
   10.0000      0.006         10.0000      26.50
     Option NO.    1   has been concluded.
     Option NO.    2   is started.

1******   OPTION  2  ***  READ SOIL PROFILE
 NEW SOIL PROFILE NO.   1      IDENTIFICATION  Jungo Landfill; PARFFN.DAT
 NUMBER OF LAYERS                   18          DEPTH TO BEDROCK        260.00
```

NO.	TYPE	THICKNESS (ft)	DEPTH (ft)	Tot. PRESS. (ksf)	MODULUS (ksf)	DAMPING	UNIT WT. (kcf)	SHEAR VEL (fps)
1	4	10.00	5.00	0.34	657.	0.050	0.067	562.0
2	4	10.00	15.00	1.02	755.	0.050	0.071	585.0
3	4	10.00	25.00	1.75	850.	0.050	0.074	608.0
4	4	10.00	35.00	2.51	955.	0.050	0.077	632.0
5	4	10.00	45.00	3.29	1053.	0.050	0.079	655.0
6	4	10.00	55.00	4.08	1142.	0.050	0.080	678.0
7	2	10.00	65.00	5.08	3019.	0.050	0.120	900.0
8	2	15.00	77.50	6.58	3363.	0.050	0.120	950.0
9	7	15.00	92.50	8.38	3727.	0.050	0.120	1000.0
10	2	15.00	107.50	10.22	3144.	0.050	0.125	900.0
11	2	15.00	122.50	12.09	3882.	0.050	0.125	1000.0
12	1	20.00	140.00	14.28	5590.	0.050	0.125	1200.0
13	2	20.00	160.00	16.78	4697.	0.050	0.125	1100.0
14	2	20.00	180.00	19.33	5814.	0.050	0.130	1200.0
15	2	20.00	200.00	21.93	6308.	0.050	0.130	1250.0
16	2	20.00	220.00	24.53	6823.	0.050	0.130	1300.0
17	2	30.00	245.00	27.78	6823.	0.050	0.130	1300.0
18	BASE				36335.	0.050	0.130	3000.0

```
  PERIOD = 1.02 FROM AVERAGE SHEAR VELOCITY =   1015.


  FREQUENCY    AMPLITUDE
 MAXIMUM AMPLIFICATION =  15.72
 FOR FREQUENCY         =   1.24 C/SEC.
     PERIOD            =   0.81 SEC.
     Option NO.    2   has been concluded.
     Option NO.    3   is started.

1******   OPTION  3  ***  READ INPUT MOTION

  FILE NAME FOR INPUT MOTION = PARFFN.DAT
    NO. OF INPUT ACC. POINTS = 10936
   NO. OF POINTS USED IN FFT = 16384
        NO. OF HEADING LINES =     5
      NO. OF POINTS PER LINE =     8
  TIME STEP FOR INPUT MOTION = 0.0050
```

```
  FORMAT FOR OF TIME HISTORY = (8F9.6)


  READING INPUT MOTION FROM ----> PARFFN.DAT
  FORMAT OF INPUT MOTION USED --> (8F9.6)

 ***** H E A D E R
PEER NGA Rotated Accelerogram (November 1, 2007)
#Misfit: 0.0707737
File Type: Accelerations (g)
File Type: Accelerations (g)
NPTS= 10936 , DT= 0.005 SEC
 **  FIRST & LAST 5 LINES OF INPUT MOTION *****

     1  0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
     2  0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
     3  0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
     4  0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
     5  0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
   ........ INPUT MOTION READ NOT ECHOED...........
  1363 -0.000076-0.000077-0.000079-0.000080-0.000081-0.000083-0.000084-0.000086
  1364 -0.000087-0.000088-0.000089-0.000091-0.000092-0.000093-0.000094-0.000095
  1365 -0.000096-0.000097-0.000097-0.000098-0.000099-0.000099-0.000100-0.000100
  1366 -0.000101-0.000101-0.000101-0.000101-0.000101-0.000101-0.000101-0.000101
  1367 -0.000100-0.000100-0.000099-0.000099-0.000098-0.000098-0.000097-0.000096

 MAXIMUM ACCELERATION =  0.23962
 AT TIME              = 28.68 SEC
 THE VALUES WILL BE MULTIPLIED BY A FACTOR =  1.043
 TO GIVE NEW MAXIMUM ACCELERATION          =  0.25000
 MEAN SQUARE FREQUENCY =       5.88 C/SEC.
  MAX ACCELERATION =    0.25000 FOR FREQUENCIES REMOVED ABOVE     100.00 C/SEC.
     Option NO.    3   has been concluded.
     Option NO.    4   is started.
1******   OPTION  4  ***  READ WHERE OBJECT MOTION IS GIVEN
   OBJECT MOTION IN LAYER NUMBER  18 OUTCROPPING
     Option NO.    4   has been concluded.
     Option NO.    5   is started.

1******   OPTION  5  ***  OBTAIN STRAIN COMPATIBLE SOIL PROPERTIES
  MAXIMUM NUMBER OF ITERATIONS                =     6
  FACTOR FOR UNIFORM STRAIN IN TIME DOMAIN    =   0.65


+              ITERATION NUMBER  1
     EARTHQUAKE   - PARFFN.DAT
     SOIL PROFILE - Jungo Landfill; PARFFN.DAT
```

ITERATION NUMBER 1

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01349	0.047	0.050	-6.6	600.8	657.2	-9.4	1.000
2	4	15.0	0.03428	0.054	0.050	7.8	632.1	754.6	-19.4	1.000
3	4	25.0	0.04747	0.060	0.050	16.1	673.4	849.5	-26.1	1.000
4	4	35.0	0.05288	0.061	0.050	18.6	742.9	955.1	-28.6	1.000
5	4	45.0	0.05297	0.061	0.050	18.6	818.5	1052.6	-28.6	1.000
6	4	55.0	0.05700	0.063	0.050	20.2	876.5	1142.1	-30.3	1.000
7	2	65.0	0.02556	0.048	0.050	-4.9	2024.4	3018.6	-49.1	1.000
8	2	77.5	0.02775	0.049	0.050	-1.3	2202.7	3363.4	-52.7	1.000
9	7	92.5	0.02938	0.088	0.050	42.9	2189.1	3726.7	-70.2	1.000
10	2	107.5	0.03896	0.061	0.050	18.3	1828.2	3144.4	-72.0	1.000
11	2	122.5	0.03408	0.056	0.050	10.7	2373.5	3882.0	-63.6	1.000
12	1	140.0	0.02513	0.047	0.050	-5.7	4819.5	5590.1	-16.0	1.000
13	2	160.0	0.03155	0.053	0.050	5.6	2953.1	4697.2	-59.1	1.000
14	2	180.0	0.02715	0.049	0.050	-2.2	3831.8	5813.7	-51.7	1.000
15	2	200.0	0.02625	0.048	0.050	-3.7	4198.4	6308.2	-50.3	1.000
16	2	220.0	0.02447	0.047	0.050	-7.0	4632.3	6823.0	-47.3	1.000
17	2	245.0	0.02357	0.046	0.050	-8.8	4681.2	6823.0	-45.8	1.000

+ ITERATION NUMBER 2
1

EARTHQUAKE - PARFFN.DAT
SOIL PROFILE - Jungo Landfill; PARFFN.DAT

ITERATION NUMBER 2

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01184	0.046	0.047	-1.8	607.1	600.8	1.0	0.914
2	4	15.0	0.03229	0.053	0.054	-1.9	638.3	632.1	1.0	0.838
3	4	25.0	0.04535	0.059	0.060	-1.3	678.8	673.4	0.8	0.793
4	4	35.0	0.05319	0.062	0.061	0.2	742.2	742.9	-0.1	0.778
5	4	45.0	0.06279	0.064	0.061	4.4	793.8	818.5	-3.1	0.778
6	4	55.0	0.07111	0.066	0.063	5.5	841.7	876.5	-4.1	0.768
7	2	65.0	0.03643	0.059	0.048	18.7	1800.4	2024.4	-12.4	0.671
8	2	77.5	0.04023	0.062	0.049	21.0	1931.2	2202.7	-14.1	0.655
9	7	92.5	0.04692	0.071	0.088	-23.2	1804.1	2189.1	-21.3	0.587
10	2	107.5	0.06205	0.079	0.061	22.9	1500.0	1828.2	-21.9	0.581
11	2	122.5	0.04994	0.071	0.056	21.0	2040.7	2373.5	-16.3	0.611
12	1	140.0	0.02565	0.048	0.047	0.9	4809.6	4819.5	-0.2	0.862
13	2	160.0	0.04415	0.066	0.053	19.9	2599.1	2953.1	-13.6	0.629

14	2	180.0	0.03388	0.056	0.049	12.3	3562.2	3831.8	-7.6	0.659
15	2	200.0	0.03098	0.052	0.048	7.8	3991.8	4198.4	-5.2	0.666
16	2	220.0	0.03044	0.052	0.047	9.4	4344.3	4632.3	-6.6	0.679
17	2	245.0	0.03208	0.054	0.046	14.3	4264.3	4681.2	-9.8	0.686

+ ITERATION NUMBER 3
1

EARTHQUAKE - PARFFN.DAT
SOIL PROFILE - Jungo Landfill; PARFFN.DAT

ITERATION NUMBER 3

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01091	0.046	0.046	-1.1	611.0	607.1	0.6	0.924
2	4	15.0	0.02897	0.052	0.053	-2.8	647.8	638.3	1.5	0.846
3	4	25.0	0.04093	0.057	0.059	-3.0	690.8	678.8	1.7	0.799
4	4	35.0	0.05144	0.061	0.062	-0.9	746.6	742.2	0.6	0.777
5	4	45.0	0.06289	0.064	0.064	0.0	793.6	793.8	0.0	0.754
6	4	55.0	0.07210	0.067	0.066	0.3	839.5	841.7	-0.3	0.737
7	2	65.0	0.03995	0.062	0.059	5.8	1738.0	1800.4	-3.6	0.596
8	2	77.5	0.04461	0.066	0.062	6.1	1853.3	1931.2	-4.2	0.574
9	7	92.5	0.05493	0.063	0.071	-12.0	1670.5	1804.1	-8.0	0.484
10	2	107.5	0.07112	0.085	0.079	6.3	1403.7	1500.0	-6.9	0.477
11	2	122.5	0.05343	0.074	0.071	3.6	1982.0	2040.7	-3.0	0.526
12	1	140.0	0.02368	0.046	0.048	-3.6	4848.0	4809.6	0.8	0.860
13	2	160.0	0.04489	0.067	0.066	1.0	2581.8	2599.1	-0.7	0.553
14	2	180.0	0.03526	0.057	0.056	2.7	3510.1	3562.2	-1.5	0.613
15	2	200.0	0.03397	0.056	0.052	6.4	3861.6	3991.8	-3.4	0.633
16	2	220.0	0.03268	0.054	0.052	5.1	4235.8	4344.3	-2.6	0.637
17	2	245.0	0.03464	0.057	0.054	5.3	4146.6	4264.3	-2.8	0.625

+ ITERATION NUMBER 4
1

EARTHQUAKE - PARFFN.DAT
SOIL PROFILE - Jungo Landfill; PARFFN.DAT

ITERATION NUMBER 4

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01066	0.045	0.046	-0.3	612.1	611.0	0.2	0.930
2	4	15.0	0.02812	0.052	0.052	-0.4	649.5	647.8	0.3	0.859
3	4	25.0	0.03947	0.057	0.057	-1.1	695.1	690.8	0.6	0.813
4	4	35.0	0.05074	0.061	0.061	-0.4	748.4	746.6	0.2	0.782

5	4	45.0	0.06246	0.064	0.064	-0.2	794.6	793.6	0.1	0.754
6	4	55.0	0.07182	0.067	0.067	-0.1	840.2	839.5	0.1	0.735
7	2	65.0	0.04115	0.063	0.062	1.8	1717.9	1738.0	-1.2	0.576
8	2	77.5	0.04619	0.068	0.066	2.0	1827.0	1853.3	-1.4	0.551
9	7	92.5	0.05891	0.060	0.063	-5.6	1611.3	1670.5	-3.7	0.448
10	2	107.5	0.07466	0.087	0.085	2.2	1369.5	1403.7	-2.5	0.446
11	2	122.5	0.05362	0.074	0.074	0.2	1978.9	1982.0	-0.2	0.511
12	1	140.0	0.02292	0.045	0.046	-1.5	4863.6	4848.0	0.3	0.867
13	2	160.0	0.04386	0.066	0.067	-1.4	2606.2	2581.8	0.9	0.550
14	2	180.0	0.03649	0.059	0.057	2.3	3465.3	3510.1	-1.3	0.604
15	2	200.0	0.03533	0.057	0.056	2.7	3805.9	3861.6	-1.5	0.612
16	2	220.0	0.03325	0.055	0.054	1.2	4209.2	4235.8	-0.6	0.621
17	2	245.0	0.03536	0.057	0.057	1.4	4115.2	4146.6	-0.8	0.608

+ ITERATION NUMBER 5
1

EARTHQUAKE - PARFFN.DAT
SOIL PROFILE - Jungo Landfill; PARFFN.DAT

ITERATION NUMBER 5

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01059	0.045	0.045	-0.1	612.4	612.1	0.1	0.931
2	4	15.0	0.02783	0.052	0.052	-0.1	650.1	649.5	0.1	0.861
3	4	25.0	0.03890	0.056	0.057	-0.4	696.8	695.1	0.2	0.818
4	4	35.0	0.05053	0.061	0.061	-0.1	748.9	748.4	0.1	0.784
5	4	45.0	0.06231	0.064	0.064	-0.1	794.9	794.6	0.0	0.755
6	4	55.0	0.07171	0.066	0.067	0.0	840.4	840.2	0.0	0.736
7	2	65.0	0.04160	0.064	0.063	0.7	1710.5	1717.9	-0.4	0.569
8	2	77.5	0.04681	0.068	0.068	0.8	1816.9	1827.0	-0.6	0.543
9	7	92.5	0.06102	0.058	0.060	-2.9	1581.4	1611.3	-1.9	0.432
10	2	107.5	0.07607	0.087	0.087	0.8	1356.3	1369.5	-1.0	0.436
11	2	122.5	0.05329	0.073	0.074	-0.3	1984.3	1978.9	0.3	0.510
12	1	140.0	0.02267	0.045	0.045	-0.5	4868.8	4863.6	0.1	0.870
13	2	160.0	0.04334	0.065	0.066	-0.7	2618.8	2606.2	0.5	0.555
14	2	180.0	0.03724	0.059	0.059	1.3	3439.1	3465.3	-0.8	0.596
15	2	200.0	0.03590	0.058	0.057	1.1	3783.4	3805.9	-0.6	0.603
16	2	220.0	0.03334	0.055	0.055	0.2	4205.1	4209.2	-0.1	0.617
17	2	245.0	0.03601	0.058	0.057	1.2	4087.5	4115.2	-0.7	0.603

+ ITERATION NUMBER 6
1

EARTHQUAKE - PARFFN.DAT
SOIL PROFILE - Jungo Landfill; PARFFN.DAT

ITERATION NUMBER 6

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	4	5.0	0.01054	0.045	0.045	-0.1	612.6	612.4	0.0	0.932
2	4	15.0	0.02767	0.051	0.052	-0.1	650.4	650.1	0.0	0.861
3	4	25.0	0.03862	0.056	0.056	-0.2	697.6	696.8	0.1	0.820
4	4	35.0	0.05046	0.061	0.061	0.0	749.1	748.9	0.0	0.784
5	4	45.0	0.06225	0.064	0.064	0.0	795.1	794.9	0.0	0.755
6	4	55.0	0.07166	0.066	0.066	0.0	840.5	840.4	0.0	0.736
7	2	65.0	0.04177	0.064	0.064	0.2	1707.9	1710.5	-0.2	0.567
8	2	77.5	0.04705	0.069	0.068	0.3	1813.1	1816.9	-0.2	0.540
9	7	92.5	0.06215	0.057	0.058	-1.5	1565.9	1581.4	-1.0	0.424
10	2	107.5	0.07664	0.088	0.087	0.3	1351.1	1356.3	-0.4	0.431
11	2	122.5	0.05297	0.073	0.073	-0.3	1989.6	1984.3	0.3	0.511
12	1	140.0	0.02257	0.045	0.045	-0.2	4870.9	4868.8	0.0	0.871
13	2	160.0	0.04308	0.065	0.065	-0.4	2625.0	2618.8	0.2	0.558
14	2	180.0	0.03763	0.060	0.059	0.7	3425.3	3439.1	-0.4	0.592
15	2	200.0	0.03613	0.058	0.058	0.4	3774.1	3783.4	-0.2	0.600
16	2	220.0	0.03332	0.055	0.055	-0.1	4206.2	4205.1	0.0	0.616
17	2	245.0	0.03641	0.059	0.058	0.7	4070.5	4087.5	-0.4	0.599

VALUES IN TIME DOMAIN

LAYER	TYPE	THICKNESS FT	DEPTH FT	MAX STRAIN PRCNT	MAX STRESS PSF	TIME SEC
1	4	10.0	5.0	0.01622	99.35	29.52
2	4	10.0	15.0	0.04258	276.77	29.51
3	4	10.0	25.0	0.05942	414.03	29.50
4	4	10.0	35.0	0.07763	581.39	28.24
5	4	10.0	45.0	0.09577	761.32	28.24
6	4	10.0	55.0	0.11025	926.55	28.24
7	2	10.0	65.0	0.06426	1099.15	28.23
8	2	15.0	77.5	0.07239	1315.22	28.23
9	7	15.0	92.5	0.09561	1512.03	28.22
10	2	15.0	107.5	0.11790	1599.09	28.22
11	2	15.0	122.5	0.08149	1616.93	28.19
12	1	20.0	140.0	0.03472	1690.48	28.16
13	2	20.0	160.0	0.06628	1735.76	27.82
14	2	20.0	180.0	0.05789	1990.95	28.35
15	2	20.0	200.0	0.05559	2103.26	28.34
16	2	20.0	220.0	0.05126	2155.44	28.32
17	2	30.0	245.0	0.05601	2289.48	28.41

PERIOD = 1.30 FROM AVERAGE SHEAR VELOCITY = 797.

```
 FREQUENCY    AMPLITUDE
MAXIMUM AMPLIFICATION =  12.06
FOR FREQUENCY         =   0.94 C/SEC.
    PERIOD            =   1.06 SEC.
    Option NO.    5   has been concluded.
    Option NO.    6   is started.

1******   OPTION  6  ***  COMPUTE MOTION IN NEW SUBLAYERS

  EARTHQUAKE -PARFFN.DAT
 SOIL DEPOSIT - Jungo Landfill; PARFFN.DAT
    LAYER           DEPTH        MAX. ACC.          TIME      MEAN SQ. FR.         ACC. RATIO       TH SAVED
                     FT            G                SEC          C/SEC             QUIET ZONE       ACC. RECORD
    WITHIN            0.0        0.29401          29.51          2.77                0.000                 0
    WITHIN           10.0        0.25505          29.51          2.47                0.000                 0
    WITHIN           20.0        0.23625          28.22          2.07                0.000                 0
    WITHIN           30.0        0.23988          28.23          1.98                0.000                 0
    WITHIN           40.0        0.24983          28.89          2.22                0.000                 0
    WITHIN           50.0        0.22334          28.89          2.51                0.000                 0
    WITHIN           60.0        0.18493          31.28          2.64                0.000                 0
    WITHIN           70.0        0.19000          28.44          2.58                0.000                 0
    WITHIN           85.0        0.17901          28.43          2.41                0.000                 0
    WITHIN          100.0        0.17639          28.39          2.59                0.000                 0
    WITHIN          115.0        0.22258          28.36          3.22                0.000                 0
    WITHIN          130.0        0.22627          28.35          3.20                0.000                 0
    WITHIN          150.0        0.20280          28.35          2.92                0.000                 0
    WITHIN          170.0        0.19109          28.71          3.49                0.000                 0
    Option NO.    6   has been concluded.
    Option NO.    6   is started.

1******   OPTION  6  ***  COMPUTE MOTION IN NEW SUBLAYERS

  EARTHQUAKE -PARFFN.DAT
 SOIL DEPOSIT - Jungo Landfill; PARFFN.DAT
    LAYER           DEPTH        MAX. ACC.          TIME      MEAN SQ. FR.         ACC. RATIO       TH SAVED
                     FT            G                SEC          C/SEC             QUIET ZONE       ACC. RECORD
    WITHIN          190.0        0.18850          28.70          3.75                0.000                 0
    WITHIN          210.0        0.15425          28.26          4.17                0.000                 0
    WITHIN          230.0        0.17835          28.75          4.48                0.000                 0
    WITHIN          260.0        0.20948          28.68          5.87                0.000                 0
    OUTCR.          260.0        0.25000          28.68          5.88                0.000                 0
    Option NO.    6   has been concluded.
    Option NO.    7   is started.

1******   OPTION  7  ***  COMPUTE STRESS/STRAIN HISTORY

 COMPUTE STRESS OR STRAIN HISTORY AT THE TOP OF  LAYER    7
 SCALE FOR PLOTTING     0.0000
IDENTIFICATION - -- Stress at the top of layer
```

```
 COMPUTE STRESS OR STRAIN HISTORY AT THE TOP OF  LAYER    7
 SCALE FOR PLOTTING     0.0000
IDENTIFICATION - -- Strain not saved
    Option NO.    7   has been concluded.
```

```
           ***********
     **                  **
     **   D I S P L M T  **
           ***********
```

Jungo Landfill, Seismic Slope Stability, BVLTFP.DAT

Yield Acceleration = 0.1400

DT = 0.0029 Accn. due to gravity = 32.200 Nlines = 2419

A max = 0.19317 Acc Factor = 1.00000 Static F.S.= 1.860

Vmax = 0.13084 Ft/S

COMPUTED PERMANENT DISPLACEMENT = 0.03379 Ft

```
           ***********
     **                  **
     **   D I S P L M T  **

           ***********
```

Jungo Landfill, Seismic Slope Stability, CHY080FP.DAT

Yield Acceleration = 0.1400

DT = 0.0050 Accn. due to gravity = 32.200 Nlines = 2760

A max = 0.17684 Acc Factor = 1.00000 Static F.S.= 1.860

Vmax = 0.00000 Ft/S

COMPUTED PERMANENT DISPLACEMENT = 0.00000 Ft

```
           ***********
     **                  **
     **   D I S P L M T  **
           ***********
```

Jungo Landfill, Seismic Slope Stability, PARFFN.DAT

Yield Acceleration = 0.1400

DT = 0.0050 Accn. due to gravity = 32.200 Nlines = 1367

A max = 0.22305 Acc Factor = 1.00000 Static F.S.= 1.860

Vmax = 0.29737 Ft/S

COMPUTED PERMANENT DISPLACEMENT = 0.05293 Ft

ATTACHMENT C
LIQUEFACTION EVALUATION RESULTS

STANDARD PENETRATION TEST-BASED LIQUEFACTION ANALYSIS USING CETIN ET AL. (2004) PROCEDURE

Referrence: "Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential" by Cetin et al. (2004), *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 130, No. 12, December 2004.

Project	Jungo Landfill
Test Boring No	EB

Depth to ground water table[1]		45 feet
Earthquake magnitude	M_w	6.2
Peak horizontal ground surface acceleration	a_{max}	0.312 g
Moist unit weight of soil	γ_m	120 pcf
Saturated unit weight of soil	γ_{sat}	130 pcf
Shear wave velocity over the upper 12 meters, in m/s	$V'_{s,12m}$	275 m/s

N correction factors:

Correction for non-standardized sampler configuration	C_S	1.00
Correction for short rod length	C_R	1.00
Correction for borehole diameter	C_B	1.00
Correction for hammer energy efficiency	C_E	1.00

Factor of Safety Against Liquefaction

Depth[2] (ft)	d[3,4] (ft)	N	σ_v (psf)	σ'_v (psf)	$\sigma_{v(rd)}$	r_d	CSR_{eq}	C_N	$N_{1,60}$	Fines Content (%)	FC[5] (%)	P_L	CRR	$(FS)_L$
20	5	29	600	600	0.028	1.00	0.203	1.60	46	84	35	99.9	9.965	49.16
25	10	20	1200	1200	0.051	1.00	0.203	1.33	27	84	35	99.9	1.504	7.43
30	15	28	1800	1800	0.072	1.00	0.202	1.08	30	84	35	99.9	1.861	9.20
35	20	25	2400	2400	0.092	0.99	0.202	0.94	23	84	35	99.9	0.953	4.72
40	25	Clay												
45	30	Clay												
50	35	Clay												
55	40	48	4800	4800	0.164	0.96	0.195	0.66	32	83	35	99.9	1.613	8.28
60	45	16	5400	5400	0.164	0.94	0.191	0.63	10	83	35	99.9	0.240	1.26
65	50	Clay												
75	60	69	7350	6414	0.164	0.87	0.201	0.57	40	83	35	99.9	2.891	14.37
80	65	Clay												
90	75	Clay												
100	85	Clay												
105	90	43	11250	8442	0.164	0.81	0.218	0.50	22	98	35	99.9	0.569	2.61
110	95	34	11900	8780	0.164	0.80	0.220	0.49	17	98	35	99.9	0.372	1.69
120	105	45	13200	9456	0.164	0.79	0.223	0.47	21	98	35	99.9	0.540	2.42

[1] Ground water table assumed at elev. 4115'

[2] Measured from the ground surface at boring location

[3] From top of landfill base assumed at elev. 4160' with no waste

[4] The highlighted depths are above water table

[5] For fines content < 5%, FC = 0; for fines content > 35%, FC = 35

STANDARD PENETRATION TEST-BASED LIQUEFACTION ANALYSIS USING CETIN ET AL. (2004) PROCEDURE

Referrence: "Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential" by Cetin et al. (2004), *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 130, No. 12, December 2004.

Project	Jungo Landfill
Test Boring No	MW-1

Depth to ground water table[1]		45 feet
Earthquake magnitude	M_w	6.2
Peak horizontal ground surface acceleration	a_{max}	0.312 g
Moist unit weight of soil	γ_m	120 pcf
Saturated unit weight of soil	γ_{sat}	130 pcf
Shear wave velocity over the upper 12 meters, in m/s	$V^*_{s,12m}$	275 m/s

N correction factors:

Correction for non-standardized sampler configuration	C_S	1.00
Correction for short rod length	C_R	1.00
Correction for borehole diameter	C_B	1.00
Correction for hammer energy efficiency	C_E	1.00

Factor of Safety Against Liquefaction

Depth[2] (ft)	d[3,4] (ft)	N	σ_v (psf)	σ'_v (psf)	$\sigma_{g(rd)}$	r_d	CSR_{eq}	C_N	$N_{1,60}$	Fines Content (%)	FC[5] (%)	P_L	CRR	$(FS)_L$
20	5	28	600	600	0.028	1.00	0.203	1.60	45	35	35	99.9	8.690	**42.87**
25	10	40	1200	1200	0.051	1.00	0.203	1.33	53	35	35	99.9	14.605	**72.12**
30	15	30	1800	1800	0.072	1.00	0.202	1.08	33	72	35	99.9	2.240	**11.08**
35	20	40	2400	2400	0.092	0.99	0.202	0.94	38	35	35	99.9	3.181	**15.77**
40	25	Clay												
45	30	Clay												
50	35	Clay												
65	50	71	6050	5738	0.164	0.92	0.196	0.61	43	35	35	99.9	4.018	**20.49**
70	55	33	6700	6076	0.164	0.89	0.199	0.59	19	35	35	99.9	0.523	**2.62**
75	60	Clay												
85	70	Clay												
95	80	Clay												

[1]Ground water table assumed at elev. 4115'

[2]Measured from the ground surface at boring location

[3]From top of landfill base assumed at elev. 4160' with no waste

[4]The highlighted depths are above water table

[5]For fines content < 5%, FC = 0; for fines content > 35%, FC = 35

STANDARD PENETRATION TEST-BASED LIQUEFACTION ANALYSIS USING CETIN ET AL. (2004) PROCEDURE

Referrence: "Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential" by Cetin et al. (2004), *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 130, No. 12, December 2004.

Project	Jungo Landfill
Test Boring No	MW-2

Depth to ground water table[1]		45 feet
Earthquake magnitude	M_w	6.2
Peak horizontal ground surface acceleration	a_{max}	0.312 g
Moist unit weight of soil	γ_m	120 pcf
Saturated unit weight of soil	γ_{sat}	130 pcf
Shear wave velocity over the upper 12 meters, in m/s	$V^*_{s,12m}$	275 m/s

N correction factors:

Correction for non-standardized sampler configuration	C_S	1.00
Correction for short rod length	C_R	1.00
Correction for borehole diameter	C_B	1.00
Correction for hammer energy efficiency	C_E	1.00

Factor of Safety Against Liquefaction

Depth[2] (ft)	d[3,4] (ft)	N	σ_v (psf)	σ'_v (psf)	$\sigma_{d(rd)}$	r_d	CSR_{eq}	C_N	$N_{1,60}$	Fines Content (%)	FC[5] (%)	P_L	CRR	$(FS)_L$
20	5	19	600	600	0.028	1.00	0.203	1.60	30	90.3	35	99.9	2.534	**12.50**
25	10	33	1200	1200	0.051	1.00	0.203	1.33	44	35	35	99.9	6.592	**32.55**
30	15	20	1800	1800	0.072	1.00	0.202	1.08	22	35	35	99.9	0.886	**4.38**
35	20	Clay												
40	25	Clay												
45	30	18	3600	3600	0.130	0.98	0.200	0.77	14	6.4	6.4	97.9	0.240	**1.20**
50	35	31	4200	4200	0.148	0.97	0.198	0.71	22	6.4	6.4	98.9	0.455	**2.30**
55	40	24	4800	4800	0.164	0.96	0.195	0.66	16	35	35	99.9	0.412	**2.12**
60	45	17	5400	5400	0.164	0.94	0.191	0.63	11	81.6	35	99.9	0.254	**1.33**
65	50	16	6050	5738	0.164	0.92	0.196	0.61	10	35	35	99.9	0.230	**1.18**
70	55	18	6700	6076	0.164	0.89	0.199	0.59	11	61.1	35	99.9	0.245	**1.23**
75	60	21	7350	6414	0.164	0.87	0.201	0.57	12	35	35	99.9	0.273	**1.36**
80	65	25	8000	6752	0.164	0.84	0.203	0.56	14	35	35	99.9	0.318	**1.57**
90	75	Clay												
95	80	Clay												

[1]Ground water table assumed at elev. 4115'

[2]Measured from the ground surface at boring location

[3]From top of landfill base assumed at elev. 4160' with no waste

[4]The highlighted depths are above water table

[5]For fines content < 5%, FC = 0; for fines content > 35%, FC = 35

STANDARD PENETRATION TEST-BASED LIQUEFACTION ANALYSIS USING CETIN ET AL. (2004) PROCEDURE

Referrence: "Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential" by Cetin et al. (2004), *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 130, No. 12, December 2004.

Project		Jungo Landfill
Test Boring No		MW-3

Depth to ground water table[1]		45 feet
Earthquake magnitude	M_w	6.2
Peak horizontal ground surface acceleration	a_{max}	0.312 g
Moist unit weight of soil	γ_m	120 pcf
Saturated unit weight of soil	γ_{sat}	130 pcf
Shear wave velocity over the upper 12 meters, in m/s	$V^*_{s,12m}$	275 m/s

N correction factors:

Correction for non-standardized sampler configuration	C_S	1.00
Correction for short rod length	C_R	1.00
Correction for borehole diameter	C_B	1.00
Correction for hammer energy efficiency	C_E	1.00

Factor of Safety Against Liquefaction

Depth[2] (ft)	d[3,4] (ft)	N	σ_v (psf)	σ'_v (psf)	$\sigma_{d(rd)}$	r_d	CSR_{eq}	C_N	$N_{1,60}$	Fines Content (%)	FC[5] (%)	P_L	CRR	$(FS)_L$
20	5	26	600	600	0.028	1.00	0.203	1.60	42	47.8	35	99.9	6.608	**32.60**
25	10	25	1200	1200	0.051	1.00	0.203	1.33	33	35	35	99.9	2.655	**13.11**
30	15	25	1800	1800	0.072	1.00	0.202	1.08	27	35	35	99.9	1.409	**6.97**
35	20	31												
40	25	29												
45	30	Clay												
50	35	Clay												
55	40	Clay												
60	45	15	5400	5400	0.164	0.94	0.191	0.63	9	35	35	99.9	0.228	**1.19**
65	50	22	6050	5738	0.164	0.92	0.196	0.61	13	35	35	99.9	0.315	**1.61**
70	55	39	6700	6076	0.164	0.89	0.199	0.59	23	72.1	35	99.9	0.708	**3.55**
75	60	Clay												
80	65	Clay												
85	70	Clay												
90	75	Clay												
95	80	Clay												
100	85	Clay												

[1]Ground water table assumed at elev. 4115'

[2]Measured from the ground surface at boring location

[3]From top of landfill base assumed at elev. 4160' with no waste

[4]The highlighted depths are above water table

[5]For fines content < 5%, FC = 0; for fines content > 35%, FC = 35

STANDARD PENETRATION TEST-BASED LIQUEFACTION ANALYSIS USING CETIN ET AL. (2004) PROCEDURE

Referrence: "Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential" by Cetin et al. (2004), *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 130, No 12, December 2004.

Project	Jungo Landfill
Test Boring No	MW-4

Depth to ground water table[1]		45 feet
Earthquake magnitude	M_w	6.2
Peak horizontal ground surface acceleration	a_{max}	0.312 g
Moist unit weight of soil	γ_m	120 pcf
Saturated unit weight of soil	γ_{sat}	130 pcf
Shear wave velocity over the upper 12 meters, in m/s	$V^*_{s,12m}$	275 m/s

N correction factors:

Correction for non-standardized sampler configuration	C_S	1.00
Correction for short rod length	C_R	1.00
Correction for borehole diameter	C_B	1.00
Correction for hammer energy efficiency	C_E	1.00

Factor of Safety Against Liquefaction

Depth[2] (ft)	d[3,4] (ft)	N	σ_v (psf)	σ'_v (psf)	$\sigma_{a(rd)}$	r_d	CSR_{eq}	C_N	$N_{1,60}$	Fines Content (%)	FC[5] (%)	P_L	CRR	$(FS)_L$
20	5	29	600	600	0.028	1.00	0.203	1.60	46	35	35	99.9	9.965	**49.16**
25	10	30	1200	1200	0.051	1.00	0.203	1.33	40	35	35	99.9	4.687	**23.15**
30	15	36	1800	1800	0.072	1.00	0.202	1.08	39	84.1	35	99.9	3.909	**19.33**
35	20	31	2400	2400	0.092	0.99	0.202	0.94	29	35	35	99.9	1.544	**7.65**
40	25	Clay												
45	30	Clay												
50	35	Clay												
55	40	Clay												
60	45	75	5400	5400	0.164	0.94	0.191	0.63	47	0	0	99.9	3.037	**15.91**
65	50	35	6050	5738	0.164	0.92	0.196	0.61	21	0	0	99.9	0.434	**2.21**
70	55	65	6700	6076	0.164	0.89	0.199	0.59	38	0	0	99.9	1.542	**7.74**
75	60	68	7350	6414	0.164	0.87	0.201	0.57	39	0	0	99.9	1.601	**7.96**
85	70	Clay												
95	80	Clay												

[1]Ground water table assumed at elev. 4115'

[2]Measured from the ground surface at boring location

[3]From top of landfill base assumed at elev. 4160' with no waste

[4]The highlighted depths are above water table

[5]For fines content < 5%, FC = 0; for fines content > 35%, FC = 35

Final Cover Revegetation Plan
Jungo Disposal Site

Prepared for:
Jungo Land & Investments
50 California Street, 24th Floor
San Francisco, CA 94111

Prepared by:
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1.0 Introduction

The purpose of this Final Cover Revegetation Plan is to provide guidance and direction on obtaining permanent stabilization upon final closure of a landfill cell. The recommendations should be implemented in conjunction with the Final Closure Plan, which will be prepared approximately two years prior to closure of a landfill cell.

2.0 Revegetation Preparation and Implementation

2.1 SITE PREPARATION AND GRADING

Prior to initiating revegetation work, the growth media (e.g., soil) will be tested by a credible lab to determine the suitability of the proposed media to support native Great Basin scrub vegetation. The sample will be taken from the soil that will form the final cover that will be revegetated. The soils samples will be taken within six months of revegetation.

Prior to initial ground disturbance for the landfill, existing percent vegetation coverage on site will be measured by a qualified professional. Three random locations will be measured using the line-point interception method (Herrick, et al, 2009) or other equivalent method.

All finished slopes where vegetation will occur will be de-compacted using rippers or tines to loosen soils, so that final compaction within the first 6 inches is not greater than 85% of maximum compaction. Additionally, prior to seeding, the soil surface will be roughened by track walking or imprinting perpendicular to the prevailing winds.

Best Management Practices (BMPs) will be implemented during site preparation and revegation to control wind- and water-borne erosion such as straw, mulch, tackifier, and possibly snow fencing. The *Nevada Contractor's Field Guide for Construction Site Best Management Practices*, June 2008 should be referenced for appropriate BMPs.

2.1.1 Noxious Weed Abatement for Revegation

A Noxious Weed Abatement Plan specific to revegetation of the final cover will be prepared prior to revegetation work as part of the Jungo Disposal Site's Final Closure Plan. A separate Weed Management Plan for operations at the site has been prepared and is part of the site's Plan of Operations. The Noxious Weed Abatement Plan for revegetation activities will identify the boundaries of the specific revegetation work to be completed.

As part of the revegetation work, noxious weeds will be controlled. At a minimum, inspections of the revegation area will be performed during the growing season following revegetation for occurrence of noxious weeds. Control and abatement, at a minimum, will consist of mechanical treatment (e.g., pruning and removal of vegetation and dead material) in combination with approved herbicide applications or Integrated Pest Management methods. The UNR Extension Service is a source of information.

2.2 MATERIALS

2.2.1 Seed

The seed used for final cover revegetation will conform with all laws and regulations pertaining to the sale and shipment of seed required by the Nevada State Department of Agriculture and the Federal Seed Act. All shipments of seed will be reported to the Nevada State Department of Agriculture for inspection. Seeds delivered to the site will be tagged and labeled in accordance with the State Agricultural Code.

Seed will be of a quality having a minimum Pure Live Seed ("PLS") as specified. Weed seed will not exceed 0.25%of the pure live seed and inert material. Individual seed test results, by species and lot number, will be provided 30 days prior to commencing the work, prior to acceptance, and before seed is blended. Weed seed will not exceed 0.25% of the pure live seed specified and shall not include any seed of cheatgrass (*Bromus tectorum*) or Sweet clovers (*Melilotus officinalis, M. alba*). Crop seed shall not exceed 1%. The seed will be rejected if other undesirable species are present in excessive quantities. All seed tags and lab tests will reflect the most recent test date.

Seed tags must show the following information:

- Scientific name
- Common name
- Lot number
- Percent purity
- Percent germination, including hard and dormant seed
- Percent weed seed
- Origin

Table 1 shows the proposed seed mix to use for revegetation. In the event that there area any changes to the species and/or varieties, Nevada Department of Wildlife will be notified.

Table 1. Revegetation Seed Mix

Botanical Name	Common Name/Variety	PLS lbs/acre
Achnatherum hymenoides	Indian ricegrass	2.00
Agroyron fragile	Siberian wheatgrass	3.00
Atriplex canescens	Four-wing saltbrush	4.00
Atriplex confertiloia	Shadscale saltbrush	2.00
Distichlis stritcus	Saltgrass	2.00
Elymus elymoides	Squirreltail	3.00
Grayia spinosa	Spiny hopsage	2.00
Sarcobatus vermiculatus	Greasewood	2.00
Spharalcea grossularia	Globemallow	0.25
TOTAL		20.25

2.2.2 Soil Medium

Topsoil that is excavated during landfill construction will be stockpiled and maintained separately to ensure that it is not mixed with subsoil horizons. The stockpiled topsoil may be temporarily vegetated to minimize the potential of erosion, and monitored and treated for weeds while it is stockpiled. Maintaining the stockpiled topsoil will be important for ensuring revegetation success.

2.2.3 Soil Amendments

Soil amendments may be added to provide a suitable growth media. The soil amendments must be in an organic slow-release form compatible with native vegetation establishment. The appropriate soil amendment will be identified upon completion of the soil testing.

2.2.4 Soil Inoculants

Soil inoculants are bacteria or fungi that can be added to the soil to improve plant growth. Although not required, the use of soil inoculants may be considered. Mycorrhizal inoculants consist of spores, mycelium, and mycorrhizal root fragments in a solid carrier suitable for handling in dry applications. The carrier must be the material in which the inoculum was originally produced and may include organic materials, vermiculite, perlite, calcined clay or other approved materials consistent with proper application, and good plant growth.

Each endomycorrhizal inoculum will carry a supplier's guarantee of number of propagules per unit weigh or volume of bulk material. Inoculum shall contain Glomus intraradices, G.

deserticola, and G. etunicatum and have a propagule count of 120 per gram of which a minimum of 20 spores per gram present at random tested sampling. The product should be AM – 120-3 or equal or the most current quality product available and should be applied at 60 lbs/acre.

A representative 100 gram sample (from a re-mixed bag in order to obtain a homogeneous sample) will be drawn from the inoculant bags. This sample will be submitted to an authorized laboratory thirty days prior to application for verification of spore count.
If the inoculant spore-density is below specified counts, additional material will be supplied to meet specifications. Inocula will be transported and stored in areas with a temperature of less than 90 degrees Fahrenheit. A dust mask should be used when handling the material.

2.2.5 Mulch

Mulch may be used as a protective cover placed over the soil to retain moisture, reduce erosion, enhance germination, and reduce weed growth. Some typical forms of mulch include recycled paper, straw, and wood fiber. All mulch must be free from weeds or other foreign matter toxic to seed germination. Recycled paper mulch consists of degradable green-dyed, 100%-recycled paper products, produced from newsprint, chipboard, corrugated cardboard, or a combination of these materials.

2.2.6 Tackifier

Tackifiers are chemical compounds used in formulating adhesives to increase the adherence of a mulch to the soil surface. Tackifier should be an organic, plant-derived substance containing psyllium, guar gum, or cornstarch such as PT-TAC, Reclamare 2400, Ecology M-Binder, Eco-tak, FischStick or approved equal. Material shall form a transparent 3-dimensional film-like crust permeable to water and air and containing no agents toxic to seed germination.

2.3 IMPLEMENTATION

Revegetation work should take place in late spring or the fall, following the onset of plant dormancy.

2.3.1 Soil Sampling and Testing

A qualified professional familiar with soils sampling, handling, and analysis shall oversee or conduct the soil sampling. Since the landfill will be constructed and closed in phases, each landfill cell will require its own sample(s) and analysis. Parameters to be tested include at minimum the following:

> Saturation percent, Soil Texture, Infiltration Rate, pH, Conductivity, Total Dissolved Salts, Cation Exchange Capacity, Potassium, Sodium, Calcium, Magnesium, Nitrate & Phosphate, Sulfate, Chloride, Boron, Sulfur or Lime Requirement, Gypsum Requirement, Sodium Absorption Ratio, Exchangeable Sodium Percent, Organic Matter.

In the event that the proposed growth media is not suitable to support the species in the Revegetation Mix, a qualified professional will be consulted to provide proposed amendments.

2.3.2 Noxious Weed Control

The Noxious Weed Abatement Plan protocol will be followed as discussed in Section 2.1.1 above.

2.3.3 Seed Bed Preparation

Any existing strands of native vegetation need to be protected. Slopes will be track walked up and down the slope or imprinted perpendicular to the slope(s) and prevailing wind direction. Final surfaces shall be non-uniform and rough.

2.3.4 Application of Soil Inoculants

In the event that inoculants are used, a dust mask must be used when handling inoculants. Inoculants will be applied by hand broadcasting or with hydraulic applications. If hand broadcasting, inoculants will be incorporated by raking.

2.3.5 Seeding

The seed labels will be removed from the seed bags at the time of seeding to verify species in the mix and application rates. Seeding may be accomplished by drilling or hydroseeding. Drilled seed can be used for slopes 3(H):1(V) or less. Tackifier will be applied over drilled seed at the

rates listed below in Section 2.3.6. Alternatively, the seed can be applied using a hydraulic application as listed below in Section 2.3.6.

2.3.6 Hydraulic Applications

Soils must be moist prior to application and applied at the following rate:

Materials	Rate
Seed	As specified
Mulch	2,000 lbs/acre
Tackifier	150 lbs/acre
Water	As needed

A hydroseeder with a paddle wheel agitator may be used to evenly apply the mixture and keep it under suspension.

3.0 Post Implementation

3.1 MAINTENANCE

The revegetated area will be maintained and monitored for three years as part of landfill post closure maintenance following the completion of revegetation work to ensure proper establishment of vegetation and control of erosion. The revegetated area will be maintained to minimize erosion, including sheet erosion, rills, or gullies.

The revegetated area must achieve 70% desirable vegetation (i.e. seed mix species or native species that have naturally been recruited) of pre-disturbance native plant cover. Non-desirable weedy species (non-natives) will not exceed 15% of the vegetation community composition three years following revegetation implementation.

The percent of revegetation establishment will be measured annually during the three year monitoring period at a minimum of three random transects using the same methodology as used in the initial vegetation measurement (see Section 2.1). The line-point intercept method (Herrick et al, 2009) or equivalent method will be used. The results from these annual measurements will guide adaptive management techniques such as re-application of seed, soil amendments, mulches, and tackifiers or modification of the seed species composition.

3.2 CONTINGENCY

Supplemental treatments will be required if revegetation efforts are unsatisfactory following completion of work. This re-treatment(s) may include re-application or adjustment of the seed mix, soil amendments, soil inoculants, mulch, and tackifier.

APPENDIX M
PHASED CONSTRUCTION OF THE PERIMETER BERM

FIGURES

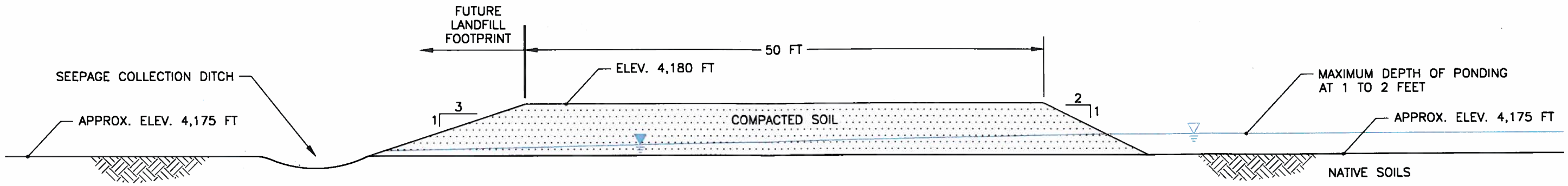

FIGURE M1a - PERIMETER RUN-ON CONTROL
BERM WITH SEEPAGE COLLECTION DITCH

10 0 10
SCALE FEET

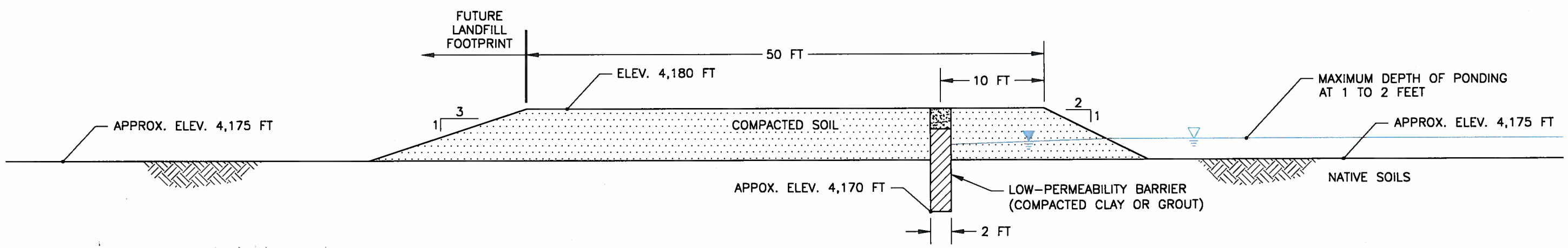

FIGURE M1b - PERIMETER RUN-ON CONTROL
BERM WITH ALTERNATIVE SEEPAGE MITIGATION

10 0 10
SCALE FEET

Golder Associates
Roseville, California

FIGURE M1
PERIMETER RUN-ON CONTROL BERM SECTION
JUNGO ROAD LANDFILL

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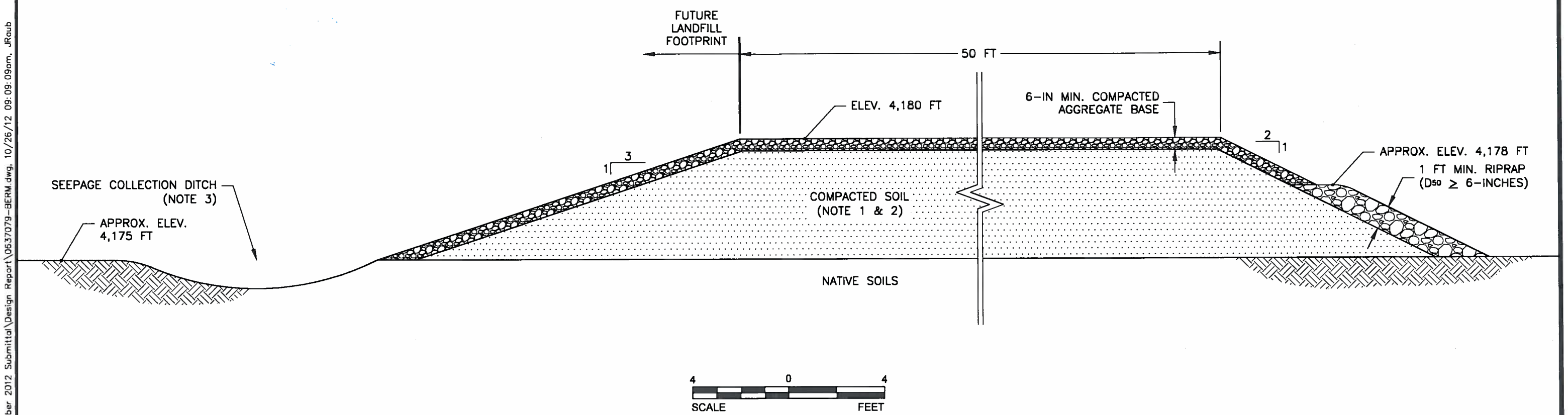

NOTES

1. SOILS SHALL BE COMPACTED TO A MINIMUM RELATIVE COMPACTION OF 90% AND AT A MOISTURE CONTENT ±3% OF OPTIMUM PER ASTM D1557.
2. COMPACTED SOILS SHALL EXHIBIT A PERMEABILITY OF 1×10^{-3} CM/S OR LESS. ADDITIONAL SEEPAGE CONTROLS SHALL BE INCLUDED IF THE SOIL PERMEABILITY EXCEEDS 1×10^{-3} CM/S. ADDITIONAL SEEPAGE CONTROL SHALL CONSIST OF A VERTICAL LOW-PERMEABILITY BARRIER COMPRISED OF CLAY OR BENTONITE GROUT AND EXHIBIT A PERMEABILITY OF 1×10^{-6} CM/S OR LESS (SEE FIGURE 1b FOR BARRIER LOCATION).
3. SEEPAGE COLLECTION DITCH SHALL BE GRADED TO LOCALIZED SURFACE WATER SUMPS.

Golder Associates
Roseville, California

FIGURE M2

PERIMETER RUN-ON CONTROL BERM CONSTRUCTION DETAILS
JUNGO ROAD LANDFILL

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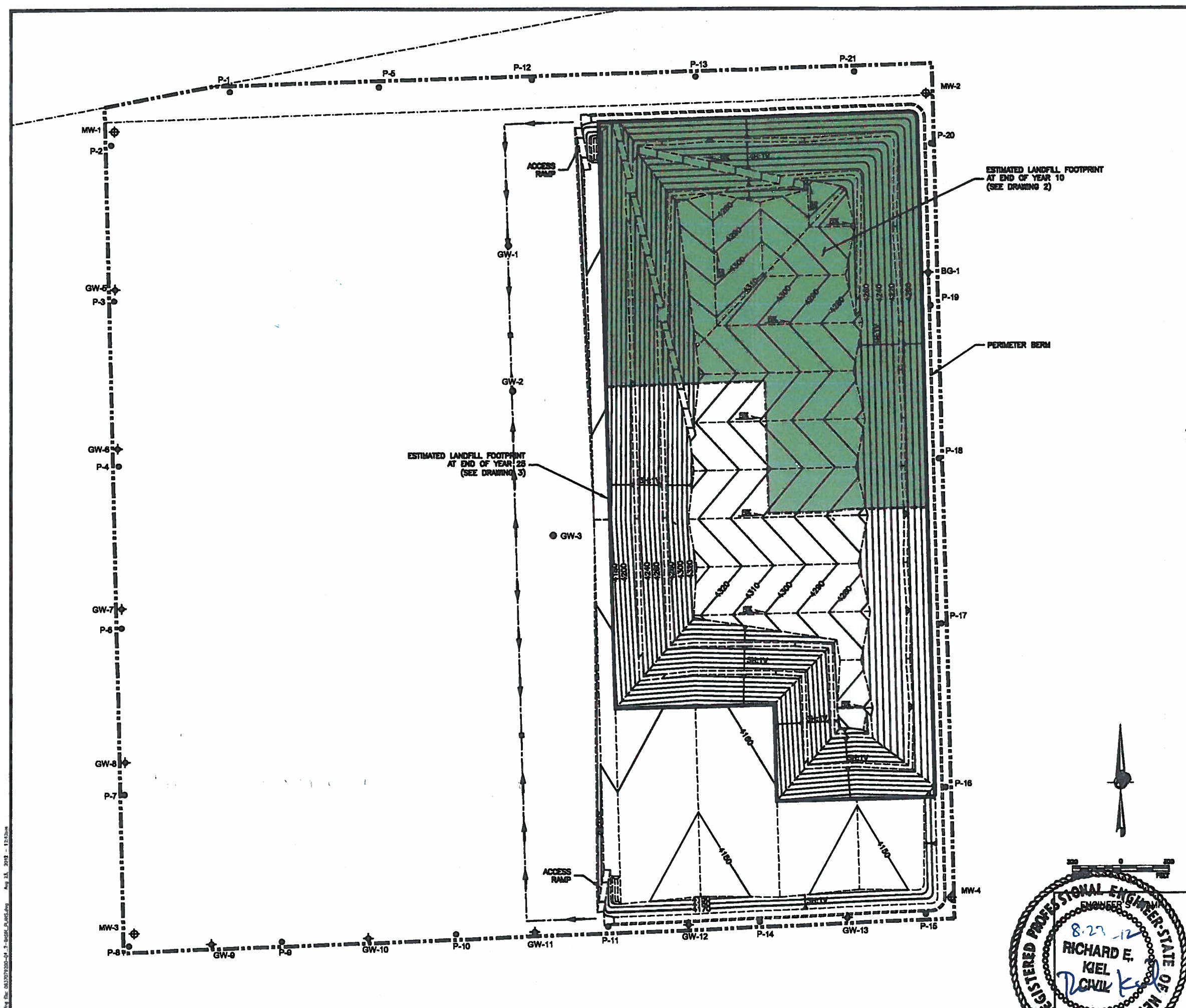
DRAWINGS



LEGEND

	PROPERTY BOUNDARY
	LIMIT OF LINER
MW-1	APPROXIMATE LOCATION OF MONITORING WELLS
14%	GRADE INDICATOR
3ft:1V	SLOPE INDICATOR
P-17	GAS PROBE LOCATION AND ID
GW-13	FINAL MONITORING WELL LOCATION
GW-4	INTIAL MONITORING WELL LOCATION

REGISTERED PROFESSIONAL ENGINEER STATE OF NEVADA
ENGINEER'S SEAL
8-23-12
RICHARD E. KIEL
CIVIL

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
1	8/23/12	JDR	ADDITIONAL INFORMATION ON PHASE CONSTRUCTION	JDR	KGH	REK

PROJECT

JUNGO ROAD LANDFILL
WINNEMUCCA, HUMBOLDT COUNTY, NEVADA

TITLE

LANDFILL DEVELOPMENT FIRST 25 YEARS

Golder Associates
Sacramento, CA

PROJECT No. 0637079-200			FILE No. 01_9-GRDN_PLANS	
DESIGN	KGH	8/23/12	SCALE AS SHOWN	REV. 0
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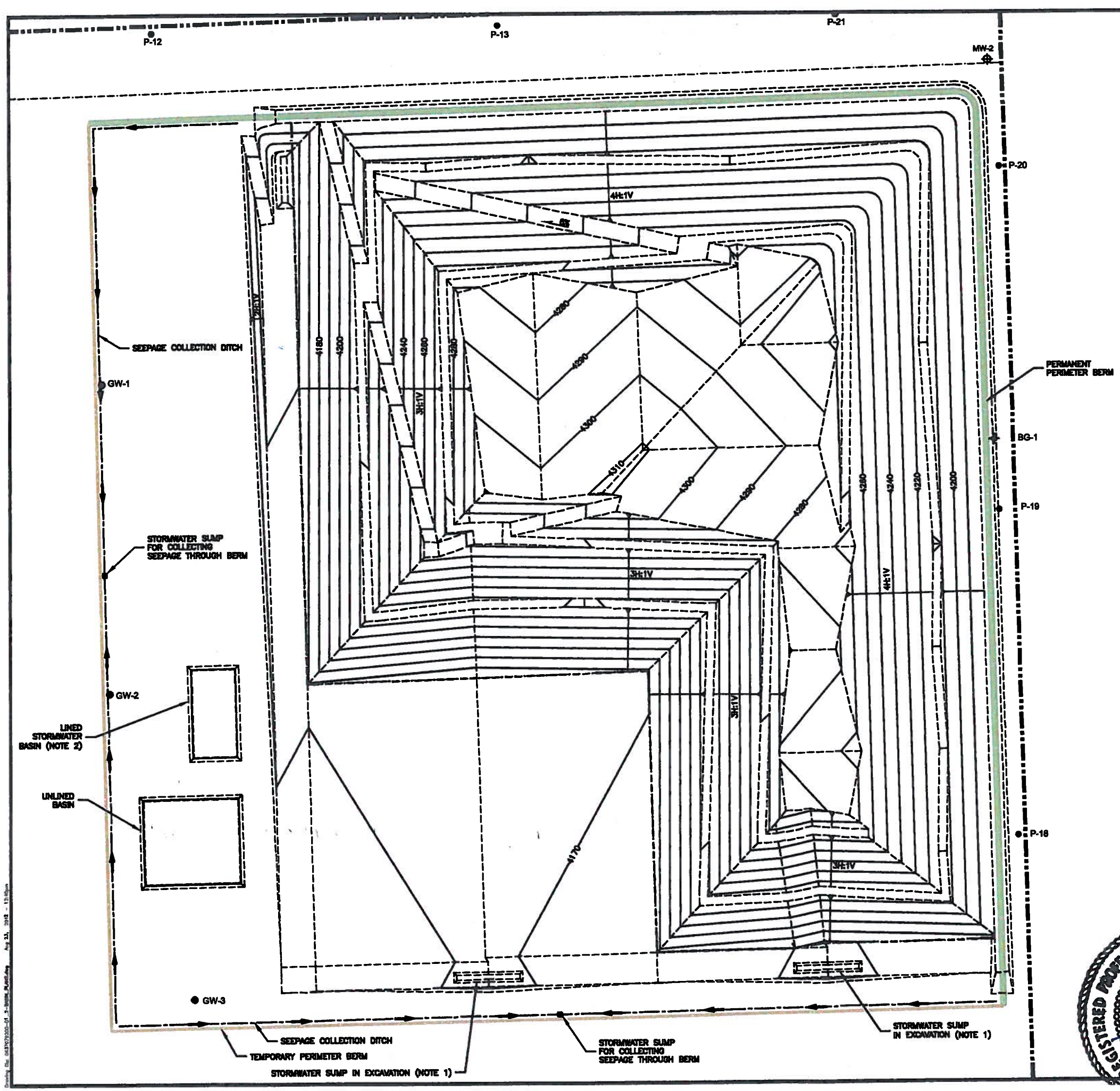

LEGEND

- PROPERTY BOUNDARY
- LIMIT OF LINER
- PERMANENT PERIMETER BERM
- TEMPORARY PERIMETER BERM
- MW-1 — APPROXIMATE LOCATION OF MONITORING WELLS
- 14% — GRADE INDICATOR
- 3H:1V — SLOPE INDICATOR
- P-17 — GAS PROBE LOCATION AND ID
- GW-13 — FINAL MONITORING WELL LOCATION
- GW-4 — INTIAL MONITORING WELL LOCATION

NOTES

1. STORMWATER TO BE DISCHARGED TO LINED STORMWATER BASIN.
2. WATER TO BE DISCHARGED TO THE UNLINED BASIN AFTER TESTING CONFIRMS NO WASTE CONTAMINANTS.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
1	8/23/12	JDR	ADDITIONAL INFORMATION ON PHASE CONSTRUCTION	JDR	KGH	REK

PROJECT

JUNGO ROAD LANDFILL
WINNEMUCCA, HUMBOLDT COUNTY, NEVADA

TITLE

PHASED RUN-ON/RUN-OFF CONTROLS AT END OF 10-YEARS

REGISTERED PROFESSIONAL ENGINEER · STATE OF NEVADA · 8-23-12 · RICHARD E. KIEL · CIVIL

Golder Associates
Sacramento, CA

PROJECT No. 0837070-200			FILE No. 01_S-0403_PLAN3	
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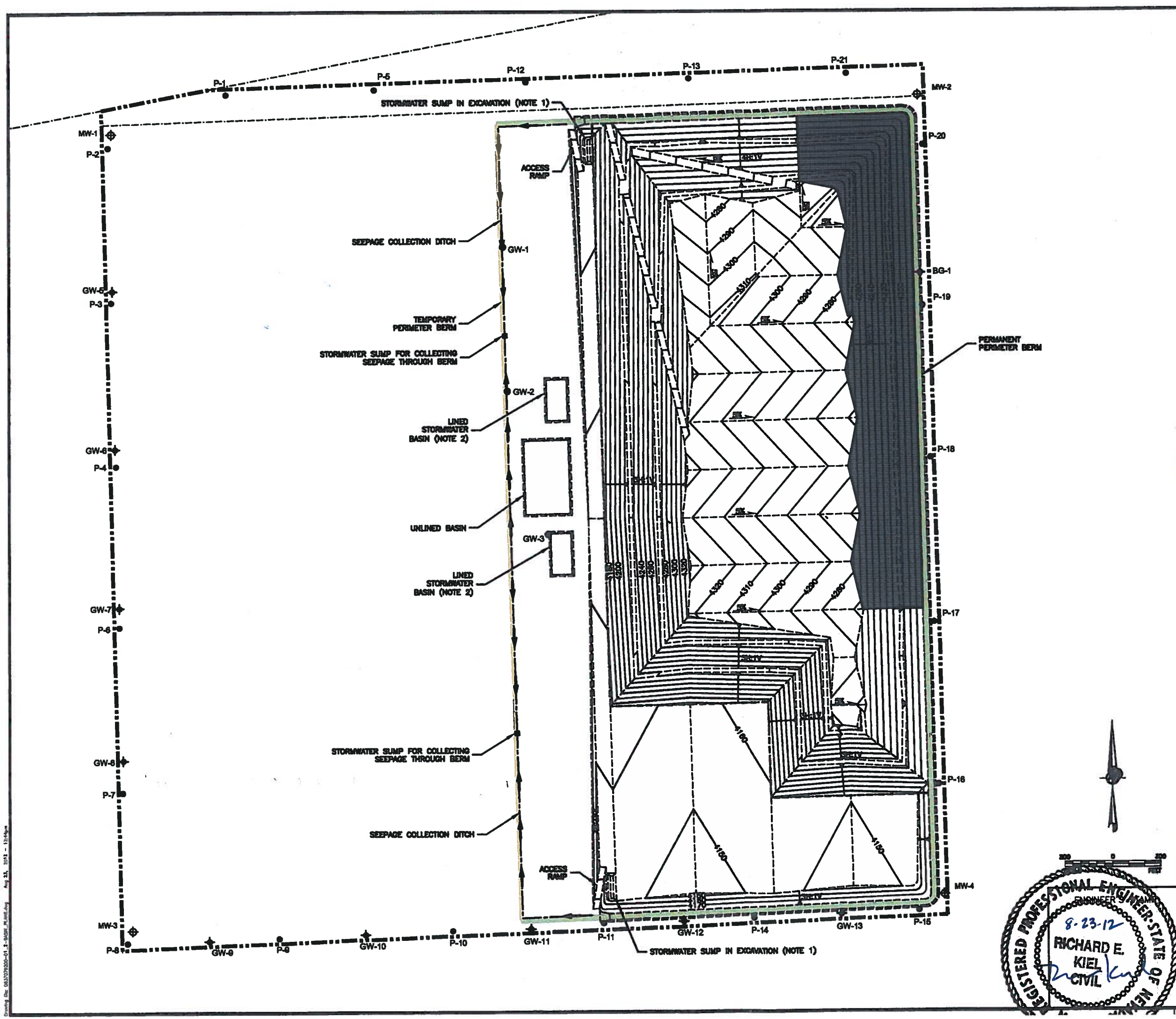

LEGEND

	PROPERTY BOUNDARY
	LIMIT OF LINER
	PERMANENT PERIMETER BERM
	TEMPORARY PERIMETER BERM
	CLOSED PORTION OF LANDFILL
MW-1	APPROXIMATE LOCATION OF MONITORING WELLS
14%	GRADE INDICATOR
3H:1V	SLOPE INDICATOR
P-17	GAS PROBE LOCATION AND ID
GW-13	FINAL MONITORING WELL LOCATION
GW-4	INTIAL MONITORING WELL LOCATION

NOTES

1. STORMWATER TO BE DISCHARGED TO LINED STORMWATER BASIN.
2. WATER TO BE DISCHARGE TO THE UNLINED BASIN AFTER TESTING CONFIRMS NO WASTE CONTAMINANTS.

REGISTERED PROFESSIONAL ENGINEER STATE OF NEVADA
ENGINEER
8-23-12
RICHARD E. KIEL
CIVIL

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
1	8/23/12	JDR	ADDITIONAL INFORMATION ON PHASE CONSTRUCTION	JDR	KGH	REK

PROJECT

JUNGO ROAD LANDFILL
WINNEMUCCA, HUMBOLDT COUNTY, NEVADA

TITLE

PHASED RUN-ON/RUN-OFF CONTROLS AT END OF 25-YEARS

Golder Associates
Sacramento, CA

PROJECT No. 0837078-200			FILE No. 01_3-GEOM_PLANS
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