Geotechnical Investigation, Infiltration Study, and Rock Rippability Report for the Proposed Decker Assemblage Industrial Site, Located at the Southeast Corner of Oleander Avenue and Decker Road, Assessor's Parcel Numbers (APN's): 314-040-001, -002, -003 & -008, Western Perris Area, County of Riverside, California

Project No. M1103-004

Dated: September 30, 2014

Prepared For:

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TRAMMELL-CROW COMPANY
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Attention: Mr. Neal Holdridge, Principal

Subject: Geotechnical Investigation, Infiltration Study, and Rock Rippability Report for the Proposed Decker Assemblage Industrial Site, Located at the Southeast Corner of Oleander Avenue and Decker Road, Assessor's Parcel Numbers (APN's): 314-040-001, -002, -003 & -008, Western Perris Area, County of Riverside, California

Matrix Geotechnical Consulting, Inc. (MATRIX) is pleased to submit herewith our Geotechnical Investigation/Infiltration Study, and Rock Rippability report for the proposed Decker Assemblage Industrial Site, located at the southeast corner of Oleander Avenue and Decker Road, Assessor's Parcel Numbers (APN's): 314-040-001, -002, -003 & -008, Western Perris Area, County of Riverside, California. This report presents the results of our review of pertinent geologic and geotechnical reports; the results of our field mapping and reconnaissance, laboratory testing, and presents our geologic and engineering judgment, opinions, conclusions, and recommendations pertaining to the geotechnical design and feasibility aspects of the proposed Decker Assemblage project.

Based on the results of the above efforts, it is our opinion that the subject site is suitable for the proposed industrial use facility project, provided the recommendations presented herein are incorporated into the design of the project and implemented during site grading and construction. MATRIX should review and approve final rough grading plans and foundation plans when those become available and revise our recommendations presented herein, if we deem it necessary.

We are pleased that you retained Matrix to assist you on the preliminary design aspects of this project. Should you have any questions regarding the contents of this report or should you require additional information, please do not hesitate to contact this office at your convenience.

Very Truly Yours,

Chris Josef | Principal

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1.0 INTRODUCTION

1.1 Purpose and Scope of Services

The purpose of the work leading to the preparation of this geotechnical, infiltration, and rock rippability report was to evaluate the pertinent geologic and geotechnical conditions on the site. We included in this report our preliminary geotechnical design criteria for grading, foundation design and construction, and other relevant geotechnical considerations for use during the design and construction of the proposed industrial site.

Our scope of services consisted of:

- A review of existing geotechnical/geologic reports and geologic maps pertinent to the site (Appendix A).

- Analysis and review of stereoscopic aerial photographs of the property (Appendix A).

- A subsurface field evaluation consisting of the excavation, sampling, and logging of ten (10) borings labeled B-1 to B-10 to depths ranging from approximately 6½ to 31½ feet. Logs of the geotechnical borings are presented in Appendix B, with the approximate locations depicted on the Geotechnical Map, Plate 1. The borings were drilled to evaluate the pertinent soil engineering characteristics of the subsurface soil on the site including classification of site soil, determination of depth to groundwater (if present), and to obtain representative soil samples.

- Excavation of sixteen (16) excavator pits to an excavated depth of 8½ to 20 feet and rippable depth up to 25 feet. Logs of the excavator pits are presented in Appendix B, with the approximate locations depicted on the Geotechnical Map, Plate 1. The excavator pits were advanced to various depths throughout the site to evaluate the alluvial soil thicknesses onsite and classify the rock materials as rippable, marginally rippable, or non-rippable.

- Drilling of thirty-three (33) rotary percussion "air-track" borings to depths of 15 to 40 feet. The logs of the air-track borings are located in Appendix B, with the approximate location depicted on the Geotechnical Map, Plate 1. The air-track borings are utilized to determine the relative hardness of the rock and suspected blasting depth. The potential blasting depth is classified into soft, medium, medium hard, and hard.

- Seven (7) seismic refraction survey lines labeled S-1 through S-7 were performed along representative areas delineated by Matrix Geotechnical Consulting field staff. The traverses were located in the field by use of Google^{TM} Earth (2013) imagery and GPS coordinates. The approximate location of the seismic traverses is located on the Geotechnical Map – Plate 1. The seismic refraction survey is located in Appendix D.

- Geologic site reconnaissance and mapping of surficial units.

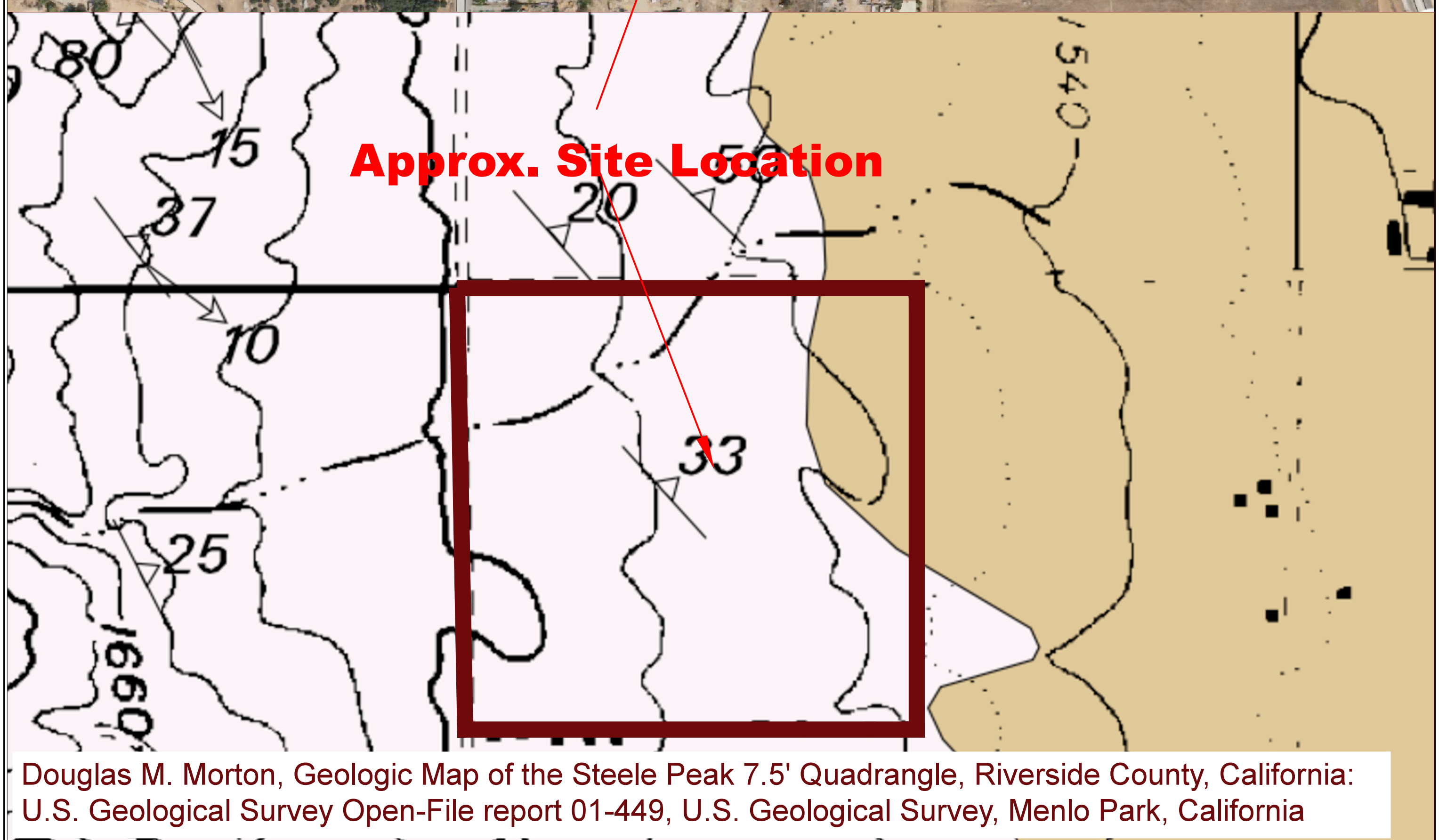
- Laboratory testing of representative soil samples obtained during the subsurface exploration (Appendix C).

- Engineering and geologic analyses of the data with respect to the design and construction of the proposed industrial site.

- Preparation of specific site seismicity, secondary seismic effects, and site response spectra (Appendix E).

- Preparation of General Earthwork and Grading Specifications (Appendix F).

- Preparation of this report presenting our review, conclusions and preliminary geotechnical design recommendations for the design and construction of the proposed industrial site.



Douglas M. Morton, Geologic Map of the Steele Peak 7.5' Quadrangle, Riverside County, California: U.S. Geological Survey Open-File report 01-449, U.S. Geological Survey, Menlo Park, California

MATRIX	FIGURE 1 - Site Location Map FIGURE 2 - Geologic Map	Project Name	DECKER ASSEMBLAGE
		Project No.	M1103-004
		Geo/Eng	JF/JN
		Scale	NOT TO SCALE
		Date	OCTOBER 2014

1.2 Location and Site Description

The project site consists of four (4) parcels, APN's: 314-040-001, -002, -003 & -008, for which parcel 314-040-002 is presently occupied by a residence, is located at the southeast corner of Decker Road and Oleander Road, in the Western Perris Area of Riverside County, California. The existing residence has utilities that are provided by the local water and power company and is presently on a septic system, having the septic lines in the front yard on the west side of the structure. The site is bounded on the north by undeveloped native land and partially by an existing industrial building. Additionally the project is bounded on the east and west by undeveloped land and on the south by existing residential and business parcels. The general location and configuration of the site is shown on the Site Location Map (Figure 1).

Based upon our document and project background review the general area of the site property is in a partially graded and natural condition. The portions of the site that are graded and/or have artificial undocumented fill are located in the northeast and southwest portions of the site. The area in the northeast appears to have a significant amount of crushed gravel present within the surficial soil and an earthen roadway surrounding the crushed gravel area. Whereas the area in the southwest is primarily located within parcels 314-040-002 and -008. This fill material was placed as a result of the landowners. During our investigation of the site, the owner of parcel 314-040-002 confirmed that fill material was imported into the site area and utilized to elevate grade for future residential use. These materials were observed to be approximately 6-7 feet in thickness overlying the rock in-place and of relatively sand and silty sand consistency.

The remainder of the site consists of annual weeds and grasses, natural swales, and arroyos, and large granitic outcrop boulders. Although identified on the geological map as having a water-borne swale at the surface, no flowing water or surficial saturated soil was present in the near surface soil. However, groundwater was present at depth within the majority of the deep excavations, hollow-stem borings, and air-track borings at an approximate depth of 20 feet within a majority of the locations onsite. We anticipate that future elevations of the site will need to account for the potential for groundwater influence on the site.

Other areas within the southeast portion of the site, an area of the majority of large boulder outcroppings within the site, were observed to be dry to the maximum depth achieved. Although surficial aerial imagery indicates that potential wet conditions may exist as a concentration of grasses and small shrubs were observed within the arroyo between the outcroppings. Confirmation of this condition is directly related to the upstream subsurface soil in excavator pit no. __ having highly saturated soil present at a depth of 20 feet. The likelihood of perched groundwater being present within this area is likely, but not observed during the investigation. The remainder of the site, within parcels 314-040-001, -002, and -008 were observed to have water within each of the borings at a depth of 20 feet. Water was observed to recharge each air-track and hollow-stem boring immediately to shortly after each consecutive advancement of a drilling flight.

From experience in the immediate area, the water condition is a perched condition, traversing across a large granitic bedrock shelf. The near surface bedrock (Val Verde Tonalite) is highly weathered and permeable, whereas the deeper bedrock is well indurated and non-weathered. The depth of groundwater is indirectly to directly associated with hard to very hard rock materials located within the site. Although some caution should be applied to reviewing the groundwater and hard rock within the western portion and eastern portion of the site. Considerable thicknesses of alluvial materials present within the eastern portion, saturated and weathered condition of the rock materials directly below the alluvium in the eastern portion of the site, do not correlate well with western subsurface conditions. The subsurface materials located in the western site area have very shallow depths of older alluvium directly over weathered rock. Where water was encountered, the air-track borings observed hard to very hard conditions and groundwater along the capillary fringe recharged the boring within moments of advancing the drill flight below a depth of 20 feet.

Relatively large corestones and subsurface boulders were observed within the subsurface site area. These corestones and subsurface boulders, while being relatively hard and very dense in-place were rippable with the use of a large 60-inch ripper attached to the excavator. Below the corestones and boulders weathered and non-indurated Tonalite was observed and was readily excavated with the use of the excavator and air-track borings. An additional discussion of the rock and rippability is discussed in Section 2.7.

The general topography of the site is slightly sloping from west to east, with subtle grade changes from north to south. Elevations within the western to eastern central axis portion of the site vary from approximately 1600 (MSL) to 1556 above mean sea level (MSL), over a distance of approximately 1500 feet. Comparatively, site elevations vary from approximately 1575 to 1580 through the central north to south axis of the site. Approximately 44 feet of relief occurs west to east and 5 feet occurs north to south.

1.3 Previous Geological and Geotechnical Investigations

Based on information provided to MATRIX, previous geotechnical reporting was performed on adjacent and nearby parcels. Representatives of MATRIX conducted a review of the files located within the County of Riverside Office of the County Geologist Building. The file review produced four (4) reports prepared by as follows: (a) Southern California Geotechnical (SCG), GEO 1659, November 4, 2004, (b) GEO 2085 December 13, 2005, and (c) GEO 2270 June 1, 2011; and (d) Salem Engineering Group, GEO 2311, November 30, 2012.

The County of Riverside issued Conditions of Approval for the subject GEO reports. Conclusions prepared by the previously prepared GEO reports concluded the following:

1.3.1 (a) Southern California Geotechnical – GEO 1659

1. No known faults cross the subject site, therefore the potential for surface rupture is considered low.
2. The site lies within a seismically active area of Southern California and the proposed structures may be expected to experience strong seismic shaking during the life of the project.
3. The upper 4 feet of the site soils are dry, porous and potentially collapsible. These materials exhibit a low expansion potential and low concentrations of soluble sulfates.
4. The proposed structures may be supported on conventional shallow footings at least 14 inches wide and embedded at least 18 inches below the lowest adjacent grade. Column footings should be at least 24 inches square and embedded at least 12 inches. All footings should bear on properly placed structural fill soils.

1.3.2 (b) Southern California Geotechnical – GEO 2085

1. The possibility of fault rupture on the subject site is considered to be extremely low.
2. Liquefaction is not considered a potential hazard at the subject site.
3. Slope stability analyses indicate the proposed cut slope will possess adequate factors of safety for static and pseudo-static conditions as well as for surficial stability.
4. The tsunami potential is considered to be negligible.
5. The potential for distress associated with seiches is considered to be negligible.

1.3.3 (c) Southern California Geotechnical – GEO 2270

1. No known faults cross the subject site, therefore the potential for surface rupture is considered low. However, the site lies within a seismically active area of Southern California and the proposed structures may be expected to experience strong seismic shaking during the life of the project.
2. Due to the dense nature of the site soils, below the surficially disturbed zone, and the depth to the water table, the potential for liquefaction affecting this site is considered low.
3. The upper 4 feet of the site soils are dry, porous and potentially collapsible. These materials exhibit a low expansion potential and low concentrations of soluble sulfates.

1.3.4 (d) Salem Engineering Group, Inc. – GEO 2311

1. The seismic hazard most likely to impact the site is ground shaking due to a large earthquake on one of the major active regional faults.
2. Active faulting does not exist at the site.
3. The surface fault rupture potential is vey low.
4. The liquefaction potential is considered to be very low.
5. The geological hazards of collapsible and expansive soil, hydroconsolidation and subsidence are considered to be very low.
6. The geologic hazards of wind and water erosion are considered to be very low.

7. The geologic hazard of seiche is considered to be very low.

1.4 Proposed Development and Grading

It is our understanding that the proposed Decker Assemblage – industrial building will consist of an approximate 714,000 square foot logistics building with truck bays located on the east and west and parking stalls located on the north and south of the proposed building. A large detention basin is located along the eastern-southeastern portion of the site. The remainder of the site will provide asphaltic concrete paving for parking area drive aisles, concrete paving within the truck dock areas, the creation of a level building pad, construction of underground utilities, curbs, gutters, infiltration areas, and other appurtenances. The preliminary configuration of the proposed building pad is shown on the Geotechnical Map, Plate 1.

1.5 Subsurface Investigation and Sampling Method

The subsurface exploration conducted for this project consisted of ten (10) hollow-stem borings labeled B-1 to B-10 excavated to depths ranging from approximately 6½ to 31½ feet below currently existing site grades. In addition thirty-three (33) rotary percussion “air-track” borings were advanced to depths of 15 to 40 feet within the site area. Sixteen (16) excavator pits were excavated to depths of 7 to 25 feet within the site area. All of the hollow-stem and air-track borings, and excavator pits were logged during drilling by a member of our staff. Representative bulk and in-situ soil samples were taken during drilling. Relatively undisturbed in-situ samples were taken with a split barrel “California Sampler” containing a series of one inch high, 2.42-inch diameter brass liners. In general, our sampling methods are as described in ASTM Test Method D-3550. In-situ samples were also taken using a 1.4-inch inside diameter split spoon sampler, in general accordance with ASTM D-1586. Both of these samplers were driven into the ground with successive blows of an automatic trip actuated 140-pound weight falling 30-inches. The blow counts obtained during driving were recorded for further use in our analysis. Bulk samples were collected and placed in sealed plastic containers to retain the original water contents. The relatively undisturbed ring samples were placed in molded plastic sleeves that were then sealed and transported to our laboratory. Samples resulting from the excavator pits were also sealed and transported to the laboratory as well. The air-track borings do not provide a sampling mechanism.

Seven (7) seismic refraction survey lines S-1 through S-7 were performed within the site area as delineated by MATRIX. The seismic traverse data collection was performed using twenty-four 14-Hertz geophones, spaced at eight to ten foot intervals to detect both the direct and refracted waves, with a 16-pound sledge-hammer being used as the energy source to produce the seismic waves.

The approximate locations of the air-track and hollow-stem borings, excavator pits and seismic lines are indicated on the Geotechnical Map, included as Plate 1 (Rear of Report). The boring logs, excavator pit logs, and air-track boring profiles, which illustrate the soil conditions encountered at the boring and excavator pit locations, as well as the results of some of the laboratory testing, are included in Appendix B.

2.0 GEOTECHNICAL CONDITIONS

2.1 Soil and Geologic Conditions

The field investigation indicates that three geologic units occur on the site; undocumented fill, Quaternary Very Old Alluvial Deposits, and Cretaceous Val Verde Tonalite. The occurrence and distribution of the units encountered, including descriptions of the units, are shown on the borings and excavator pits in Appendix B and on the Geotechnical Map – Plate 1 (map pocket). The geologic units are described below.

2.2 Site Geology

Based upon our understanding of the regional area and a review of the geotechnical boring logs and excavator pits the surficial earth materials on the site are comprised of artificial fills placed by others in the southwestern and northeastern portion of the site, and Quaternary Very Old Alluvial Fan Deposits, and Cretaceous Val Verde Tonalite. The Very Old Alluvial fan deposits overlie the majority of the eastern portion of the site area and to depths of 3 to 12 feet. The Val Verde Tonalite underlies the balance of the site both below the alluvium and in some areas, exposed at the surface. Large granitic outcroppings associated with the Tonalite exist on the south and southeastern portion of the project. A general description of the earth materials observed on the site is provided in the following paragraphs:

2.2.1 Artificial Fill, by Others (Afo):

Artificial Fill, placed by others materials was mapped directly from the surface, mainly within the southwest and northeast portion of the site. The artificial fill was generated from placement of crushed gravel throughout the northeast portion of the site and the creation of a gravel roadway. The fill materials in the southwest were imported by the owners of parcel numbers 314-040-002 and -008 to elevate the site for construction of residences. The Artificial Fill material is approximately 2 to 6½ feet, notably thicker in the southwest parcels as previous grades suggest. The Artificial fill, consists of liht-brown to brown silty sand, sand, or silt, dry to damp, and medium dense in the southwest. Materials located in the northeast are mainly crushed gravels.

2.2.2 Quaternary Very Old Alluvial Fan Deposits (Qvof)

Quaternary Very Old Alluvial Fan Deposits were mapped directly below the fill materials and at the surface throughout the central western portion of the property extending to the east. These materials were comprised of silt, clayey sand and silty sand, permeable to non-permeable, light pale brown to brown in color, medium dense to dense and were interfingered with caliche stringers, elluvial horizons directly above the bedrock, and colluvial deposits of silty-clayey material in the banks of the arroyos onsite.

2.2.3 Cretaceous Val Verde Tonalite (Kvt):

The Val Verde Tonalite underlies most of the site. Tonalite has a similar chemical composition to gabbro, but includes a higher percentage of quartz. Foliation within the Val Verde Tonalite mapped in the area generally strikes to the northeast (USGS, Steelepeak Quadrangle). The foliation generally has a vertical to near vertical dip and the direction of dip varies from a northeast to a southwest dip.

The Val Verde Tonalite was observed to be white-gray to gray and was found to be in a moderately hard to very hard state. In select areas, the upper 5 to 24 feet was more weathered and considered to be in a soft to moderately hard state. The unit was encountered throughout the majority of the site, beneath a veneer of topsoil or very old alluvium.

2.3 Landslides

Our review of the pertinent geologic literature did not indicate the presence of landslides on or directly adjacent to the site. The subject site is slightly to moderately sloping from west to east and not located within an area mapped as being potentially affected by earthquake-induced landsliding.

2.4 Groundwater

Groundwater was observed during field investigation. Based upon our knowledge of the site and local area, the groundwater observed is perched above the Tonalite. The granitic environment within the local and regional area is heavily weathered to non-weathered and contains zones of fresh very dense granitic bedrock with weathered fractures and seams that allow water to move freely within the rock. Depending upon the final design elevation of the proposed building pad groundwater may or may not adversely impact the proposed project development. Cuts in excess of 20 feet are likely to yield zones of seepage at the toe of slope (if configured within the site) or saturated conditions at the subgrade. The use of subdrains, curtain drains, or cut-off walls is very likely within areas of the site that water can travel from west to east. However, it is not uncommon for groundwater or seepage conditions to develop were none previously existed. Groundwater elevations are dependent on seasonal precipitation, irrigation, land use, among other factors, and may vary significantly as a result. Proper surface and subsurface drainage of irrigation and rainwater will be important to future performance of the project. Once a design pad elevation and plan is proposed MATRIX should review the plans and provide a design for recommendations of subdrains, curtain drains, or cut-off walls at that time.

In general, it is our opinion that those groundwater conditions will not have an influence on the subject site if properly managed through civil design with geotechnical input, although changes in ground conditions can occur. Based upon the dense to very dense to hard conditions of the Val Verde Tonalite, groundwater is not expected to be a constraint for the proposed industrial construction.

2.5 Surface Drainage

Existing surface drainage is evident within the site. Small surficial depressions and arroyos traverse the site from west to east. In addition an active storm drain inlet is present at the northeast corner of the project to handle unknown amounts of surface discharge. These surficial depressions are likely to carry significant volumes of water during a small to peak storm event. Ponding areas were not noticeable during our geotechnical investigation. In general, during a storm event, excessive water flow may likely traverse the site in a west to east pattern, as elevations suggest.

2.6 Seismicity

2.6.1 Faulting and Seismic Coefficients

The site is not located within an Alquist-Priolo Earthquake Fault Zone and there are not any faults (active, potentially active, or inactive) report on the pertinent literature onsite. Based on our background review, the site is not mapped in the vicinity of geologic hazards such as landslides, liquefaction areas, or faulting. The site is location in a seismically active region of Southern California. The possibility of damage from ground rupture is considered nil because active faults are not known to cross the site.

According to information obtained from the Acceleration Response Spectra (ARS) Online and the 2007 Caltrans Fault database, Table 1 lists the potential controlling fault located within a search radius of 50 miles from the property, its closest distance to the site and other information. The nearest known "active" fault is the San Jacinto Fault located approximately 8.0 miles northeast of the site. The San Jacinto Fault have been included in a State of California Earthquake Fault Zone. A maximum credible seismic event of magnitude 6.8 is postulated for the San Jacinto Fault with an estimated maximum credible peak site acceleration of 0.40g using the USGS acceleration-attenuation relationship.

TABLE 1
Nearby Faults

Fault Name	Fault Type	Dip (degrees) and Direction	Site Acceleration	Distance to Site[1]	Maximum Moment Magnitude (Mmax)
San Jacinto	Strike Slip		0.40	1.86	6.8[3]

[1] Closest distance from site to fault trace or surface projection of rupture area, based on Caltrans Design Manual Version 1.0 (2009)
[2] Site on footwall side of fault
3Based on review of the published reports on the San Jacinto Fault, a Mmax of 6.8 was used for the San Jacinto Section, consistent with Caltrans internal use.

Site accelerations were developed for the site based on the CBC, 2013 and Caltrans 2013 Acceleration Response Spectra (ARS) Online, Version 2.3.06. A site Coordinate of 33.857292° N, -117.267976° W was used to derive the seismic design parameters presented below in Table 2. MATRIX obtained its seismic design parameters in accordance with the California Building Code (CBC) Section 1613 using the United States Geological Survey (USGS) computer program, Earthquake Ground Motion Parameters and the site-specific Interactive Deaggregations software to develop further site analysis. The deaggregated site coefficients for 10 percent in 50 year (475-year recurrence interval) and for 2 percent in 50 year (2475-year recurrence interval) are listed herein using a V_s = 760 feet per second, associated with soil type D, a site specific PGA equivalent to 10% in 50 years = 0.39g and 2% in 50 years = 0.63g. The value of 2% in 50 years is associated with the 2013 California Building Code. However, the effective ground acceleration or (EGA) for the site is commonly taken as 2/3 to ¾ of the 2% in 50 years (2475 recurrence interval). MATRIX recommends that a site-specific coefficient of 0.42g be utilized for the subject site. (See Deaggregated Plots – Appendix E). The appropriate design spectrum should be selected by the project structural engineer.

TABLE 2
Seismic Design Parameters

Seismic Soil Parameters (2013 CBC Section 1613)	
Site Class Definition (Table 1613.5.2)	D
Mapped Spectral Response Acceleration Parameter Ss (for 0.2 second) (Figure 1613.5(3))	1.50
Mapped Spectral Response Acceleration Parameter, S_1 (for 1.0 second) (Figure 1613.5(4))	0.60
Site Coefficient Fa (short period) (Table 1613.5.3(1))	1.00
Site Coefficient F_v (1-second period) (Table 1613.5.2(2))	1.50
Adjusted Maximum Considered Earthquake (MCE) Spectral Response Acceleration Parameter S_{MS} (short period) (Eq. 16-37)	1.50
Adjusted Maximum Considered Earthquake (MCE) Spectral Response Acceleration Parameter S_{M1} (1-second period) (Eq. 16-38)	0.90
Design Spectral Response Acceleration Parameter, S_{DS} (short period) (Eq. 16-39)	1.00
Design Spectral Response Acceleration Parameter, S_{D1} (1-second period) (Eq. 16-40)	0.60

2.6.2 Liquefaction & Seismically Induced Settlement

Liquefaction is a seismic phenomenon in which loose, saturated, granular soil behaves similarly to a fluid when subjected to high-intensity ground shaking. Liquefaction occurs when three general conditions exist: 1) shallow groundwater; 2) low density non-cohesive (granular) soil; and 3) high-intensity ground motion. Studies indicate that saturated, loose to medium dense, near surface cohesionless soil exhibits the highest liquefaction potential. Dry cohesionless soil may experience dynamic compaction during an earthquake. In general, cohesive soil may not be susceptible to liquefaction. Groundwater was not identified below existing site grade. The potential for liquefaction to occur on the site is nil.

Dynamic settlement on the site of non-saturated fill and alluvium approximately 1-inch is anticipated, for proposed engineered fill and Val Verde Tonalite. A differential settlement of approximately ½-inch in 30-feet for engineered fill Val Verde Tonalite is expected because of seismic shaking. A corresponding angular distortion ratio of 1/500 may be utilized in the design of the site.

2.6.3 Shallow Ground Rupture

Shallow ground rupture cannot be completely precluded from occurring on the project site. However, based on our geologic mapping, literature review, and aerial photo analysis it appears that active faulting/potential shallow ground rupture is considered unlikely because of the absence of identified faults on the site. The potential for ground cracking because of shaking from distant seismic events is considered unlikely, although it is a possibility at any site.

2.6.4 Tsunami and Seiches

Based on the elevation of the of the site with respect to sea level and its distance from large open-bodies of water, the potential for seiche and/or tsunami waves to occur on the site is considered to be nil.

2.6.5 Lateral Spreading

Saturated soil that has experienced liquefaction may be subject to lateral spreading where located adjacent to free-faces, such as slopes, channels, and rivers. Therefore, lateral spreading does not appear to present a causative hazard to the site and the effects of lateral spreading on the site are considered to be nil.

2.7 Seismic Refraction Survey

A field seismic refraction survey was performed throughout the site. A total of seven (7) seismc refraction lines were performed in areas designated by MATRIX personnel. Matrix Geotechnical Consulting subcontracted Terra Geosciences – Mr. Donn Schwartzkopf, PGP to perform the seismic lines. Mr. Schwartzkopf and TerraGeosciences personnel located the traverses in the field by using Google EarthTM imagery and GPS coordinates. The equipment utilized consisted of twenty-four 14-Hertz geophones, speaced at eight-to ten-foot intervals, on each line to detect both the direct and refracted waves; a 16-pound sledge-hammer being used as the energy source to produce the seismic waves.

In general the site can be broken down into three velocity layers, V1, V2, and V3, respectively. The V1 layer is the uppermost layer and consists of topsoil, colluvial soil, older alluvium, and/or completely weathered and fractured bedrock. An average weighed velocity of 1,514 to 2,222 feet per second, is applied to these materials. In general, this was observed to be accurate within the excavator pits, hollow-stem and air-track borings. Materials were readily excavatable and required very little to moderate effort to remove soil or advance a flight auger.

The second layer V2 is located directly below the V1 layer. It has an average weighed velocity of 3,673 to 7,745 feet per second. From experience working within these rock materials, a value of 4,500 feet per second and higher yields heavy ripping and or a blasting requirement. For comparison, various charts of rippability and rock engineering properties have been provided within the Terra Geosciences report. This layer is dominated by the highly weathered and fractured Tonalite bedrock and some fresh corestones and boulders which required switching from the excavator bucket to a ripper shank. Although it should be noted that the excavatability was only reduced by some of the corestones that were observed within the excavator pit subgrade. These corestones and boulders will be fresh and well indurated and weathered depending upon location and depth. There did not appear to be a consistent depth or area of the site that presented similar characteristics for the presence of significantly hard material at depth. Additionally, it should be observed that air-track borings did encounter these corestones and boulders. However, in some instances the air-track rotary percussion hammer results, which were not an indication of hard bedrock as the hammer continued through the hard materials and advanced into rippable material below.

The third layer V3 indicates the presence of slight weathering of the Tonalite bedrock. This layer has a seismic velocity range of 11,549 to 17,849 feet per second. These materials are unlikely to be excavated by conventional earth-moving equipment and will most likely require blasting. Large fractions of the fresh bedrock material was observed in some of the excavator pits and prevented the ripper shank from advancing deeper than the observed rock depth. These materials are generally limited to selective areas in the southeast, central, and central northern portion of the site, where rock is generally exposed at the surface.

2.8 Slope Stability

The site is generally flat and we understand that significant slopes are not proposed to develop the site for its intended use. Once final grading plans become available, MATRIX should review the final proposed grading and provide supplemental recommendations with regards to slopes, as necessary.

2.9 Laboratory Testing

The following tests were performed on soil samples recovered from within the borings and excavation pits: maximum density and optimum water content (ASTM D1557), direct shear, consolidation, Expansion Index, sulfate and chloride content, resistivity, and pH. The evaluated data, a discussion of the tests performed, and a summary of the results are presented in Appendix C. Those results should be confirmed at the completion of site grading by the engineering geologist/geotechnical engineer's onsite representative.

2.10 Infiltration Characteristics

Based upon our review of the subsurface soil characteristics, MATRIX performed testing for infiltration testing of the native soil within the eastern portion of the site, directly adjacent to the property line. The testing apparatus utilized was a double-ring infiltrometer. In accordance with County of Riverside Flood Control guidelines, two (2) tests were performed within the native soil. Results of the testing indicate an average infiltration value of 1½ per hour.

3.0 CONCLUSIONS

Based on the results of our geotechnical site reconnaissance, field and laboratory investigations, and our understanding of the site, it is our opinion that the proposed industrial facility and improvements are feasible from a geotechnical viewpoint, provided the conclusions and recommendations contained in this report are incorporated into the project design process and implemented during construction. The following is a summary of the primary geotechnical conclusions determined from our analysis of the site.

- Based on our review of some of the pertinent geologic maps, stereoscopic aerial photos, and reports, the site is underlain by Artificial Fill, placed by others, Quaternary Very Old Alluvial Fan Deposits, and the Cretaceous Val Verde Tonalite.

- The site is not located within a State of California Earthquake Fault Zone.

- Groundwater is not considered a constraint for the proposed industrial development, provided that the design elevation of the site is reviewed by MATRIX.

- The potential for liquefaction to occur is considered negligible.

- Active or potentially active faults were not identified, to exist on, or project toward the site.

- Known landslides do not occur on, or have the potential to impact the site.

- Laboratory test results of the near surface soil (fill and native) indicate a very low expansion potential as evaluated by the Expansion Index (EI) test. The EI test consists of remolding a soil to an arbitrary density that bears little or no relationship to field density conditions. At best the EI is an index of probable soil behavior. The Index is not useful to the engineer assigned the task of designing a foundation.

- Laboratory testing indicates that site soil has a negligible potential for soluble sulfate attack on Type II/V concrete.

- Laboratory test results of the near surface soil indicate that onsite soil has a moderate corrosion potential to buried metals.

- The Artificial Fill, previously placed by others and Very Old Fan Deposits has the potential to settle and should be overexcavated to underlying competent Val Verde Tonalite, within the entire site, areas of proposed structures, fill or new as remedial improvements. Anticipated removal depths range from approximately 3½ to 15 feet below the existing surface (See Geotechnical Map, Plate 1).

- Transition areas should be overexcavated to a depth of the Fill Height / 3, to minimize the effects of differential settlement.

- The existing onsite soil appears, from a geotechnical perspective, to be suitable material for use as fill, provided it is relatively free from rocks (larger than 3 inches in maximum dimension), construction debris, and organic material. It is anticipated that the onsite soil may be excavated with conventional heavy-duty earth moving equipment.

4.0 RECOMMENDATIONS

4.1 Site Earthwork

We anticipate that earthwork at the site will consist of site preparation and remedial grading, followed by the installation of underground utilities, and foundations for the proposed industrial site. All earthwork and grading should be performed in accordance with all applicable requirements of the County of Riverside and the Earthwork Specifications presented in Appendix F. In case of conflict, the following recommendations shall supersede those presented in Appendix F.

4.1.1 Site Preparation

Prior to grading of areas that may receive structural fill, structures or other improvements the areas should be cleared of surface obstructions, existing debris and stripped of vegetation. Vegetation and debris should be removed and properly disposed of offsite. All debris from the demolition of any onsite facilities of any type should be removed and properly disposed of offsite. Holes resulting from the removal of buried tree roots, obstructions, structures or utilities, which extend below finished site grades should be excavated to Val Verde Tonalite and replaced with a suitable compacted fill material. Areas to receive fill and/or other surface improvements should be scarified to a minimum depth of 6 inches, brought to a near-optimum water content, and recompacted to 90 percent or more relative compaction (based on American Standard of Testing and Materials [ASTM] Test Method D1557).

4.1.2 Overexcavation and Recompaction

The site is overlain with Artifical fill, placed by others and Very Old Alluvial deposits. The site should be excavated within the entire site fill area to remove alluvial soil to the underlying Val Verde Tonalite. A fill keyway should be established on the eastern side and southern side of the project to commence filling of the site to reach design elevation. Prior to placement of fill material the bottom of the proposed fill keyway should be underlain with a gravel blanket approximately 12 inches thick, properly drain with subdrains connected to a solid piped outlet. The presence of grading water in a hard rock site and the influence of underground seasonal water conditions are likely to see a significant rise in the water on the fill portion of the site during rough grading. Control of the this water will be necessary to achieve dense and stable conditions throughout the installation of the fill materials. Alternatively, dewatering wells could be established along the eastern perimeter of the project during the grading to prevent water from infiltrating into the subgrade of the compacted fill material.

Transition parcels should have the cut portion over-excavated at equal depth for fill depths of 0 to 5 feet, 5 feet for fill depths exceeding 5 feet and up to 10 feet, 10 feet for fill depths exceeding 10 and up to 15 feet, and H/3 (where "H" is the proposed fill height) for fills greater than 15 feet. Over–excavation in building areas should extend 5 feet or more beyond the proposed structure. Although not anticipated, localized, deeper over-excavation should be anticipated where deemed necessary by the geotechnical consultant based on observation during grading.

Following the over-excavation, the exposed rock subgrade should be surveyed by the project surveyor to determine that the underlying rock has not created a depression within the subgrade where water could pond. All bedrock should be shaped to drain with some percent fall away from structures. The onsite MATRIX engineering geologist and senior field technician will be observing these conditions and making recommendations if any grades do not appear to be in general accordance with our preliminary geotechnical report.

If a large area of loose/soft bottom is encountered (not likely in a rock project such as this), we recommend that a layer of geotextile fabric be placed to stabilize the bottom before placing the primary structural fill. Such additional subsurface treatment should be determined in the field by MATRIX during foundation subgrade preparation activities. Upon completion of the required overexcavation, backfill should be placed in accordance with recommendations presented later in this report.

Within any proposed roadway pavement areas 24 inches of the native soil below the design subgrade should be removed and recompacted, that is **below** the proposed structural section (total thickness of asphaltic concrete and aggregate base) of the roadway. However, localized, deeper overexcavation should be anticipated where deemed necessary by the geotechnical consultant based on observations during grading.

4.1.3 Import Soil for Grading

In the event import soil is needed to achieve final design grades, all import materials should be free of deleterious/oversize materials, have a very low expansion potential, negligible corrosion potential, and receive prior approval by Matrix Geotechnical Consulting 48 hours prior to commencement of delivery onsite. Laboratory testing of import soil must consist of maximum density and optimum water content, Expansion Index, sulfate, chloride, resistivity, pH, sieve analysis, and R-value.

4.1.4 Shrinkage and Bulking

Volumetric changes in earth quantities occur when excavated onsite earth materials are replaced as properly compacted fill or when fill is imported on a volumetric basis. The following (Table 3) is an estimate of losses from removal of organics, shrinkage and bulking factors for the various geologic units found on the site. These estimates are based on in-place densities of the various materials and on the estimated average degree of relative compaction specified during grading.

TABLE 3
Bulking and Shrinkage

GEOLOGIC UNIT	SHRINKAGE/BULKING PERCENT
Artificial Fill, by Others	10 to 15 (shrinkage)
Quaternary Very Old Alluvial Deposits	5 to 10 (shrinkage)
Cretaceous Val Verde Tonalite (weathered)	0 to 2 (shrinkage)*
Cretaceous Val Verde Tonalite (non-weathered)	0 to 5 (bulking)

*Negligible

The above estimates of shrinkage are intended as an aid for project engineers in determining earthwork quantities. **However, these estimates should be used with some caution because those are not absolute values,** rather preliminary estimates which may vary with depth of overexcavation, stripping losses, field conditions at the time of grading, etc. (Handling losses, and reduction in volume because of removal of oversized material, are not included in these estimates).

4.1.5 Fill Placement and Compaction

Areas prepared to receive structural fill should be scarified to a minimum depth of 6 inches, brought to optimum-water content, and recompacted to 90 percent or more relative compaction (based on ASTM Test Method D1557). The optimum lift thickness to produce a uniformly compacted fill will depend on the type and size of compaction equipment used. In general, fill should be placed in uniform lifts generally not exceeding 8 inches in uncompacted thickness. Fill materials shall be free of cobbles and boulders, with not more than 25% of the material being greater than 3 inches in size. Placement and compaction of fill should be performed in accordance with local grading ordinances under the observation and testing of the geotechnical consultant. In general, oversized material greater than 8 inches shall not be placed within 10 vertical feet of finish grade or within 2 feet of future utilities or underground construction. Oversize material may be incorporated into design fills in accordance with our standard grading details (see Appendix E).

4.1.6 Trench Backfill and Compaction

Onsite soil is generally considered to be suitable as trench backfill provided it is screened of rocks and other material over 3 inches in diameter and free of organic material. The trench backfill soil should possess a well-distributed grain size of coarse and fine gravel as well as coarse, medium, and fine sands. It is expected that onsite soil will meet this specification. Trench backfill should be compacted in uniform lifts (generally not exceeding 8 inches in uncompacted thickness) by mechanical means to 90 percent or more relative compaction (per ASTM Test Method D1557).

4.1.7 Temporary Stability of Trenches

All excavations for the proposed development must be performed in accordance with current OSHA (Occupational Safety and Health Agency) regulations and those of other regulatory agencies, as appropriate.

Based upon previous construction experience within the County of Riverside, working within Very Old Alluvial Deposits and Val Verde Tonalite, temporary vertical trenches or other cuts may be cut up to five feet. Those deeper than five feet shoud be slot-cut, shored, or cut to a 1H:1V (horizontal, H: vertical, V) slope gradient. Surface water should be diverted away from exposed cuts, and not be allowed to pond on or near the top of the cut slopes. Temporary cuts should not be left open for an extended period of time. Recommendations and stability calculations can be provided upon request for the use of cantilevered shoring, soldier piles, and underpinning. A foundation and/or shoring plan review must be completed by MATRIX prior to construction to confirm the location and suitability of potential shoring with respect to new structures.

If trenches are shallow and the use of conventional equipment may result in damage to the utilities, clean sand, having a sand equivalent (SE) of 30 or greater, should be used to bed and shade the utilities. Sand backfill should be densified. The densification may be accomplished by jetting or flooding. However, a representative of MATRIX shall observe the sub-soil conditions within the trench to determine the soil drainage condition potential. The presence of silt or clay bearing sub-soil within a trench suggests the use of a vibratory plate and then tamping to ensure adequate compaction of the trench backfill. A representative from MATRIX should observe, probe, and test the backfill to verify compliance with the project specifications.

4.1.8 Cal/OSHA Soil Classification

Based on the soil types encountered during our preliminary investigation, onsite soil can be generally classified as Type B. MATRIX does not limit the soil classification to one type as soil may locally change over short distances. Furthermore, this classification should not preclude a Cal/OSHA "competent person" from determining soil type on a case-by-case basis.

4.2 Foundation Selection

4.2.1 General

Preliminary recommendations for conventional foundation design construction are presented herein. When the final structural loads for the proposed structures become available, those should be provided to our office to verify the recommendations presented herein.

The information and recommendations presented in this section are minimums from a geotechnical point of view and are not meant to supersede design by the project structural engineer or civil engineer specializing in the structural design or those of a corrosion consultant.

4.2.2 Conventional Foundations

Place continuous footings at a minimum depth of 18-inch for exterior and interior construction into certified compacted fill. All continuous footings should have a minimum width of 15 inches.

Shallow foundations may be designed for a maximum allowable bearing capacity of 2,000 lb/ft^2, for continuous and spread footings. This value may be increased by 300 psf for each additional foot in depth and 150 psf for each additional foot of width to a maximum value of 3,000 psf, for dead load plus live load.

Spread or isolated pad footings shall be a minimum width of 24 inches and be founded 18 inches deep into certified compacted fill or approved Paralic Deposits or Friars Formation, where exposed. The bearing capacities should be re-evaluated when loads and footing sizes are finalized.

Lateral forces on footings may be resisted by passive earth resistance and friction along the bottom of the footing. Foundations may be designed for a coefficient of friction of 0.35, and a passive earth pressure of 250 lb/ft^2/ft. When combining passive and friction forces, passive resistance should be reduced by 1/3.

All footing trenches and bearing pads must be cut neat and level, and should be free of sloughed materials. See Table 4 for subgrade water conditioning for both continuous footing trenches and pads.

TABLE 4 CONVENTIONAL CONTINUOUS FOUNDATION DESIGN PARAMETERS	
Expansion Potential	**Very Low**
Soil Category	I
Footing Depth Below Lowest Adjacent Finish Grade	
Interior/Exterior	18
Footing Width	15
Footing Reinforcement	No. 4 Rebar Two (2) on Top Two (2) on Bottom
Slab Thickness	6 inches (minimum)
Under-Slab Requirements	A water and vapor retarding system (Stego or equivalent) should be placed below the slab on grade and on water sensitive areas as discussed in Section 4.2.3
Foundation and Slab Subgrade Water Content	At 10% above optimum water content prior to placement of concrete
Footing Embedment Next to Swales and Slopes If exterior footings are proposed adjacent to drainage swales are proposed within five (5) feet horizontally of a swale, the footing should be embedded 10" below the bottom of the swale. Footings adjacent to slopes should be placed at least five (5) feet horizontally from the edge of the footing to the face of the slope.	

*For Expansion potential greater than Low Expansion, alternative design guidelines will be provided by the Geotechnical Engineer.

4.2.4 Building Floor Slabs

We recommend a minimum floor slab thickness of 6 inches, reinforced with No. 3 bars spaced a maximum of 18 inches on center, both ways. Support slab reinforcement on concrete chairs to provide placement of the reinforcing near mid-depth of the slab, or as otherwise specified by the project structural engineer. Concrete should be either Type II/V having a minimum compressive strength of 4000 pounds per square inch (psi) and a water to cement ratio of 0.45.

Interior floor slabs with water sensitive floor coverings should be underlain by a 15-mil thick water/vapor barrier (Stego or equivalent), to mitigate the upward migration of water from the underlying subgrade soil. The water/vapor barrier product must meet the performance standards of an ASTM E 1745 Class A material and have a permeance rating less than 0.01 perms as described in ASTM E 96-95 and ASTM E 154-88, and be properly installed in accordance with ACI Publication 302. It is the responsibility of the contractor to ensure that the water-vapor barrier system is placed in accordance with the project plans and the manufacturers and architectural specifications, and that the water /vapor retarder materials are free of tears and punctures prior to concrete placement. Additional water reduction and/or prevention measures may be needed, depending on the performance requirements of future interior floor coverings. Lap the membrane twelve inches or more and tape the seams. Where water sensitive floor coverings are not anticipated, the water/vapor barrier may be eliminated.

Sand layer requirements are the purview of the structural engineer, and provided in accordance with ACI Publication 302 "Guide for Concrete Floor and Slab Construction". In general, two inches of sand above and below the water/vapor barrier can be used as a guide. The use of sand layers is not a soil engineering issue and hence outside our purview. Ultimately, the design of the water retarder system and recommendations for concrete placement and curing are the purview of the developer, architect, building designer or the engineer responsible for the design of the foundations and floor slabs on grade.

Subgrade preparation below the concrete and sand shall consist of 4-inches of ¾-inch crushed aggregate rock or an equivalent material. The crushed aggregate base should be thoroughly water conditioned and be compacted with a minimum of 3 passes, each way, with a vibratory plate compactor.

Prior to placing concrete, vapor barrier, and sand, the subgrade soil below all floor slabs should be pre-watered to achieve a water content that is at least equal to or slightly greater than optimum water content. This water content should penetrate to a minimum depth of 12 inches into the subgrade soil. The water content of the floor slab subgrade soil should be verified by the geotechnical engineer within 24-hours prior to concrete placement. Proper concrete curing techniques should be utilized to reduce the potential for slab curling or the formation of excessive shrinkage cracks.

4.3 Lateral Earth Pressures and Retaining Wall Design Considerations

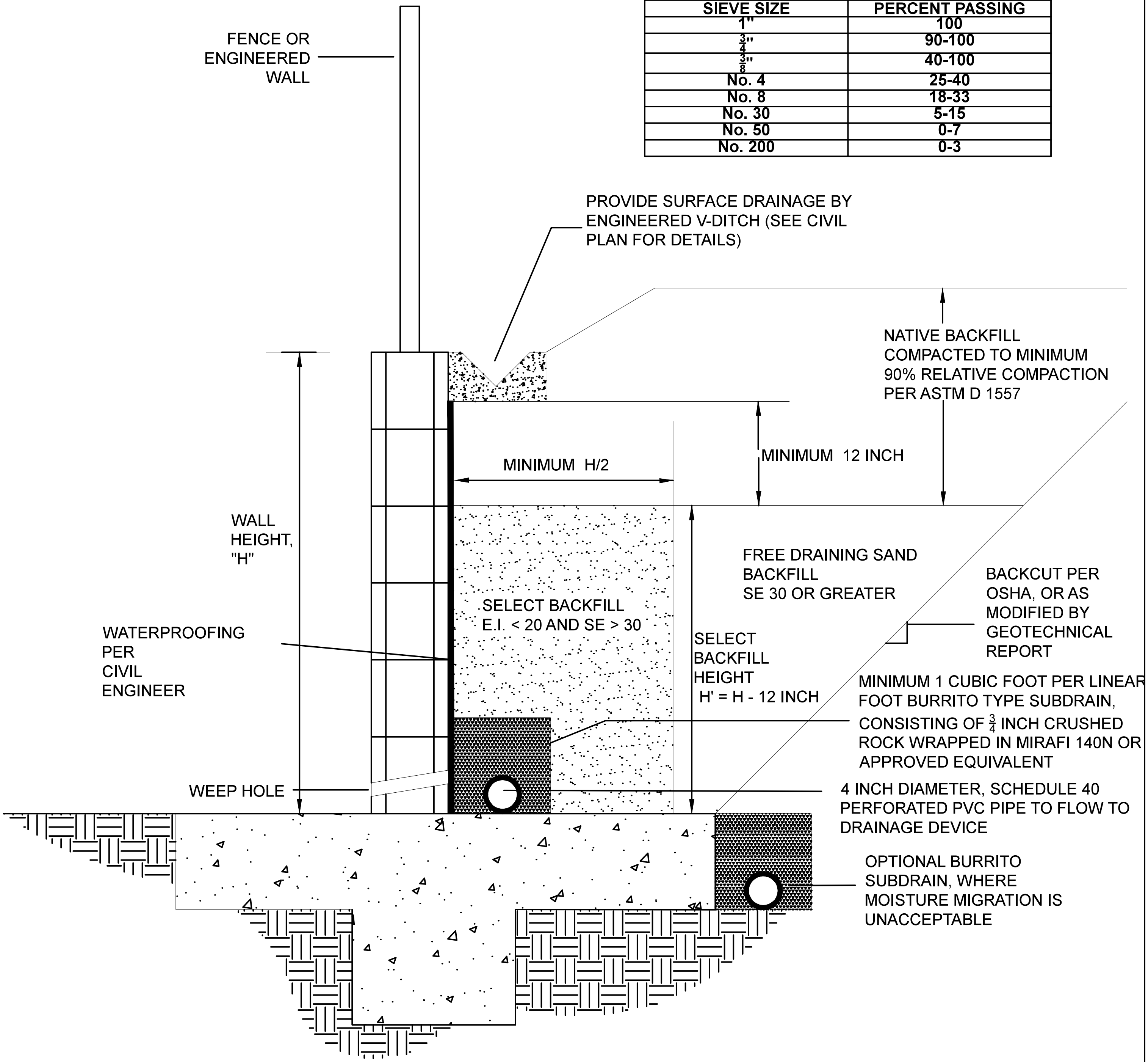
Retaining walls should be founded on fill compacted per these recommendations or in dense Val Verde Tonalite. Foundations may be designed in accordance within the recommendations presented in Section 4.2.2. It should be noted that the values for lateral bearing presented therein are based upon level conditions at the toe. Reduced values may be appropriate for walls adjacent to descending slopes. In general, conventional walls may be designed to retain either native materials or select granular backfill. MATRIX must test and approve retaining wall backfill materials. Retaining walls should be backfilled with free draining materials (SE> 30) within one-half (½) the height of the wall, measured horizontally from the back of the wall, and compacted to project specifications. The upper twelve (12) inches of backfill should consist of clayey soil. Drainage systems should be provided to walls to relieve potential hydrostatic pressure. Specifications for the quality of backfill soil should be defined on the retaining wall plans. It should be anticipated that suitable backfill material will have to be imported or selectively produced from onsite sources and should consist of granular, very low expansive materials. The following lateral earth pressures are recommended for retaining walls. The recommended lateral pressures for approved on-site soil (sand equivalency greater than 30 and non-expansive) for level or sloping backfill are presented on Table 5.

TABLE 5
Lateral Earth Pressures

Design Parameter		Soil Type	
		Imported Aggregate Base (Assumed)	**Val Verde Tonalite**
Internal Friction Angle (ϕ)		38°	32°
Unit Weight		130 lbs/ft^3	125 lbs/ft^3
Equivalent Fluid Pressure	Active Condition (Level backfill)	40 lbs/ft^3	55 lbs/ft^3
	Active Condition (2H:1V backfill)	55 lbs/ft^3	85 lbs/ft^3
	At-Rest Condition (Level backfill)	60 lbs/ft^3	75 lbs/ft^3
	At-Rest Condition (2H:1V backfill)	75 lbs/ft^3	95 lbs/ft^3
Passive Pressure		330	250

*Onsite backfill soil must be free from organics.

CLASS 2 FILTER PERMEABLE MATERIAL GRADATION PER CALTRANS SPECIFICATIONS	
SIEVE SIZE	PERCENT PASSING
1"	100
$\frac{3}{4}$"	90-100
$\frac{3}{8}$"	40-100
No. 4	25-40
No. 8	18-33
No. 30	5-15
No. 50	0-7
No. 200	0-3



MATRIX

FIGURE 3
RETAINING WALL DIAGRAM

Project Name	MARKHAM D.M.G.
Project No.	M1114-035
Geo/Eng	JPN
Scale	NOT TO SCALE
Date	JULY 2014

Equivalent fluid pressures are calculated utilizing a soil unit weight of γ = 130 pcf and γ = 125 pcf, for Imported Aggregate Base and Formational Soil, respectively. Restrained retaining walls should be designed for "at-rest" conditions, utilizing K_o.

- The design loads presented in the above table applied a horizontal loading. Friction between wall and retained soil should not be allowed in the retaining wall analyses.

- Additional allowances should be made in the retaining wall design to account for the influence of construction loads, temporary loads, and possible nearby structural footing loads.

- Unit weights of 120 pcf and 130 pcf may be used to model the dry and wet density of onsite compacted fill materials.

- Select backfill should be granular, structural quality backfill with an Expansion index of 20 or less. The select backfill must extend at least one-half the wall height behind the wall. The upper one-foot of backfill should be comprised of native onsite soil.

- The wall design should include waterproofing (where appropriate) and back drains or weep holes for relieving possible hydrostatic pressures. The back drain should be comprised of a 4-ich perforated PVC pipe in a 1 foot by 1 foot, ¾-inch gravel matrix, wrapped with a geo-fabric, Mirafi 140N (or equivalent). The back drain should be installed with a minimum gradient of 2 percent and should be outletted to an appropriate location. For subterranean walls, this may include drainage by sump pumps.

- Backfill should not be placed against retaining wall concrete until the minimum design concrete strength (specified by others) is achieved by compression testing of field cast concrete cylinders.

4.4 Structural Setbacks

Structural setbacks, in addition to those required per the CBC, are not required because of geologic or geotechnical conditions within the site. Footing setbacks from basement foundation walls, if any, should be designed to minimize the effects of loading within the active zone of the subterranean walls. Where foundations are anticipated to be within the active zone for a potential subterranean wall, special design criteria for retaining wall active bearing pressures should be provided by MATRIX. The geotechnical and structural engineers must evaluate surcharge loading effects from the adjacent structures.

4.5 Corrosivity to Concrete and Metal

The National Association of Corrosion Engineers (NACE) defines corrosion as "a deterioration of a substance or its properties because of a reaction with its environment". The "environment" from a geotechnical viewpoint is the prevailing foundation soil and the "substances" are the reinforced concrete foundations or various buried metallic elements such as rebars, piles, pipes, etc., which are in direct contact with or within close vicinity of the foundation soil.

In general, soil environments that are detrimental to concrete possess high concentrations of soluble sulfates and/or pH values of less than 5.5. ACI 318R-05 Table 4.3.1 provides specific guidelines for the concrete mix design based on different amount of soluble sulfate content. The minimum amount of chloride ions in the soil environment that are corrosive to steel, either in the form of reinforcement protected by concrete cover, or plain steel substructures such as steel pipes or piles, is 500 ppm per California Test 532.

Based on testing performed during this investigation within the project site, the onsite soil is classified as having a negligible sulfate exposure condition in accordance with ACI 318R-05 Table 4.3.1. It is also our opinion that onsite soil should be considered to possess a moderate corrosion potential to buried metals because of its low resistivity.

Despite the minimum recommendation above, Matrix Geotechnical Consulting is not a corrosion-engineering firm. We recommend that you consult with a competent corrosion engineer and conduct additional testing to evaluate the actual corrosion potential of the site and to provide recommendations to reduce the corrosion potential with respect to the proposed improvements. The recommendations of the corrosion engineer may supersede our findings and recommendations.

4.6 Concrete Flatwork and Improvements

In an effort to minimize shrinkage cracking, concrete flatwork should be constructed of uniformly cured, low-slump concrete and should contain sufficient control/contraction joints (typically spaced at 8 to 10 feet, maximum).

Additional provisions need to be incorporated into the design and construction of all improvements exterior to the structures (walls, patios, walkways, planters, etc.). Design considerations may need to include provisions for differential bearing materials (bedrock versus compacted fill), ascending/descending slope conditions, bedrock structure, perched (irrigation) water, special surcharge loading conditions, potential expansive soil pressure, and differential settlement/heave.

Exterior improvements should be designed and constructed by qualified professionals using appropriate design methodologies that account for the onsite soil and geologic conditions. The above considerations should be used when designing, constructing, and evaluating long-term performance of the exterior improvements on the site.

The owner is advised of its maintenance responsibilities as well as geotechnical issues that could affect design and construction of future owner improvements. The information contained within this report should be considered for inclusion in owner packages (sale, transfer, lease, etc.) to inform the potential owner or lease-holder of issues relative to drainage, expansive soil, landscaping, irrigation, corrosive soil, and slope maintenance.

4.7 Preliminary Pavement Design

The following pavement recommendations assume proper drainage and construction monitoring, and are based on either the Portland Concrete Cement (PCA) or Caltrans design parameters for a twenty (20) year design period. However these designs also assume a routine pavement maintenance program to obtain the anticipated 20-year pavement service life.

Structural pavement sections presented herein for pavements are based on assumed subgrade soil conditions at the completion of grading and a review of the soil samples recovered during our subsurface exploration. However, it should be understood that the soil material exposed during grading may differ from the materials sampled and tested during this investigation. Therefore, preliminary pavement recommendations are subject to verification and possible revision based on any revised Traffic Indices (TI) as well as sampling and testing of subgrade soil present after grading. The client and/or civil engineer should verify that the TI's are representative of the anticipated traffic volumes. If the client and/or civil engineer determines that the expected traffic volume will exceed the assumed traffic indices, Matrix Geotechnical Consulting should be contacted for supplementary recommendations. The design traffic indices equate to the following approximate daily traffic volumes over a 20-year design life, assuming six operational traffic days per week.

Traffic Index	No. of Heavy Trucks per Day
4.0	5
5.0	8
6.0	10
7.0	15

With respect of the traffic volumes indicated above, a truck is defined as a 5-axle tractor-trailer unit with one 8-kip axle and two 32-kip tandem axles. All of the traffic indices allow for 1,000 automobiles per day.

Our laboratory testing determined an R-value of soil of 28 for design purposes we assumed an R-value of 25 for planning and prepared the following preliminary asphaltic concrete (AC) pavement sections (Table 6) based on assumed Traffic Indices (T.I.) of 5.0, 6.5, 7.0, and 7.5, and for Portland cement concrete (PCC) pavement sections (Table 7) for automobile parking and drive areas, light and moderate truck traffic.

TABLE 6
Preliminary Pavement Design – Asphaltic Concrete
Recommended Minimum Pavement Sections

ASPHALT PAVEMENTS (R = 25)				
Proposed Condition	**Thickness (inches)**			
	Private Drive/Parking Lot	Enhanced Local Road	Collector	Industrial Road
Assumed Traffic Index	5.0	6.5	7.0	7.5
Design R-value	30	30	30	30
AC Thickness (inches)	3.5	3.5	4.0	5.0
AB Thickness (inches)	7.0	11.0	11.0	13.0

Notes: AC – Asphaltic Concrete
AB – Aggregate Base

The thicknesses of the provided section are considered minimum thicknesses. We utilized a design R-Value of 30 for these minimum recommendations. Increasing the thickness of any or all of the above layers will reduce the likelihood of the pavement experiencing distress during its service life. The above recommendations are based on the assumption that proper maintenance and drainage of irrigation areas adjacent to the roadway will occur throughout the design life of the pavement. Failure to maintain a proper maintenance and/or irrigation program will jeopardize the integrity of the pavement.

TABLE 7
Preliminary Pavement Design – Portland Cement Concrete
Recommended Minimum Pavement Sections

PORTLAND CEMENT CONCRETE PAVEMENTS			
Materials	**Thickness (inches)**		
	Automobile Parking and Drive Areas	Light Truck Traffic Areas	Moderate Truck Traffic Areas
PCC	5	6	8.5
AB	4	6	6
Compacted Subgrade (95% minimum compaction)	12	12	12

Crushed aggregate base should be compacted to a minimum of 95 percent relative compaction placed over a subgrade compacted to a minimum of 95 percent relative compaction per ASTM D1557 or the R-Value dry density, whichever is greater, throughout its upper 12 inches. Aggregate base should meet the specifications of the latest edition of the "Standard Specifications for Public Works Construction" (Greenbook) or the specifications of Caltrans Class 2 aggregate base. **Subgrade R-values shall be obtained by MATRIX upon completion of finished subgrade soil conditions within the site at the conclusion of rough or precise grading to confirm that our preliminary R-values remain applicable and valid for the as-graded conditions.** MATRIX should provide geotechnical observation and testing during construction.

The concrete should be a 28-day compressive strength of 4,000 pounds per square-inch (psi). Subgrade conditions assume a modulus of subgrade reaction of 100 pounds per cubic-inch (pci). Reinforcing within all pavements should be designed by the structural engineer. The maximum joint spacing within the entire PCC pavement is recommended to be equal to or less than 20 times the pavement thickness. The structural engineer should determine the actual joint spacing and reinforcing of the Portland cement concrete pavements.

4.8 Control of Surface Water and Drainage Control

Positive drainage of surface water away from structures is very important. Water must not be allowed to pond onsite or directly adjacent to or behind retaining walls. Design fine-grade elevations should be maintained throughout the life of the structure or if design fine grade elevations are altered, adequate area drains should be installed in order to provide rapid discharge of water, away from structures and slopes. Positive drainage may be accomplished by providing drainage away from buildings at a gradient of at least 2 percent to a location identified for drainage and further maintained by a suitable outlet or sump-pump (as necessary). Where existing conditions prevent 2 percent fall away from structures, alternative drainage methods should be incorporated by the civil engineer into his design of the drainage of the site. Additionally, MATRIX should review and comment on the use of alternative drainage devices within the site.

Planters with open bottoms adjacent to buildings should be avoided. Planters should not be located adjacent to buildings unless provisions for drainage, such as catch basins, and/or area drains, are made. Over watering must be avoided.

4.9 Slope Landscaping and Maintenance (as necessary)

Adequate slope and pad drainage facilities must be incorporated into the design of the finish grading for the subject site. The overall stability of graded slopes should not be adversely affected provided all drainage provisions are properly constructed and maintained thereafter and provided all engineered slopes are landscaped with a deep rooted, drought tolerant and maintenance free plant species, as recommended by the project landscape architect and reviewed by MATRIX.

4.10 Future Plan Reviews, Construction Observation and Testing

Future plan reviews are necessary to verify that recommendations and conclusions provided by Matrix Geotechnical Consulting preliminary studies are incorporated into the plans. Modifications to the plan or additional subsurface exploration/laboratory testing may be required based upon our review; therefore our review should be performed before any related construction is initiated. Such reviews should include, but are not limited to a review of :

- Precise Grading Plans
- Foundation and Structural Plans
- Retaining Wall and Shoring Plans
- Storm Drain/Sewer/Water/Dry Utility Plans

Plans should be forwarded to the project geotechnical engineer and/or engineering geologist for review and comments, as deemed necessary.

The recommendations provided in this report are based on limited subsurface observations and geotechnical analysis. A representative of MATRIX should check the interpolated subsurface conditions in the field during construction.

The geotechnical consultant should also perform construction observation and testing during future grading, excavations, backfill of utility trenches, preparation of pavement subgrade and placement of aggregate base, foundation or retaining wall construction or when an unusual soil condition is encountered at the site. Grading plans, foundation plans, and final project drawings should be reviewed by this office prior to construction.

5.0 LIMITATIONS

Our services were performed using the degree of care and skill ordinarily exercised, under similar circumstances, by California licensed civil or geotechnical engineers and geologists practicing in this or similar localities. Other warranties, expressed or implied are not made as to the conclusions and professional advice included in this report. The soil samples taken and submitted for laboratory testing, the observations made and the in-situ field testing performed are considered to be representative of the entire project; however, soil and geologic conditions revealed by future excavation may be different than our preliminary findings. If this occurs, the responsible party (client or contractor performing the work) must notify Matrix Geotechnical Consulting immediately of the changed conditions. These conditions must be evaluated by the project geotechnical engineer and geologist, and design(s) adjusted as required or alternate design(s) recommended.

This report is issued with the understanding that it is the responsibility of the owner, or of his/her representative, to ensure that the information and recommendations contained herein are brought to the attention of the architect and/or project engineer and incorporated into the plans, and that the necessary steps are taken to determine that the contractor and/or subcontractor properly implements our recommendations in the field. The contractor and/or subcontractor should notify the owner if they consider any of the recommendations presented herein to be unsafe.

Matrix Geotechnical Consulting, Inc. is not responsible for construction means, methods, techniques, sequences, or procedures, or for safety or precautionary programs in connection with the construction, for the acts and omissions of the CONTRACTOR, or any other person performing any of the construction, or for the failure of any of them to carry out the construction in accordance the final design drawings and specifications.

The findings of this report are valid as of the present date. However, changes in the conditions of a property can and do occur with the passage of time, whether they be because of natural processes or the works of man on this or adjacent properties.

In addition, changes in applicable or appropriate standards may occur, whether they result from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated wholly or partially by changes outside our control. This report should be reviewed and updated after a maximum period of 2-years or if the project concept changes from that described herein. This report has not been prepared for use by any parties or projects other than those specifically named or described herein. This report may not contain sufficient information for other parties or other purposes.

The opportunity to be of service is appreciated. Should you have any questions regarding the content of this report, or should you require additional information, please do not hesitate to contact this office.

Respectfully submitted,

MATRIX GEOTECHNICAL CONSULTING

Josh Feffer, CEG 2138
Associate Geologist

John P. Nielsen, GE 641
Associate Engineer

CEJ/JF/JPN

APPENDIX A

REFERENCES

APPENDIX A

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APPENDIX B

MATRIX FIELD BORING LOGS/TEST PITS/AIR-TRACK BORINGS

<table>
<tr><td colspan="2">Project Name: DECKER ASSEMBLAGE</td><td colspan="2">Logged by: CEJ</td><td colspan="4">LOG OF TRENCH TP- 1</td></tr>
<tr><td colspan="2">Project Number: M1103-004</td><td colspan="2">Elevation: 1561</td><td colspan="4">ENGINEERING PROPERTIES</td></tr>
<tr><td colspan="2">Equipment: CAT 345B</td><td colspan="2">Location/Grid: SEE GEOTECHNICAL MAP</td><td rowspan="2">USCS</td><td rowspan="2">Sample No.</td><td rowspan="2">Water Content (%)</td><td rowspan="2">Dry Density (pcf)</td></tr>
<tr><td>GEOLOGIC ATTITUDES</td><td>DATE: SEPTEMBER 3, 2013</td><td>DESCRIPTION: PROPOSED RESIDENTIAL PAD</td><td>GEOLOGIC UNIT</td></tr>
<tr><td></td><td colspan="2">0–9' <u>QUATERNARY VERY OLD ALLUVIAL FAN DEPOSITS</u>
SILTY SAND; DARK BROWN, DRY TO DAMP, LOOSE, CAVING CAVING SIDEWALLS

9–12.5' <u>CRETACEOUS VAL VERDE TONALITE</u>
GRANITICS; INTENSELY WEATHERED, GRAY-WHITE, DAMP, READILY EXCAVATABLE, BECOMING HARDER IN BOTTOM OF TRENCH.</td><td>QVOF

KVT</td><td>SM</td><td>BAG-1
0-5'</td><td></td><td></td></tr>
<tr><td colspan="2">TOTAL DEPTH = 12.5'</td><td>NO GROUDWATER</td><td>BACKFILLED: YES</td><td colspan="3">SURFACE SLOPE 1 ~ 2%</td><td>TREND E – W</td></tr>
</table>

<table>
<tr><td colspan="2">Project Name: DECKER ASSEMBLAGE</td><td colspan="2">Logged by: CEJ</td><td colspan="4">LOG OF TRENCH TP- 2</td></tr>
<tr><td colspan="2">Project Number: M1103-004</td><td colspan="2">Elevation: 1571</td><td colspan="4">ENGINEERING PROPERTIES</td></tr>
<tr><td colspan="2">Equipment: CAT 345B</td><td colspan="2">Location/Grid: SEE GEOTECHNICAL MAP</td><td rowspan="2">USCS</td><td rowspan="2">Sample No.</td><td rowspan="2">Water Content (%)</td><td rowspan="2">Dry Density (pcf)</td></tr>
<tr><td>GEOLOGIC ATTITUDES</td><td>DATE: SEPTEMBER 3, 2013</td><td>DESCRIPTION: PROPOSED RESIDENTIAL PAD</td><td>GEOLOGIC UNIT</td></tr>
<tr><td></td><td colspan="2">0–3' <u>QUATERNARY VERY OLD ALLUVIAL FAN DEPOSITS</u>
SILTY SAND; RED BROWN, DRY TO DAMP, MEDIUM DENSE

3–4' <u>CRETACEOUS VAL VERDE TONALITE</u>
GRANITICS; INTENSELY WEATHERED AND CHEMICAL WEATHERING, GRAY-WHITE, DAMP, READILY EXCAVATABLE

4-7.5' BECOMING NON-EXCAVATABLE, SWITCHED TO RIPPER SHANK, MODERATE TO HEAVY RIPPING WITH SHANK TO REFUSAL</td><td>QVOF

KVT</td><td>SM</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">TOTAL DEPTH = 7.5'</td><td>NO GROUDWATER</td><td>BACKFILLED: YES</td><td colspan="3">SURFACE SLOPE 1 ~ 2%</td><td>TREND E – W</td></tr>
</table>

<table>
<tr><td colspan="3">Project Name: DECKER ASSEMBLAGE</td><td colspan="2">Logged by: CEJ</td><td colspan="4">LOG OF TRENCH TP- 3</td></tr>
<tr><td colspan="3">Project Number: M1103-004</td><td colspan="2">Elevation: 1577</td><td colspan="4">ENGINEERING PROPERTIES</td></tr>
<tr><td colspan="3">Equipment: CAT 345B</td><td colspan="2">Location/Grid: SEE GEOTECHNICAL MAP</td><td rowspan="2">USCS</td><td rowspan="2">Sample No.</td><td rowspan="2">Water Content (%)</td><td rowspan="2">Dry Density (pcf)</td></tr>
<tr><td>GEOLOGIC ATTITUDES</td><td colspan="2">DATE: SEPTEMBER 3, 2013</td><td>DESCRIPTION: PROPOSED RESIDENTIAL PAD</td><td>GEOLOGIC UNIT</td></tr>
<tr><td></td><td colspan="3">0–1’ <u>QUATERNARY VERY OLD ALLUVIAL FAN DEPOSITS</u>
SILTY SAND; DARK RED BROWN, DRY, LOOSE, PREVIOUSLY DISKED

1–7.5’ BECOMING PALE-YELLOW BROWN, DAMP, MEDIUM DENSE

8-17.5’ <u>CRETACEOUS VAL VERDE TONALITE</u>
GRANITICS; GRAY-WHITE, INTENSELY WEATHERED, READILY EXCAVATABLE, CORESTONES IN EASTERN HALF OF TEST PIT

11-17.5’ USING RIPPER TO PENETRATE ROCK WITH CONSIDERABLE DIFFICULTY TO REFUSAL</td><td>QVOF

KVT</td><td>SM</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">TOTAL DEPTH = 17.5’</td><td>NO GROUDWATER</td><td>BACKFILLED: YES</td><td colspan="3">SURFACE SLOPE 1 ~ 2%</td><td colspan="2">TREND E – W</td></tr>
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<tr><td colspan="3">Project Number: M1103-004</td><td colspan="2">Elevation: 1590</td><td colspan="4">ENGINEERING PROPERTIES</td></tr>
<tr><td colspan="3">Equipment: CAT 345B</td><td colspan="2">Location/Grid: SEE GEOTECHNICAL MAP</td><td rowspan="2">USCS</td><td rowspan="2">Sample No.</td><td rowspan="2">Water Content (%)</td><td rowspan="2">Dry Density (pcf)</td></tr>
<tr><td>GEOLOGIC ATTITUDES</td><td colspan="2">DATE: SEPTEMBER 3, 2013</td><td>DESCRIPTION: PROPOSED RESIDENTIAL PAD</td><td>GEOLOGIC UNIT</td></tr>
<tr><td></td><td colspan="3">0–3’ <u>QUATERNARY VERY OLD ALLUVIAL FAN DEPOSITS</u>
SILTY SAND; PALE YELLOW BROWN, DRY, MEDIUM DENSE

8-20’ <u>CRETACEOUS VAL VERDE TONALITE</u>
GRANITICS; GRAY-WHITE, INTENSELY WEATHERED, READILY EXCAVATABLE</td><td>QVOF

KVT</td><td>SM</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">TOTAL DEPTH = 20’</td><td>NO GROUDWATER</td><td>BACKFILLED: YES</td><td colspan="3">SURFACE SLOPE 1 ~ 2%</td><td colspan="2">TREND E – W</td></tr>
</table>

Project Name: DECKER ASSEMBLAGE			Logged by: CEJ		LOG OF TRENCH TP- 5		
Project Number: M1103-004			Elevation: 1594		ENGINEERING PROPERTIES		
Equipment: CAT 345B			Location/Grid: SEE GEOTECHNICAL MAP				
GEOLOGIC ATTITUDES	DATE: SEPTEMBER 3, 2013	DESCRIPTION: PROPOSED RESIDENTIAL PAD		GEOLOGIC UNIT	USCS	Sample No.	Water Content (%)	Dry Density (pcf)
	0–4’	**<u>QUATERNARY VERY OLD ALLUVIAL FAN DEPOSITS</u>** SILTY SAND; LIGHT BROWN, DRY, LOOSE		QVOF	SM			
	4–7’	STRONG BROWN, DAMP, MEDIUM DENSE						
	7-11.0’	**<u>CRETACEOUS VAL VERDE TONALITE</u>** GRANITICS; GRAY-WHITE, INTENSELY WEATHERED, READILY EXCAVATABLE, CORESTONES IN BOTTOM OF TEST PIT		KVT				
	11-12.5’	USING RIPPER TO PENETRATE ROCK WITH CONSIDERABLE DIFFICULTY TO REFUSAL						
TOTAL DEPTH = 12.5’	NO GROUDWATER	BACKFILLED: YES		SURFACE SLOPE 1 ~ 2%		TREND E – W		

Project Name: DECKER ASSEMBLAGE			Logged by: CEJ		LOG OF TRENCH TP- 6		
Project Number: M1103-004			Elevation: 1595		ENGINEERING PROPERTIES		
Equipment: CAT 345B			Location/Grid: SEE GEOTECHNICAL MAP				
GEOLOGIC ATTITUDES	DATE: SEPTEMBER 3, 2013	DESCRIPTION: PROPOSED RESIDENTIAL PAD		GEOLOGIC UNIT	USCS	Sample No.	Water Content (%)	Dry Density (pcf)
	0–2’	**<u>QUATERNARY VERY OLD ALLUVIAL FAN DEPOSITS</u>** SILTY SAND; DARK RED BROWN, DRY, LOOSE-MEDIUM DENSE		QVOF	SM			
	2–4.5’	SLIGHTLY POROUS, CLAYEY SAND, MEDIUM DENSE			SC			
	4.5-25’	**<u>CRETACEOUS VAL VERDE TONALITE</u>** GRANITICS; GRAY-WHITE, INTENSELY WEATHERED, READILY EXCAVATABLE TO FULL DEPTH		KVT				
TOTAL DEPTH = 25’	NO GROUDWATER	BACKFILLED: YES		SURFACE SLOPE 1 ~ 2%		TREND E – W		

Project Name: DECKER ASSEMBLAGE		Logged by: CEJ		LOG OF TRENCH TP- 7			
Project Number: M1103-004		Elevation: 1581		ENGINEERING PROPERTIES			
Equipment: CAT 345B		Location/Grid: SEE GEOTECHNICAL MAP		USCS	Sample No.	Water Content (%)	Dry Density (pcf)
GEOLOGIC ATTITUDES	DATE: SEPTEMBER 3, 2013	DESCRIPTION: PROPOSED RESIDENTIAL PAD	GEOLOGIC UNIT				
	0–2'	**<u>QUATERNARY VERY OLD ALLUVIAL FAN DEPOSITS</u>** SILTY SAND; LIGHT BROWN, DRY, LOOSE-MEDIUM DENSE	**QVOF**	SM			
	2–3'	SLIGHTLY POROUS, DARK BROWN, CLAYEY SAND, MEDIUM DENSE		SC			
	3-15'	**<u>CRETACEOUS VAL VERDE TONALITE</u>** GRANITICS; GRAY-WHITE-PALE, INTENSELY TO MODERATELY WEATHERED, READILY EXCAVATABLE TO FULL DEPTH	**KVT**				
TOTAL DEPTH = 15'	**NO GROUDWATER**	**BACKFILLED: YES**	**SURFACE SLOPE 1 ~ 2%**		**TREND E – W**		

Project Name: DECKER ASSEMBLAGE		Logged by: CEJ		LOG OF TRENCH TP- 8			
Project Number: M1103-004		Elevation: 1573		ENGINEERING PROPERTIES			
Equipment: CAT 345B		Location/Grid: SEE GEOTECHNICAL MAP		USCS	Sample No.	Water Content (%)	Dry Density (pcf)
GEOLOGIC ATTITUDES	DATE: SEPTEMBER 4, 2013	DESCRIPTION: PROPOSED RESIDENTIAL PAD	GEOLOGIC UNIT				
	0–3.5'	**<u>QUATERNARY VERY OLD ALLUVIAL FAN DEPOSITS</u>** SILTY SAND; LIGHT BROWN-BROWN, DRY, MEDIUM DENSE	**QVOF**	SM			
	3.5-7'	**<u>CRETACEOUS VAL VERDE TONALITE</u>** GRANITICS; GRAY-WHITE-PALE, DAMP, MODERATELY WEATHERED,	**KVT**				
	7-9'	CORESTONES PRESENT WITHIN SUBGRADE OF PIT, USING RIPPER, MODERATELY HARD TO VERY HARD, TO REFUSAL					
TOTAL DEPTH = 9'	**NO GROUDWATER**	**BACKFILLED: YES**	**SURFACE SLOPE 1 ~ 2%**		**TREND E – W**		

<table>
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<tr><td colspan="3">Project Number: M1103-004</td><td colspan="2">Elevation: 1576</td><td colspan="4">ENGINEERING PROPERTIES</td></tr>
<tr><td colspan="3">Equipment: CAT 345B</td><td colspan="2">Location/Grid: SEE GEOTECHNICAL MAP</td><td rowspan="2">USCS</td><td rowspan="2">Sample No.</td><td rowspan="2">Water Content (%)</td><td rowspan="2">Dry Density (pcf)</td></tr>
<tr><td>GEOLOGIC ATTITUDES</td><td colspan="2">DATE: SEPTEMBER 4, 2013</td><td>DESCRIPTION: PROPOSED RESIDENTIAL PAD</td><td>GEOLOGIC UNIT</td></tr>
<tr><td></td><td colspan="3">0–2' <u>QUATERNARY VERY OLD ALLUVIAL FAN DEPOSITS</u>
SILTY SAND; LIGHT BROWN-BROWN, DRY, MEDIUM DENSE

2-6' <u>CRETACEOUS VAL VERDE TONALITE</u>
GRANITICS; GRAY-WHITE-PALE, DAMP, INTENSELY WEATHERED,

6-12' CORESTONES PRESENT WITHIN SUBGRADE OF PIT, HEAVY RIPPING, MODERATELY HARD TO VERY HARD, TO REFUSAL</td><td>QVOF

KVT</td><td>SM</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">TOTAL DEPTH = 12'</td><td colspan="2">NO GROUDWATER</td><td>BACKFILLED: YES</td><td colspan="2">SURFACE SLOPE 1 ~ 2%</td><td colspan="2">TREND E – W</td></tr>
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<tr><td colspan="3">Project Name: DECKER ASSEMBLAGE</td><td colspan="2">Logged by: CEJ</td><td colspan="4">LOG OF TRENCH TP- 10</td></tr>
<tr><td colspan="3">Project Number: M1103-004</td><td colspan="2">Elevation: 1599</td><td colspan="4">ENGINEERING PROPERTIES</td></tr>
<tr><td colspan="3">Equipment: CAT 345B</td><td colspan="2">Location/Grid: SEE GEOTECHNICAL MAP</td><td rowspan="2">USCS</td><td rowspan="2">Sample No.</td><td rowspan="2">Water Content (%)</td><td rowspan="2">Dry Density (pcf)</td></tr>
<tr><td>GEOLOGIC ATTITUDES</td><td colspan="2">DATE: SEPTEMBER 4, 2013</td><td>DESCRIPTION: PROPOSED RESIDENTIAL PAD</td><td>GEOLOGIC UNIT</td></tr>
<tr><td></td><td colspan="3">0–6' <u>ARTIFICIAL FILL, BY OTHERS</u>
SILTY SAND TO SAND; LIGHT BROWN, LOOSE, DRY

6-7' <u>QUATERNARY VERY OLD ALLUVIAL FAN DEPOSITS</u>
SILTY SAND; LIGHT BROWN-BROWN, DAMP, MEDIUM DENSE

7-24' <u>CRETACEOUS VAL VERDE TONALITE</u>
GRANITICS; GRAY-WHITE-PALE, DAMP, MODERATELY WEATHERED,</td><td>AFO

QVOF

KVT</td><td>SM

SM</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">TOTAL DEPTH = 24'</td><td colspan="2">NO GROUDWATER</td><td>BACKFILLED: YES</td><td colspan="2">SURFACE SLOPE 1 ~ 2%</td><td colspan="2">TREND E – W</td></tr>
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<tr><td colspan="2">Project Number: M1103-004</td><td colspan="2">Elevation: 1585</td><td colspan="4">ENGINEERING PROPERTIES</td></tr>
<tr><td colspan="2">Equipment: CAT 345B</td><td colspan="2">Location/Grid: SEE GEOTECHNICAL MAP</td><td rowspan="2">USCS</td><td rowspan="2">Sample No.</td><td rowspan="2">Water Content (%)</td><td rowspan="2">Dry Density (pcf)</td></tr>
<tr><td>GEOLOGIC ATTITUDES</td><td>DATE: SEPTEMBER 4, 2013</td><td>DESCRIPTION: PROPOSED RESIDENTIAL PAD</td><td>GEOLOGIC UNIT</td></tr>
<tr><td></td><td colspan="2">0–3.5’ <u>QUATERNARY VERY OLD ALLUVIAL FAN DEPOSITS</u>
SILTY SAND; LIGHT BROWN-BROWN, DRY, MEDIUM DENSE

3.5-6’ <u>CRETACEOUS VAL VERDE TONALITE</u>
GRANITICS; GRAY-WHITE-PALE, DAMP, MODERATELY WEATHERED,

6-12.5’ CORESTONES PRESENT WITHIN SUBGRADE OF PIT, USING RIPPER, MODERATELY HARD TO VERY HARD TO REFUSAL</td><td>QVOF

KVT</td><td>SM</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">TOTAL DEPTH = 12.5’ / NO GROUDWATER</td><td>BACKFILLED: YES</td><td colspan="3">SURFACE SLOPE 1 ~ 2%</td><td colspan="2">TREND N – S</td></tr>
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<table>
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<tr><td colspan="2">Project Number: M1103-004</td><td colspan="2">Elevation: 1580</td><td colspan="4">ENGINEERING PROPERTIES</td></tr>
<tr><td colspan="2">Equipment: CAT 345B</td><td colspan="2">Location/Grid: SEE GEOTECHNICAL MAP</td><td rowspan="2">USCS</td><td rowspan="2">Sample No.</td><td rowspan="2">Water Content (%)</td><td rowspan="2">Dry Density (pcf)</td></tr>
<tr><td>GEOLOGIC ATTITUDES</td><td>DATE: SEPTEMBER 4, 2013</td><td>DESCRIPTION: PROPOSED RESIDENTIAL PAD</td><td>GEOLOGIC UNIT</td></tr>
<tr><td></td><td colspan="2">0–3.5’ <u>ARTIFICIAL FILL, BY OTHERS</u>
SILTY SAND; LIGHT BROWN, DRY, LOOSE

3.5’-4 <u>QUATERNARY VERY OLD ALLUVIAL FAN DEPOSITS</u>
SILTY SAND; LIGHT BROWN-BROWN, DRY, MEDIUM DENSE

4-18’ <u>CRETACEOUS VAL VERDE TONALITE</u>
GRANITICS; GRAY-WHITE-PALE, DAMP, MODERATELY WEATHERED, SLIGHT INCREASE IN WATER CONTENT AT BOTTOM OF PIT</td><td>AFO

QVOF

KVT</td><td>SM

SM</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">TOTAL DEPTH = 18’ / NO GROUDWATER</td><td>BACKFILLED: YES</td><td colspan="3">SURFACE SLOPE 1 ~ 2%</td><td colspan="2">TREND E – W</td></tr>
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Project Name: DECKER ASSEMBLAGE			Logged by: CEJ		LOG OF TRENCH TP- 13			
Project Number: M1103-004			Elevation: 1587		ENGINEERING PROPERTIES			
Equipment: CAT 345B			Location/Grid: SEE GEOTECHNICAL MAP		USCS	Sample No.	Water Content (%)	Dry Density (pcf)
GEOLOGIC ATTITUDES	DATE: SEPTEMBER 4, 2013		DESCRIPTION: PROPOSED RESIDENTIAL PAD	GEOLOGIC UNIT				
	0–0.5’	**ARTIFICIAL FILL, BY OTHERS** SILTY SAND TO SAND; LIGHT BROWN, LOOSE, VERY DRY		AFO	SM			
	0.5-1.5’	**QUATERNARY VERY OLD ALLUVIAL FAN DEPOSITS** SILTY SAND; LIGHT BROWN-BROWN, DRY, MEDIUM DENSE		QVOF	SM			
	1.5-13’	**CRETACEOUS VAL VERDE TONALITE** GRANITICS; GRAY-WHITE-PALE, DAMP, MODERATELY WEATHERED,		KVT				
	13-18’	CORESTONES PRESENT WITHIN SUBGRADE OF PIT, USING RIPPER, MODERATELY HARD						
TOTAL DEPTH = 18’	NO GROUDWATER		BACKFILLED: YES	SURFACE SLOPE 1 ~ 2%			TREND E – W	

Project Name: DECKER ASSEMBLAGE			Logged by: CEJ		LOG OF TRENCH TP- 14			
Project Number: M1103-004			Elevation: 1567		ENGINEERING PROPERTIES			
Equipment: CAT 345B			Location/Grid: SEE GEOTECHNICAL MAP		USCS	Sample No.	Water Content (%)	Dry Density (pcf)
GEOLOGIC ATTITUDES	DATE: SEPTEMBER 4, 2013		DESCRIPTION: PROPOSED RESIDENTIAL PAD	GEOLOGIC UNIT				
	0–6.5’	**QUATERNARY VERY OLD ALLUVIAL FAN DEPOSITS** SILTY SAND; LIGHT BROWN-BROWN, VERY DRY, LOOSE – MEDIUM DENSE		QVOF	SM			
	6.5-16’ -	**CRETACEOUS VAL VERDE TONALITE** GRANITICS; GRAY-WHITE-PALE, DAMP, MODERATELY WEATHERED, RIPPER USED TO PENETRATE ROCK WITH MODERATE TO HARD DIFFICULTY TO REFUSAL		KVT				
TOTAL DEPTH = 16’	NO GROUDWATER		BACKFILLED: YES	SURFACE SLOPE 1 ~ 2%			TREND E – W	

<table>
<tr><td colspan="2">Project Name: DECKER ASSEMBLAGE</td><td colspan="2">Logged by: CEJ</td><td colspan="4">LOG OF TRENCH TP- 15</td></tr>
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<tr><td colspan="2">Equipment: CAT 345B</td><td colspan="2">Location/Grid: SEE GEOTECHNICAL MAP</td><td rowspan="2">USCS</td><td rowspan="2">Sample No.</td><td rowspan="2">Water Content (%)</td><td rowspan="2">Dry Density (pcf)</td></tr>
<tr><td>GEOLOGIC ATTITUDES</td><td>DATE: SEPTEMBER 4, 2013</td><td>DESCRIPTION: PROPOSED RESIDENTIAL PAD</td><td>GEOLOGIC UNIT</td></tr>
<tr><td></td><td colspan="2">0–3’ <u>QUATERNARY VERY OLD ALLUVIAL FAN DEPOSITS</u>
SILTY SAND; LIGHT BROWN-BROWN, DRY, MEDIUM DENSE

3-10’ <u>CRETACEOUS VAL VERDE TONALITE</u>
GRANITICS; GRAY-WHITE-PALE, DAMP, MODERATELY WEATHERED, READILY EXCAVATABLE</td><td>QVOF

KVT</td><td>SM</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">TOTAL DEPTH = 10’</td><td>NO GROUDWATER</td><td>BACKFILLED: YES</td><td colspan="2">SURFACE SLOPE 1 ~ 2%</td><td colspan="2">TREND E – W</td></tr>
</table>

<table>
<tr><td colspan="2">Project Name: DECKER ASSEMBLAGE</td><td colspan="2">Logged by: CEJ</td><td colspan="4">LOG OF TRENCH TP- 16</td></tr>
<tr><td colspan="2">Project Number: M1103-004</td><td colspan="2">Elevation: 1580</td><td colspan="4">ENGINEERING PROPERTIES</td></tr>
<tr><td colspan="2">Equipment: CAT 345B</td><td colspan="2">Location/Grid: SEE GEOTECHNICAL MAP</td><td rowspan="2">USCS</td><td rowspan="2">Sample No.</td><td rowspan="2">Water Content (%)</td><td rowspan="2">Dry Density (pcf)</td></tr>
<tr><td>GEOLOGIC ATTITUDES</td><td>DATE: SEPTEMBER 3, 2013</td><td>DESCRIPTION: PROPOSED RESIDENTIAL PAD</td><td>GEOLOGIC UNIT</td></tr>
<tr><td></td><td colspan="2">0–2’ <u>QUATERNARY VERY OLD ALLUVIAL FAN DEPOSITS</u>
SILTY SAND; LIGHT BROWN-BROWN, DRY, MEDIUM DENSE

2-10’ <u>CRETACEOUS VAL VERDE TONALITE</u>
GRANITICS; GRAY-WHITE-PALE, DAMP, MODERATELY WEATHERED, READILY EXCAVATABLE TO FULL DEPTH OF TEST PIT</td><td>QVOF

KVT</td><td>SM</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">TOTAL DEPTH = 10’</td><td>NO GROUDWATER</td><td>BACKFILLED: YES</td><td colspan="2">SURFACE SLOPE 1 ~ 2%</td><td colspan="2">TREND E – W</td></tr>
</table>

JOB# 4277	HOLE# 1	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5				45			
6				46			
7		Soft	Rotation	47			
8				48			
9				49			
10				50			
11				51			
12		Medium	Rotation	52			
13				53			
14				54			
15		Med Hard	Rotation	55			
16				56			
17				57			
18				58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 2	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5				45			
6				46			
7		Soft	Rotation	47			
8				48			
9				49			
10				50			
11				51			
12				52			
13				53			
14				54			
15		Medium	Rotation	55			
16				56			
17				57			
18				58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 3	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5				45			
6		Soft	Rotation	46			
7				47			
8				48			
9				49			
10				50			
11		Med.Hard	Rotation	51			
12				52			
13				53			
14				54			
15		Medium	Rotation	55			
16				56			
17				57			
18				58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 4	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5				45			
6				46			
7		Medium	Rotation	47			
8				48			
9				49			
10				50			
11				51			
12				52			
13				53			
14				54			
15		Med.Hard	Rotation	55			
16				56			
17				57			
18				58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 5	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5				45			
6				46			
7				47			
8				48			
9				49			
10		Soft	Rotation	50			
11				51			
12				52			
13				53			
14				54			
15		Med.Hard	Rotation	55			
16				56			
17				57			
18				58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 6	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5		Soft	Rotation	45			
6				46			
7				47			
8				48			
9			DG	49			
10		Medium	Rotation	50			
11				51			
12				52			
13				53			
14			DG	54			
15		Med.Hard	Rotation	55			
16				56			
17				57			
18				58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 7	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4		Soft	Rotation	44			
5				45			
6				46			
7			DG	47			
8				48			
9		Med.Hard	Rotation	49			
10				50			
11				51			
12			DG	52			
13				53			
14				54			
15				55			
16		Hard	Percussion	56			
17		1/2'Seam		57			
18				58			
19				59			
20		Hard	Percussion	60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 8	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1		Soft	Rotation	41			
2				42			
3				43			
4		Med.Hard	Percussion	44			
5				45			
6				46			
7				47			
8		Hard	Percussion	48			
9				49			
10		Soft	Rotation	50			
11				51			
12				52			
13			DG	53			
14				54			
15				55			
16				56			
17		Med.Hard	Rotation	57			
18				58			
19				59			
20		Hard	Percussion	60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 9	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5				45			
6		Soft	Rotation	46			
7				47			
8				48			
9				49			
10				50			
11				51			
12				52			
13				53			
14				54			
15				55			
16				56			
17				57			
18				58			
19				59			
20		Hard	Percussion	60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 10	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5				45			
6				46			
7				47			
8		Med.Hard	Rotation	48			
9				49			
10		Hard	Percussion	50			
11				51			
12				52			
13				53			
14				54			
15				55			
16		Med.Hard	Rotation	56			
17				57			
18				58			
19				59			
20		Med.Hard	Percussion	60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 11	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3		Soft	Rotation Percussion	43			
4		Hard	Percussion	44			
5				45			
6			Granite	46			
7				47			
8				48			
9		Hard	Percussion	49			
10			Seam	50			
11				51			
12				52			
13			Granite	53			
14				54			
15				55			
16				56			
17		Hard	Percussion	57			
18			Seam	58			
19		Hard	Percussion	59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 12	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3		Soft	Rotation Percussion	43			
4				44			
5				45			
6				46			
7			Granite	47			
8				48			
9				49			
10				50			
11		Hard	Percussion	51			
12				52			
13				53			
14				54			
15				55			
16			DG	56			
17				57			
18				58			
19				59			
20		Med.Hard	Rotation	60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 13	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2		Soft	Rotation Percussion	42			
3				43			
4				44			
5				45			
6			DG	46			
7				47			
8				48			
9		Med.Hard	Rotation	49			
10				50			
11				51			
12				52			
13				53			
14				54			
15				55			
16				56			
17				57			
18				58			
19				59			
20		Hard	Percussion	60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 14	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5				45			
6				46			
7		Soft	Rotation Percussion	47			
8				48			
9		Med.Hard	Rotation	49			
10		Hard	Percussion	50			
11		Med.Hard	Rotation	51			
12				52			
13				53			
14				54			
15				55			
16				56			
17				57			
18		Med.Hard	Rotation	58			
19				59			
20				60			
21				61			
22		Med.Hard	Rotation	62			
23				63			
24				64			
25				65			
26				66			
27		Med.Hard	Percussion	67			
28				68			
29				69			
30		Med.Hard	Rotation	70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 15	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5				45			
6		Soft	Rotation	46			
7				47			
8				48			
9				49			
10				50			
11				51			
12				52			
13				53			
14				54			
15				55			
16				56			
17				57			
18				58			
19				59			
20				60			
21				61			
22				62			
23		Med.Hard	Rotation	63			
24				64			
25				65			
26				66			
27			Blue	67			
28			Granite	68			
29				69			
30		XHard	Percussion	70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 16	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5				45			
6				46			
7				47			
8				48			
9		Soft	Rotation	49			
10				50			
11				51			
12				52			
13				53			
14				54			
15				55			
16		Medium	Rotation	56			
17				57			
18				58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25		Med.Hard	Rotation	65			
26				66			
27				67			
28				68			
29				69			
30		Med.Hard	Rotation	70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 17	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3		Soft	Rotation Percussion	43			
4				44			
5				45			
6				46			
7				47			
8				48			
9				49			
10				50			
11				51			
12				52			
13				53			
14				54			
15				55			
16				56			
17				57			
18		Med.Hard	Rotation	58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40		Hard	Percussion	80			

JOB# 4277	HOLE# 18	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3		Soft	Rotation Percussion	43			
4				44			
5				45			
6				46			
7				47			
8				48			
9				49			
10				50			
11				51			
12				52			
13				53			
14				54			
15		Medium	Rotation	55			
16				56			
17				57			
18				58			
19				59			
20				60			
21				61			
22				62			
23		Med.Hard	Rotation	63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30		Med.Hard	Percussion	70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40		Hard	Percussion	80			

JOB# 4277	HOLE# 19						
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51					
RIPPABLE:		NEUTRAL NO LOAD: 500psi					
Marginal:		ROTATION UNDER LOAD: 800-950psi					
BLASTING req.:		DRILL W/PERCUSION :1100psi					

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2		Soft	Rotation Percussion	42			
3				43			
4				44			
5				45			
6				46			
7				47			
8				48			
9				49			
10				50			
11				51			
12		Med.Hard	Rotation	52			
13				53			
14				54			
15				55			
16				56			
17				57			
18				58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28		Hard	Percussion	68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35			Blue Granite	75			
36				76			
37				77			
38				78			
39				79			
40		XHard	Percussion	80			

JOB# 4277	HOLE# 20	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5		Soft	Rotation	45			
6				46			
7				47			
8				48			
9				49			
10				50			
11				51			
12				52			
13				53			
14				54			
15				55			
16				56			
17				57			
18				58			
19				59			
20				60			
21				61			
22		Med.Hard	Rotation	62			
23				63			
24				64			
25				65			
26				66			
27		Hard	Percussion	67			
28				68			
29				69			
30				70			
31				71			
32				72			
33		Med.Hard	Rotation	73			
34				74			
35				75			
36				76			
37		Hard	Percussion	77			
38				78			
39				79			
40		Med.Hard	Rotation	80			

JOB# 4277	HOLE#21	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3		Medium	Rotation	43			
4				44			
5				45			
6				46			
7				47			
8				48			
9				49			
10				50			
11				51			
12				52			
13				53			
14				54			
15				55			
16				56			
17				57			
18				58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40		Med.Hard	Rotation	80			

JOB# 4277	HOLE# 22	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5				45			
6		Soft	Rotation Percussion	46			
7				47			
8				48			
9				49			
10				50			
11				51			
12		Med.Hard	Rotation	52			
13				53			
14				54			
15				55			
16				56			
17				57			
18				58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40		Hard	Percussion	80			

JOB# 4277	HOLE#23	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5				45			
6		Soft	Rotation Percussion	46			
7				47			
8		Med.Hard	Percussion	48			
9				49			
10				50			
11				51			
12				52			
13				53			
14				54			
15				55			
16		Hard	Percussion	56			
17			seam	57			
18				58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40		XHard	Percussion	80			

JOB# 4277	HOLE#24	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5		Soft	Rotation Percussion	45			
6				46			
7				47			
8				48			
9				49			
10				50			
11				51			
12				52			
13				53			
14				54			
15				55			
16				56			
17				57			
18				58			
19				59			
20		XHard	Percussion	60			
21				61			
22				62			
23				63			
24		Medium	Rotation	64			
25				65			
26				66			
27				67			
28				68			
29				69			
30		Med.Hard	Percussion	70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 25	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2		Soft	Rotation Percussion	42			
3				43			
4				44			
5				45			
6				46			
7				47			
8				48			
9				49			
10				50			
11				51			
12				52			
13				53			
14				54			
15				55			
16				56			
17				57			
18				58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30		Med.Hard	Percussion	70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE#27	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5				45			
6				46			
7		Soft	Rotation Percussion	47			
8				48			
9				49			
10				50			
11				51			
12				52			
13				53			
14				54			
15				55			
16				56			
17				57			
18				58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30		Med.Hard	Percussion	70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE# 28	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4		Soft	Rotation Percussion	44			
5				45			
6				46			
7		Med.Hard	Rotation	47			
8				48			
9				49			
10				50			
11				51			
12				52			
13				53			
14		Hard	Percussion	54			
15				55			
16				56			
17				57			
18		Soft	Rotation	58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30		XHard	Percussion	70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

JOB# 4277	HOLE#29	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5				45			
6				46			
7				47			
8				48			
9				49			
10				50			
11				51			
12		Medium	Rotation	52			
13				53			
14				54			
15				55			
16		Hard	Percussion	56			
17				57			
18				58			
19				59			
20				60			
21		XHard	Percussion	61			
22		Soft	Rotation seam	62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40		Hard	Percussion	80			

JOB# 4277	HOLE# 30	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5				45			
6				46			
7				47			
8				48			
9				49			
10				50			
11				51			
12		Medium	Rotation	52			
13				53			
14				54			
15	24sf			55			
16				56			
17	26sf			57			
18				58			
19	25sf			59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27	30"minute			67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40		XHard	Percussion	80			

JOB# 4277	HOLE#31	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3		Soft	Rotation	43			
4				44			
5		Medium	Rotation	45			
6				46			
7				47			
8				48			
9				49			
10				50			
11				51			
12				52			
13				53			
14				54			
15				55			
16				56			
17				57			
18				58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25		Hard	Percussion	65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32		Med.Hard	Percussion	72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40		Hard	Percussion	80			

JOB# 4277	HOLE# 32	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2		Soft	Rotation Percussion	42			
3				43			
4				44			
5				45			
6				46			
7				47			
8				48			
9				49			
10				50			
11				51			
12				52			
13				53			
14		Med.Hard	Rotation	54			
15				55			
16				56			
17				57			
18				58			
19				59			
20				60			
21				61			
22				62			
23				63			
24		Medium	percussion	64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32		Medium	Rotation	72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40		Hard	Percussion	80			

JOB# 4277	HOLE# 33	
DATE: 9/4/14		DRILL MAKE/MODEL: INGERSAL RAND ECM 720 CRAWLER DRILL #838 T-51
RIPPABLE:		NEUTRAL NO LOAD: 500psi
Marginal:		ROTATION UNDER LOAD: 800-950psi
BLASTING req.:		DRILL W/PERCUSION :1100psi

DEPTH	TIME	RQ	NOTES	DEPTH	TIME	RQ	NOTES
1				41			
2				42			
3				43			
4				44			
5				45			
6		Soft	Rotation Percussion	46			
7				47			
8				48			
9				49			
10				50			
11				51			
12				52			
13				53			
14				54			
15				55			
16				56			
17		Hard	Percussion	57			
18			seam	58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31		XHard	Percussion	71			
32			seam	72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40		XHard	Percussion	80			

APPENDIX C

LABORATORY TESTING PROCEDURES AND TEST RESULTS

APPENDIX C

Laboratory Testing Procedures and Test Results

The laboratory-testing program was directed towards providing quantitative data relating to the relevant engineering properties of the soil. Samples considered representative of site conditions were tested in general accordance with American Society for Testing and Materials (ASTM) procedure and/or California Test Methods (CTM), where applicable. The following summary is a brief outline of the test type and a table summarizing the test results.

Soil Classification: Soil were classified according the Unified Soil Classification System (USCS) in accordance with ASTM Test Methods D2487 and D2488. The soil classifications (or group symbol) are shown on the laboratory test data and test pit logs.

Expansion Index: the Expansion Index Test, U.B.C. Standard No. 18 2 and/or ASTM D4829 evaluated the expansion potential of selected samples. Specimens are molded under a given compactive energy to approximately the optimum water content and approximately 50 percent saturation or approximately 90 percent relative compaction. The prepared 1-inch-thick by 2.42-inch-diameter specimens are loaded to an equivalent 144 psf surcharge and are inundated with tap water until volumetric equilibrium is reached. The results of these tests are presented in the table below:

SAMPLE LOCATION	SAMPLE DESCRIPTION	EXPANSION INDEX	EXPANSION POTENTIAL*
B-1, Bulk 0-5’	Silty SAND	10	Non-Expansive
B-5, Bulk 0-5’	Silty SAND	8	Expansive

*Per ASTM D4829

Consolidation: Consolidation tests were performed on selected, remolded ring samples with ASTM D 2435 (California Modified). Results of these tests are graphically presented on Plate C-1, C-2, and C-3

Soluble Sulfates: The soluble sulfate contents of selected samples were determined by standard geotechnical methods (CTM 417). The soluble sulfate content is used to determine the appropriate cement type and maximum water-cement ratios. The test results are presented in the table below:

SAMPLE LOCATION	SAMPLE DESCRIPTION	SULFATE CONTENT (ppm)	SULFATE EXPOSURE*
B-1, Bulk 0-5’	Silty SAND	48	*Negligible*
B-5, Bulk 0-5’	Silty SAND	55	*Negligible*

*Per ACI 318R-05 Table 4.3.1

Minimum Resistivity and pH Tests: Minimum resistivity and pH tests were performed with CTM 643. The results are presented in the table below:

SAMPLE LOCATION	SAMPLE DESCRIPTION	pH	MINIMUM RESISTIVITY (ohm-cm)
B-1, Bulk 0-5’	Silty SAND	7.1	2,300
B-5, Bulk 0-15’	Silty SAND	6.8	1,800

Chloride Content: Chloride content was tested with CTM 422. The results are presented below:

SAMPLE LOCATION	SAMPLE DESCRIPTION	CHLORIDE CONTENT (ppm)
B-1, Bulk 0-5’	Silty SAND	164
B-5, Bulk 0-15’	Silty SAND	180

Maximum Dry Density Tests: The maximum dry density and optimum water content of typical materials were determined in accordance with ASTM D1557. The results of these tests are presented in the table below:

SAMPLE LOCATION	SAMPLE DESCRIPTION	MAXIMUM DRY DENSITY (% by weight)	OPTIMUM WATER CONENT (%)
B-2, Bulk 0-5’	Silty SAND	127.0	10.7
B-5, Bulk, 5-7’	Silty SAND	129.5	9.6

Direct Shear: Direct shear tests were performed on selected remolded and/or undisturbed samples with ASTM D 3080. Results of these tests are presented in the table below.

SAMPLE LOCATION	SAMPLE DESCRIPTION	FRICTION ANGLE (degrees)*	APPARENT COHESION (psf)*	FRICTION ANGLE (degrees)**	APPARENT COHESION (psf)**
B-1, Bulk 0-5'	Silty SAND	33	289	30	215
B-5, Bulk 0-15'	Silty SAND	28	410	26	330
B-5, Bulk 0-5'***	Silty SAND	32	275	30	260

*Peak Values; **Ultimate Values; ***Remolded

R-Value: The R-value of representative samples were determined with CTM 301. The test results are presented in the table below:

SAMPLE LOCATION	SAMPLE DESCRIPTION	R-VALUE
B-3, Bulk @ 0-5 feet	Silty SAND	28

APPENDIX D

SEISMICITY

PSH Deaggregation on NEHRP BC rock

Unnamed 117.268° W, 33.857 N.

Peak Horiz. Ground Accel.>=0.3939 g

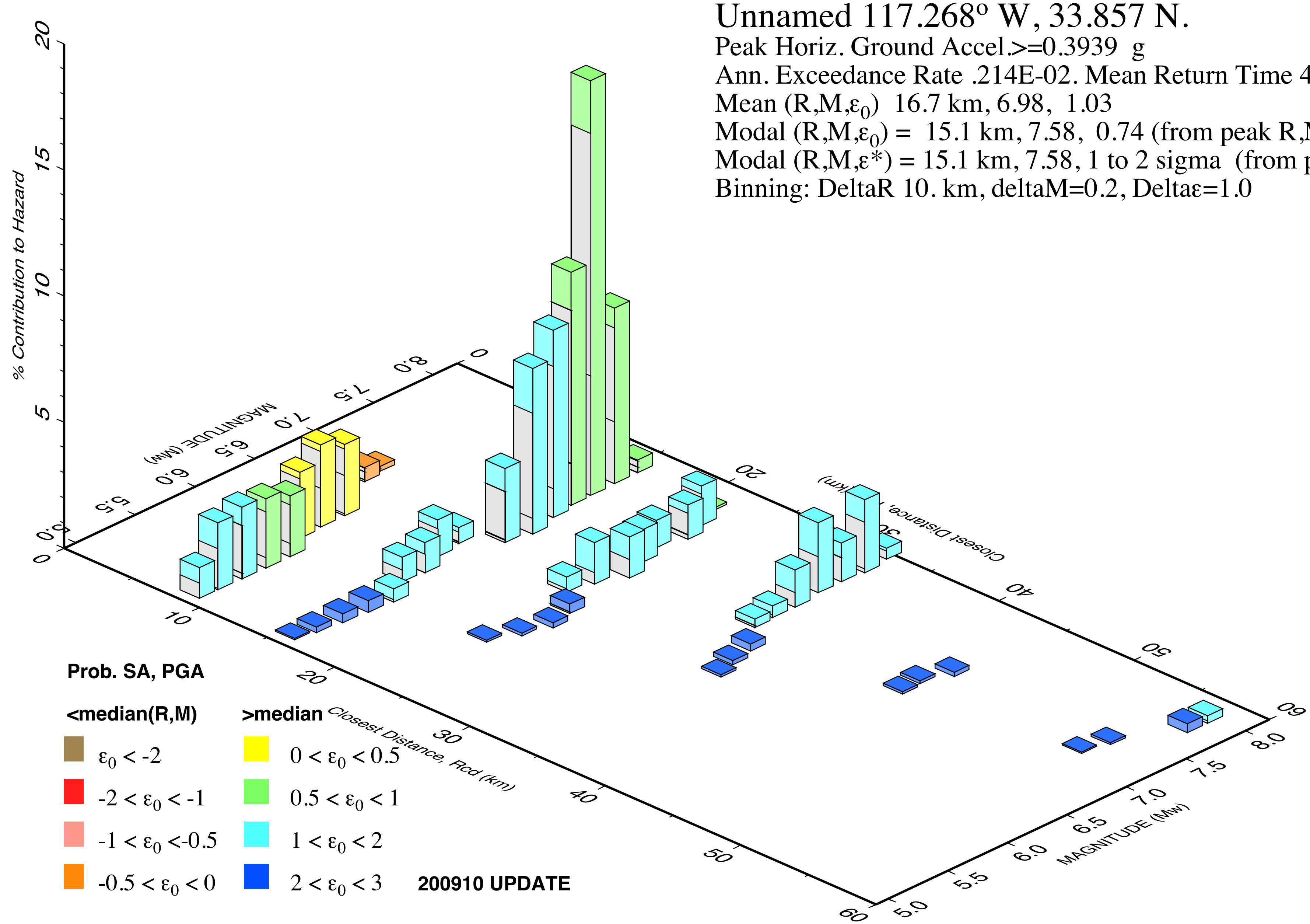
Ann. Exceedance Rate .214E-02. Mean Return Time 475 years

Mean (R,M,ε_0) 16.7 km, 6.98, 1.03

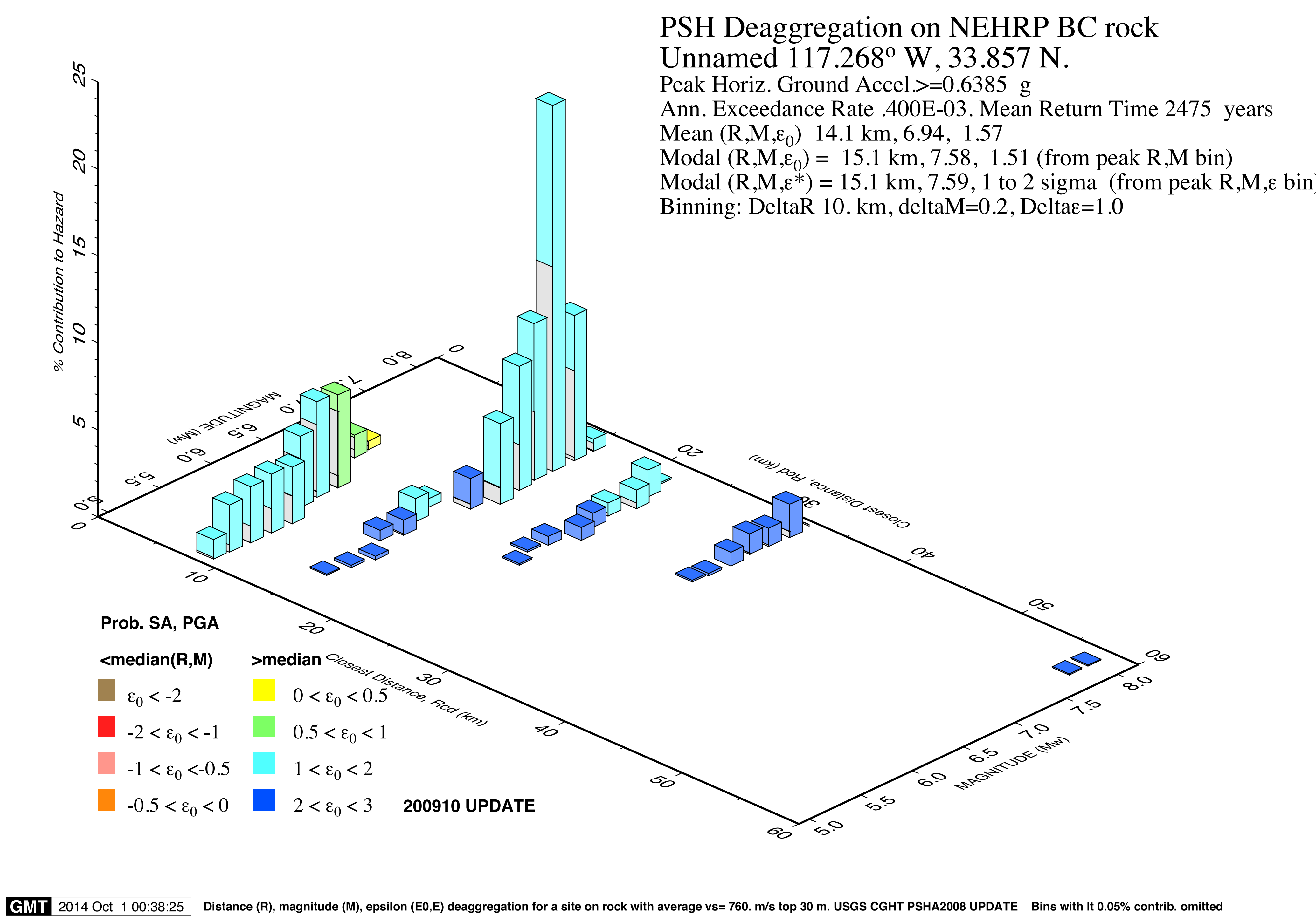
Modal (R,M,ε_0) = 15.1 km, 7.58, 0.74 (from peak R,M bin)

Modal (R,M,ε^*) = 15.1 km, 7.58, 1 to 2 sigma (from peak R,M,ε bin)

Binning: DeltaR 10. km, deltaM=0.2, Deltaε=1.0



GMT 2014 Oct 1 00:39:57 Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on rock with average vs= 760. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted


PSH Deaggregation on NEHRP BC rock
Unnamed 117.268° W, 33.857 N.
Peak Horiz. Ground Accel.>=0.6385 g
Ann. Exceedance Rate .400E-03. Mean Return Time 2475 years
Mean (R,M,ε0) 14.1 km, 6.94, 1.57
Modal (R,M,ε0) = 15.1 km, 7.58, 1.51 (from peak R,M bin)
Modal (R,M,ε*) = 15.1 km, 7.59, 1 to 2 sigma (from peak R,M,ε bin)
Binning: DeltaR 10. km, deltaM=0.2, Deltaε=1.0
% Contribution to Hazard
0
5
10
15
20
25
MAGNITUDE (Mw)
5.0
5.5
6.0
6.5
7.0
7.5
8.0
Closest Distance, Rcd (km)
10
20
30
40
50
60
Prob. SA, PGA
<median(R,M)
>median
ε0 < -2
-2 < ε0 < -1
-1 < ε0 <-0.5
-0.5 < ε0 < 0
0 < ε0 < 0.5
0.5 < ε0 < 1
1 < ε0 < 2
2 < ε0 < 3
200910 UPDATE
GMT 2014 Oct 1 00:38:25
Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on rock with average vs= 760. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted

TERRA GEOSCIENCES

SEISMIC REFRACTION SURVEY

PROPOSED COMMERCIAL DEVELOPMENT PROJECT

ASSESSOR'S PARCEL NUMBERS 314-040-001 & -003

WESTERN PERRIS AREA, RIVERSIDE COUNTY, CALIFORNIA

Project No. 142740-1

August 29, 2014

Prepared for:

Matrix Geotechnical Consulting
41769 Enterprise Circle North
Suite 107
Temecula, California 92590

Matrix Geotechnical Consulting
41769 Enterprise Circle North, Suite 107
Temecula, California 92590

Attention: Mr. Chris Josef

Regarding: Seismic Refraction Survey
Proposed Commercial Development Project
Assessor's Parcel Numbers 314-040-001 & -003
Western Perris Area, Riverside County, California
MGC Project No. M1103-004

INTRODUCTION

As requested, this firm has performed a geophysical survey using the seismic refraction method for the above-referenced site. The purpose of this investigation was to assess the general seismic velocity characteristics of the underlying earth materials and to evaluate whether high velocity earth materials (non-rippable) are present which could possibly indicate areas of potential excavation difficulties, and also to aid in evaluating the subsurface structure and seismic velocity distribution. The local earth materials that surficially mantle the site have been mapped by Morton (2001) to consist of very old alluvial fan deposits (early Pleistocene age) comprised of well-indurated sand deposits, directly underlain by Cretaceous age granitic rocks (locally referred to as the Val Verde tonalite) consisting of a gray-weathering, relatively homogeneous, massive to well-foliated, medium- to coarse-grained, biotite hornblende tonalite. As requested, the locations of the seismic survey lines have been approximated on a captured Google™ Earth image (Google™ Earth, 2013) which is presented as the Seismic Line Location Map, Plate 1, for reference. As authorized by you, the following services were performed during this study:

- ***Review of available published and unpublished geologic/geophysical data in our files pertinent to the site.***
- ***Performing a geophysical survey by a State of California licensed Professional Geophysicist; to include seven seismic refraction traverses.***
- ***Preparation of this report, presenting our findings and conclusions with respect to the bedrock velocity characteristics and the expected excavation potentials.***

Accompanying Map and Appendices

Plate 1 - Seismic Line Location Map
Appendix A - Layer Velocity Models
Appendix B - Refraction Tomographic Models
Appendix C - Excavation Considerations
Appendix D - References

SEISMIC REFRACTION SURVEY

Methodology

The seismic refraction method consists of measuring (at known points along the surface of the ground) the travel times of compressional waves generated by an impulsive energy source and can be used to estimate the layering, structure, and seismic acoustic velocities of subsurface horizons. Seismic waves travel down and through the soils and rocks, and when the wave encounters a contact between two earth materials having different velocities, some of the wave's energy travels along the contact at the velocity of the lower layer. The fundamental assumption is that each successively deeper layer has a velocity greater than the layer immediately above it. As the wave travels along the contact, some of the wave's energy is refracted toward the surface where it is detected by a series of motion-sensitive transducers (geophones). The arrival time of the seismic wave at the geophone locations can be related to the relative seismic velocities of the subsurface layers in feet per second (fps), which can then be used to aid in interpreting both the depth and type of materials encountered.

Field Procedures

Seven seismic refraction survey lines (Seismic lines S-1 through S-7) were performed along representative areas as delineated by your firm. The traverses were located in the field by use of Google™ Earth (2013) imagery and GPS coordinates. Twenty-four 14-Hertz geophones, spaced at eight- to ten-foot intervals, were employed on each line to detect both the direct and refracted waves, with a 16-pound sledge-hammer being used as the energy source to produce the seismic waves. Seismic Line S-2 consisted of two overlapped individual spreads to provide a longer continuous profile. The seismic wave arrivals were digitally recorded in SEG-2 format on a Geometrics StrataVisor™ NZXP model signal enhancement refraction seismograph. Seven shot points were utilized along each spread using forward, reverse, and several intermediate locations in order to obtain high resolution survey data for velocity analysis and depth modeling purposes. The data was acquired using a sampling rate of 0.0625 milliseconds having a record length of 0.07 seconds with no acquisition filters. During acquisition, the seismograph displays the seismic wave arrivals on the computer screen which were used to analyze the arrival time of the primary seismic "P"-waves at each geophone station, in the form of a wiggle trace for quality control purposes in the field. Each geophone and seismic shot location was surveyed using a hand level and ruler for relative topographic correction, with "0" representing the lowest point along each line.

Data Processing

The recorded seismic data was subsequently transferred to our office computer for processing and analyzing purposes, using the computer programs **SIPwin** (**S**eismic Refraction **I**nterpretation **P**rogram for **Win**dows) developed by Rimrock Geophysics, Inc. (2004); **Refractor** (Geogiga, 2001-2013); and **Rayfract™** (Intelligent Resources, Inc., 1996-2014). All of the computer programs perform their analysis using exactly the same input data which includes the first-arrival "P"-waves and survey line geometry.

- **SIPwin** is a ray-trace modeling program that evaluates the subsurface using layer assignments based on time-distance curves and is better suited for layered media, using the "Seismic Refraction Modeling by Computer" method (Scott, 1973). The first step in the modeling procedure is to compute layer velocities by least-squares techniques. Then the program uses the delay-time method to estimate depths to the top of layer-2. A forward modeling routine traces rays from the shot points to each geophone that received a first-arrival ray refracted along the top of layer-2. The travel time of each such ray is compared with the travel time recorded in the field by the seismic system. The program then adjusts the layer-2 depths so as to minimize discrepancies between the computed ray-trace travel times and the first arrival times picked from the seismic waveform record. The process of ray tracing and model adjustment is repeated a total of six times to improve the accuracy of depths to the top of layer-2. This first-arrival picks were then used to generate the Layer Velocity Models using the **SIPwin** computer program, which presents the subsurface velocities as individual layers and are presented within Appendix A for reference. In addition, the associated Time-Distance Plot for the survey lines which shows the individual data picks of the first "P-wave" arrival times, also appears in Appendix A.

- **Refractor** is seismic refraction software that also evaluates the subsurface using layer assignments utilizing interactive and interchangeable analytical methods that include the Delay-Time method, the ABC method, and the Generalized Reciprocal Method (GRM). These methods are used for defining irregular non-planar refractors and are briefly described below. The <u>Delay-Time</u> method will measure the delay time depth to a refractor beneath each geophone rather than at shot points. Delay-time is the time spent by a wave to travel up or down through the layer (slant path) compared to the time the wave would spend if traveling along the projection of the slant path on the refractor. The <u>ABC</u> (intercept time) method makes use of critically refracted rays converging on a common surface position. This method involves using three surface to surface travel times between three geophones and the velocity of the first layer in an equation to calculate depth under the central geophone and is applied to all other geophones on the survey line. The <u>GRM</u> method is a technique for delineating undulating refractors at any depth from in-line seismic refraction data consisting of forward and reverse travel-times and is capable of resolving dips of up to 20% and does not over-smooth or average the subsurface refracting layers. In addition, the technique provides an approach for recognizing and compensating for hidden layer conditions.

- **Rayfract™** is seismic refraction tomography software that models subsurface refraction, transmission, and diffraction of acoustic waves which generally indicates the relative structure and velocity distribution of the subsurface using first break energy propagation modeling. An initial 1D gradient model is created using the DeltatV method (Gebrande and Miller, 1985) which gives a good initial fit between modeled and picked first breaks. The DeltatV method is a turning-ray inversion method which delivers continuous depth vs. velocity profiles for all profile stations. These profiles consist of horizontal inline offset, depth, and velocity triples. The method handles real-life geological conditions such as velocity gradients, linear increasing of velocity with depth, velocity inversions, pinched-out layers and outcrops, and faults and local velocity anomalies. This initial model is then refined automatically with a true 2D WET (Wavepath Eikonal Traveltime) tomographic inversion (Schuster and Quintus-Bosz, 1993).

WET tomography models multiple signal propagation paths contributing to one first break, whereas conventional ray tracing tomography is limited to the modeling of just one ray per first break. This computer program performs the analysis by using the same first-arrival P-wave times and survey line geometry that were generated during the layer velocity model analyses. The associated Refraction Tomographic Models which display the subsurface earth material velocity structure, is represented by the velocity contours (isobars displayed in feet/second), supplemented with the color-coded velocity shading for visual reference, and are presented within Appendix B.

The combined use of these computer programs provided a more thorough and comprehensive analysis of the subsurface structure and velocity characteristics. Each computer program has a specific purpose based on the objective of the analysis being performed. **SIPwin** and **Refractor** were primarily used for detecting generalized subsurface velocity layers providing "weighted average velocities." The processed seismic data of these two programs were compared and averaged to provide a final composite layer velocity model which provided a more thorough representation of the subsurface. **Rayfract™** provided tomographic velocity and structural imaging that is very conducive to detecting strong lateral velocity characteristics such as imaging corestones, dikes, and other subsurface structural characteristics.

SUMMARY OF GEOPHYSICAL INTERPRETATION

To begin our discussion, it is important to consider that the seismic velocities obtained within bedrock materials are influenced by the nature and character of the localized major structural discontinuities (foliation, fracturing, relic bedding, etc.), creating anisotropic conditions. Anisotropy (direction-dependent properties of materials) can be caused by "micro-cracks," jointing, foliation, layered or inter-bedded rocks with unequal layer stiffness, small-scale lithologic changes, etc (Barton, 2007). Velocity anisotropy complicates interpretation and it should be noted that the seismic velocities obtained during this survey may have been influenced by the nature and character of any localized structural discontinuities within the bedrock underlying the subject site. Generally, it is expected that higher (truer) velocities will be obtained when the seismic waves propagate along direction (strike) of the dominant structure, with a damping effect when the seismic waves travel in a perpendicular direction. Such variable directions can result in velocity differentials of between 2% to 40% depending upon the degree of the structural fabric (i.e., weakly-moderately-strongly foliated, respectively). Therefore, the seismic velocities obtained during our field study and as discussed below, should be considered *minimum* velocities at this time.

The first method described below used for data analysis is the traditional layer method (**SIPwin** and **Refractor**). Using this method, it should be understood that the data obtained represents an average of seismic velocities within any given layer. For example, high seismic velocity boulders, dikes, or other local lithologic inconsistencies, may be isolated within a low velocity matrix, thus yielding an average medium velocity for that layer. Therefore, in any given layer, a range of velocities could be anticipated, which can also result in a wide range of excavation characteristics. In general, the site where locally surveyed was noted to be characterized by three major subsurface layers with respect to seismic velocities. The following layer summaries have been prepared using the **SIPwin** and **Refractor** analysis, with the representative Layer Velocity Models presented within Appendix A along with their respective Time-Distance Plots.

- **Velocity Layer V1**:

  This uppermost velocity layer (V1) is most likely comprised of topsoil, colluvium, older alluvial sediments, and/or completely-weathered and fractured bedrock materials. This layer has an average weighted velocity of 1,514 to 2,222 fps, which is typical for these types of unconsolidated surficial earth materials.

- **Velocity Layer V2**:

  The second layer (V2) yielded a seismic velocity range of 3,673 to 7,745 fps, which is typical for highly- to moderately-weathered bedrock materials. This velocity range may indicate the presence of homogeneous weathered bedrock with a relatively wide spaced joint/fracture system and/or the possibility of buried relatively-fresher boulders within a very-highly decomposed bedrock matrix. Additionally, the presence of older alluvial sediments, such as mapped by Morton (2001), may also be locally present based upon the degree of sediment induration.

- **Velocity Layer V3**:

  The third layer (V3) indicates the presence of slightly-weathered to fresh granitic bedrock, having a seismic velocity range of 11,549 to 17,849 fps. These higher velocities signify the decreasing effect of weathering as a function of depth and could indicate the presence of abundant widely-scattered buried fresh large crystalline boulders in highly-weathered matrix, or possibly a slightly-weathered to fresher crystalline bedrock matrix, that has a wide-spaced fracture system.

Using **Rayfract™**, tomographic models were also prepared for comparative purposes to better illustrate the general structure and velocity distribution of the subsurface, as presented within Appendix B. Although no discrete velocity layers or boundaries are created, these models generally resemble the corresponding overall average layer velocities as presented within Appendix A. In general, the seismic velocity of the bedrock and/or alluvial deposits gradually increases with depth, with numerous strong lateral velocity differentials suggesting the presence of buried corestones and/or dike structures. The colors representing the velocity gradients have been standardized on all of the models for comparative purposes.

GENERALIZED RIPPABILITY CHARACTERISTICS OF BEDROCK

A summary of the generalized rippability characteristics of bedrock based on a compilation of rippability performance charts prepared by Caterpillar, Inc. (2004), Caltrans (Stephens, 1978), and Santi (2006), has been provided to aid in evaluating potential excavation difficulties with respect to the seismic velocities obtained along the local areas surveyed. These seismic velocity ranges and rippability potentials have been tabulated below for reference.

TABLE 1- CATERPILLAR RIPPABILITY CHART (D9 Ripper)

Granitic Rock Velocity	Rippability
< 6,800	Rippable
6,800 – 8,000	Moderately Rippable
> 8,000	Non-Rippable

Additionally, we have provided the Caltrans Rippability Chart as presented below within Table 2 for comparison. These values are from published Caltrans studies (Stephens, 1978) that are based on their experience which are more conservative than Caterpillar's rippability charts. It should be noted that the type of bedrock was not indicated.

TABLE 2- STANDARD CALTRANS RIPPABILITY CHART

Velocity (feet/sec ±)	Rippability
< 3,500	Easily Ripped
3,500 – 5,000	Moderately Difficult
5,000 – 6,600	Difficult Ripping / Light Blasting
> 6,600	Blasting Required

Table 3 is partially modified from the "Engineering Behavior from Weathering Grade" as presented by Santi (2006), which also provides velocity ranges with respect to rippability potentials, along with other rock engineering properties that may be pertinent.

TABLE 3- SUMMARY OF ROCK ENGINEERING PROPERTIES

ENGINEERING PROPERTY:	Slightly Weathered	Moderately Weathered	Highly Weathered	Completely Weathered
Excavatability	Blasting necessary	Blasting to rippable	Generally rippable	Rippable
Slope Stability	½ :1 to 1:1 (H:V)	1:1 (H:V)	1:1 to 1.5:1 (H:V)	1.5:1 to 2:1 (H:V)
Schmidt Hammer Value	51 – 56	37 – 48	12 – 21	5 – 20
Seismic Velocity (fps)	8,200 – 13,125	5,000 – 10,000	3,300 – 6,600	1,650 – 3,300

Additionally, as presented below on Figure 1, the Caterpillar D9R Ripper Performance Chart (Caterpillar, 2012) has been provided for reference.

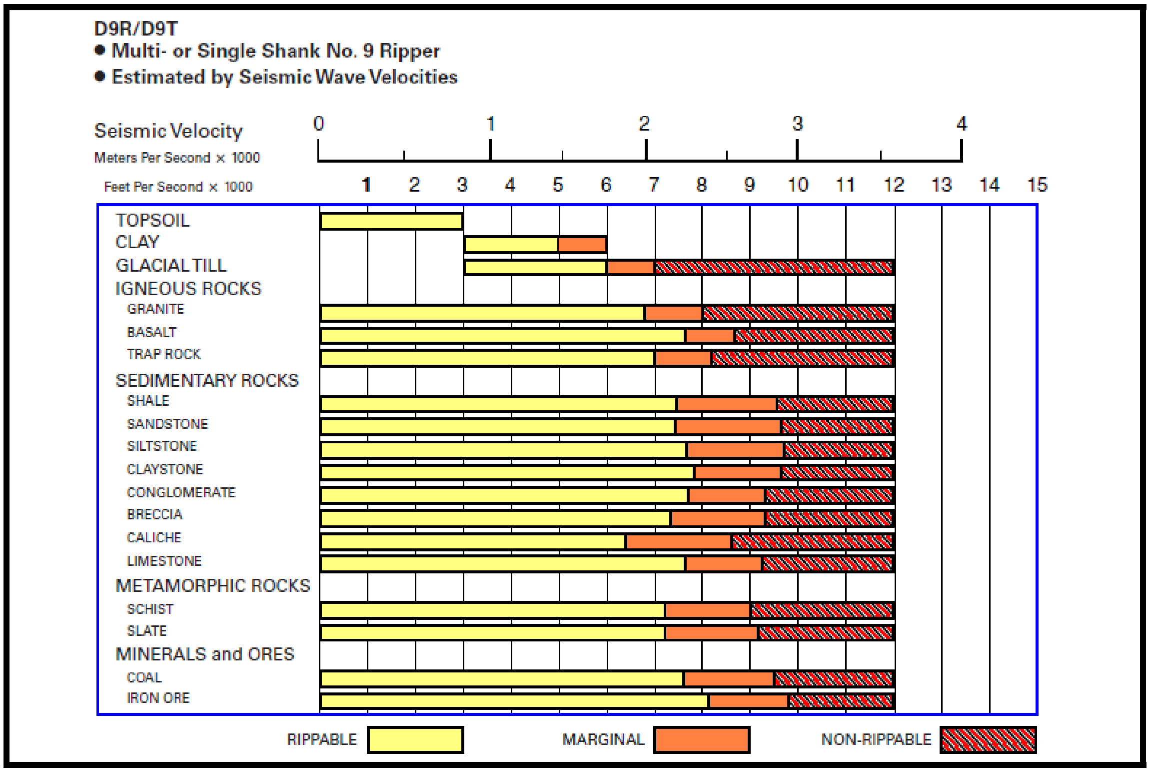


FIGURE 1- Caterpillar D9R Ripper Performance Chart

For purposes of the discussion in this report with respect to the expected bedrock rippability characteristics, we are assuming that a D9R/D9T dozer will be used as a minimum, such as illustrated above. Smaller excavating equipment will most likely result in slower production rates and possible refusal within relatively lower velocity bedrock materials. It should be noted that the decision for blasting of bedrock materials for facilitating the excavation process is sometimes made based upon economic production reasons and not solely on the rippability (velocity/hardness) characteristics of the bedrock.

A summary of the generalized rippability characteristics of granitic bedrock has been provided to aid in evaluating potential excavation difficulties with respect to the seismic velocities obtained along the local area surveyed. The velocity ranges described below are approximate and assume typical, good-working, heavy excavation equipment, such as single shank D9R dozer, such as described by Caterpillar, Inc. (2000 and 2012); however, different excavating equipment (i.e., trenching equipment) may not correlate well with these velocity ranges. Trenching operations which utilize large excavator-type equipment within granitic bedrock materials, typically encounter very difficult to non-productable conditions where seismic velocities are generally greater than 4,000± fps, and less for smaller backhoe-type equipment.

- **Rippable Condition (0 - 4,000 ft/sec)**:

  This velocity range indicates rippable materials which may consist of alluvial-type deposits and decomposed granitic bedrock, with random hardrock floaters. These materials typically break down into silty sands (depending on parent lithologic materials), whereas floaters will require special disposal. Some areas containing numerous hardrock floaters may present utility trench problems. Large floaters exposed at or near finished grade may present problems for footing or infrastructure trenching.

- **Marginally Rippable Condition (4,000 - 7,000 ft/sec)**:

  This range of seismic velocities indicates materials which may consist of moderately weathered bedrock and/or large areas of fresh bedrock materials separated by weathered fractured zones. These bedrock materials are generally rippable with difficulty by a Caterpillar D9R or equivalent. Excavations may produce material that will partially break down into a coarse, silty to clean sand, with a high percentage of very coarse sand to pebble-sized material depending on the parent bedrock lithology. Less fractured or weathered materials will probably require blasting to facilitate removal.

- **Non-Rippable Condition (7,000 ft/sec or greater)**:

  This velocity range includes non-rippable material consisting primarily of moderately fractured bedrock at lower velocities and only slightly fractured or unfractured rock at higher velocities. Materials in this velocity range may be marginally rippable, depending upon the degree of fracturing and the skill and experience of the operator. Tooth penetration is often the key to ripping success, regardless of seismic velocity. If the fractures and joints do not allow tooth penetration, the material may not be ripped effectively; however, pre-blasting or "popping" may induce sufficient fracturing to permit tooth entry. In their natural state, materials with these velocities are generally not desirable for building pad grade, due to difficulty in footing and utility trench excavation. Blasting will most likely produce oversized material, requiring special disposal.

GEOLOGIC & EARTHWORK CONSIDERATIONS

To evaluate whether a particular bedrock material can be ripped or excavated, this geophysical survey should be used in conjunction with the geologic and/or geotechnical report and/or information gathered for the subject project which may describe the physical properties of the bedrock. The physical characteristics of bedrock materials that favor ripping generally include the presence of fractures, faults, and other structural discontinuities, weathering effects, brittleness or crystalline structure, stratification or lamination, large grain size, moisture permeated clay, and low compressive strength. If the bedrock is foliated and/or fractured at depth, this structure could aid in excavation production.

Unfavorable bedrock conditions can include such characteristics as massive and homogeneous formations, non-crystalline structure, absence of planes of weakness, fine-grained materials, and formations of clay origin where moisture makes the material plastic. Use of these physical bedrock conditions along with the subsurface velocity characteristics as presented within this report should aid in properly evaluating the type of equipment that will be necessary and the production levels that can be anticipated for this project. A summary of excavation considerations is included within Appendix C in order to provide you with a better understanding of the complexities of excavation in bedrock materials. These concepts should be understood so that proper planning and excavation techniques can be employed by the selected grading contractor.

SUMMARY OF FINDINGS AND CONCLUSIONS

The raw field data was considered to be of good quality with minor amounts of ambient “noise” being introduced during our survey, most likely from vehicular traffic along nearby roads and the 215 Freeway, local air traffic, and also on-site water-well pumping. Analysis of the data and picking of the primary “P”-wave arrivals was performed with minor difficulty, with some interpolation of data being necessary. Based on the results of our comparative seismic analyses of the computer programs **SIPwin**, **Refractor**, and **Rayfract™**, the seismic refraction survey line models appear to generally coincide with one another, with some minor variances due to the methods that these programs process and integrate the input data. The anticipated excavation potentials of the velocity layers encountered locally during our survey are as follows:

- **Velocity Layer V1**:

  No excavating difficulties are expected to be encountered within the uppermost, low-velocity layer V1 (average weighted velocity of 1,514 to 2,222 fps) and should excavate with conventional ripping. This layer is expected to be comprised of topsoil, colluvium, older alluvial sediments, and/or completely-weathered and fractured bedrock materials. Localized boulders should be anticipated based on surficial exposures, which may require more significant excavation techniques.

- **Velocity Layer V2**:

  The second layer V2 (average weighted velocity of 3,673 to 7,745 fps) is believed to consist of highly- to moderately-weathered granitic bedrock (within higher end of velocity range) and/or possibly older alluvial sediments (within lower end of velocity range). Using the rock classifications as presented within Tables 1 through 3, seismic wave velocities of less than 6,800± fps are generally noted to be within the threshold for conventional ripping. Isolated floaters (i.e., boulders, corestones, etc.) should be expected to be present within this layer and could produce somewhat difficult conditions locally. Placement of infrastructure within this velocity layer may require some breaking and/or light blasting to obtain desired grade.

- **Velocity Layer V3**:

  The third layer V3 is believed to consist of fresh to slightly-weathered bedrock. Extremely hard excavation difficulties within this deeper velocity layer (average weighted velocity range of 11,549 to 17,849 fps) will be encountered. This layer may consist of relatively fresher homogeneous bedrock, or may contain higher velocity scattered boulders, dikes, and other lithologic variables, within a relatively lower velocity bedrock matrix. Continuous blasting will most likely be required within this velocity layer to achieve desired grade, including any infrastructure.

The ray sampling coverage of the subsurface seismic waves that were acquired during the processing of the tomographic models appeared to be of very good quality which was verified by having a Root Mean Square Error (RMS) of 0.8 to 2.0 percent (see lower right-hand corner of each model). The RMS error (misfit between picked and modeled first break times) is automatically calculated during the processing routine, with a value of less than 2.0% being preferred, of which all of the models obtained. Based on the tomographic models and typical excavation characteristics observed within granitic bedrock of the southern California region, anticipation of gradual increasing hardness with depth should be anticipated during grading. Significant lateral velocity variations will most likely be encountered across the predominance of the site generally due to the presence of buried corestones and/or dikes such as imaged in some of the tomographic refraction models and as also expressed as scattered outcrops across the subject site.

CLOSURE

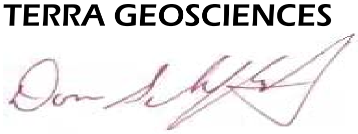
The field geophysical survey was performed by the undersigned on August 22 and 23, 2014 using "state of the art" geophysical equipment and techniques along the selected portions of the subject study area as directed by you. The seismic data was further evaluated using recently developed tomographic inversion techniques to provide a more thorough analysis and understanding of the subsurface structural conditions. It should be noted that our data was obtained along only seven specific locations therefore other areas in the local vicinity beyond the limits of our seismic lines may contain different velocity layers and depths not encountered during our field survey. Additional survey traverses may be necessary to further evaluate the excavation characteristics across other portions of the site where cut grading will be proposed.

In summary, the results of this seismic refraction survey are to be considered as an aid to assessing the rippability and excavation potentials of the bedrock locally. This information should be carefully reviewed by the grading contractor and representative “test” excavations with the proposed type of excavation equipment for the proposed construction should be considered, so that they may be correlated with the data presented within this report. Estimates of layer velocity boundaries as presented in this report are generally considered to be within 10± percent of the total depth of the contact.

It is important to understand that the fundamental limitation for seismic refraction surveys is known as nonuniqueness, wherein a specific seismic refraction data set does not provide sufficient information to determine a single "true" earth model. Therefore, the interpretation of any seismic data set uses "best-fit" approximations along with the geologic models that appear to be most reasonable for the local area being surveyed. Client should also understand that when using the theoretical geophysical principles and techniques discussed in this report, sources of error are possible in both the data obtained and in the interpretation and that the results of this survey may not represent actual subsurface conditions. These are all factors beyond **Terra Geosciences** control and no guarantees as to the results of this survey can be made. We make no warranty, either expressed or implied.

This opportunity to be of service is sincerely appreciated. If you should have any questions regarding this report or do not understand the limitations of this study or the data and results that are presented, please do not hesitate to contact our office at your earliest convenience.

Respectfully submitted,
TERRA GEOSCIENCES



Donn C. Schwartzkopf
Principal Geophysicist
PGP 1002

SEISMIC LINE LOCATION MAP

PROJECT NO. 142740-1

PLATE 1

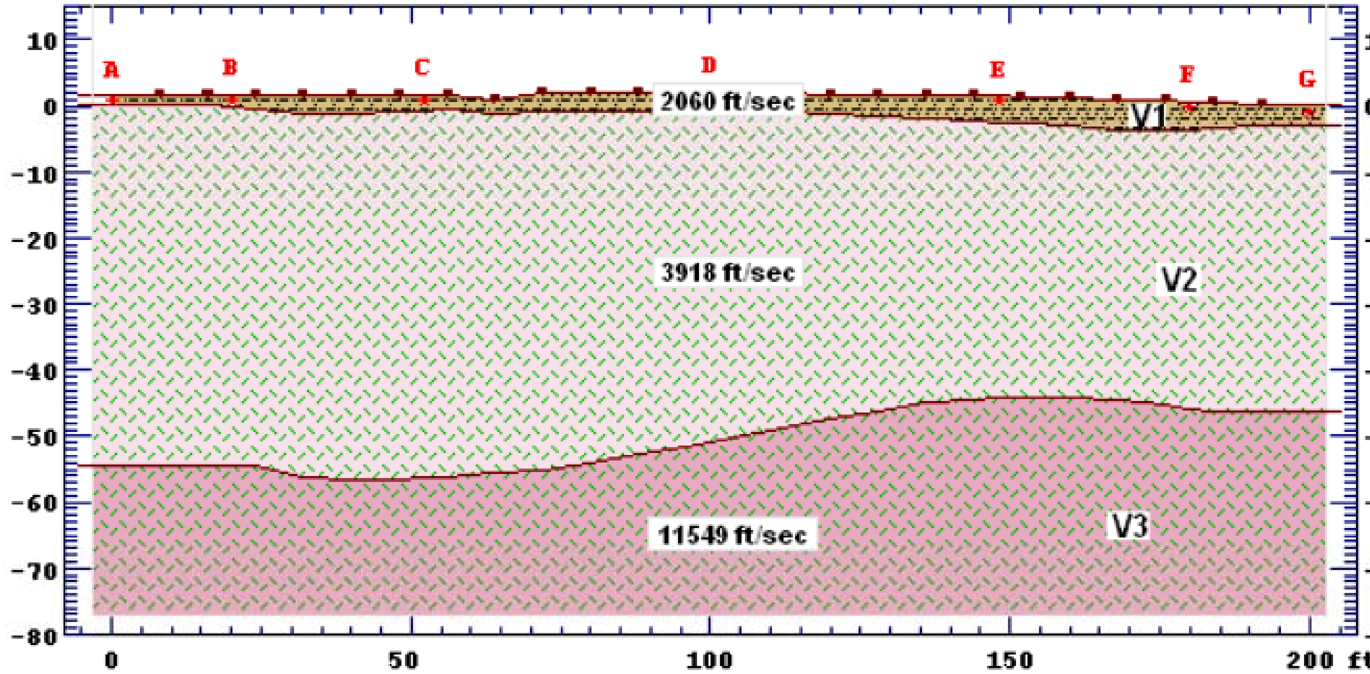
APPENDIX A

LAYER VELOCITY MODELS

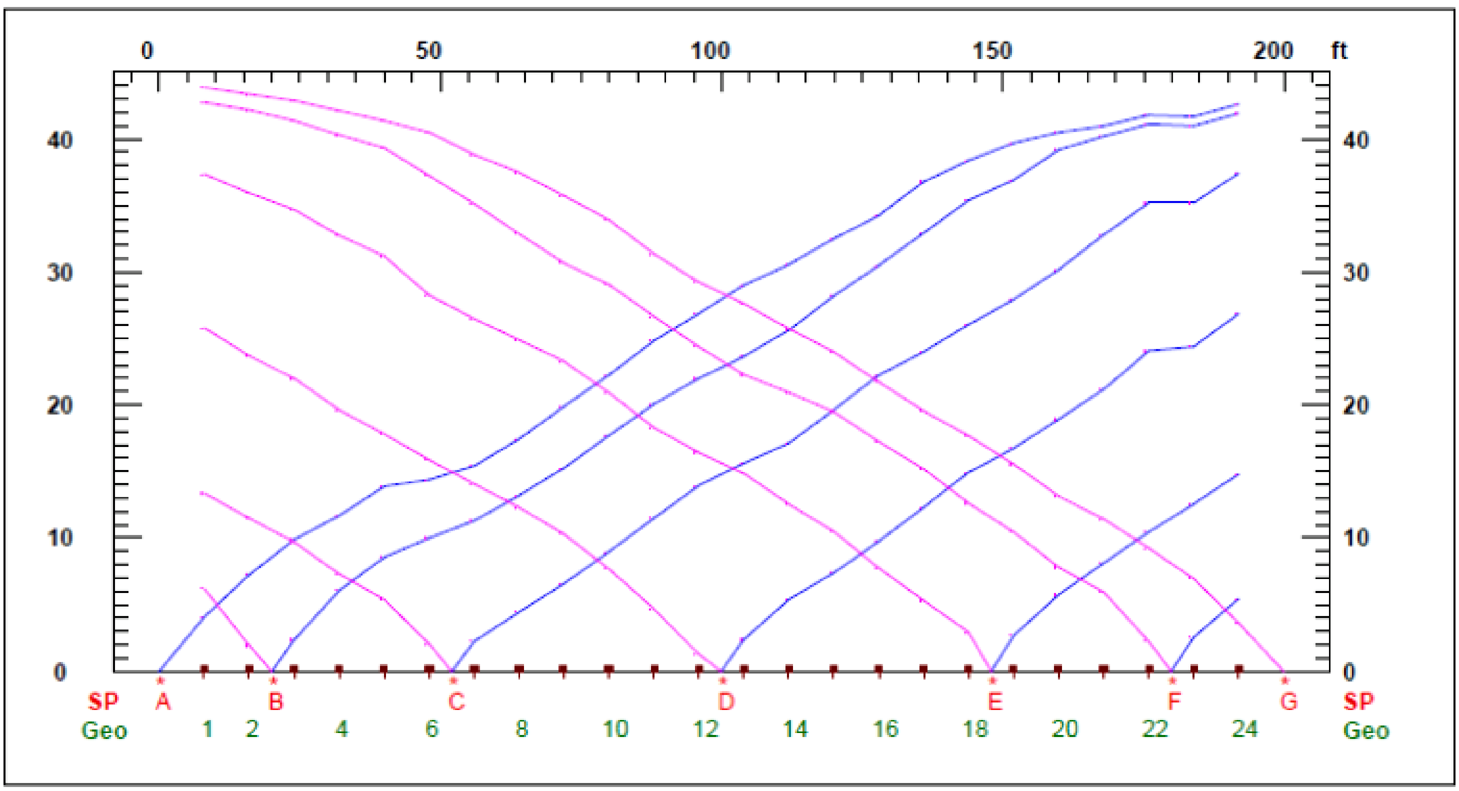
SEISMIC LINE S-1

< South - North >

LAYER VELOCITY MODEL

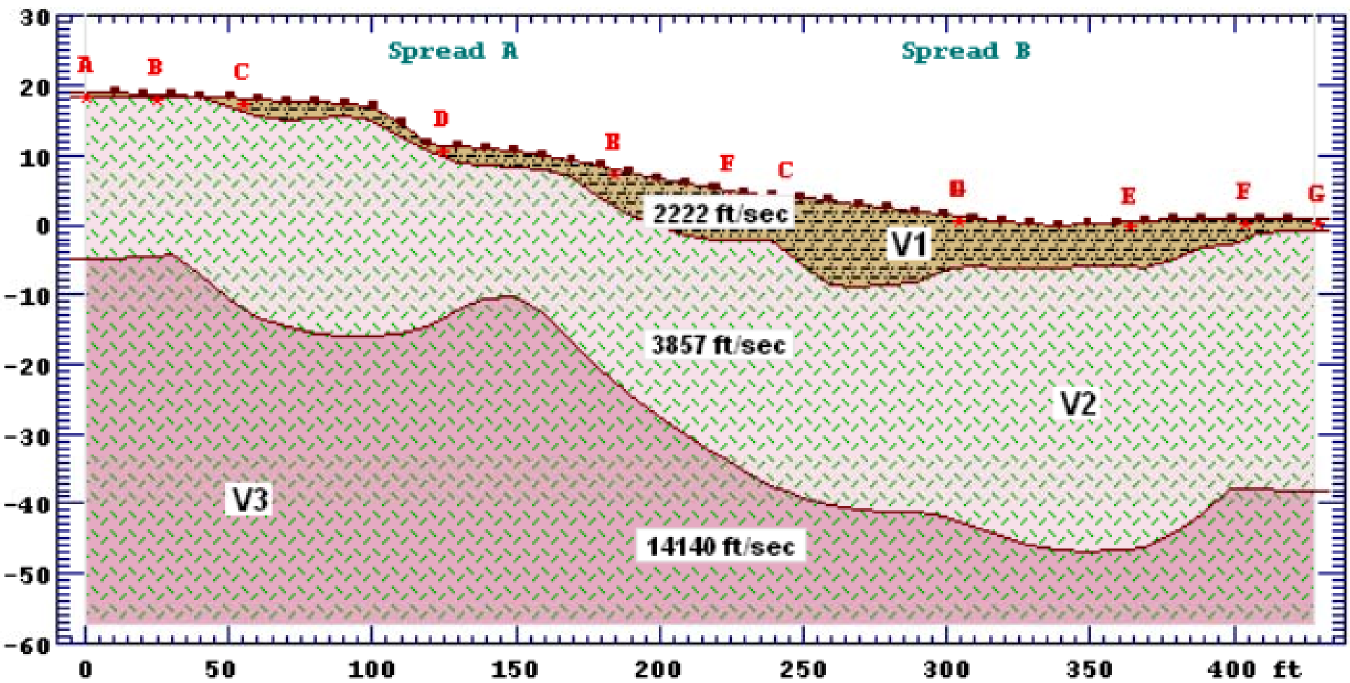


TIME-DISTANCE PLOT

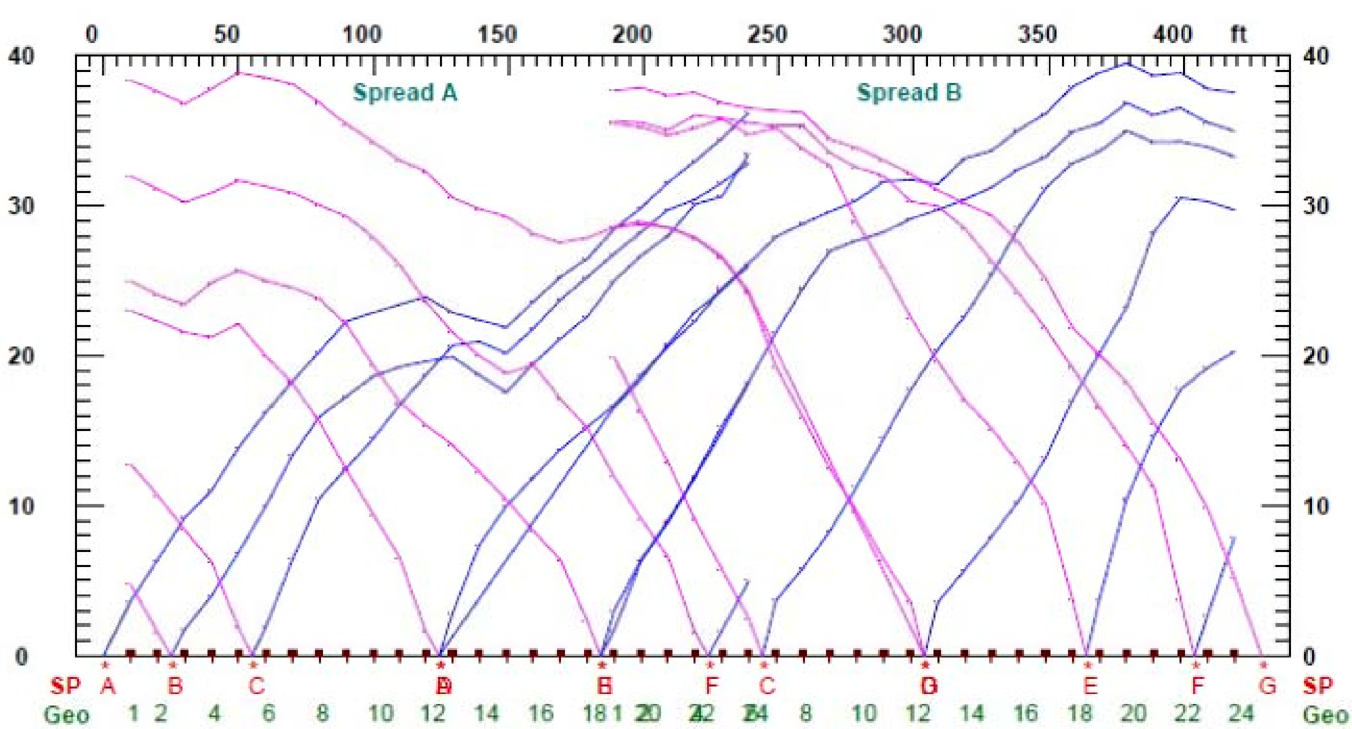


SEISMIC LINE S-2
< West - East >

LAYER VELOCITY MODEL



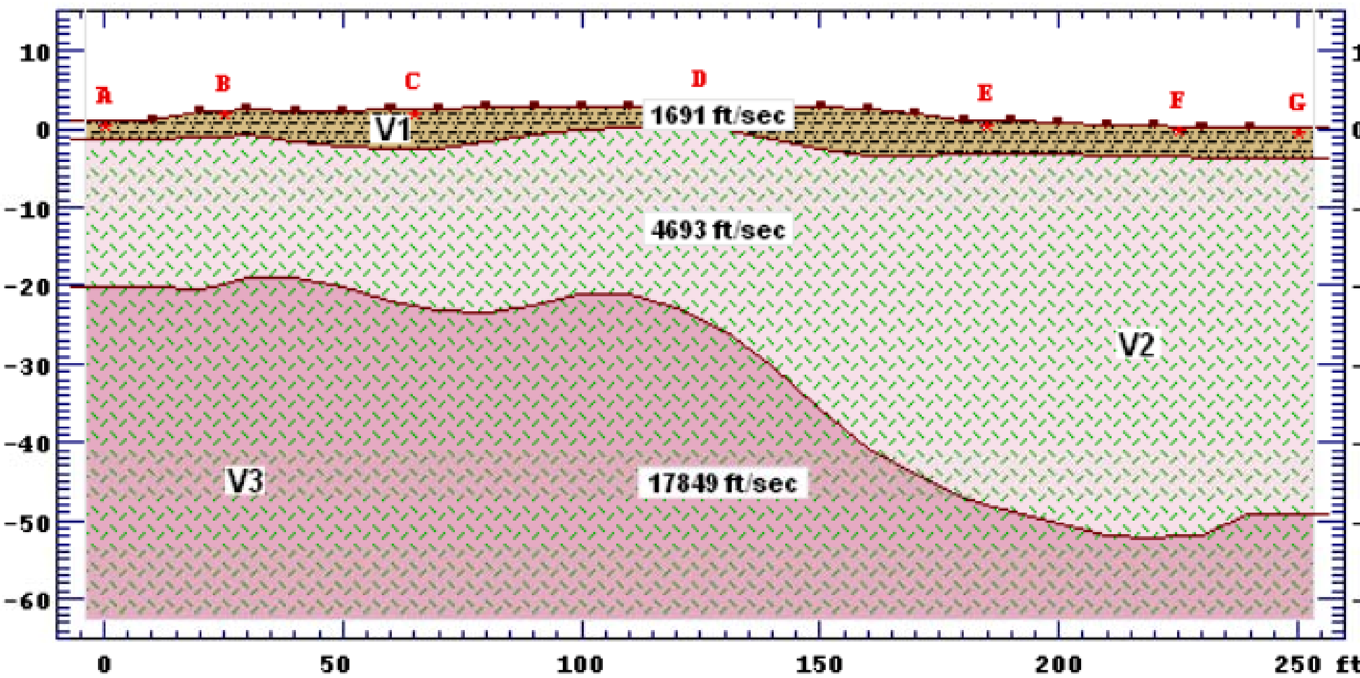
TIME-DISTANCE PLOT



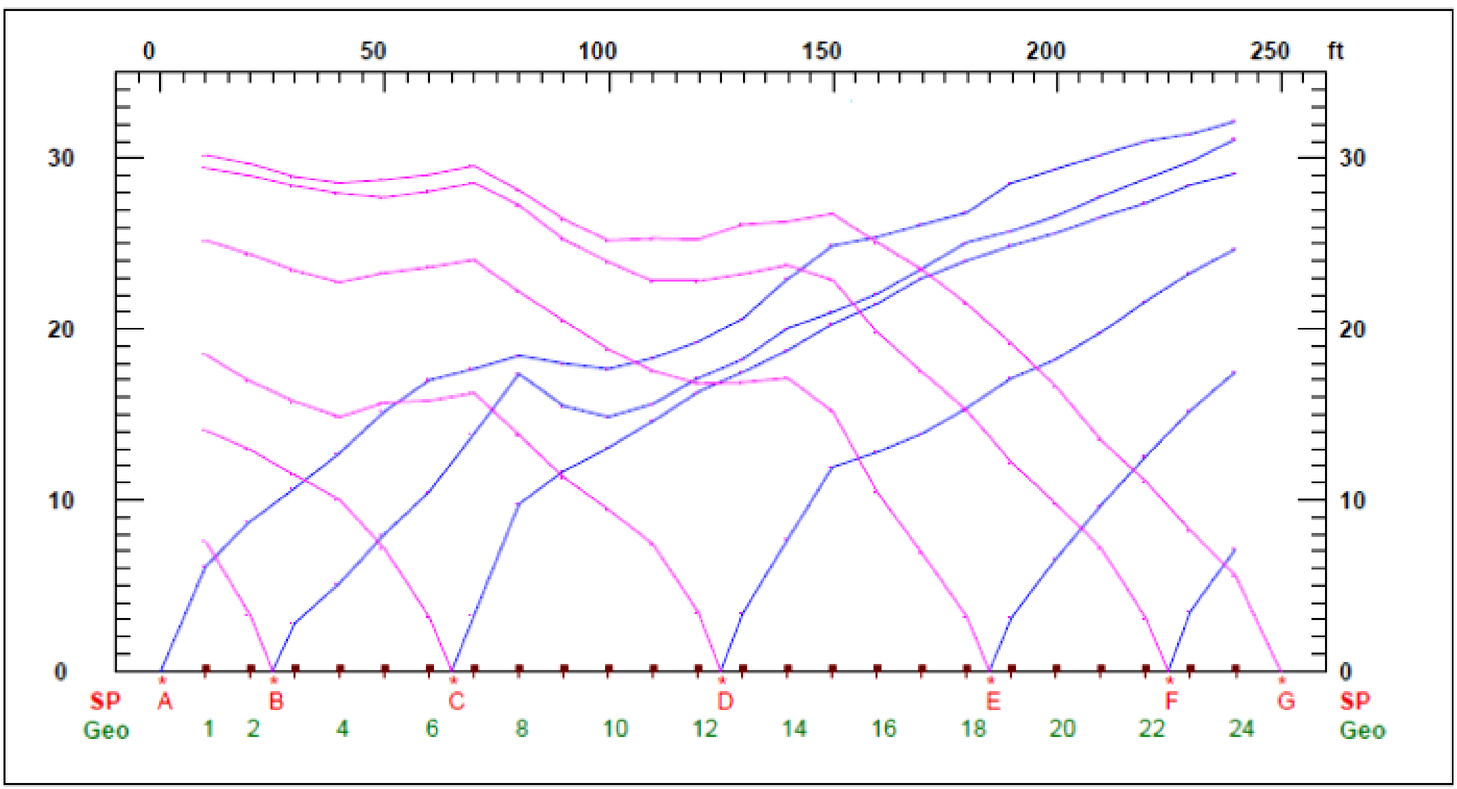
SEISMIC LINE S-3

< West - East >

LAYER VELOCITY MODEL



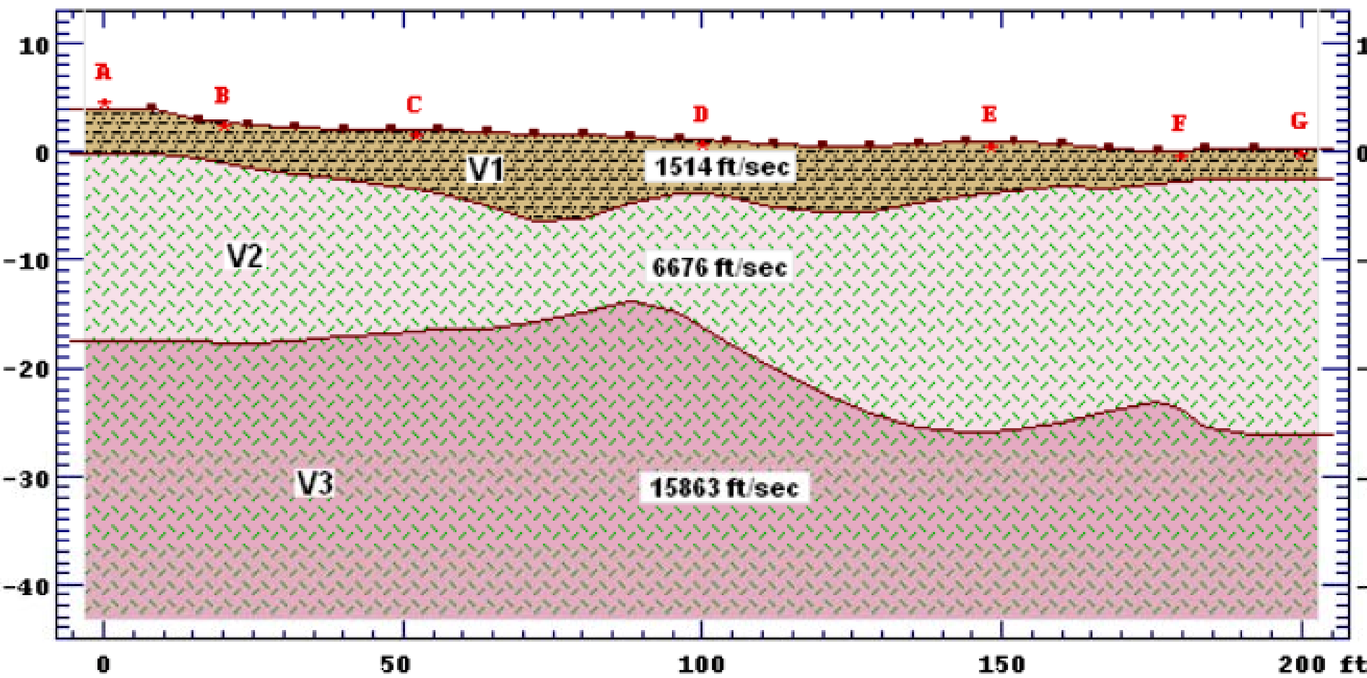
TIME-DISTANCE PLOT



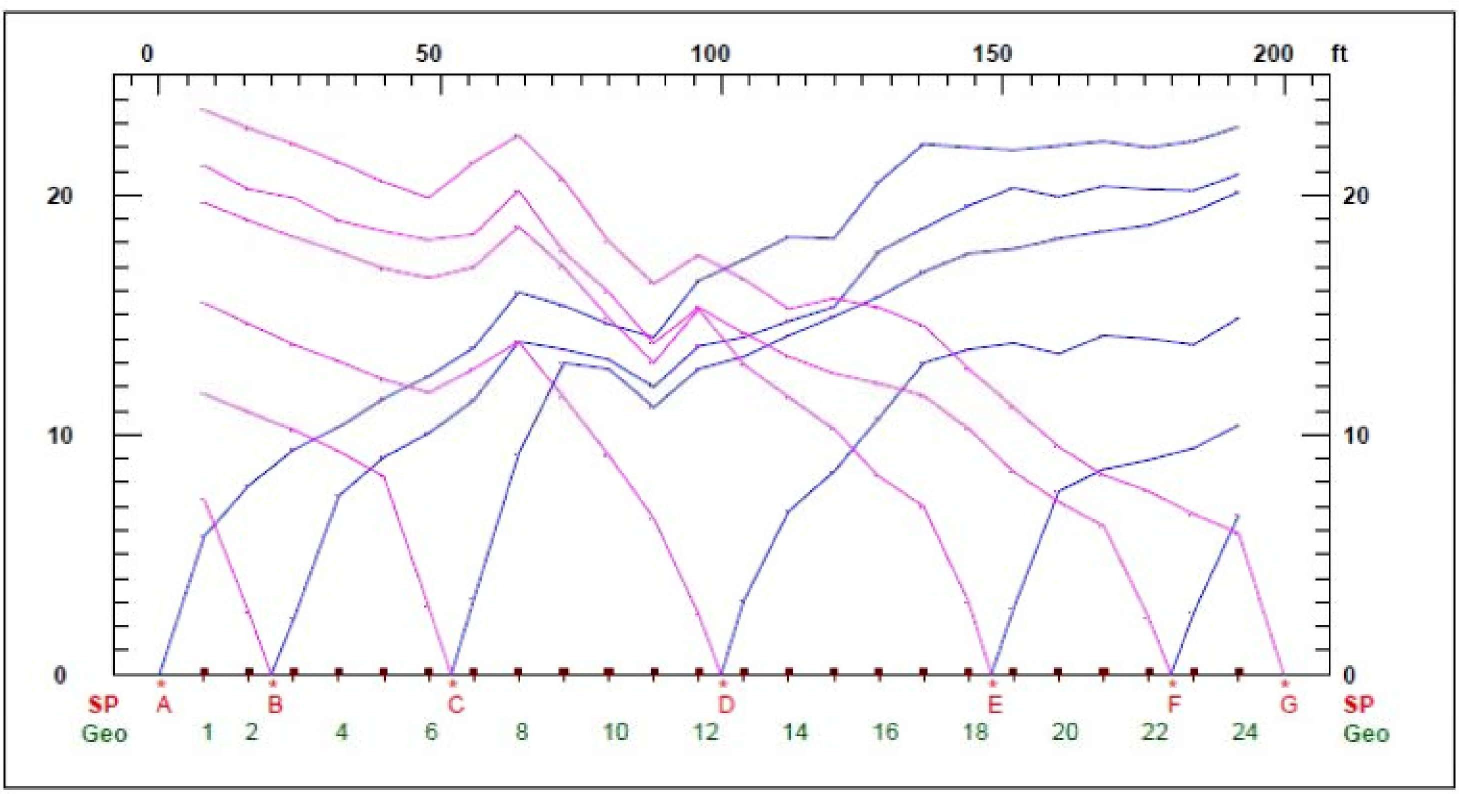
SEISMIC LINE S-4

< South - North >

LAYER VELOCITY MODEL



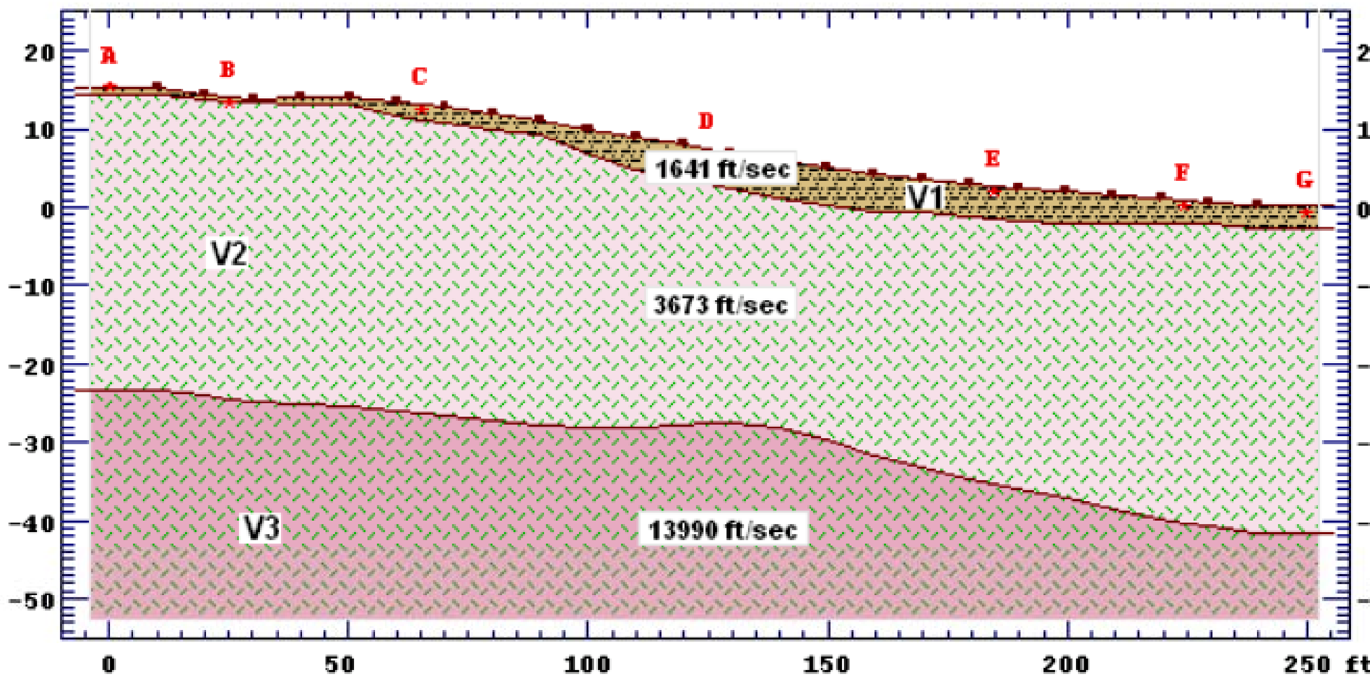
TIME-DISTANCE PLOT



SEISMIC LINE S-5

< West - East >

LAYER VELOCITY MODEL



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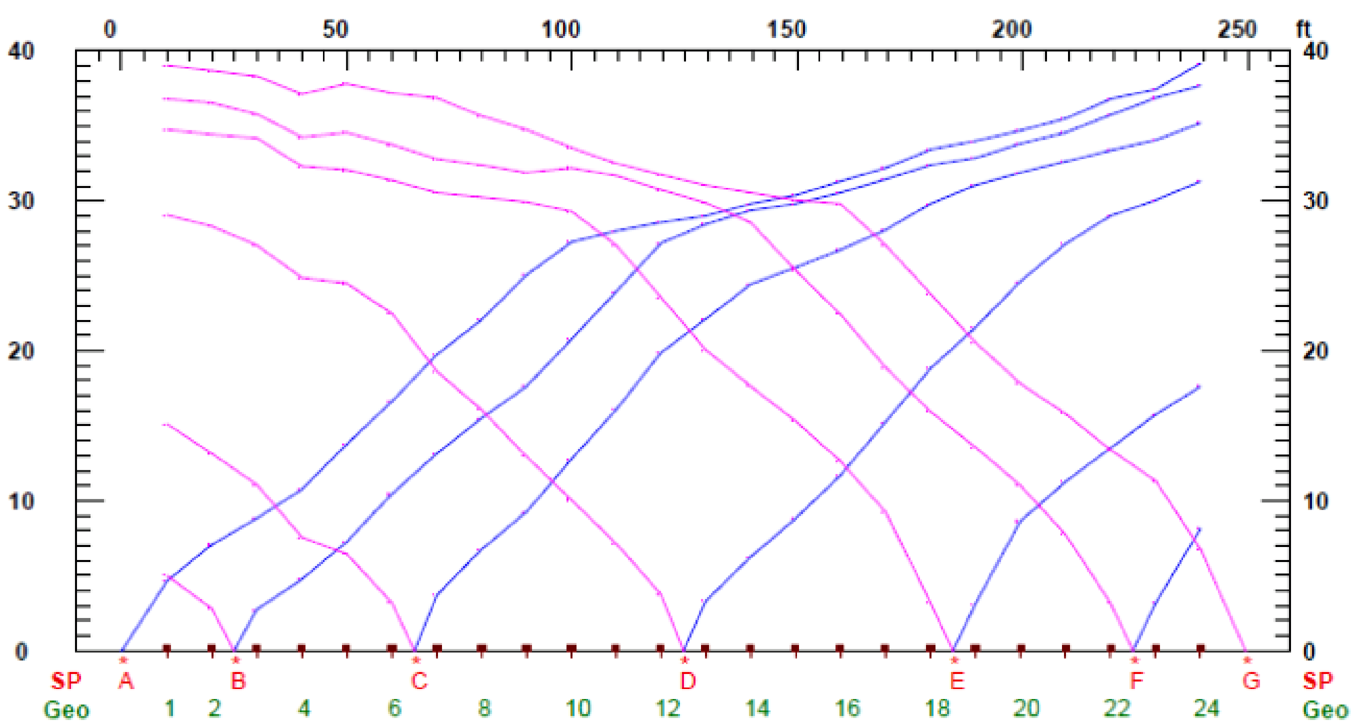
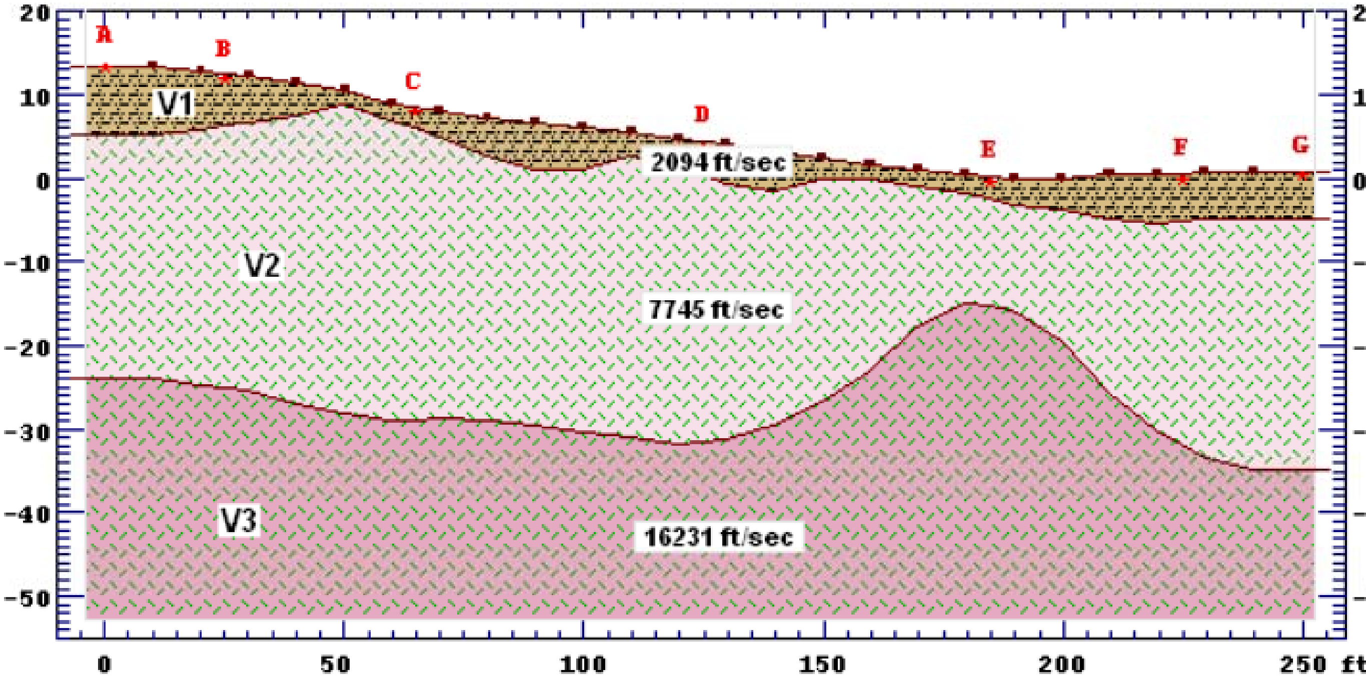


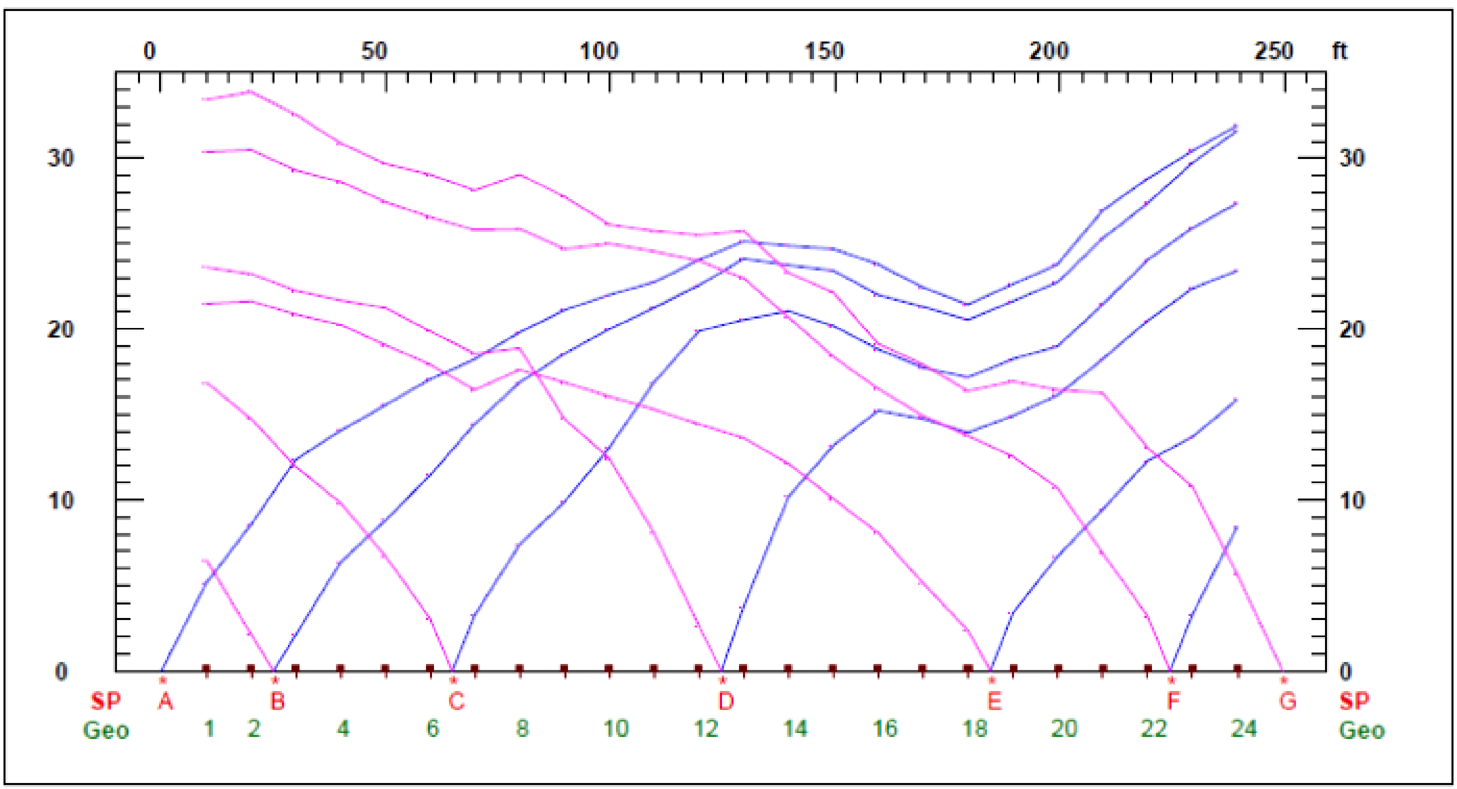
SEISMIC LINE S-6

< West - East >

LAYER VELOCITY MODEL



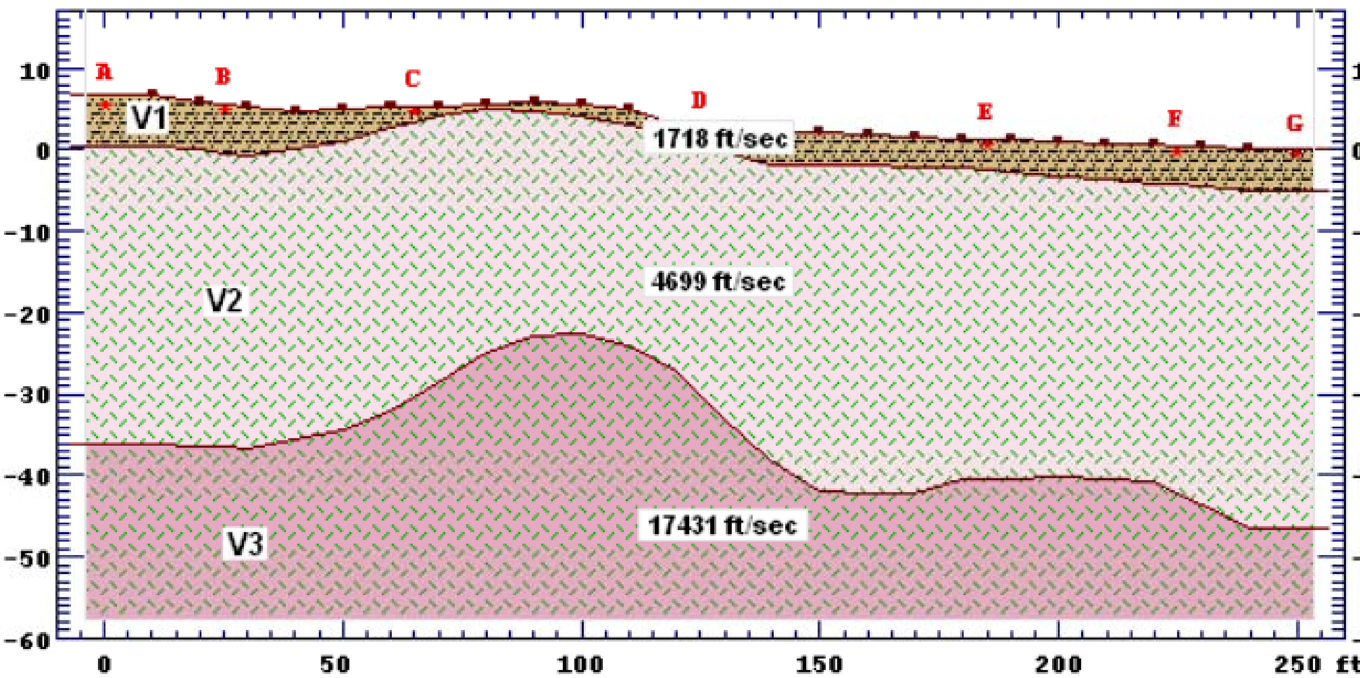
TIME-DISTANCE PLOT



SEISMIC LINE S-7

< West - East >

LAYER VELOCITY MODEL



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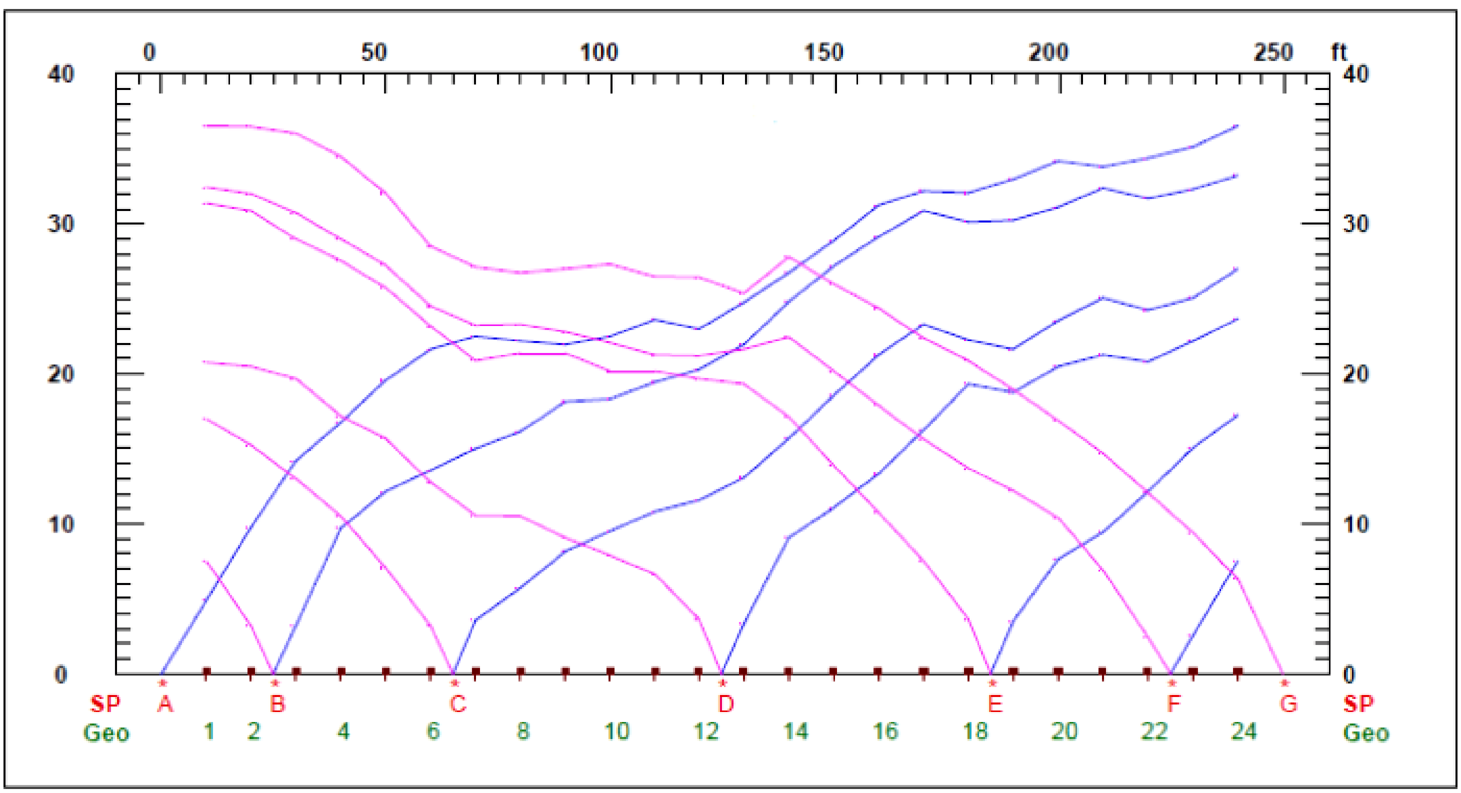


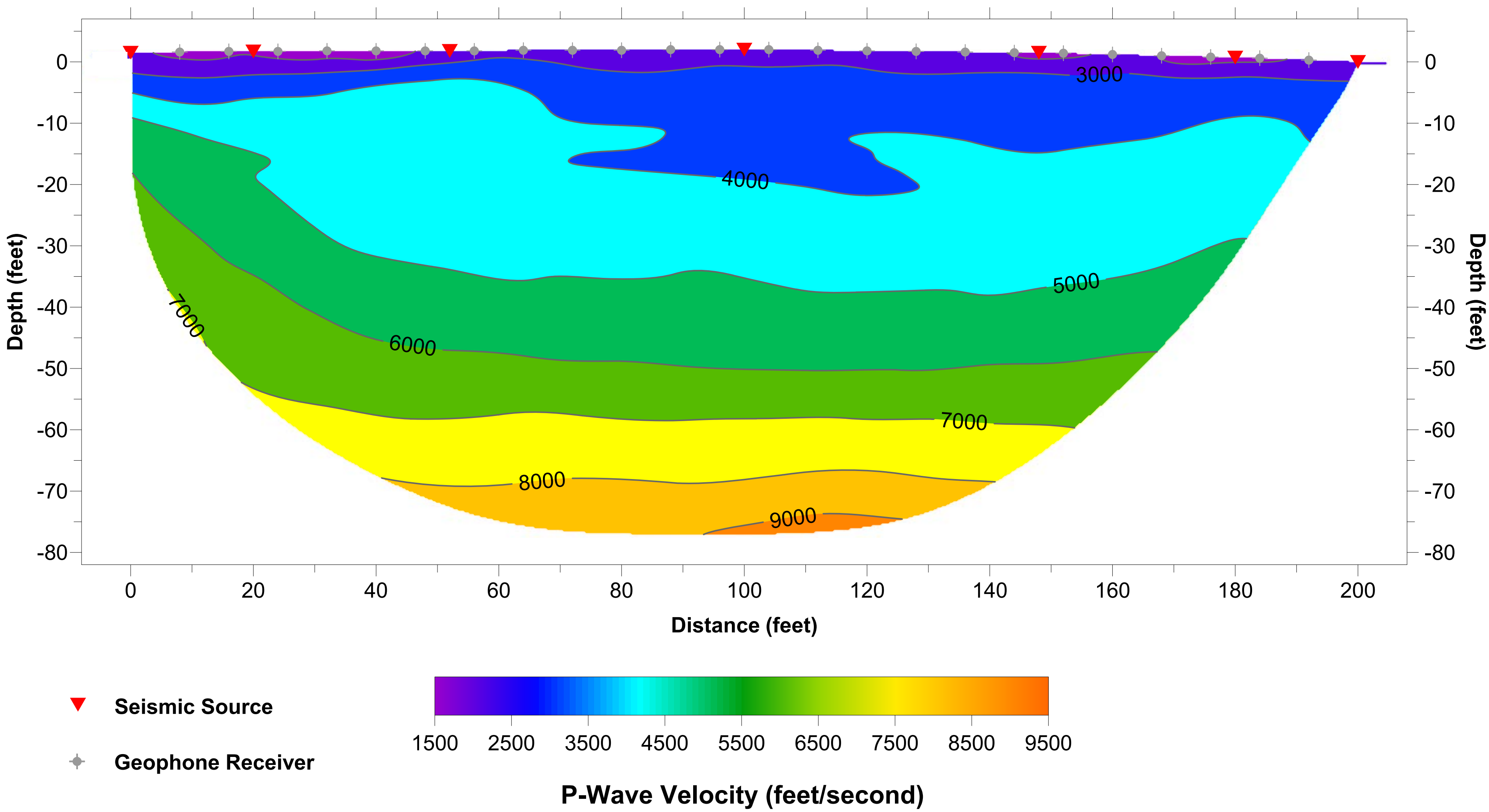
APPENDIX B

REFRACTION TOMOGRAPHIC MODELS

SEISMIC LINE S-1

← South - North →

REFRACTION TOMOGRAPHIC MODEL



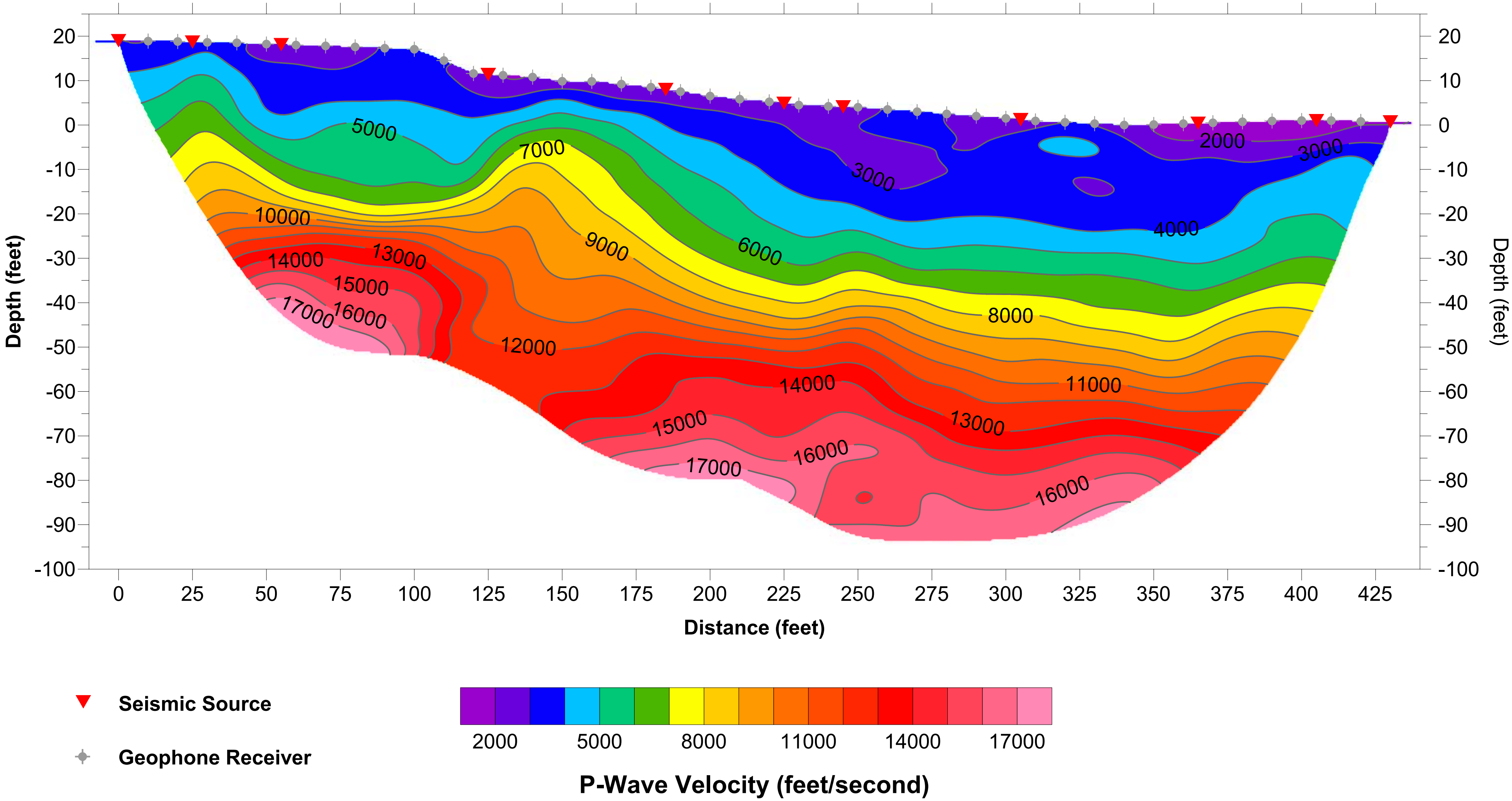
SCALE: 1" = 25' (Horizontal & Vertical)

RMS error 0.8 %, Rayfract Version 3.32

SEISMIC LINE S-2

← West - East →

REFRACTION TOMOGRAPHIC MODEL



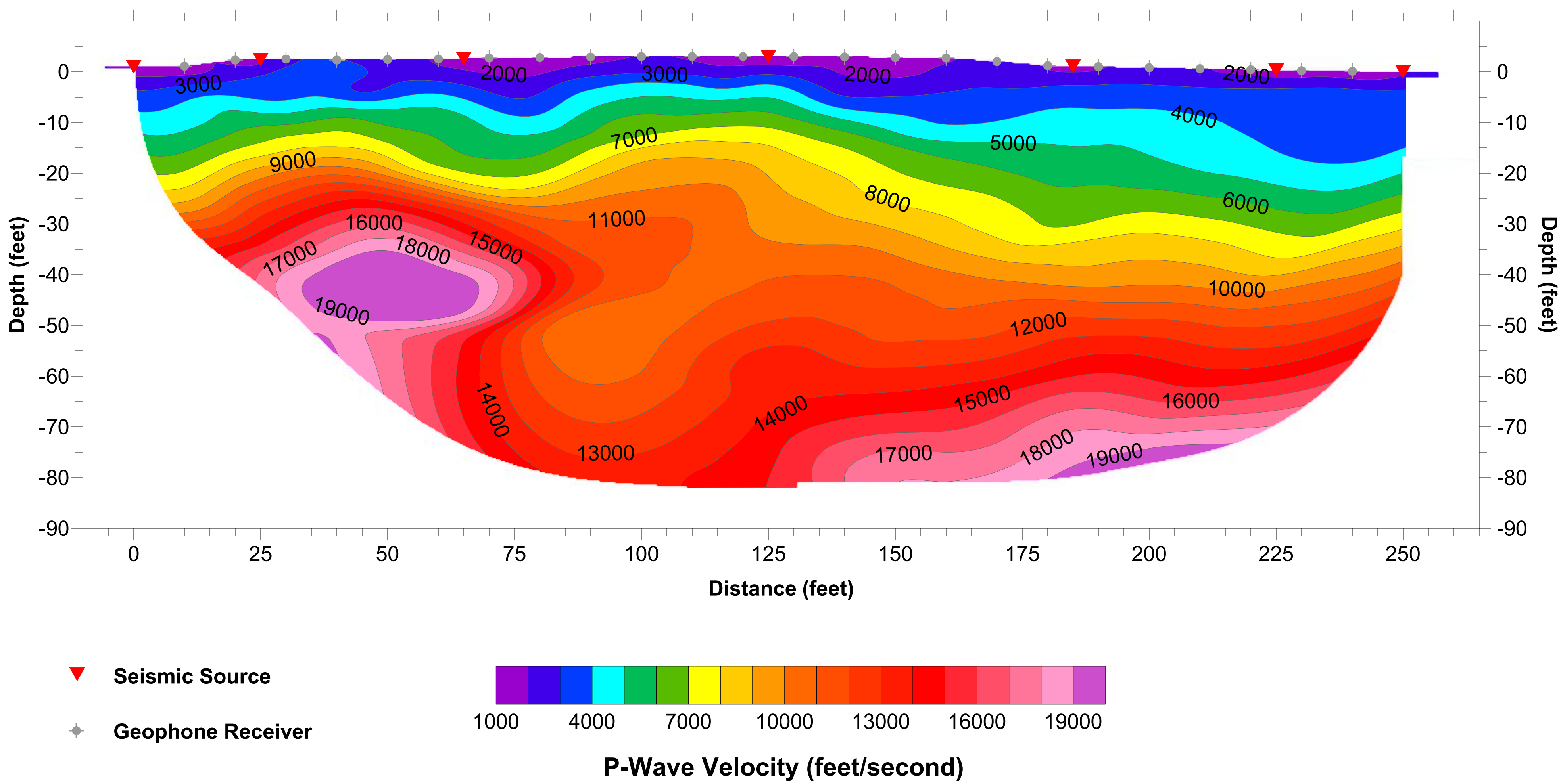
NOTE: Vertical Exaggeration 1.5X

RMS error 1.7 %, Rayfract Version 3.32

SEISMIC LINE S-3

← West - East →

REFRACTION TOMOGRAPHIC MODEL



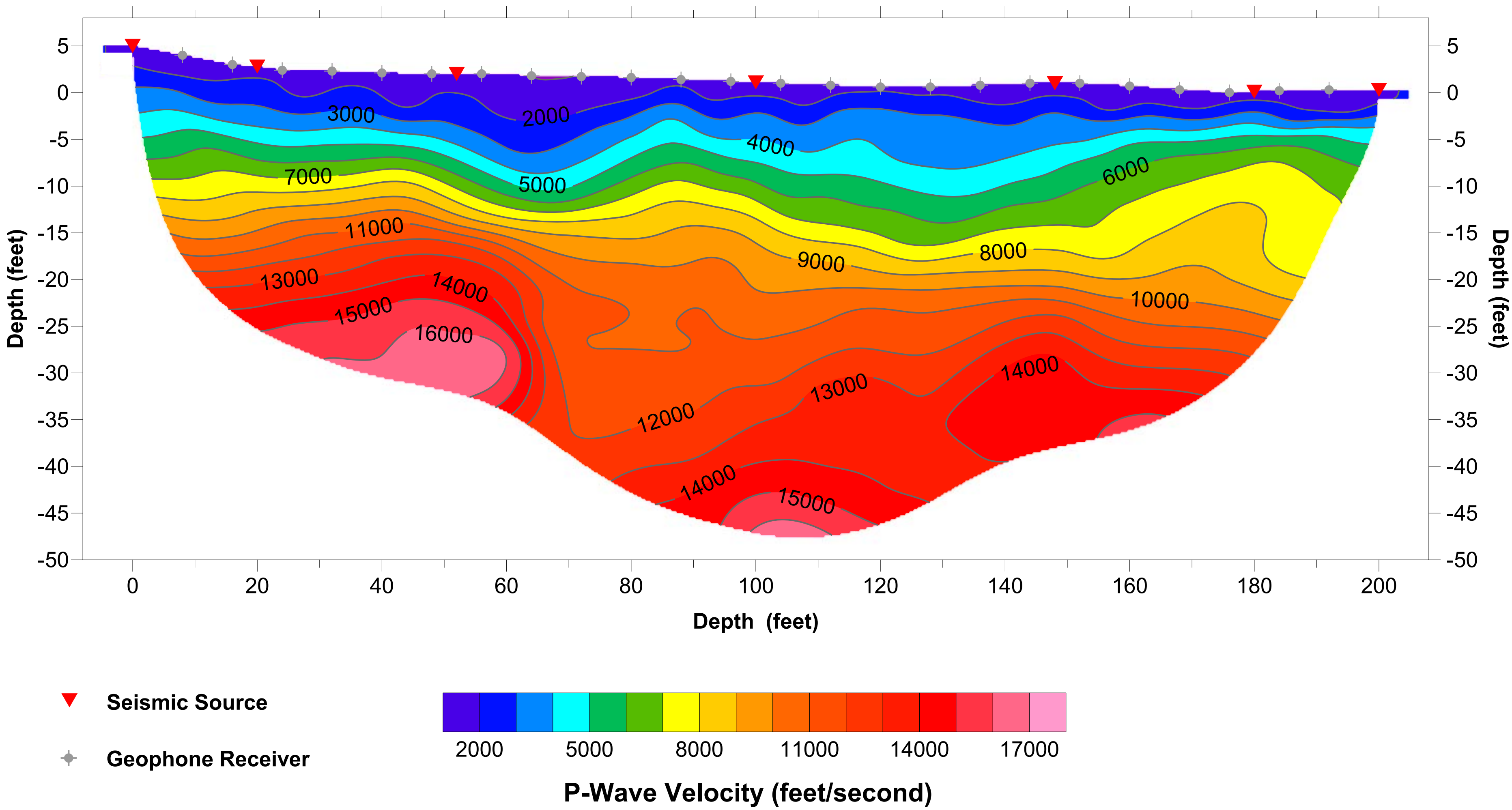
SCALE: 1" = 30' (Horizontal & Vertical)

RMS error 1.4 %, Rayfract Version 3.32

SEISMIC LINE S-4

← South - North →

REFRACTION TOMOGRAPHIC MODEL



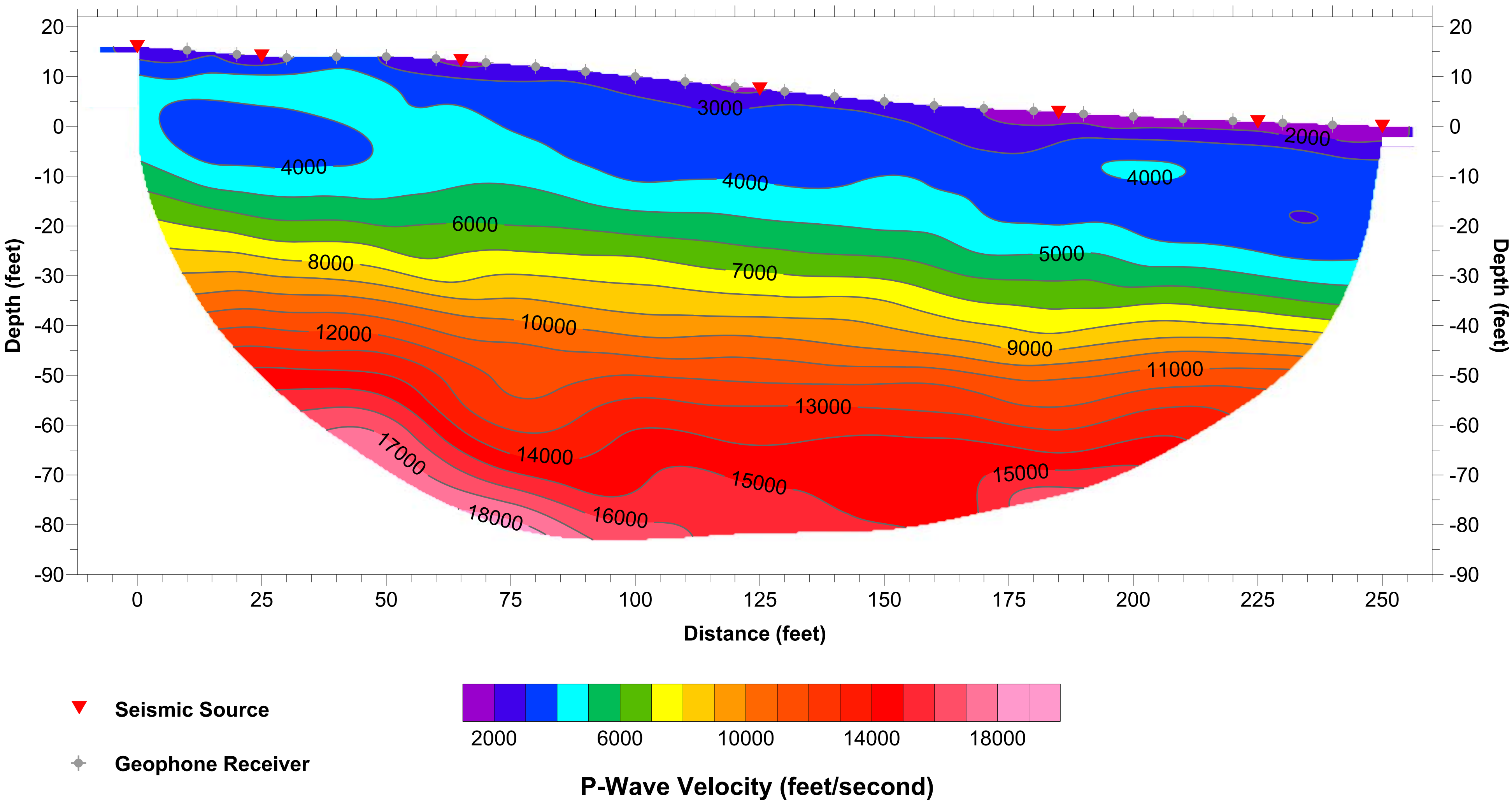
NOTE: Vertical Exaggeration 1.5X

RMS error 2.0 %, Rayfract Version 3.32

SEISMIC LINE S-5

← West - East →

REFRACTION TOMOGRAPHIC MODEL



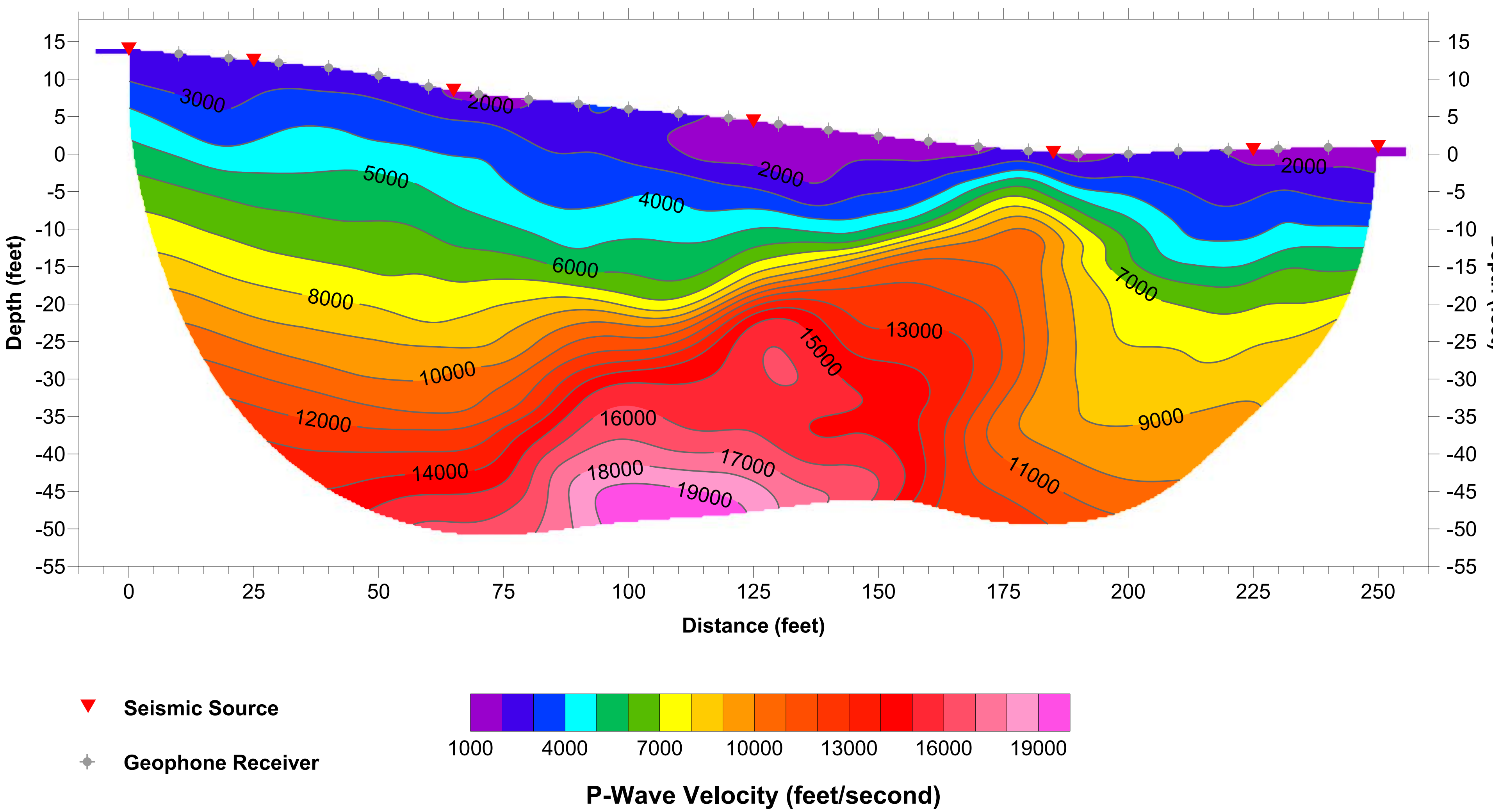
SCALE: 1" = 30' (Horizontal & Vertical)

RMS error 1.3 %, Rayfract Version 3.32

SEISMIC LINE S-6

← West - East →

REFRACTION TOMOGRAPHIC MODEL



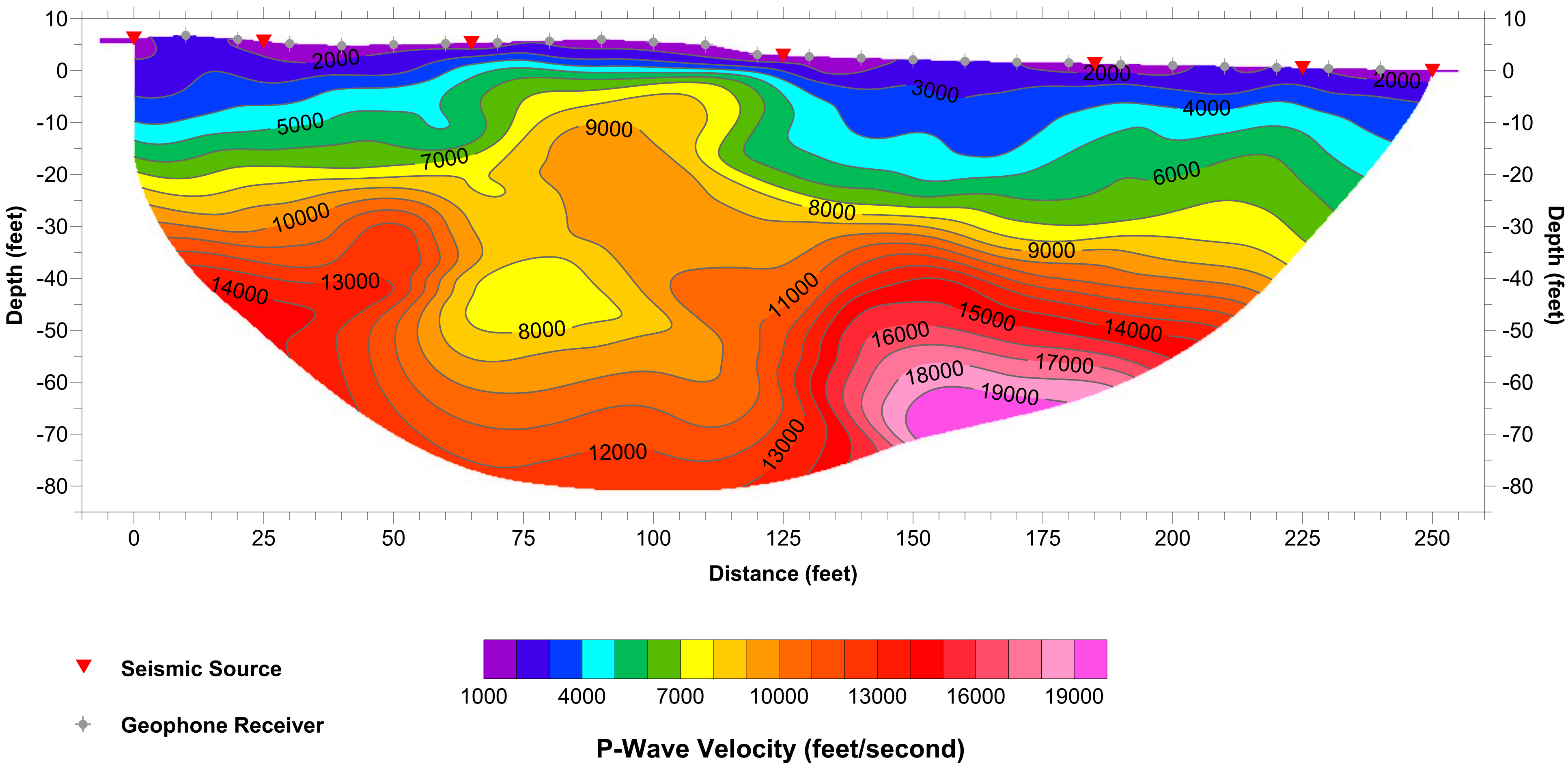
NOTE: Vertical Exaggeration 1.5X

RMS error 1.7 %, Rayfract Version 3.32

SEISMIC LINE S-7

← West - East →

REFRACTION TOMOGRAPHIC MODEL



SCALE: 1" = 30' (Horizontal & Vertical)

RMS error 1.7 %, Rayfract Version 3.32

APPENDIX C

EXCAVATION CONSIDERATIONS

EXCAVATION CONSIDERATIONS

These excavation considerations have been included to provide the client with a brief overall summary of the general complexity of hard bedrock excavation. It is considered the clients responsibility to insure that the grading contractor they select is both properly licensed and qualified, with experience in hard-bedrock ripping processes. To evaluate whether a particular bedrock material can be ripped, this geophysical survey should be used in conjunction with the geologic or geotechnical report prepared for the project which describes the physical properties of the bedrock. The physical characteristics of bedrock materials that favor ripping generally include the presence of fractures, faults and other structural discontinuities, weathering effects, brittleness or crystalline structure, stratification of lamination, large grain size, moisture permeated clay, and low compressive strength. Unfavorable conditions can include such characteristics as massive and homogeneous formations, non-crystalline structure, absence of planes of weakness, fine-grained materials, and formations of clay origin where moisture makes the material plastic.

When assessing the potential rippability of the underlying bedrock of a given site, the above geologic characteristics along with the estimated seismic velocities can then be used to evaluate what type of equipment may be appropriate for the proposed grading. When selecting the proper ripping equipment there are three primary factors to consider, which are:

- ***Down Pressure available at the tip, which determines the ripper penetration that can be attained and maintained,***
- ***Tractor flywheel horsepower, which determines whether the tractor can advance the tip, and,***
- ***Tractor gross-weight, which determines whether the tractor will have sufficient traction to use the horsepower.***

In addition to selecting the appropriate tractor, selection of the proper ripper design is also important. There are basically three designs, being radial, parallelogram, and adjustable parallelogram, of which the contractor should be aware of when selecting the appropriate design to be used for the project. The penetration depth will depend upon the down-pressure and penetration angle, as well as the length of the shank tips (short, intermediate, and long).

Also important in the excavation process is the ripping technique used as well as the skill of the individual tractor operator. These techniques include the use of one or more ripping teeth, up- and down-hill ripping, and the direction of ripping with respect to the geologic structure of the bedrock locally. The use of two tractors (one to push the first tractor-ripper) can extend the range of materials that can be ripped. The second tractor can also be used to supply additional down-pressure on the ripper. Consideration of light blasting can also facilitate the ripper penetration and reduce the cost of moving highly consolidated rock formations.

All of the combined factors above should be considered by both the client and the grading contractor, to insure that the proper selection of equipment and ripping techniques are used for the proposed grading.

APPENDIX D

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REFERENCES

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APPENDIX E

EARTHWORK SPECIFICATIONS

APPENDIX E

MATRIX GEOTECHNICAL CONSULTING

EARTHWORK SPECIFICATIONS

These specifications present generally accepted standards and minimum earthwork requirements for the development of the project. These specifications shall be the guidelines for earthwork except where specifically superceded in preliminary geology and soil reports, grading plan review reports or by prevailing grading codes or ordinances of the controlling agency.

1.0 <u>GENERAL</u>

1.1 The contractor shall be responsible for the satisfactory completion of all earthwork in accordance with the project plans and specifications.

1.2 The project Soil Engineer and Engineering Geologist of their representative shall provide testing services, and Geotechnical consultation during the duration of the project.

1.3 All clearing, grubbing, stripping and site preparation for the project shall be accomplished by the Contractor to the satisfaction of the Soil Engineer.

1.4 It is the Contractor's responsibility to prepare the ground surface to receive the fills to the satisfaction of the Soil Engineer and to place, spread, mix and compact the fill in accordance with the job specifications and as requested by the Soil Engineer. The Contractor shall also remove all material considered by the Soil Engineer to be unsuitable for use in the construction of compacted fill.

1.5 The Contractor shall have suitable and sufficient equipment in operation to handle the amount of fill being placed. When necessary, equipment will be shut down temporarily in order to permit proper compaction of fills.

2.0 <u>GENERAL</u>

2.1 Excessive vegetation and all deleterious material should be disposed of offsite as required by the Soil Engineer. Existing fill, soil, alluvium or rock materials determined by the Soil Engineer as being unsuitable for placement in compacted fills shall be removed and wasted from the site. Where applicable, the Contractor may obtain the approval of the Soil Engineer and the controlling authorities for the project to dispose of the above-described materials, or a portion thereof, in designated areas onsite.

After removals as described above have been accomplished, earth materials deemed unsuitable in their natural, in-place condition, shall be removed as recommended by the Soil Engineer/Engineering Geologist.

2.2 After the removals as delineated in Item 2.0, 2.1 above, the exposed surfaces shall be disked or bladed by the Contractor to the satisfaction of the Soil Engineer. The prepared ground surfaces shall then be brought to the specified water content, mixed as required, and compacted and tested as specified. In areas where it is necessary to obtain the approval of the controlling agency, prior to placing fill, it will be the contractor's responsibility to notify the proper authorities.

2.3 Any underground structures such as cesspools, cisterns, mining shafts, tunnels, septic tanks, wells, pipelines or others not located prior to grading are to be removed or treated in a manner prescribed by the Soil Engineer and/or the controlling agency for the project.

3.0 COMPACTED FILLS

3.1 Any materials imported or excavated on the property may be utilized in the fill, provided each material has been determined to be suitable by the Soil Engineer. Deleterious material not disposed of during clearing or demolition shall be removed from the fill as directed by the Soil Engineer.

3.2 Rock or rock fragments less than eight inches in the largest dimension may be utilized in the fill, provided they are not placed in contracted pockets and the distribution of the rocks is approved by the Soil Engineer.

3.3 Rocks greater than eight inches in the largest dimension shall be taken offsite, or placed in accordance with the recommendations of the Soil Engineer in areas designated as suitable for rock disposal.

3.4 All fills, including onsite and import materials to be used for fill, shall be tested in the laboratory by the Soil Engineer. Proposed import materials shall be approved prior to importation.

3.5 The fill materials shall be placed by the Contractor in layers that when compacted shall not exceed six inches. Each layer shall be spread evenly and shall be thoroughly mixed during the spreading to obtain near uniform water content and a uniform blend of materials.

All compaction shall be achieved at optimum water content, or above, as determined by the applicable laboratory standard. No upper limit on the optimum water content is necessary; however, the Contractor must achieve the necessary compaction and will be alerted when the material is too wet and compaction cannot be attained.

3.6 Where the water content of the fill material is below the limit specified by the Soil Engineer, water shall be added and the materials shall be blended until a uniform water content, within specified limits, is achieved. Where the water content of the fill material is above the limits specified by the Soil Engineer, the fill materials shall be aerated by disked, blading or other satisfactory methods until the water content is within the limits specified.

3.7 Each fill layer shall be compacted to minimum project standards, in compliance with the testing methods specified by the controlled governmental agency and in accordance with recommendations for the Soil Engineer.

In the absence of specific recommendations by the Soil Engineer to the contrary, the compaction standard shall be ASTM D 1557.

3.8 Where a slope-receiving fill exceeds a ration of five-horizontal to one-vertical, the fill shall be keyed and benched through all unsuitable topsoil, colluvium, alluvium, or creep material, into sound bedrock or firm material, in accordance with the recommendations and approval of the Soil Engineer.

3.9 Side hill fills shall have a <u>minimum key width</u> of 15 feet into bedrock of firm material, unless otherwise specified in the soil report and approved by the Soil Engineer in the field.

3.10 Drainage terraces and subdrainage devices shall be constructed in compliance with the ordinances of the controlling governmental agency and/or with the recommendations of the Soil Engineer and Engineering Geologist.

3.11 The contractor shall be required to maintain the specified minimum relative compaction our to the finish slope face of fill slopes, buttresses, and stabilization fills as directed by the Soil Engineer and/or governing agency for the project. The may be achieved by either overbuilding the slope and cutting back to the compacted core, or by direct compaction of the slope face with suitable equipment, or by any other procedure which produces the designated result.

3.12 Fill-over-cut slopes shall be properly keyed through topsoil, colluvium or creep material into rock or firm material: and the transition shall be stripped of all soil or unsuitable materials prior to placing fill.

The cut portion should be made and evaluated by the Engineering Geologist prior to placed of fill above.

3.12 Pad areas in natural ground and cut shall be approved by the Soil Engineer. Finished surfaces of these pads may require scarification and recompaction.

4.0 <u>CUT SLOPES</u>

4.1 The Engineering Geologist shall inspect all cut slopes and shall be notified by the Contractor when cut slopes are started.

4.2 If, during the course of grading, unforeseen adverse or potentially adverse geologist conditions are encountered, the Engineering Geologist and Soil Engineer shall investigate, analyze and make recommendations to treat these problems.

4.3 Non-erodible interceptor swales shall be placed at the top of cut slopes that face the same direction as the prevailing drainage.

4.4 Unless otherwise specified in soil and geological reports, no cut slopes shall be excavated higher or steeper than allowed by the ordinances or controlling governmental agencies.

4.5 Drainage terraces shall be constructed in compliance with the ordinances of the controlling governmental agencies, and/or in accordance with the recommendations of the Soil Engineer or Engineering Geologist.

5.0 GRADING CONTROL

5.1 Fill placement shall be observed by the Soil Engineer and/or his representative during the progress of grading.

Field density tests shall be made by the Soil Engineer and/or his representative to evaluate the compaction and water content compliance of each layer of fill. Density tests shall be performed at intervals not to exceed two feet of fill height. Where sheepsfoot rollers are used, the soil may be disturbed to a depth of several inches. Density determinations shall be taken in the compacted material below the disturbed surface at a depth determined by the Soil Engineer or his representative.

5.2 Where tests indicate that the density of any layer of fill, or portion thereof, is below the required relative compaction, or improper water content is evident, the particular layer or portion shall be reworked until the required density and/or water content has been attained. No additional fill shall be placed over an area until the last placed lift of fill has been test and found to meet the density and water content requirements and that lift approved by the Soil Engineer.

5.3 Where the work is interrupted by heavy rains, fill operations shall not be resumed until field observations and tests by the Soil Engineer indicate the water content and density of the fill are within the limits previously specified.

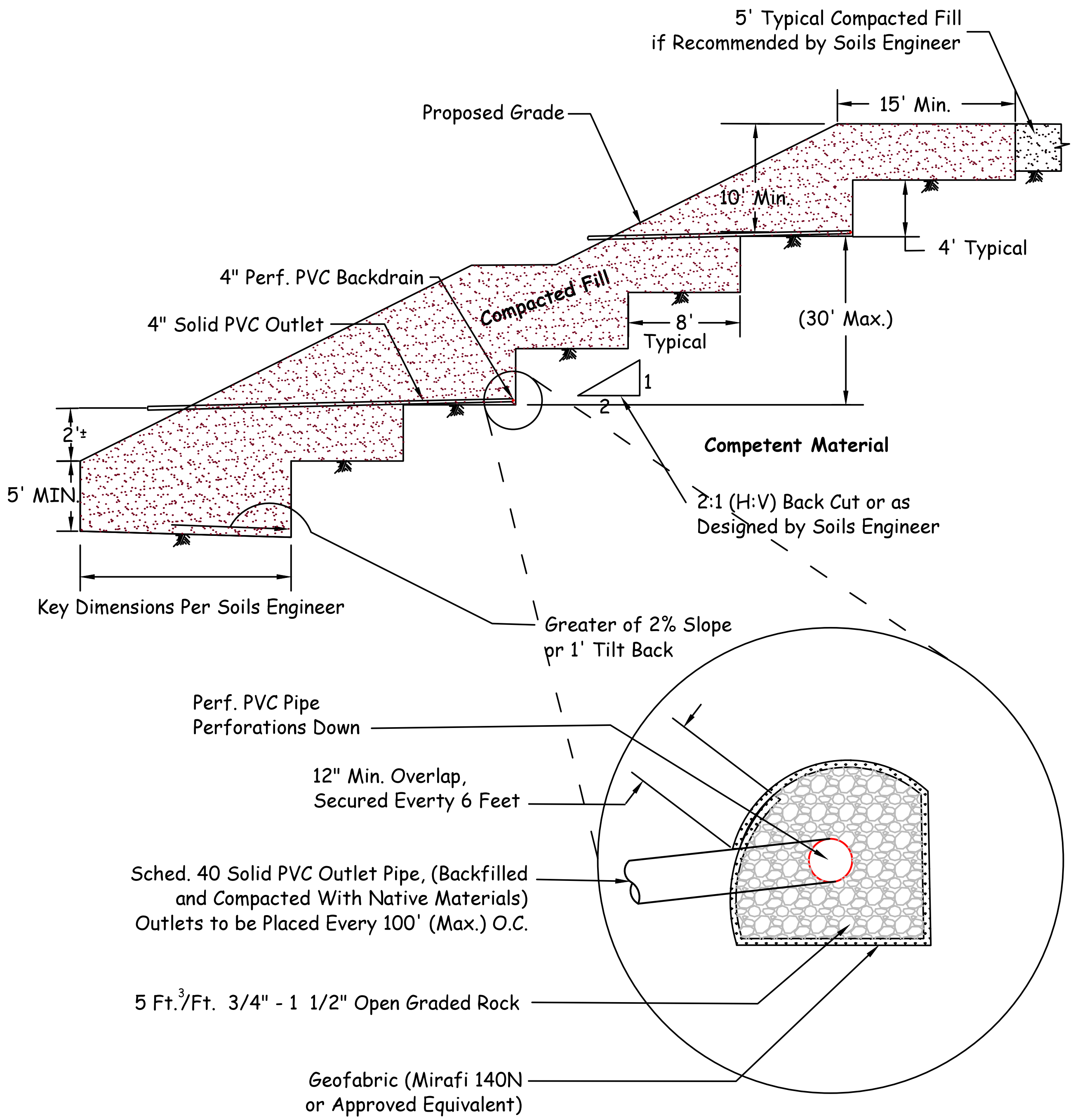
5.4 During construction, the Contractor shall properly grade all surfaces to maintain good drainage and prevent ponding of water. The Contractor shall take remedial measures to control surface water and to prevent erosion of graded area until such time as permanent drainage and erosion measures have been installed.

5.5 Observation and testing by the Soil Engineer shall be conducted during the filling and compacting operations in order that he will be able to state in his opinion all cut and filled areas area graded in accordance within the approved specifications.

5.6 After completion of grading and after the Soil Engineer and Engineering Geologist have finished their observations of the work, final reports shall be submitted. No further excavation or filling shall be undertaken without prior notification of the Soil Engineer and/or Engineering Geologist.

6.0 SLOPE

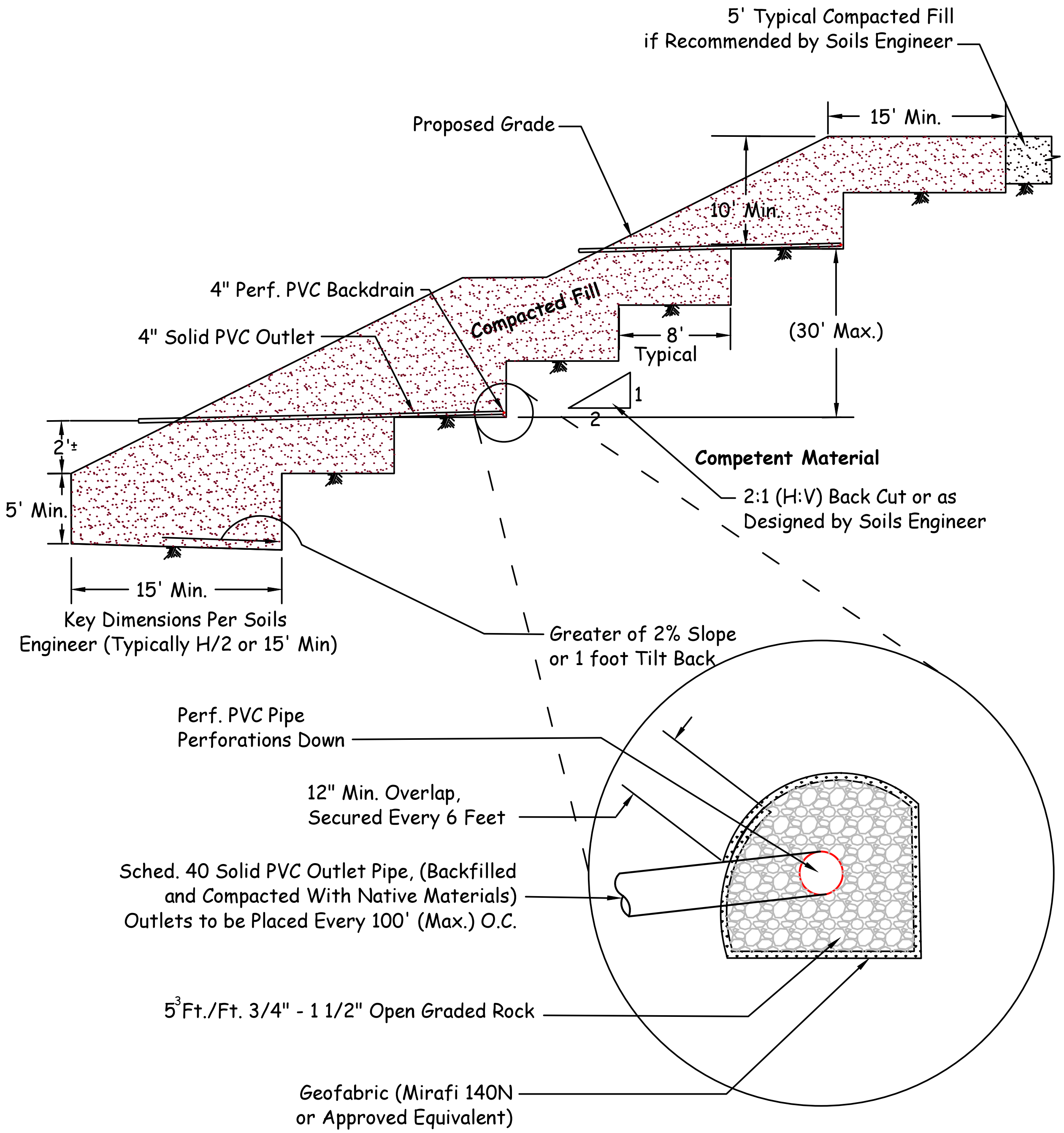
6.1 All finished cut and fill slopes shall be planted and/or protected from erosion in accordance with the project specification and/or recommended by a landscape architect.



MATRIX

TYPICAL BUTTRESS DETAIL

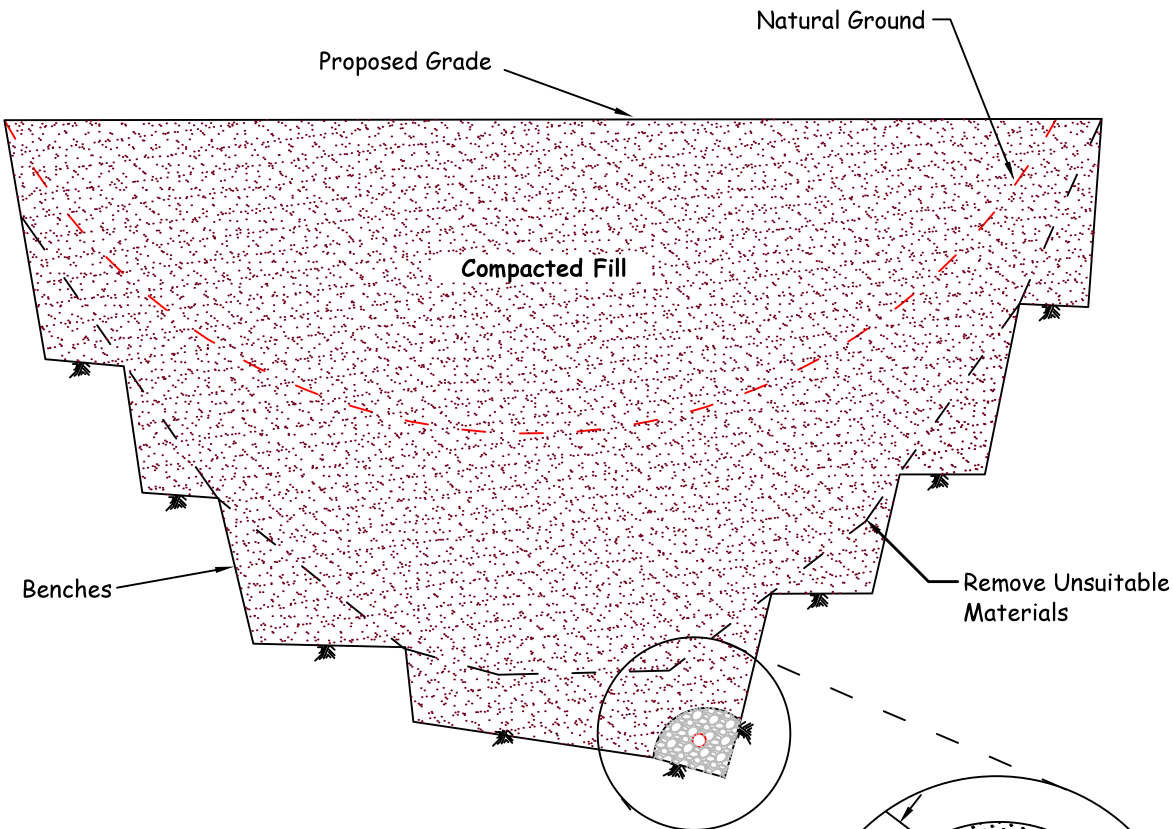
July 1, 2012

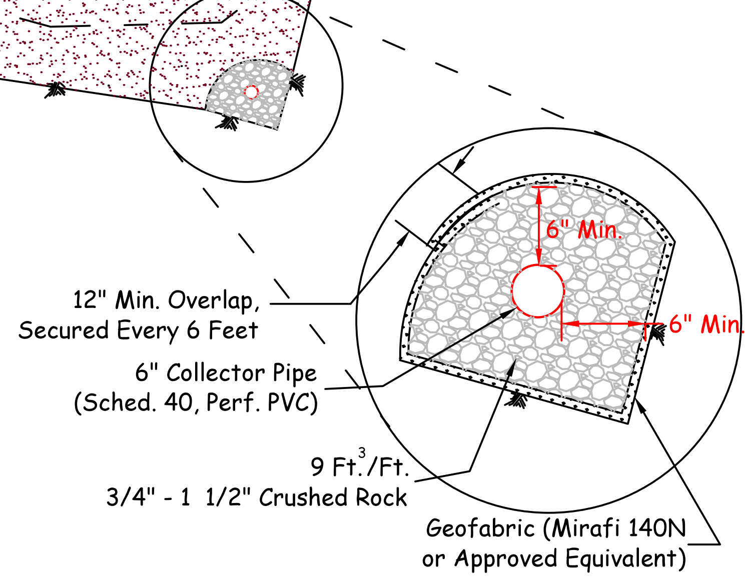


MATRIX

TYPICAL STABILIZATION FILL DETAIL

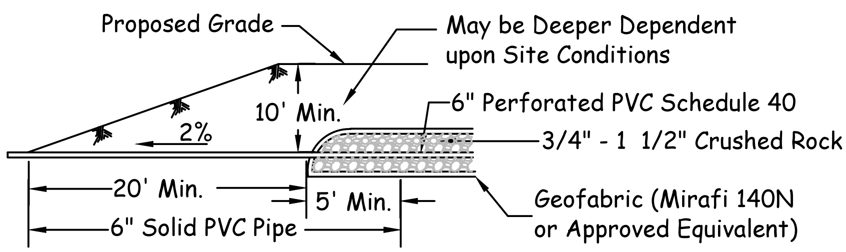
July 1, 2012





Notes:
1) Continuous Runs in Excess of 500' Shall Use 8" Diameter Pipe.
2) Final 20' of Pipe at Outlet Shall be Solid and Backfilled with Fine-grained Material.

Proposed Outlet Detail

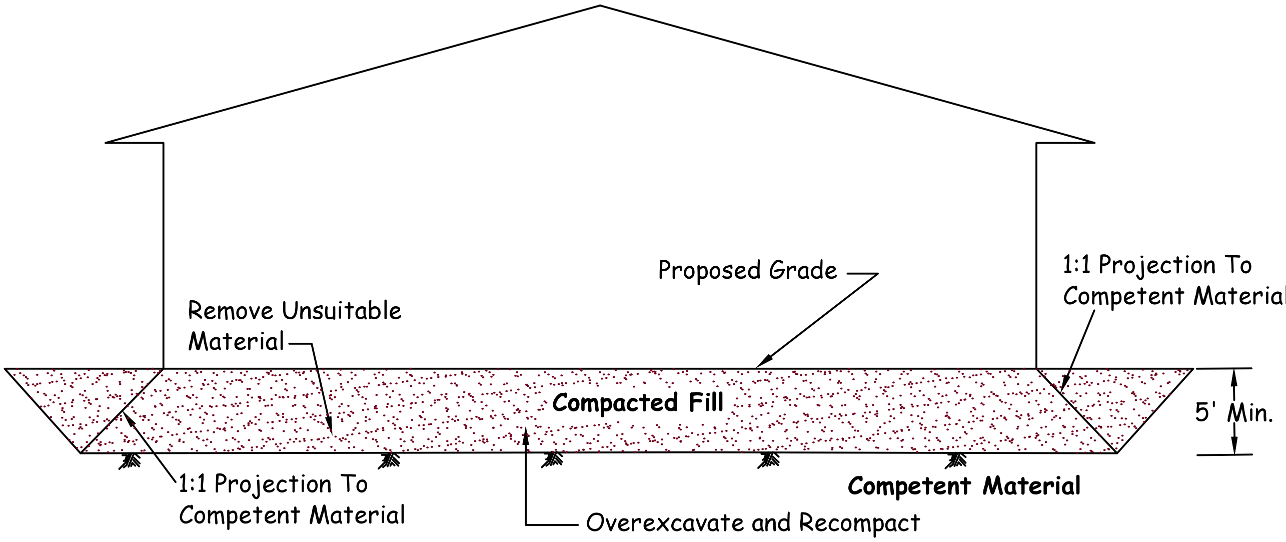


MATRIX

CANYON SUBDRAINS

July 1, 2012

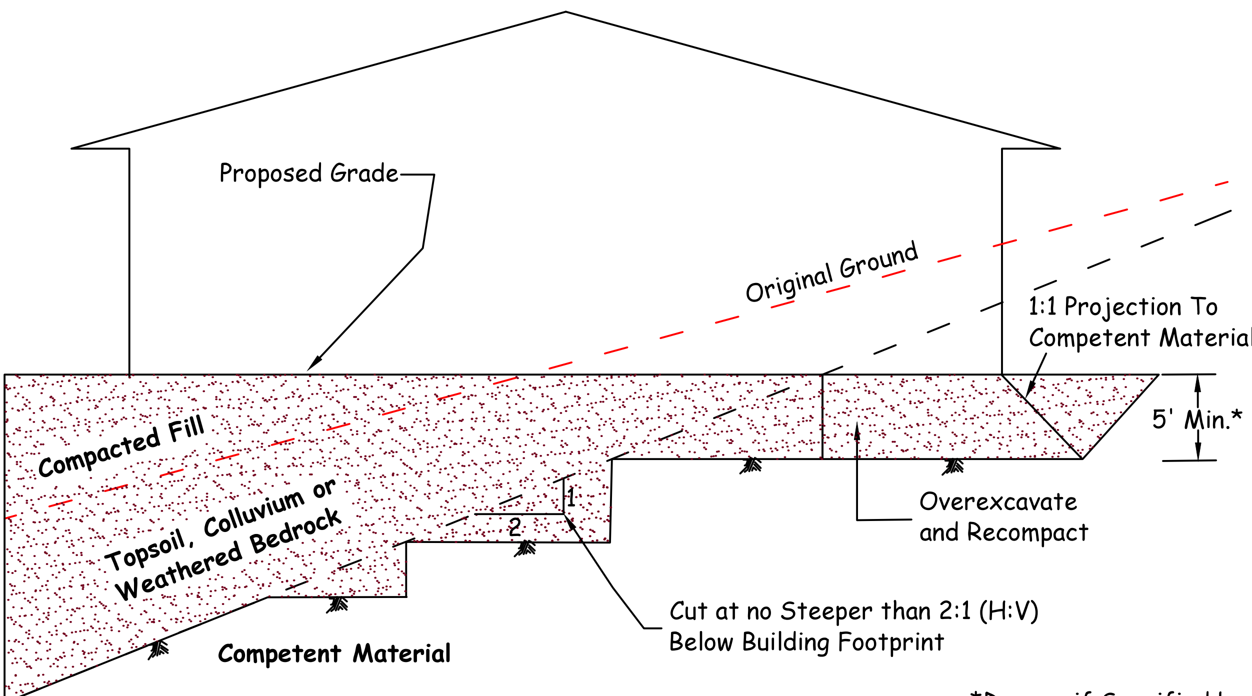
Cut Lot
(Exposing Unsuitable Soils at Design Grade)



Note 1: Removal Bottom Should be Graded With Minimum 2% Fall Towards Street or Other Suitable Area (as Determined by Soils Engineer) to Avoid Ponding Below Building

Note 2: Where Design Cut Lots are Excavated Entirely Into Competent Material, Overexcavation May Still be Required for Hard-Rock Conditions or for Materials With Variable Expansion Characteristics.

Cut/Fill Transition Lot



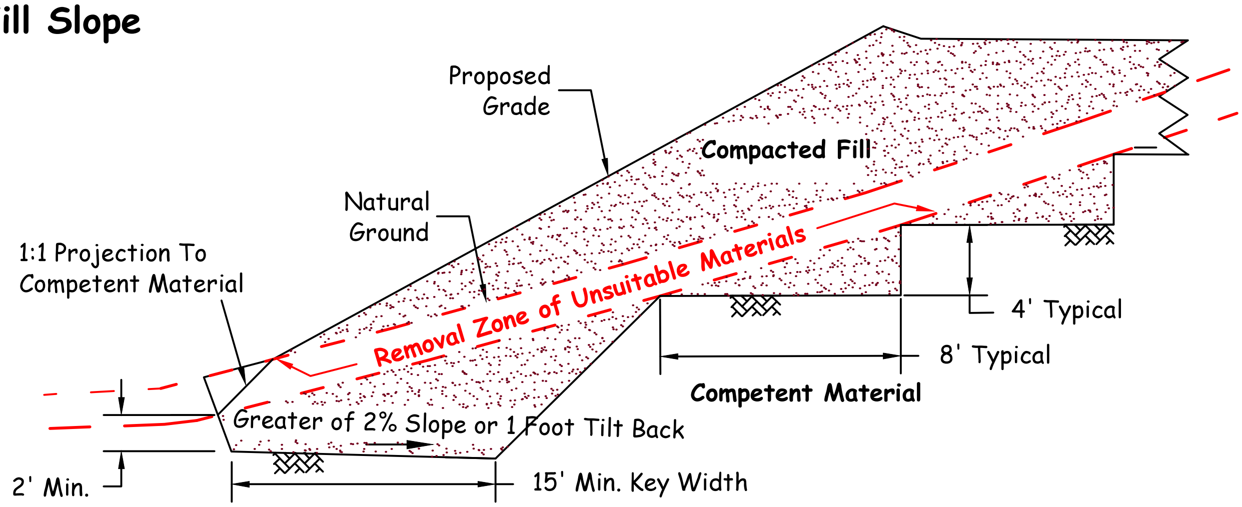
*Deeper if Specified by Soils Engineer

MATRIX

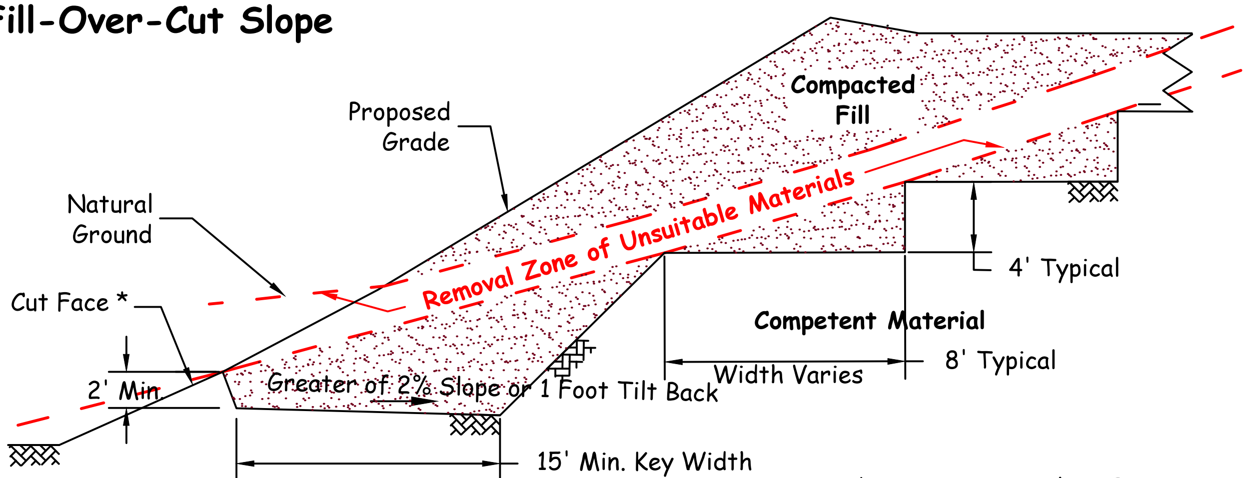
CUT AND TRANSITION LOT OVEREXCAVATION DETAIL

July 1, 2012

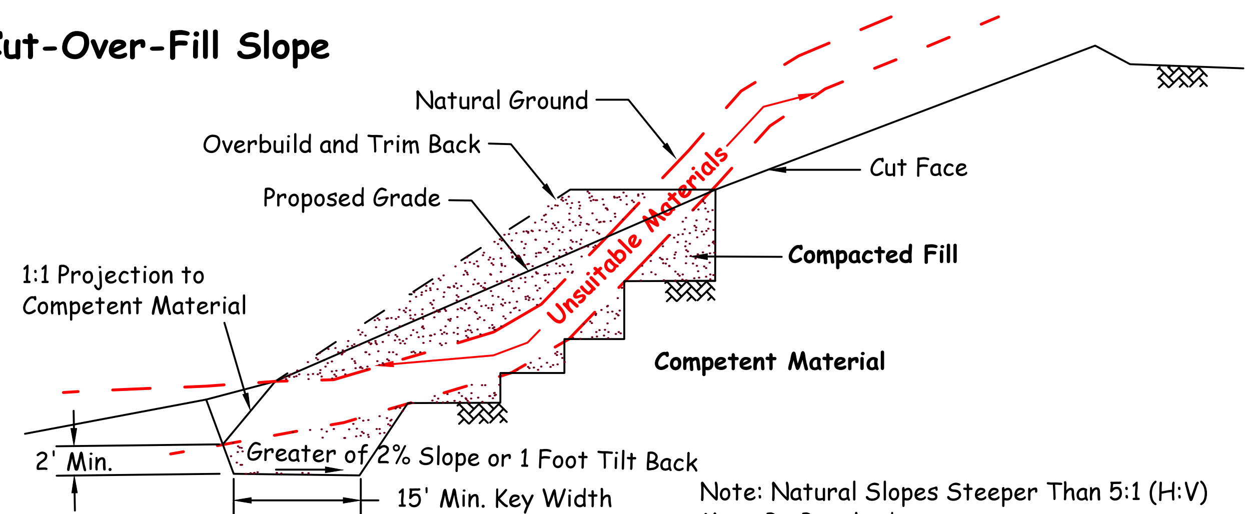
Fill Slope



Fill-Over-Cut Slope



Cut-Over-Fill Slope

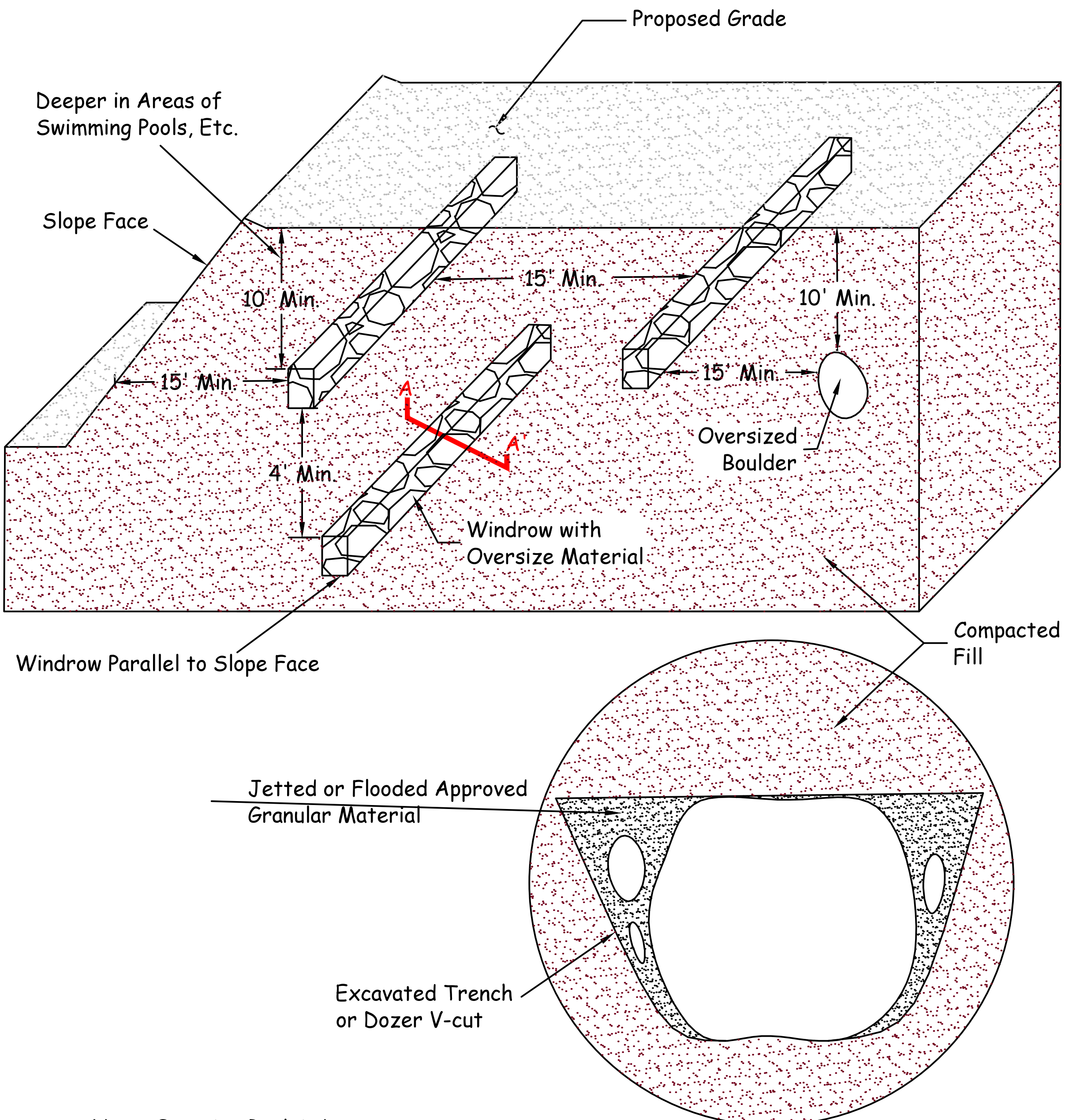


Note: Natural Slopes Steeper Than 5:1 (H:V)
Must Be Benched.

MATRIX

KEYING AND BENCHING

July 1, 2012



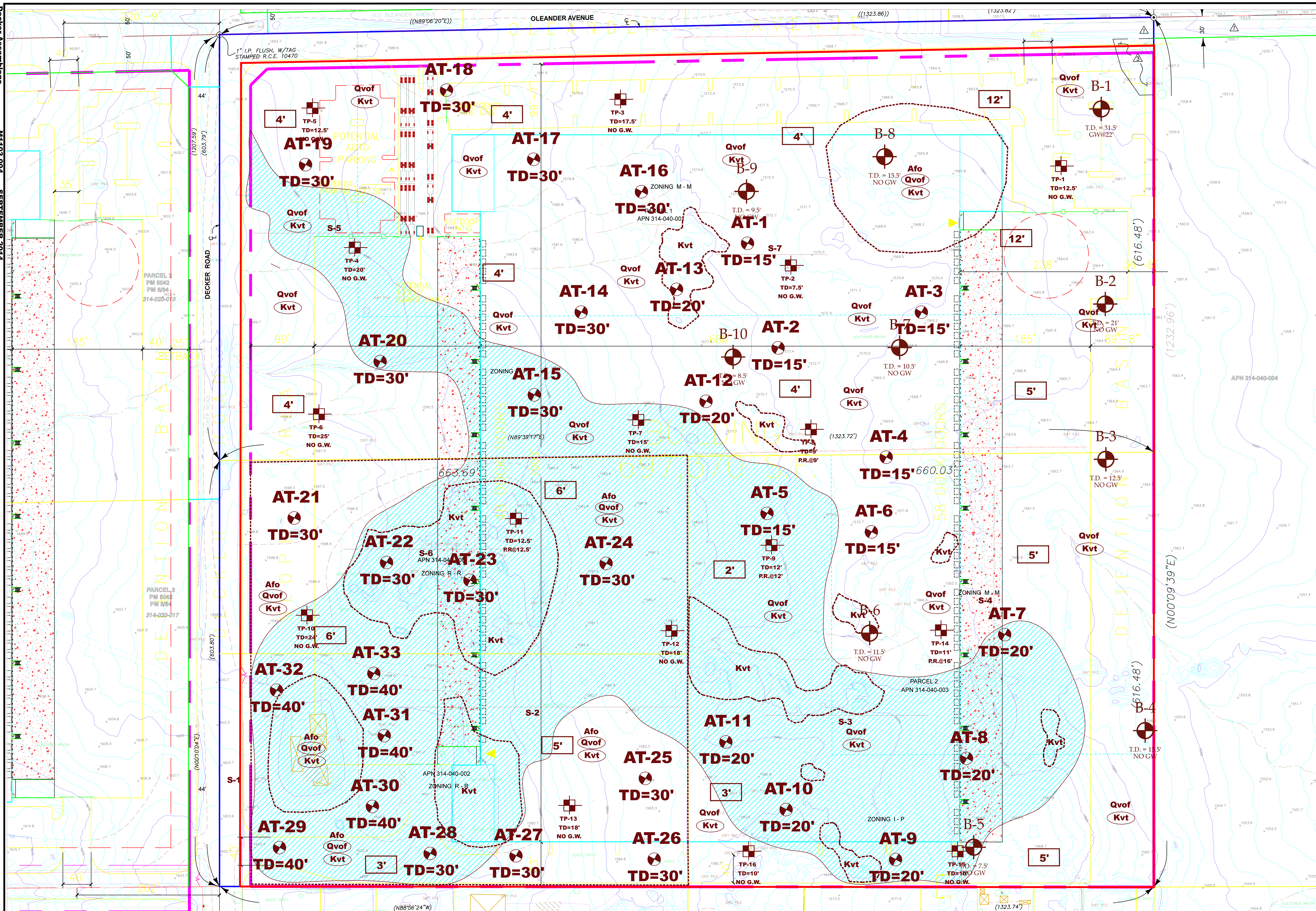
Note: Oversize Rock is Larger than 8" in Maximum Dimension.

Section A-A'

MATRIX

OVERSIZE ROCK DISPOSAL DETAIL

July 1, 2012



LEGEND

(Locations are Approximate)

Earth Units

Afo - Artificial Fill, by Others

Qvof - Quaternary Very Old Fan Deposits

Kvt - Cretaceous Val Verde Tonalite

Symbols

- Limits of Report

- Geologic Contact (dotted where buried)

S-7 - Seismic Line

B-10 T.D. = 51.5' NO GW - Boring Location

AT-33 TD=20' - Air-Track Boring Location

TP-10A TD=6.5' NO G.W. - Test Pit Location

12' - Indicates Alluvial Removal Depth (in feet)

- Indicates Potential Hard Rock Area, As Observed from Investigation

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Joshua Feffer	John P. Nielsen
Associate Geologist	Associate Engineer

GEOTECHNICAL MAP

DECKER ASSEMBLAGE
WESTERN PERRIS AREA, COUNTY OF RIVERSIDE, CALIFORNIA

Name:	DECKER ASSEMBLAGE
Project No.	M1103-004
Client:	TRAMMELL-CROW COMPANY, LLC
Scale:	1" = 50
Date:	SEPTEMBER 2014
Sheet No.	1 OF 1
Figure No.	1