



May 22, 2024  
Updated August 19, 2025  
68-105023

**KGA Architecture**  
**9075 W. Diablo Drive**  
**Las Vegas, NV 89148**

Attention: Mr. Lee Norsworthy, Partner, Director of Architecture

Subject: Geotechnical Evaluation for State of Nevada Public Works Division  
(SPWD Project No.: 23-P06) for the Southern Nevada Forensic Facility, (Health and Human  
Services Campus on West Charleston Blvd, Las Vegas, NV

Dear Mr. Norsworthy,

As requested, Arroyo Engineering Consultants, Inc. (AEC) has completed the Geotechnical Investigation for the Subject project. The following report summarizes our findings.

The professional opinions expressed in this report meet the standard of care of our profession. The test holes for this study were located to obtain a reasonably accurate picture of subsurface soil conditions for design purposes consistent with our scope of work and budget. Variations can occur from the conditions encountered in the test holes. These variations are sometimes sufficient to necessitate modifications in the recommendations of this report and/or the structures design.

If unexpected conditions are observed during construction or in the event that any changes of the proposed structures are planned, we should be notified to review the recommendations contained in this report. Construction of foundations and placement and compaction of fill should be observed by a representative of our firm.

AEC appreciates the opportunity to be of service, if there are any questions regarding the recommendations in this report, please contact the undersigned at (702) 241-5339.

Respectfully Submitted:

Aaron C. Hastings, P.E.  
Arroyo Engineering Consultants, Inc.



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## **INTRODUCTION**

This report presents the results of our geotechnical evaluation for the proposed new Forensic Facility and associated improvements to be constructed at the Desert Regional Center. The Desert Regional Center is located in the southwest corner of Charleston Boulevard and Jones Boulevard, Las Vegas, Nevada. A Vicinity Map identifying the project site is shown in Figure 1. The authority having jurisdiction for this project is the State of Nevada.

## **PURPOSE AND SCOPE**

The purpose of our services was to perform a geotechnical exploration with the objective of providing geotechnical recommendations for the proposed improvements. The scope of our investigation included subsurface exploration, soil sampling, laboratory testing, and preparation of this report. Recommendations provided in this report are based upon our understanding of the project, field and laboratory investigations, and experience with similar projects.

Our investigation did not include any environmental sampling or testing at the site. It is our understanding that any site environmental considerations have been addressed by others and are not a part of the scope for this report.

## **PROJECT DESCRIPTION**

It is our understanding that this project consists of the construction of a new Forensic building. The Forensic building is anticipated to be a four-story steel framed structure with a footprint of approximately 82,332 square feet (326,905 square feet total area). The building will be supported on a concrete slab on grade foundation with perimeter and isolated column footings. New foundation column loads are anticipated to be on the order of 100 to 300 kips (DL + LL) and continuous footing loads on the order of 25 to 50 kips per foot.

The final site grades for the project are anticipated to be within 5 feet of the existing site grades. Any changes to the anticipated loads and/or site grade should be reviewed by the geotechnical engineer to evaluate the continued applicability of the recommendations contained in this report.

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## **SITE DESCRIPTION**

The site is located in the southwest corner of Charleston Boulevard and Jones Boulevard, Las Vegas, Nevada. The site area for the proposed Forensics building is made up of two separate parcels of land; 163-02-601-007 & 163-02-502-001. Refer to Figures 2A & 2B Site Plan & Overlay for the specific site location.

The entire site has been previously developed with improvements including an existing building structure, solar farm and other improvements.

As noted, the entire site is developed and has fills relating to existing and/or previous development in all areas. These fills are considered to be uncontrolled. In general, the site drainage appeared to be by surface drainage to the nearby roadways. The total elevation change across the site was approximately 14 feet.

## **GEOLOGIC INFORMATION**

The site is located in the central portion of the Las Vegas Valley. This area is on alluvial remnants consisting of rocks and soils deposited by the outlying alluvial fans. The soils in this area generally consist of sands, gravels, silts and clays, pebbles, and cobbles. These soils are often found to have varying degrees of cementation.

Throughout the Las Vegas Valley there are several unclassified faults shown on the *Map of Faults and Earth Fissures in the Las Vegas Area* (C.M. DePolo and John W. Bell, 2000). The origin of these faults is uncertain and continues to be debated. The nearest mapped fault is located approximately ½ of a mile to the south of the site. The location of the fault was determined from the map “Map of Faults and Earth Fissures in the Las Vegas Area” by C.M. dePolo and John W. Bell in 2000. The location of this fault is not anticipated to adversely affect development at the site.

According to the IBC (2024) the Las Vegas Valley is located in a seismic considerations zone, which is considered to be a low-to-moderate seismic area. The historical earthquake record for the Las Vegas area is characterized by infrequent earthquakes of relatively low magnitude. The major recorded earthquakes in the area have ranged between 4.0 and 5.0 Richter magnitude. Site specific seismic design criteria are located in the Recommendations section of this report.

The site is not located in a “Special Geotechnical Considerations Area” on the Clark County Soils Guidelines Map (most current is Revision 2013). The following table identifies the specific geotechnical considerations for this site (refer to Figure 3).

## **SPECIAL GEOTECHNICAL CONSIDERATION SUMMARY**

<b>Condition mapped at site</b>	<b>Special Geotechnical Consideration Description</b>
<b>NO</b>	Steep Slopes (greater than 15 percent) and shallow bedrock
<b>NO</b>	Subsidence and 2000-foot compaction or seismic fault buffer zone
<b>NO</b>	Potential drainage areas or recent sediment deposits. May also have solubility, clay swell, corrosion, gypsum salt, expansive or hydro-collapsible potential.
<b>NO</b>	Solubility, clay swell, corrosion, gypsum salt, expansive or hydro-collapsible potential.
From Clark County Soils Guidelines Map Rev, 2013	

Based on the results of our investigation along with our experience in the area, the potential for fault-related surface rupture at this site is considered to be low.

As part of this investigation AEC performed a Detailed Liquefaction screening in accordance with Appendix O of the SNBCA. Our screening included one boring to a depth of 50 feet (refer to Boring B-2). The results of the Screening indicate that the potential for liquefaction at the site is low. This is based on the insitu soils meeting Conditions 1, Groundwater greater than 50 feet depth from the surface.

### **FIELD INVESTIGATION**

Subsurface conditions were investigated by drilling four borings at the locations shown on Figures 2 (Site Plan). The borings were advanced to depths of 20 to 50 feet below the existing ground surface using a hollow stem auger drill. Insitu soil samples were obtained, and relative consistency of the soils evaluated using Standard Penetration Testing (SPT) in accordance with ASTM D1586. The soil samples encountered were classified in the field and through further examination in the laboratory in general accordance with the Unified Soils Classification System.

All classifications were performed by individuals meeting the requirements of SNBCA 1803.6 #11. The boring logs for these explorations are attached in Appendix A (B-1 to B-4).

## **LABORATORY TESTING**

Laboratory tests were conducted on samples considered representative for the purpose of classification and to determine pertinent physical and engineering properties. These tests include Moisture Content, Sieve Analysis, Plasticity Index, Solubility, Swell and Soil Soluble Sulfates. Test results are summarized in the following tables and/or are presented on the attached boring Logs. Detailed testing reports are located in Appendix B.

### **SOIL CORROSIVITY AND SOLUBILITY SUMMARY**

<b>Sample Location</b>	<b>Test Performed/Method</b>	<b>Result</b>	<b>Notes*</b>	
B-2 @ 5'	Soluble Sulfates-SM4500 E	0.75%	<b>S2 (Severe)</b>	
	Solubility	1.06%	<b>Moderate</b>	
B-3 @ 5'	Soluble Sulfates-SM4500 E	.08%	<b>S0 (Low)</b>	
	Solubility	0.10%	<b>Low</b>	
Soluble Sulfates ACI 318-14 Table 19.3.1.1, Solubility 2018 SNBCA Table 1804.4.1				
<b>U.S. Standard Sieve</b>				
	<b>SIEVE ANALYSIS - Percent Finer by Weight</b>			
	B-1 @ 10-15'	B-1 @ 20'	B-2 @ 5'	B-4 @ 15'
1"	100	NA	90	100
½"	96	NA	67	96
#4	87	NA	42	90
#16	77	NA	34	87
#50	70	NA	30	80
#100	62	NA	22	67
#200	38	24	12	47
Plasticity Index (PI)	LL=27, PL=19, PI=8	LL = 22, PL = 16, PI = 6	LL = NV, PL = NP, PI = NP	LL=20, L=16, PI=4
Classification	SC - Clayey SAND	SM/SC - Silty/Clayey SAND	SM - Silty SAND	SM/SC - Silty/Clayey SAND
See Appendix B for additional laboratory testing.				

## **SWELL TEST SUMMARY**

<b>Sample Location</b>	<b>Test Performed/Method</b>	<b>Result</b>	<b>Notes</b>
B-2 @ 5'	Swell per SNBC 1803.5.3.2	<b>0.2%</b>	<b>LOW</b>
B-4 @ 15'		<b>2.8%</b>	<b>LOW</b>
<b>Oven Dried, 60 PSF surcharge</b>			

## **SUBSURFACE CONDITIONS**

The following summary is based on the subsurface conditions observed at the locations explored. The area for the proposed improvements was found to have uncontrolled fills over all of the areas planned for improvement. It appears that these fills were placed during construction of the previous improvements. Based on the information from our site visit, this fill was observed to range in depth up to approximately 2 feet.

Deeper and more extensive uncontrolled fills may be present at the site. Additional information regarding the uncontrolled fills is provided in the "Site Clearing and Excavations of Uncontrolled Fills" section of this report.

Uncontrolled fills will need to be removed from the areas proposed for improvements including; structure areas, paved, flatwork areas and fence/retaining wall areas.

The native soils at the site (underlying the uncontrolled fills) were predominantly near surface clayey to silty sands with varying amounts of gravel and cobbles and trace to little gypsum. The native near surface (top 10 feet) soils were found to be Low Expansive, Low to Moderately Soluble and Severely Corrosive to concrete (including masonry) and metals. The native soils generally became more clayey and with depth.

The native soils generally were found to be loose to medium dense/ firm near to the surface and became more dense/stiff with depth. Moderately cemented to fully cemented hard materials were encountered in each of the borings at the site and the following table summarizes the encountered cemented soils (caliche).

### CEMENTED SOILS (CALICHE) SUMMARY

Boring	Depth	Thickness (Feet)	Notes
B-1	8	1.5	Hard to very Hard
B-1	19	>1	Hard to very Hard, Boring ended on Caliche
B-2	3	1	Hard to very Hard
B-2	7.5	2	Hard to very Hard
B-3	12	3	Hard to very Hard
B-3	17	2	Hard to very Hard
B-4	6.5	2.5	Hard to very Hard
B-4	12.5	0.5	Hard to very Hard
See Boring Logs B-1 to B-4 for more details regarding cemented soils.			

Groundwater was not encountered at the site and is not anticipated to impact this project.

## ENGINEERING ANALYSIS AND RECOMMENDATIONS

### **General**

Based on our field and laboratory investigation, the site is suitable for the proposed development. In general, development of the site will have to address:

- **Shallow to deep uncontrolled fills and/or disturbed/low density native materials, existing building structures, existing and abandoned underground utilities which may include leach fields, wells and or remnant foundations, asphalt pavements and related parking lot improvements, in areas for proposed improvements.**

Based on laboratory test results of the samples obtained during our field investigation, the near surface native soils are Moderately to Highly Expansive, Low to moderate Soluble (gypsum solubility) possess concentrations of soluble sulfates considered as having Moderate to Severe corrosion potential for concrete and metals. Additionally, the native soils were noted to range from loose to dense (firm to stiff) and moisture contents ranged from low to wet (near ground water level). Special earthwork recommendations are provided below and should be followed prior to foundation construction. The design and construction at this site shall conform to the requirements of the 2024 International Building Code and/or the “Southern Nevada Building Amendments to the 2024 International Building Code” and to the specific recommendations contained in this report.

### **2024 IBC SEISMIC DESIGN CRITERIA**

A. Approximate Site Location: Latitude 36.15536, Longitude -115.22682			
B. Site Class: C (See REMI Survey in Appendix C),			
C. Mapped Spectral Acceleration Values			
	0.2 sec	Ss = 0.514 (g)	
	1.0 sec	S1 = 0.178 (g)	
D. Spectral Response Accelerations			
	0.2 sec	SMs = 0.666 (g)	[Fa = 1.294]
	1.0 sec	SM1 = 0.267 (g)	[Fv = 1.5]
E. Design Spectral Response Accelerations			
	0.2 sec	SDs = 0.444 (g)	[SDs = 2/3 SMs]
	1.0 sec	SD1 = 0.178 (g)	[SD1 = 2/3 SM1]
Seismic Accelerations from ASCE 7-16, Site Location estimated from Google Earth			

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## **EARTHWORK RECOMMENDATIONS**

### **Site Clearing and Excavations of Uncontrolled Fills**

Before fill placement begins, all vegetation, organic material, debris, and uncontrolled fill soils should be removed from within the proposed structure areas and areas to receive pavements and or structural fill. Uncontrolled fill refers to any fill that was not observed and tested during placement. Native soils that have low in-place densities should also be removed to expose medium dense or firm native materials.

The site currently has improvements including buildings, pavements, solar farm and other improvements such as curbs, light poles, existing utilities, etc. Unknown buried structures may still be on the site, including septic tanks/leach fields, remnant foundations, abandoned utilities. Based on our visual observations and subsurface exploration the site has up to 2 feet of fill materials. Deeper fills may be located at the site. All of these fills are considered to be Uncontrolled and are not suitable for support of the proposed improvements and will require removal. It is possible that there are additional concealed fills and other buried structures as noted above.

Based on the extent of the uncontrolled fills we recommend that the contractor perform a detailed evaluation of the site to identify concealed uncontrolled fills, utilities and other potential hazards.

After performing required excavations, the exposed soils should be observed to verify removal of all unsuitable deposits. Exposed soils, in areas to receive fill, should then be scarified to a depth of 12 inches, moisture conditioned or dried as necessary and compacted as recommended in the Fill Placement and Compaction section of this report.

It is anticipated that some of the uncontrolled fills can be blended, stockpiled, cleaned of debris and screened over a 6 inch sieve to meet the requirements of Structural Fill.

### **Site Demolition**

It is our understanding that the existing building and associated improvements will be removed in the areas for the new Forensic improvements. The entire building including any foundations shall be removed from the site prior to the grading of the site. All related utilities shall be removed from the area of the proposed new structure including at least 5 feet beyond in all directions as practical. It is possible that deeper “wet” utilities (sewer and water) can be abandoned in place when located at least 5 feet below the lowest new foundation. Abandoned “wet” utilities should be entirely filled with flowable grout or similar material.

All existing landscaping in areas for improvements shall be removed. Any trees will require removal of the roots. Deeper removals will be required to be benched prior to fill placement. Typical benches shall be 3:1 (H:V) or flatter.

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## **Overexcavation – Slab on Grade & Continuous and Isolated Footings**

In order to provide more uniform bearing conditions and limit the differential settlement, the area of the proposed new continuous and/or isolated footings should be overexcavated sufficiently to provide a minimum of 24 inches of Structural Fill below the new foundations. All footing overexcavations shall be laterally overexcavated on all sides (where practical) a minimum of 5 feet.

Slab areas and areas for new pavements and flatwork shall be overexcavated a minimum of 24 inches below the slab and/or pavement section. Transition areas for overexcavations of footings to slabs shall be sloped a minimum of 3:1 H:V or flatter.

Additional overexcavations may be necessary in areas where proposed structural improvements are located within the existing structure and landscape areas.

After removal of the uncontrolled fills and required over excavations, the exposed bottom should be scarified a minimum of 8 inches, moisture conditioned and compacted as detailed in the Fill Placement and Compaction section.

The overexcavated areas should then be returned to the final grades using Structural Fill in accordance with the Fill Placement and Compaction section of this report.

Prior to structural fill placement, the overexcavated areas should be observed by a Geotechnical Engineer or their representative.

## **Fill Materials**

### **Structural Fill**

Structural Fill is soil material used for support of structures, including foundations, slab on grade, retaining walls, and paved/flatwork areas. Structural fills should meet the requirements of Imported fills as detailed below. It should be noted that the near surface native onsite soils along with some of the uncontrolled fills may meet the requirements for Structural Fill once properly processed.

All proposed materials for use as Structural Fill should be stockpiled onsite and approved by the Geotechnical Engineer prior to their use.

### **Imported Fill**

For this project, Imported Fill soils should consist of granular materials that are; low expansive (less than 4% in accordance with SNBCA 1808.6.1.1), soluble sulfates exposure not exceeding S2 (ACI 318-14 Table 19.3.1.01), low soluble materials (less than 2% per SNBCA 1808.04.4.1) that are reasonably well graded from coarse to fine. Maximum of 35 percent passing the -200 sieve and 100 percent passing the 6-inch sieve.

### Other Fill Materials

Should conform to the specifications stated in the Uniform Standard Specifications for Public Works Construction, Off-Site Improvements, Clark County Area, Nevada, or as approved by the Geotechnical Engineer.

### Fill Placement and Compaction

All fill materials should be moisture conditioned or dried as required, evenly spread on a horizontal plane in 8-inch loose lifts and compacted to the following:

Fill materials placed within structural areas should be compacted to a minimum of 95 percent of maximum dry density and at within 2 percent of the optimum moisture content as determined by ASTM D1557.

Scarified native and or existing Structural Fill soils should be compacted to a minimum of 90 percent of maximum dry density and within 2 percent of optimum moisture content as determined by ASTM D1557.

### Testing and Inspection Requirements for Soils

Scarified native soils and each 8-inch lift of the structural fill material should be tested for compliance to the required compaction and moisture content prior to proceeding with the next lift of material.

A minimum of 1 test for each 10,000 square feet or portion thereof. Field compaction testing shall be done using nuclear methods in accordance with ASTM D2922.

Inspection requirements for the soils should be Periodic (4A) per 2018 IBC Table 1705.6.

### Foundations – New Concrete Foundations

After the earthwork recommendations have been met, foundations as described below for the structure (including retaining walls) established on properly placed structural fill may be designed for a maximum allowable soil bearing pressure of 3,500 pounds per square foot based upon dead load plus long-term live load. A one-third increase in allowable bearing pressure may be used for short duration loads, such as wind or seismic loads. Foundations should be embedded a minimum of 18 inches below the lowest adjacent grade for continuous footings and 24 inches for isolated column footings.

Perimeter and column footings should be a minimum of 12 inches and 24 inches in width respectively. Additional bearing capacity of 200 pounds per square foot for each foot of width beyond those noted above and 500 pounds per square foot for each additional foot of depth can be applied.

The maximum allowable bearing capacity with these additions is 5,000 pounds per square foot.

A soils modulus of subgrade reaction of 150 pci (pounds per cubic inch) can be used in the design of the foundations.

Lateral support for the foundations will be provided by a combination of friction along the base and passive resistance of the adjacent soils.

Friction along the base of the footings may be computed using an allowable coefficient of friction of 0.35 with the normal dead load. An allowable lateral passive earth pressure may be computed using an equivalent fluid weighing 250 pounds per cubic foot for footing cast against dense/firm native soils and/or properly compacted fill.

The maximum net allowable passive pressure for shallow footings may not exceed 2,000 pounds per square foot. Passive pressures in the upper 12 inches should be neglected unless confined by concrete slab on grade.

***All foundation systems should be designed by a Nevada Registered Structural Engineer.***

## **Settlements**

Total settlement for structures, placed in accordance with the recommendations herein, should be on the order of 1 inch, with differential settlements on the order of 1/2-inch in 25 feet.

## **CONCRETE FLOOR SLABS AND FLATWORK**

Concrete floor slabs and exterior flatwork should be supported by a minimum 6-inch layer of Type II Aggregate Base. The Aggregate Base Course should be compacted to a minimum 95 percent of dry density tested according to ASTM D1557. Moisture content at placement should be within 2 percent of optimum moisture content.

A moisture barrier shall be provided beneath the concrete floor slabs and should consist of a visqueen (polyethylene) membrane covered by a 2-inch minimum sand backfill blanket to deter punctures and aid in concrete cure. The membrane should be visqueen with a minimum 10-mil thickness. All joints shall lap a minimum of 6 inches. Alternative configurations of moisture barrier placement are acceptable as long as they meet the requirements of ACI 302 "Guide for Concrete Floor and Slab Construction". It is noted that the placement of the concrete directly on the barrier can lead to additional cracking due to the arid desert environment. All concrete placements and curing operations should be performed in accordance with the American Concrete Institute (ACI) Manual of Concrete Practice.

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## **RETAINING STRUCTURES/LATERAL LOADS**

**Cantilevered retaining walls:** less than 10 feet in retained height with level backfill, no surcharge load and no seepage or groundwater, should be designed to resist backfill soil pressures in the active earth pressure state. Refer to Figure 4A Active Lateral Earth Pressures for more details.

(This assumes that the top of the wall is capable of some movement following backfill).

In locations of restrained wall corners the use of At Rest Pressures (see below for Restrained Walls) should be applied to the wall for a distance of 2 times the height of the wall in each direction.

For design purposes, a backfill soil pressure equivalent to that developed by a fluid with a density of 40 pounds per cubic foot would be appropriate for granular free draining backfill.

When surcharge loads ( $q$ ) are located on top of the wall within a distance less than the height of the wall, the additional lateral load on the wall can be calculated as  $P_q = q * 0.30$ .

Seismic loads to be applied to the wall shall be done in accordance with the 2018 Southern Nevada Building Code Amendments Section 1610.1.1 Equation 16-35a.

Horizontal loads acting on foundations on properly placed structural fill will be resisted by friction along the base of the footing and the passive earth pressures against the loaded side of the footings. Where passive pressure is needed for footings to resist horizontal loads, the backfill must be observed and tested for compliance with the requirements of structural fill.

Friction along the base of the footings may be computed using an allowable coefficient of friction of 0.35 with the normal dead load. An allowable lateral passive earth pressure may be computed using an equivalent fluid weighing 250 pounds per cubic foot, for footing cast against dense native soils and/or properly compacted fill. The maximum net allowable passive pressure for shallow footing may not exceed 2,000 pounds per square foot. Passive pressures in the upper 12 inches should be neglected unless confined by concrete slab on grade. Backfill behind the wall should be compacted to no less than 85 percent and no more than 90 percent of ASTM D1557. Backfill should not be used to support structures.

**Restrained Retaining Walls:** less than 10 feet in retained height with level backfill, no surcharge load and no seepage or groundwater, should be designed to resist backfill soil pressures in the at rest earth pressure state. Refer to Figure 4B At Rest Lateral Earth Pressures for more details.

(This assumes that the top of the wall is NOT capable of movement following backfill.)

For design purposes, a backfill soil pressure equivalent to that developed by a fluid with a density of 65 pounds per cubic foot would be appropriate for granular free draining backfill.

When surcharge loads ( $q$ ) are located on top of the wall within a distance less than the height of the wall, the additional lateral load on the wall can be calculated as  $P_q = q * 0.50$ .

If Seismic loads are to be applied to the wall this shall be done in accordance with the 2018 Southern Nevada Building Code Amendments Section 1610.1.1 Equation 16-35b.

Horizontal loads acting on foundations on properly placed structural fill will be resisted by friction along the base of the footing and the passive earth pressures against the loaded side of the footings. Where passive pressure is needed for footings to resist horizontal loads, the backfill must be observed and tested for compliance with the requirements of structural fill.

Friction along the base of the footings may be computed using an allowable coefficient of friction of 0.35 with the normal dead load. An allowable lateral passive earth pressure may be computed using an equivalent fluid weighing 250 pounds per cubic foot, for footing cast against dense native soils and/or properly compacted fill.

The maximum net allowable passive pressure for shallow footing may not exceed 2,000 pounds per square foot. Passive pressures in the upper 12 inches should be neglected unless confined by concrete slab on grade. Backfill behind the wall should be compacted to no less than 85 percent and no more than 90 percent of ASTM D1557. Backfill should not be used to support structures.

All retaining walls shall be waterproofed and provided with appropriate drainage systems. Back drains and/or weep holes shall be used. The retaining wall drainage system shall be designed by an experienced civil/structural engineer.

## **FLEXIBLE PAVEMENTS – PARKING AREAS**

The new parking and drive lanes will require overexcavation as shown in the following pavement section. Additionally, once the subgrade has been exposed and processed, the subgrade should be proof rolled to ensure stability. Proof Rolling should be observed by the geotechnical engineer of record.

**Table 1: Pavement Section**

<b>Roadway Type</b>	<b>Asphalt Concrete Inches</b>	<b>Type II Base Inches</b>	<b>Type I Base Inches</b>
Onsite Parking Areas	3	4	12±
Onsite Drive Areas-Auto	3	4	12±
Onsite Drive Areas – Truck*	4.5	6.5	12±

Notes:\* This section assumes a minimum Subgrade R value of 50 which shall be verified prior to construction. (Truck Drive Areas assume a 8.5 Traffic Index – to be verified by Civil Engineer).  
± Structural Fill can be used in-Lieu of Type I aggregate Base.

Asphalt and base coarse aggregate materials shall conform to the requirements of the applicable *Uniform Standard Specifications for Offsite Improvements, Clark County, Nevada*.

### **SUBSURFACE EXCAVATION AND STABILITY**

Based on materials encountered during our field exploration, the near surface (less than 10 feet) native non-cemented materials located on the site should not require special excavation methods. Cemented hard layers were noted in all borings and may require special excavation methods when encountered. All excavations shall be constructed in accordance with the applicable OSHA requirements. Groundwater is not anticipated to be encountered at this site for the shallow (less than 10 feet) excavations.

It is our experience that the lateral extent, depth, thickness and hardness of cemented materials can vary between the areas explored for this study. Contractors should satisfy themselves to the excavatability of the onsite materials prior to construction.

### **SURFACE DRAINAGE AND MOISTURE PROTECTION**

Positive drainage should be established away from the exterior walls of structures and maintained throughout the life of the structure.

The recommended minimum slope is 5% for the first 10 feet when soils are exposed, and 2% for hardscape (concrete or asphalt). Limited watering should be established within 5 feet of structures. Roof down spouts and other water collection systems should discharge a minimum distance of 5 feet from the exterior building walls.

All utility trenches should be backfilled with compacted fill for a minimum distance of 5 feet beyond the structure footings. Utility backfill should be compacted to a minimum of 90 percent of ASTM D1557 and within 2 percent of optimum moisture content.

## **SOIL CORROSIVITY**

A laboratory test on soil samples selected as representative possess concentrations of water-soluble sulfates considered to be Severe (S2) when exposed to concrete. Additionally, it is our experience that higher sulfate containing materials are often brought onsite, as such we recommend that all concrete in contact with soil be designed to meet the requirements for SEVERE Sulfate exposure. We recommend a Type V or equivalent sulfate resistant cement for all concrete.

Concrete mixes should be designed in accordance with ACI 318-14 Table 19.3.1.01 Sulfate Exposure S2 for SEVERE exposure. All metals in contact with the native soils should be provided appropriate corrosion protection as determined by a corrosion engineer.

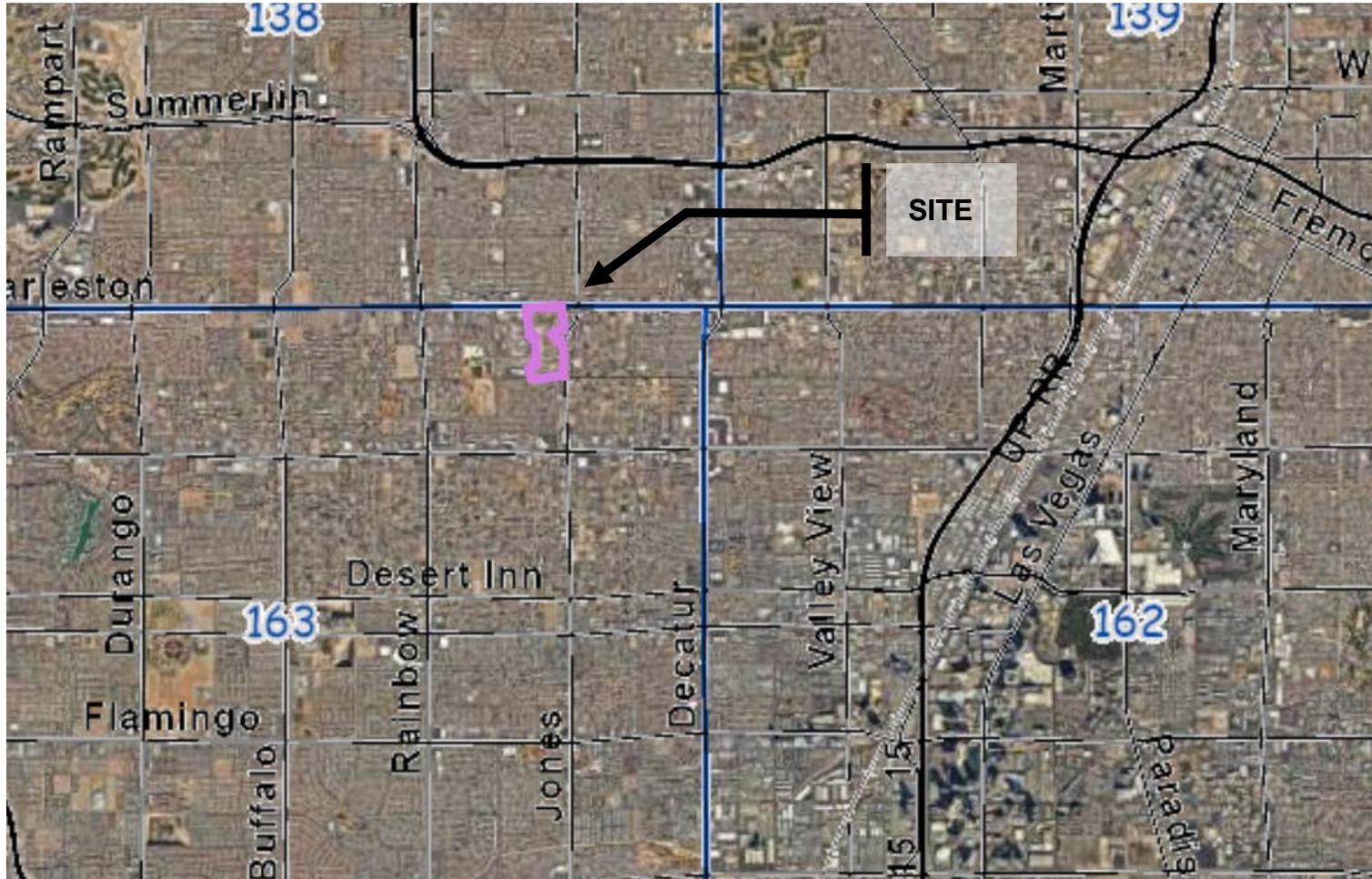


Image from Clark County Assessors



### Vicinity Map

Southern Nevada Forensics Facility (SPWD 23-P06)  
 SWC Charleson Blvd and Jones Blvd  
 KGA Architecture

DATE: 5/2024  
 68-105023

FIGURE 1

↑ NORTH  
 N.T.S.

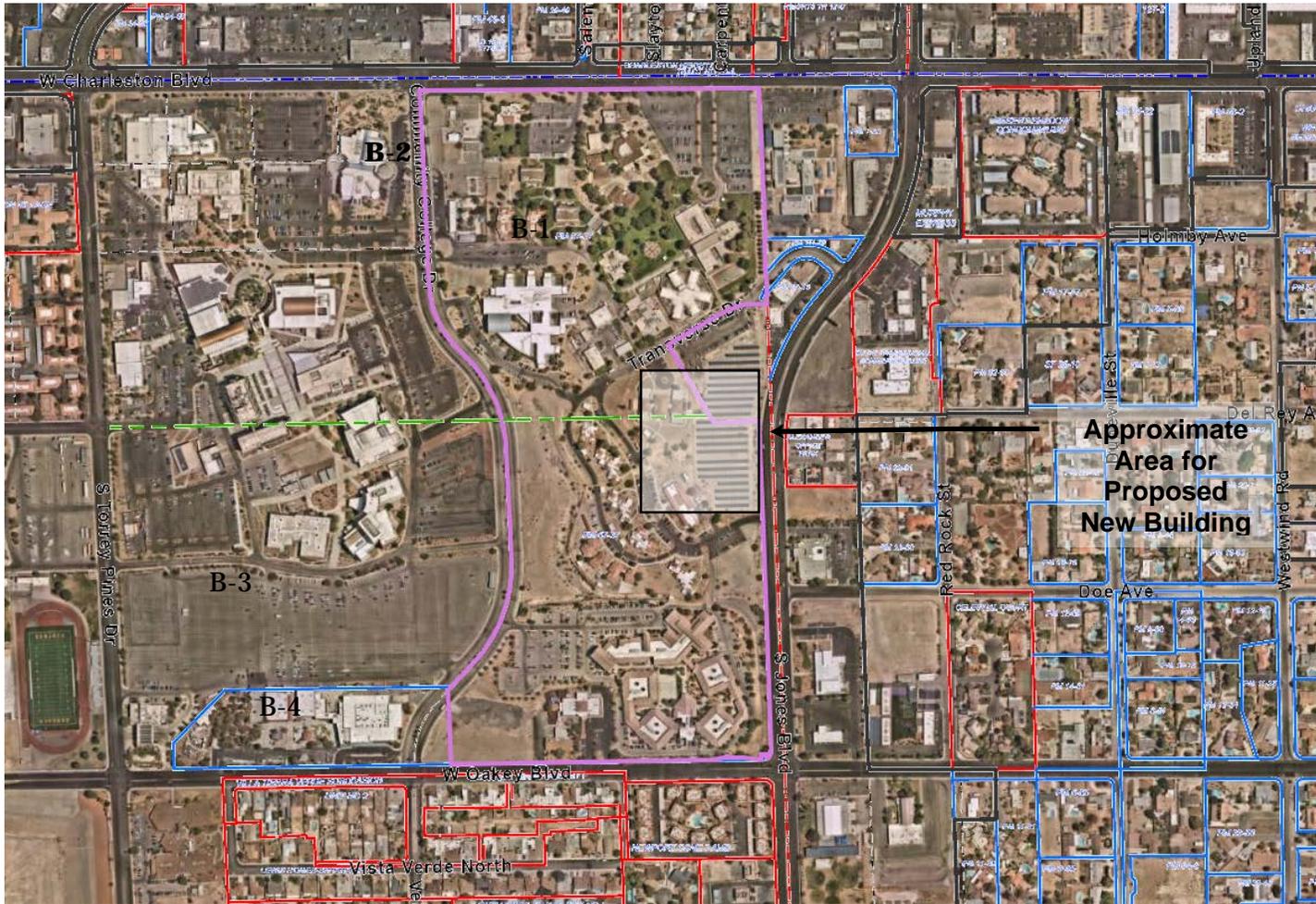


Image: Google Earth



### Site Plan

Southern Nevada Forensics Facility (SPWD 23-P06)  
 SWC Charleston Blvd and Jones Blvd  
 KGA Architecture

DATE: 05/2024  
 68-105023

FIGURE 2A





Photo from Google Earth/KGA

B-1 

**Approximate Boring Locations**



**Site Plan - Overlay**  
 Southern Nevada Forensics Facility (SPWD 23-P06)  
 SWC Charleson Blvd and Jones Blvd  
 KGA Architecture

DATE: 05/2023  
 68-105023

FIGURE 2B



**North**  
 NTS

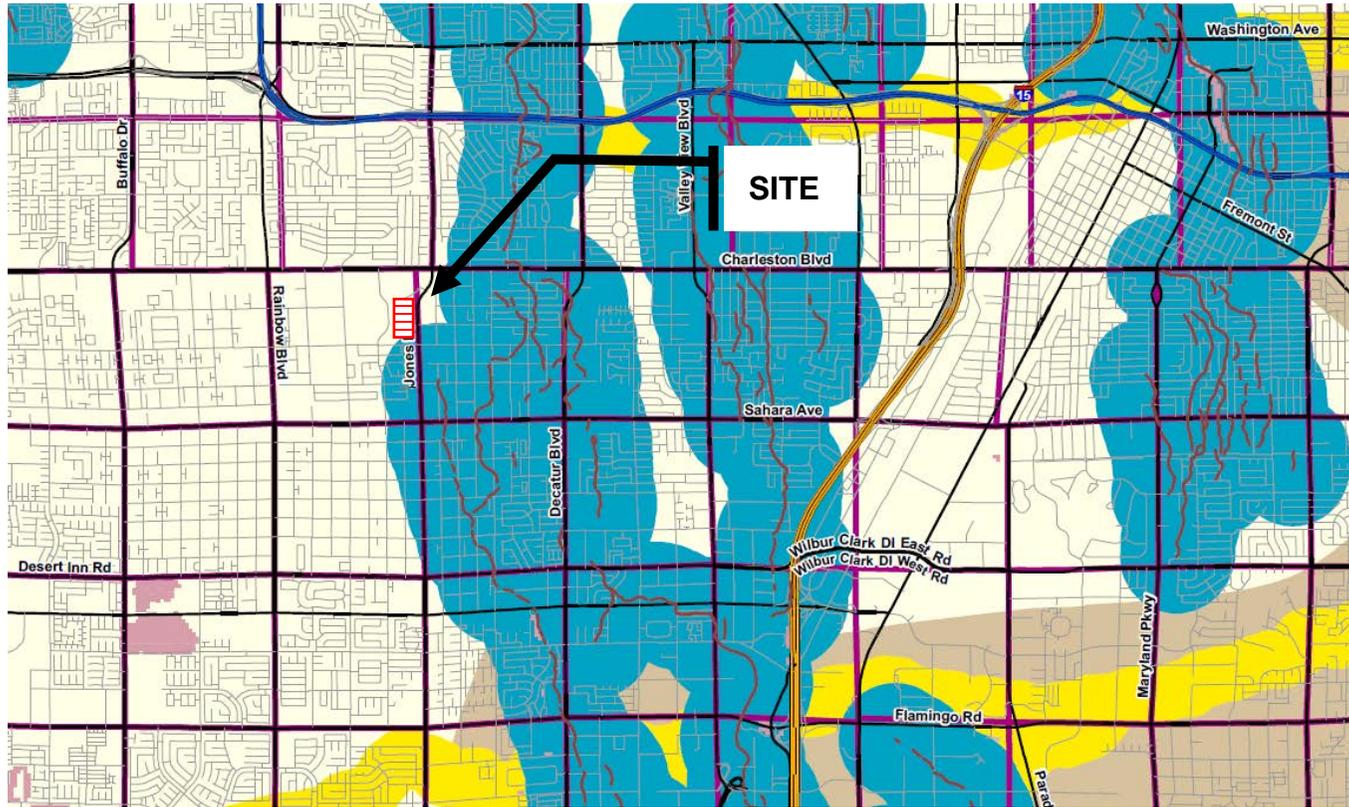


Image from Clark County Soils Guidelines Map

- Special geotechnical consideration area. Subsidence and 2,000 foot compaction or seismic fault buffer zone (includes 90% of mapped fissures).
- Special geotechnical consideration area. Potential drainage areas or recent sediment deposits. May also have solubility, clay swell, corrosion, gypsum salt, expansive or hydro-collapsible potential.
- Special geotechnical consideration area. Solubility, clay swell, corrosion, gypsum salt, expansive or hydro-collapsible potential.
- Standard geotechnical consideration area. Mixed alluvial sand and gravel.
- Faults, Inferred Faults, Concealed Faults

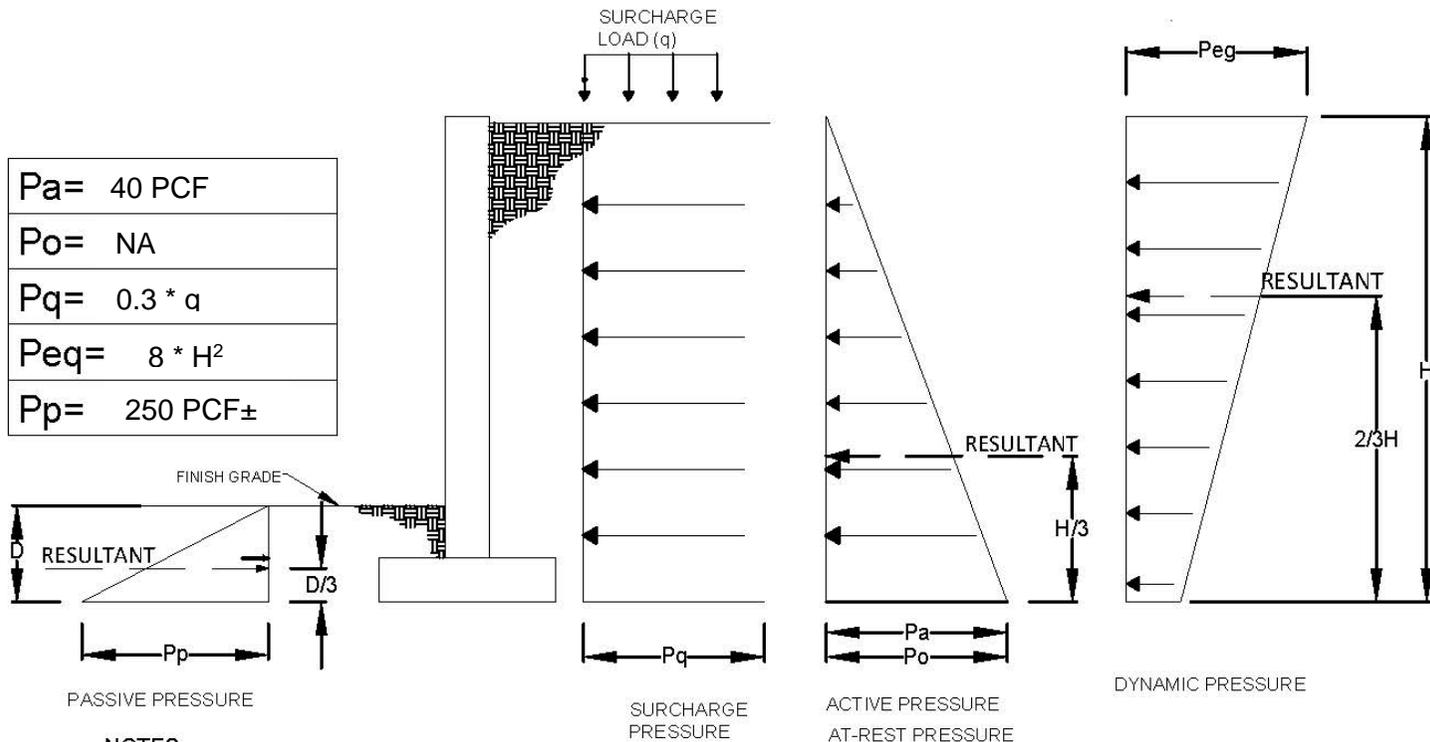


**Soils Guidelines Map**  
 Southern Nevada Forensics Facility (SPWD 23-P06)  
 SWC Charleston Blvd and Jones Blvd  
 KGA Architecture

DATE: 05/2024  
 68-105023

FIGURE 3





NOTES:  
 ASSUMES NO HYDROSTATIC PRESSURE BUILD-UP  
 BEHIND THE RETAINING WALL. GRANULAR BACKFILL MATERIALS SHOULD BE  
 USED FOR RETAINING WALLS. DRAINAGE PER GEOTECHNICAL REPORT.

± Ignore top 12" Unless confined by slab on grade.

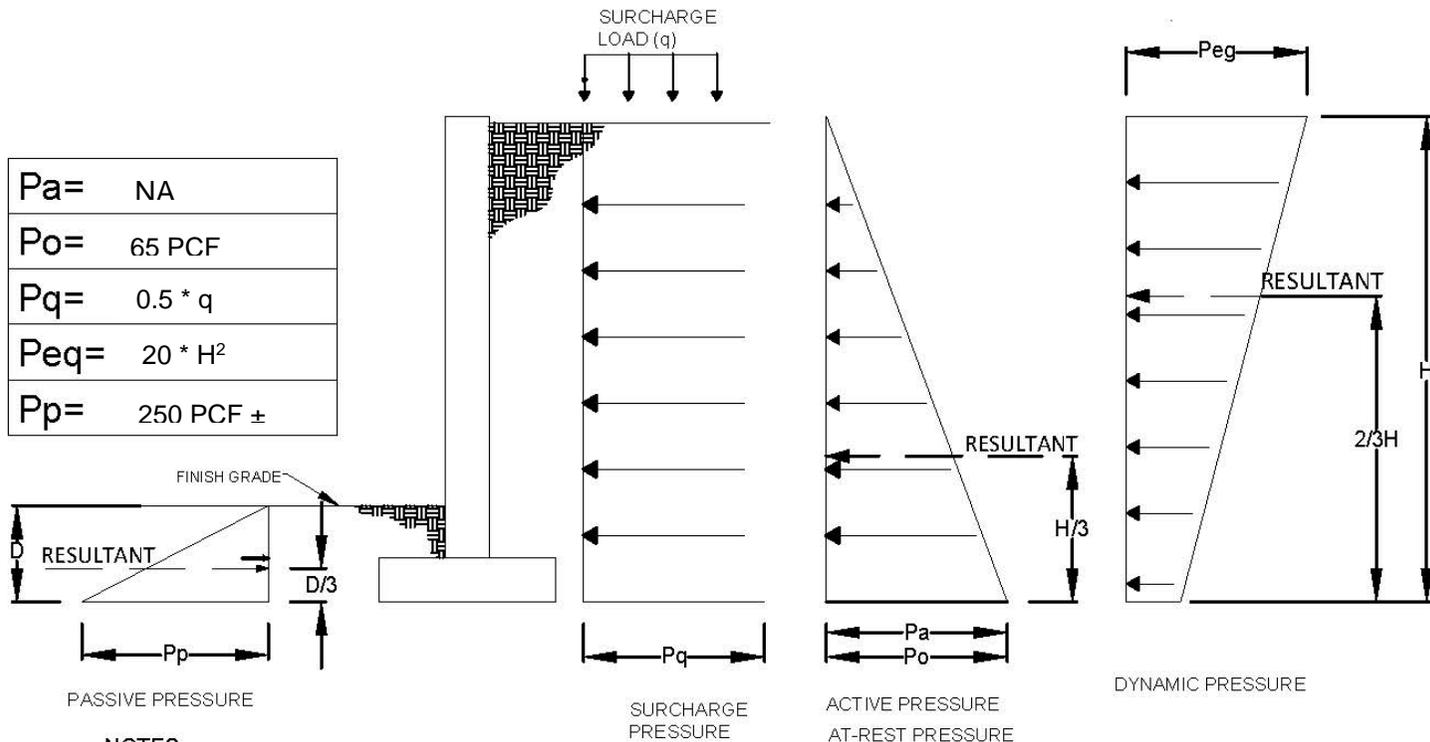
LATERAL EARTH PRESSURES  
 RETAINING WALLS



**ACTIVE LATERAL EARTH PRESSURES**  
 Southern Nevada Forensics Facility (SPWD 23-P06)  
 SWC Charleson Blvd and Jones Blvd  
 KGA Architecture

DATE: 05/2024  
 68-105023

FIGURE 4A



NOTES:  
 ASSUMES NO HYDROSTATIC PRESSURE BUILD-UP  
 BEHIND THE RETAINING WALL. GRANULAR BACKFILL MATERIALS SHOULD BE  
 USED FOR RETAINING WALLS. DRAINAGE PER GEOTECHNICAL REPORT.

**LATERAL EARTH PRESSURES  
 RETAINING WALLS**

$\pm$  Ignore top 12" Unless confined by slab on grade.



**AT - REST LATERAL EARTH  
 PRESSURES**  
 Southern Nevada Forensics Facility (SPWD 23-P06)  
 SWC Charleston Blvd and Jones Blvd  
 KGA Architecture

DATE: 05/2024  
 68-105023

FIGURE 4B

**APPENDIX A**  
**BORING LOGS**



# LOG OF BORING No. B-1

**PROJECT:** Southern Nevada Forensics Facility 23-P06 **PROJECT NO.:** 68-105023  
**CLIENT:** KGA Architecture  
**PROJECT LOCATION:** West Charleston Campus - Health and Human Services  
**LOCATION:** East most boring, see site Plan  
**NORTHING:** 36.15533 **EASTING:** -115.22746 **ELEVATION:** 2298 MSL  
**DRILLER:** Eagle **LOGGED BY:** AEC  
**DRILLING METHOD:** Diedrich D-50 Track Drill W/HSA **DATE:** 4/24/2024  
**DEPTH TO - WATER> INITIAL:** ∇ NA **AFTER 24 HOURS:** ∇ **CAVING>** C

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Elevation (feet)	Depth (feet)	USCS	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS	
								Plastic Limit	Liquid Limit
2298	0	FILL	Fill: Landscape rock with some construction debris, roots and cobbles						
2295	3	SM/GM	Silty SAND and GRAVEL, light brown, low moisture, medium dense to dense, some cobbles, low plastic fines						
			More gravel and cobbles			20 25 23			
2292	6				1				
2289	9	ROCK	Cemented Sand and Gravel, CALICHE, hard to 9.5						
		SC	More weakly cemented		2	- 50/5	38		
2286	12		Clayey SAND with trace gravel, tan, moist, dense, sand is fine, fines low plastic Weakly cemented 13 to 15 feet						
2283	15				3	21 34 36			70 →
			Weakly cemented 17 to 19' then cemented						
2280	18								
		ROCK	Cemented Sand and Gravel, CALICHE, hard						
2277	21		Boring terminated at 20 ft. Continue Cemented!		4	- 3	24		

All samples SPT in accordance with ASTM D1586, No Ground Water, backfilled with cuttings



# LOG OF BORING No. B-2

**PROJECT:** Southern Nevada Forensics Facility 23-P06 **PROJECT NO.:** 68-105023  
**CLIENT:** KGA Architecture  
**PROJECT LOCATION:** West Charleston Campus - Health and Human Services  
**LOCATION:** Center boring, see site Plan  
**NORTHING:** 36.15536 **EASTING:** -115.2268 **ELEVATION:** 2291 MSL  
**DRILLER:** Eagle **LOGGED BY:** AEC  
**DRILLING METHOD:** Diedrich D-50 Track Drill W/HSA **DATE:** 4/24/2024  
**DEPTH TO - WATER> INITIAL:** ∇ NA **AFTER 24 HOURS:** ∇ **CAVING>** C

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Elevation (feet)	Depth (feet)	USCS	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS	
								Plastic Limit	Liquid Limit
	0	FILL	Fill: Landscape rock with some construction debris, roots and cobbles						
2289		SM/GM	Silty SAND and GRAVEL, light brown, low moisture, medium dense to dense, some cobbles, low plastic fines						
	3	ROCK	Cemented Sand and Gravel, CALICHE, hard to 4						
2286		SM	Silty SAND with Gravel, tan, low moisture, medium dense to dense, sand is medium, low plastic fines, little gypsum Solubility = 1.06% Non Plastic Fines		1	6 4 5	12		
2283		ROCK	Cemented Sand and Gravel, CALICHE, hard to 9.5						
2280		SP-SM	Silty SAND with Gravel, Tan, Low moisture, dense, low plastic, Sand is medium.		2	39 45 39	84		
	12		More sandy, little gravel, dense						
2277			More gravels						
	15		Continue						
2274					3	16 24 25			
	18								
2271									
	21		Continue, gravel to sand varies, trace to little gypsum.		4	21 21 14			

All samples SPT in accordance with ASTM D1586, No Ground Water, backfilled with cuttings. Nearby in old landscape area large roots and tree stumps noted.



**LOG OF BORING  
No. B-2**

PROJECT: Southern Nevada Forensics Facility 23-P06 PROJECT NO.: 68-105023  
 CLIENT: KGA Architecture  
 PROJECT LOCATION: West Charleston Campus - Health and Human Services  
 LOCATION: Center boring, see site Plan  
 NORTHING: 36.15536 EASTING: -115.2268 ELEVATION: 2291 MSL  
 DRILLER: Eagle LOGGED BY: AEC  
 DRILLING METHOD: Diedrich D-50 Track Drill W/HSA DATE: 4/24/2024  
 DEPTH TO - WATER> INITIAL: ∇ NA AFTER 24 HOURS: ∇ CAVING> C

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Elevation (feet)	Depth (feet)	USCS	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS	
								Plastic Limit	Liquid Limit
2268	24		Cobbles	[Pattern]					
2265	27		Continue very dense	[Pattern]	5	16 40 35			75 →
2262	30			[Pattern]	6	13 17 13			
2259	33			[Pattern]					
2256	36			[Pattern]					
2253	37	ROCK	Cemented sand and gravel, CALICHE, hard to 38	[Pattern]					
2250	38	SP/GP	Sand with gravel, tan, low moisture, dense with weak partial cementation,	[Pattern]					
2250	39			[Pattern]	7	20 37 50/4			87 →
2250	42	ROCK	Cemented sand and gravel, CALICHE, hard to 44	[Pattern]					

All samples SPT in accordance with ASTM D1586, No Ground Water, backfilled with cuttings.  
 Nearby in old landscape area large roots and tree stumps noted.



**LOG OF BORING  
No. B-2**

PROJECT: Southern Nevada Forensics Facility 23-P06 PROJECT NO.: 68-105023  
 CLIENT: KGA Architecture  
 PROJECT LOCATION: West Charleston Campus - Health and Human Services  
 LOCATION: Center boring, see site Plan  
 NORTHING: 36.15536 EASTING: -115.2268 ELEVATION: 2291 MSL  
 DRILLER: Eagle LOGGED BY: AEC  
 DRILLING METHOD: Diedrich D-50 Track Drill W/HSA DATE: 4/24/2024  
 DEPTH TO - WATER> INITIAL: NA AFTER 24 HOURS: NA CAVING> C

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Elevation (feet)	Depth (feet)	USCS	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS	
								Plastic Limit	Liquid Limit
2247	45	SP/GP	Sand with gravel, tan, low moisture, dense with weak partial cementation and/or cobbles.						
2244	48								
2241	51		Boring terminated at 50 ft. No Ground Water!		8	20 12 14			
2238	54								
2235	57								
2232	60								
2229	63								

*All samples SPT in accordance with ASTM D1586, No Ground Water, backfilled with cuttings.  
 Nearby in old landscape area large roots and tree stumps noted.*



# LOG OF BORING No. B-3

**PROJECT:** Southern Nevada Forensics Facility 23-P06 **PROJECT NO.:** 68-105023  
**CLIENT:** KGA Architecture  
**PROJECT LOCATION:** West Charleston Campus - Health and Human Services  
**LOCATION:** South end of solar field, see site Plan  
**NORTHING:** 36.15478 **EASTING:** -115.22658 **ELEVATION:** 2295 MSL  
**DRILLER:** Eagle **LOGGED BY:** AEC  
**DRILLING METHOD:** Diedrich D-50 Track Drill W/HSA **DATE:** 4/25/2024  
**DEPTH TO - WATER> INITIAL:**  $\nabla$  NA **AFTER 24 HOURS:**  $\nabla$  **CAVING>** C

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Elevation (feet)	Depth (feet)	USCS	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS	
								Plastic Limit	Liquid Limit
2295	0	FILL	Fill: Landscape rock with some construction debris, cobbles						
2292	3	SM/GM	Silty SAND and GRAVEL, light brown, low moisture, medium dense to dense, some cobbles, low plastic fines						
			Solubility = 0.10						
2289	6				1	10 9 9			
2286	9				2	18 20 18			
2283	12	ROCK	Weakly Cemented Sand and Gravel from 12 to 13 then hard cemented CALICHE to 15						
2280	15	SP/GP	Sand and Gravel, light brown, low moisture, dense, little silt/clay, few cobbles		3	15 28 24			
2277	18	ROCK	Cemented sand and gravel, CALICHE, hard from 17 to 19						
		SM	Silty SAND with gravel, low moisture, dense, sand is medium grained, little clay with low to medium PI.						
2274	21		Boring terminated at 20 ft. Continue. No Ground Water.		4	10 12 9			

All samples SPT in accordance with ASTM D1586, No Ground Water, backfilled with cuttings



# LOG OF BORING No. B-4

**PROJECT:** Southern Nevada Forensics Facility 23-P06 **PROJECT NO.:** 68-105023  
**CLIENT:** KGA Architecture  
**PROJECT LOCATION:** West Charleston Campus - Health and Human Services  
**LOCATION:** East end of solar field, see site Plan  
**NORTHING:** 36.15514 **EASTING:** -115.22608 **ELEVATION:** 2289 MSL  
**DRILLER:** Eagle **LOGGED BY:** AEC  
**DRILLING METHOD:** Diedrich D-50 Track Drill W/HSA **DATE:** 4/25/2024  
**DEPTH TO - WATER> INITIAL:** ∇ NA **AFTER 24 HOURS:** ∇ **CAVING>** C

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Elevation (feet)	Depth (feet)	USCS	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS	
								Plastic Limit	Liquid Limit
2289	0	FILL	Fill: Landscape rock with disturbed native, few cobbles to 24 inches						
2286	3	SM/GM	Silty SAND and GRAVEL, light brown, low moisture, medium dense to dense, some cobbles, low plastic fines						
2283	6	ROCK	Cemented sand and gravel, CALICHE, mod to hard out at 9 feet.		1	7 9 11			
2280	9	SP	Sand and Gravel, light brown, low moisture, dense, little silt/clay, few cobbles		2	12 50/4			62
2277	12	ROCK	Weakly Cemented Sand and Gravel from 12.5 to 13						
		SP	Sand and Gravel, light brown, low moisture, dense, little silt/clay, few cobbles						
2274	15	CL/SC	Clayey SAND to Sandy CLAY, Red Brown, moist, soft to firm, fines are medium plastic		3	3 3 2	47		
2271	18								
2268	21		Boring terminated at 20 ft. No Ground Water		4	4 10 16			

All samples SPT in accordance with ASTM D1586, No Ground Water, backfilled with cuttings

# KEY TO SYMBOLS

Symbol Description

## Strata symbols



Fill



Silty sand and gravel



Basalt  
(or generic rock)



Clayey sand/  
Low plasticity clay



Silty sand



Poorly graded sand  
with silt



Poorly graded sand  
and gravel



Poorly graded sand

## Notes:

1. Exploratory borings were drilled on 4/25/2024 using a track mounted hollow stem auger with an auto hammer.
2. No free water was encountered at the time of drilling.
3. Boring locations were paced from existing features and elevations from Google Earth.
4. These logs are subject to the limitations, conclusions, and recommendations in this report.
5. Results of tests conducted on samples recovered are reported on the logs.

**APPENDIX B**  
**LABORATORY TESTING**

# CCPE LTD.

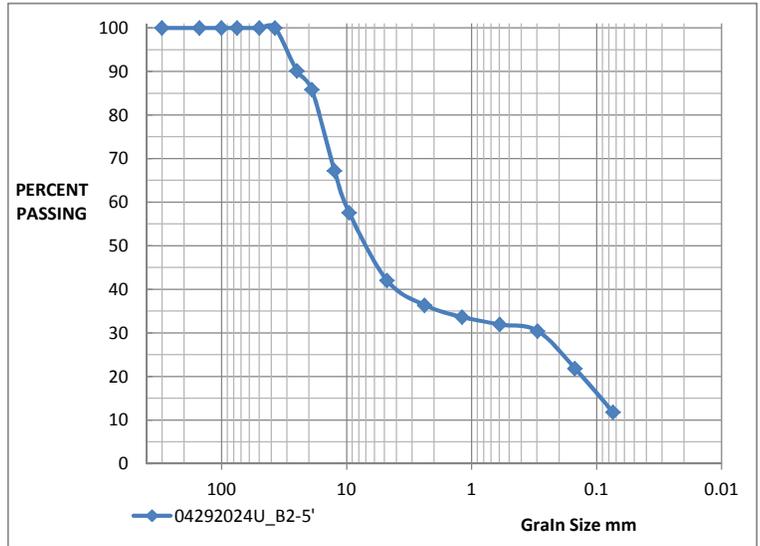
CUNNINGHAM'S CONSULTING FOR PROCESS AND EQUIPMENT LTD.

Soils Test Report	Report Date: 5/4/2024	Report No.: GL- 770A
-------------------	-----------------------	----------------------

Client: ARROYO ENGINEERING CONSULTANTS 1328 ECHO CREEK STREET HENDERSON, NV 89052	SAMPLE DATE: UNKNOWN RECEIVED DATE: 4/29/2024 FIELD TECHNICIAN: ARRON HASTINGS SAMPLE I.D.: 04292024U_B2-5' MATERIAL DESCRIPTION: NATIVE MATERIAL SOURCE: BORING SAMPLE LOCATION: UNKNOWN SAMPLE TYPE: SPT LAB TECHNICIAN: Carl Cunningham	
PROJECT: FORENSICS LAB PROJECT ADDRESS: AARON HASTINGS CLIENT CONTACT: 702.241-5339		

**ASTM C136 / C117 OR D6913**

SIEVE		PERCENT PASSING	SPECIFICATION	
US	MM		MIN.	MAX
12"	300	100		
6"	150	100		
4"	100	100		
3"	75	100		
2"	50	100		
1 1/2"	37.5	100		
1"	25	90		
3/4"	19	86		
1/2"	12.5	67		
3/8"	9.525	58		
#4	4.76	42		
#8	2.38	36		
#16	1.19	34		
#30	0.595	32		
#50	0.297	30		
#100	0.149	22		
#200	0.074	12		



Classification / Description ASTM D2487				SM	SILTY SAND			TAN		
REPORTED TESTING		SPEC	RESULT	UNIT				SPEC	RESULT	UNIT
Gravel %	--	58	%		LIQUID LIMIT*			--	NV	--
Sand %	--	42	%		PLASTIC LIMIT			--	NP	--
Cu =	Cu>4or(6)	142.86	--		PLASTICTY INDEX			--	NP	--
Cc =	1<Cc<3	0.08	--							
Moisture ASTM D 2216/ C566								--	3.6	%
ASTMD2435(SNBCA 1803.5.3.2)								--	0.2	%
								--	--	--

NOTES:  
SINGLE POINT LIQUID LIMIT\*

COMMENTS:



REVIEWED BY: *Carl Cunningham*

# CCPE LTD.

CUNNINGHAM'S CONSULTING FOR PROCESS AND EQUIPMENT LTD.

**Soils Test Report**

**Report Date:** 5/4/2024

**Report No.:** GL- 770C

**Client:** ARROYO ENGINEERING CONSULTANTS  
1328 ECHO CREEK STREET  
HENDERSON, NV 89052

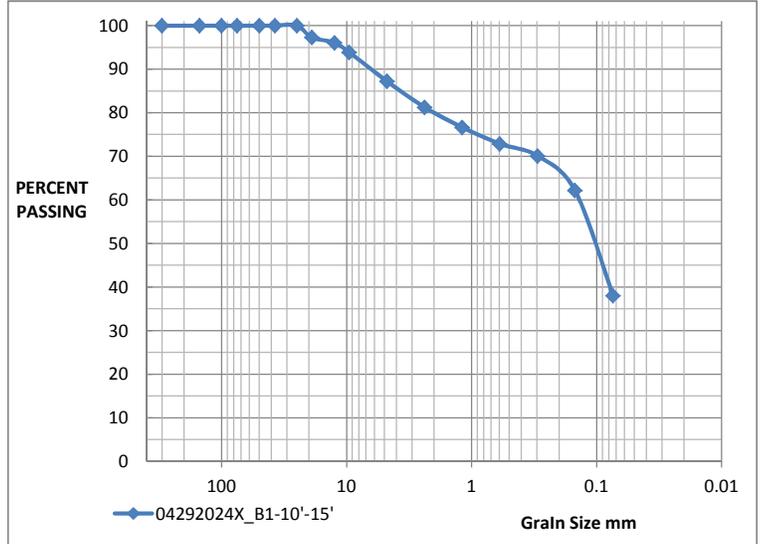
**SAMPLE DATE:**  
**RECEIVED DATE:**  
**FIELD TECHNICIAN:**  
**SAMPLE I.D.:**  
**MATERIAL DESCRIPTION:**  
**MATERIAL SOURCE:**  
**SAMPLE LOCATION:**  
**SAMPLE TYPE:**  
**LAB TECHNICIAN:**

UNKNOWN
4/28/2024
ARRON HASTINGS
04292024X_B1-10'-15'
NATIVE
Boring
Unknown
SPT
Carl Cunningham

**PROJECT:** FORENSICS LAB  
**PROJECT ADDRESS:** UNKNOWN  
**CLIENT CONTACT:** AARON HASTINGS  
702.241-5339

**ASTM C136 / C117 OR D6913**

SIEVE		PERCENT PASSING	SPECIFICATION	
US	MM		MIN.	MAX.
12"	300	100		
6"	150	100		
4"	100	100		
3"	75	100		
2"	50	100		
1 1/2"	37.5	100		
1"	25	100		
3/4"	19	97		
1/2"	12.5	96		
3/8"	9.525	94		
#4	4.76	87		
#8	2.38	81		
#16	1.19	77		
#30	0.595	73		
#50	0.297	70		
#100	0.149	62		
#200	0.074	38		



Classification / Description ASTM D2487		SC	CLAYEY SAND		TAN		
REPORTED TESTING	SPEC	RESULT	UNIT		SPEC	RESULT	UNIT
Gravel %	--	4	%	LIQUID LIMIT*	--	27	--
Sand %	--	96	%	PLASTIC LIMIT	--	19	--
Cu =	Cu>4or(6)	--	--	PLASTICTY INDEX	--	8	--
Cc =	1<Cc<3	--	--				
Moisture ASTM D 2216/ C566					--	5.3	%
					--	--	--
					--	--	--

**NOTES:**  
SINGLE POINT LIQUID LIMIT\*

**COMMENTS:**

  
**REVIEWED BY:**

*Carl Cunningham*



# CCPE LTD.

CUNNINGHAM'S CONSULTING FOR PROCESS AND EQUIPMENT LTD.

**Soils Test Report**

Report Date: 5/10/2024

Report No.: GL- 770D

Client: ARROYO ENGINEERING CONSULTANTS  
1328 ECHO CREEK STREET  
HENDERSON, NV 89052

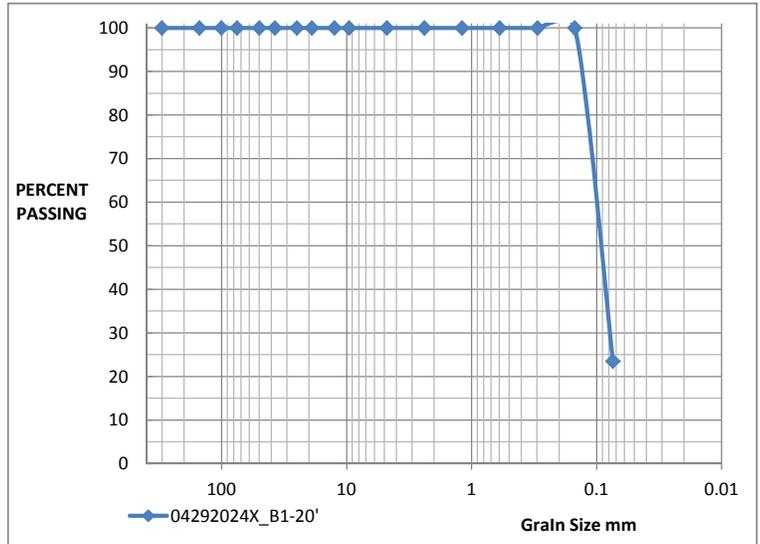
SAMPLE DATE:  
RECEIVED DATE:  
FIELD TECHNICIAN:  
SAMPLE I.D.:  
MATERIAL DESCRIPTION:  
MATERIAL SOURCE:  
SAMPLE LOCATION:  
SAMPLE TYPE:  
LAB TECHNICIAN:

Unknown
4/29/2024
ARRON HASTINGS
04292024X_B1-20'
NATIVE
Boring
Unknown
SPT
Carl Cunningham

PROJECT: HICKORY 2651 WESTWOOD DRIVE  
PROJECT ADDRESS: UNKNOWN  
CLIENT CONTACT: AARON HASTINGS  
702.241-5339

ASTM C136 / C117 OR D6913

SIEVE		PERCENT PASSING	SPECIFICATION	
US	MM		MIN.	MAX
12"	300	100		
6"	150	100		
4"	100	100		
3"	75	100		
2"	50	100		
1 1/2"	37.5	100		
1"	25	100		
3/4"	19	100		
1/2"	12.5	100		
3/8"	9.525	100		
#4	4.76	100		
#8	2.38	100		
#16	1.19	100		
#30	0.595	100		
#50	0.297	100		
#100	0.149	100		
#200	0.074	24		



Classification / Description ASTM D2487		SC-SM	SILTY CLAYEY SAND			WHITE		
REPORTED TESTING	SPEC	RESULT	UNIT		SPEC	RESULT	UNIT	
Gravel %	--	4	%	LIQUID LIMIT*	--	22	--	
Sand %	--	96	%	PLASTIC LIMIT	--	16	--	
Cu =	Cu>4or(6)	--	--	PLASTICTY INDEX	--	6	--	
Cc =	1<Cc<3	--	--					
Moisture ASTM D 2216/ C566					--	5.1	%	
ASTMD2435(SNBCA 1803.5.3.2)					--	--	%	
					--	--	--	

NOTES:  
SINGLE POINT LIQUID LIMIT\*

COMMENTS:



REVIEWED BY: *Carl P...*

**Report Date:** May 2, 2024

**Report:** 30430

**Client:**

CCPE Ltd.  
 5734 Meikle Ln.  
 Las Vegas, NV 89156

## Laboratory Report

**Client Project:** FORENSICS LAB

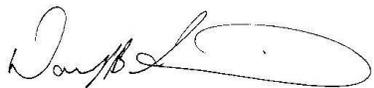
**PO Number:** NA

Sample received May 2, 2024  
 Sample processed May 2, 2024

Client Lab ID	Na <sup>+</sup> (%)	SO <sub>4</sub> <sup>2-</sup> (%)	Na <sub>2</sub> SO <sub>4</sub> (%)	Soil Solubility (%)
04292024U_B2@5'	<0.01	0.75	<0.01	1.06
04292024V_B3@5'	<0.01	0.08	<0.01	0.10

Note: mg kg<sup>-1</sup> is equal to ppm. To calculate ppm from Na<sub>2</sub>SO<sub>4</sub>, multiply the percent by 10,000; this will equal a near estimate without significant figures. <0.01 denotes below instrument detection limits (IDL). Below IDL does not affect the outcome of the overall sample(s) values. Methods are SM4500-SO<sub>4</sub><sup>2-</sup>, SM4500-Na<sup>+</sup>; and Na<sub>2</sub>SO<sub>4</sub> by calculation. Soil Solubility is the % soluble in DI water that passes through a 0.45 µm Whatman filter paper per SM2540B.

Respectively Submitted,



Douglas B Sims, PhD  
 Environmental Geochemist

dsims@simsassociates.net  
 C: 512-809-5094

## **APPENDIX C**

### **ReMi Survey**

# BC-Geophysics



05-06-2024

To:

Aaron Hastings, P.E.  
Henderson, NV 89052  
1328 Echo Creek Street, Henderson, NV 89052  
702-247-7645  
[aec@aec-nv.com](mailto:aec@aec-nv.com)

**A Seismic Survey Test was executed on parcel APN: 163-02-601-007 in Las Vegas, NV: for Arroyo Engineering Consultants, Inc.** The survey was done on April 26, 2024, by Jim O'Donnell of BC Geophysics.

A single test was done using the Seismic Refraction Microtremor or (ReMi) method. ReMi returns reliable 1-D, S-wave ( $V_s$ ) values, an average over the line length. The IBC Soils "Site Class" can be determined from ReMi Tests and ReMi is the seismic method of choice in the Las Vegas Valley as over 10,000 ReMi lines have been run for the CC Building Services Dept. in a seismic microzonation program. See reference; "Earthquake hazard class mapping by parcel in Las Vegas Valley" (Pancha et al 2017). All our seismic data are processed with Geogiga Advanced Surface Wave Software (Geogiga Surface Plus 9.0).

The method is an appropriate 1D  $V_s$  sounding technique. Key to effectively incorporating these results into engineering design and construction specifications is the understanding that the  $V_s$  results are determined using dispersive surface wave analysis and an awareness that the model inversion process can lead to non-unique solutions (i.e., equivalence modeling of layer thickness versus velocity- (see Jim O'Donnell et al, 2011). The International Building Code (IBC) Soils Site Classification relates shear-wave velocity and Rock/Soil type to a National Earthquake Hazard Reduction Program (NEHRP) Site Class.

**The site classification for this site is "C" at  $V_s$ 100ft=1862 ft/s.**

The ReMi test used: a DAQLink 3 seismograph (<http://seismicsource.com/html/products/acquisition-systems/daqlink3>), 24 geophones (vertical 4.5 Hz) spaced at 10ft intervals to give a line length of 230ft. Thirty (30) records were used to average the Velocity Spectra (p-f image); with T=30s, and a Sample Rate=2ms.

*Jim O'Donnell*

Jim O'Donnell

BC-Geophysics

Seismic Surveys- Passive Surface Waves, Refraction-Tomography

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**Table 1:** The International Building Code (IBC) **Soils Site Classification chart** relates shear-wave velocity and Rock/Soil type to a National Earthquake Hazard Reduction Program (NEHRP) Site Class. Basins in Nevada typically have shallow shear-wave velocities that correlate with NEHRP Site Class C (1,200–2,500 ft/s) or Site Class D (600–1,200 ft/s), whereas the surrounding mountain ranges with hard or more competent rock commonly fall into Site Class B (2,500–5,000 ft/s).

Site Class	Site Profile Name	Soil Shear Wave Velocity, $\bar{v}_s$ (ft/sec)	Standard Penetration Resistance, $\bar{N}$ or $N_{ch}$	Undrained Shear Strength, $\bar{S}_u$ (psf)
A	Hard rock	$\bar{v}_s > 5,000$	NA	NA
B	Rock	$2,500 < \bar{v}_s \leq 5,000$	NA	NA
C	Very dense soil and soft rock	$1,200 < \bar{v}_s \leq 2,500$	> 50	> 2,000 psf
D	Stiff soil	$600 < \bar{v}_s \leq 1,200$	15 to 20	1,000 to 2,000 psf
E	Soft clay soil	$\bar{v}_s \leq 600$	<15	<1,000psf
		Any profile with more than 10 ft of soil having the following characteristics: <ul style="list-style-type: none"> <li>• Plasticity index <math>PI &gt; 20</math></li> <li>• Moisture content <math>w \geq 40\%</math>, and</li> <li>• Undrained shear strength <math>S_u &lt; 500</math> psf</li> </ul>		
F	Soil requires site response analysis	Liquefiable soils, peat, high plasticity clay		

References:

Pancha, S. K. Pullammanappallil, L. T. West, J. N. Louie, and W. K. Hellmer, 2017, Large scale earthquake hazard class mapping by parcel in Las Vegas Valley, Nevada: *Bulletin of the Seismological Society of America*, **107**, no. 2 (April), 741-749, doi: 10.1785/0120160300.

<https://pdfs.semanticscholar.org/8dc5/0724683d32e76bb76c013cd9a6869da9a18d.pdf>

Jim O'Donnell, Aasha Pancha, and Craig M. dePolo, **Shallow Shear-Wave Velocities Based on Refraction Microtremor Measurements in Areas Damaged by the 2008 Mw 6.0 Wells, Nevada Earthquake**

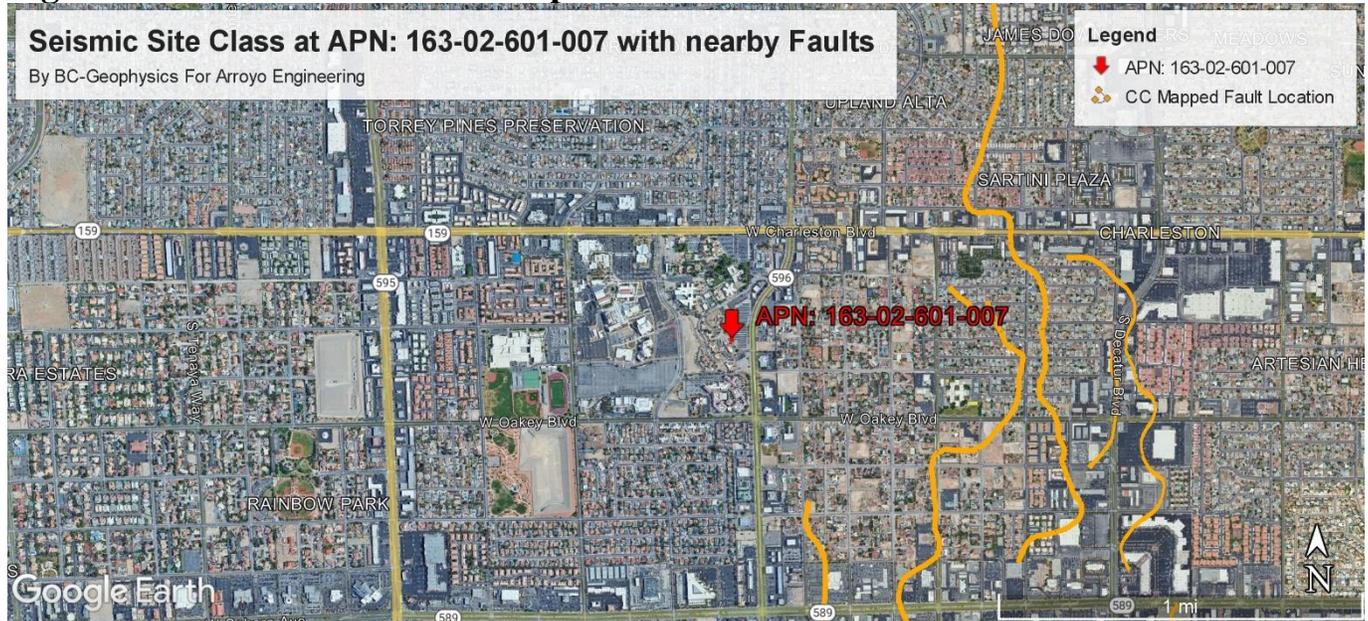
The 21 February 2008 Mw 6.0 Wells, Nevada Earthquake; Bureau of Mines and Geology, University of Nevada, Reno: Nevada Bureau of Mines and Geology Special Publication 36: 2011

[https://www.dropbox.com/s/77i912zswg32x6r/Wells%20M6%20III e \(O'Donnell %26 others\)%20\(3\).pdf?dl=0](https://www.dropbox.com/s/77i912zswg32x6r/Wells%20M6%20III%20e%20(O'Donnell%20%26%20others)%20(3).pdf?dl=0)

Geogiga Surface Plus 9.0 — Advanced Surface Wave Data Processing Software

<http://www.geogiga.com/en/surfaceplus.php>

**Figure 1-A: General Area Site Map**



**Figure 1-B Site Map with close up of ReMi line**

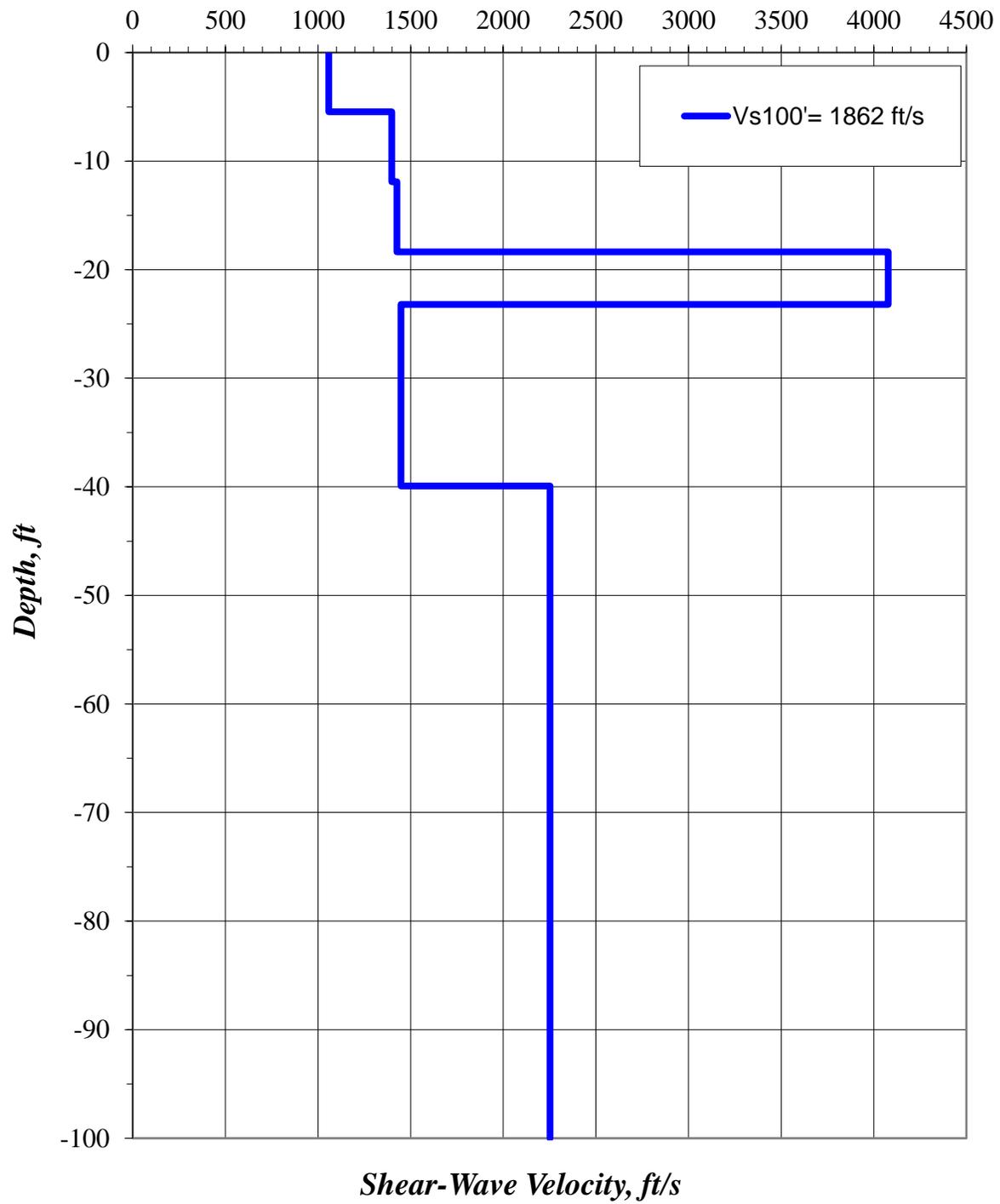
Coordinates for Geophone # 1 Lat 36° 9'19.57"N, Long 115°13'36.46"W

Coordinates for Geophone # 24 36° 9'17.30"N, Long 115°13'36.42"W

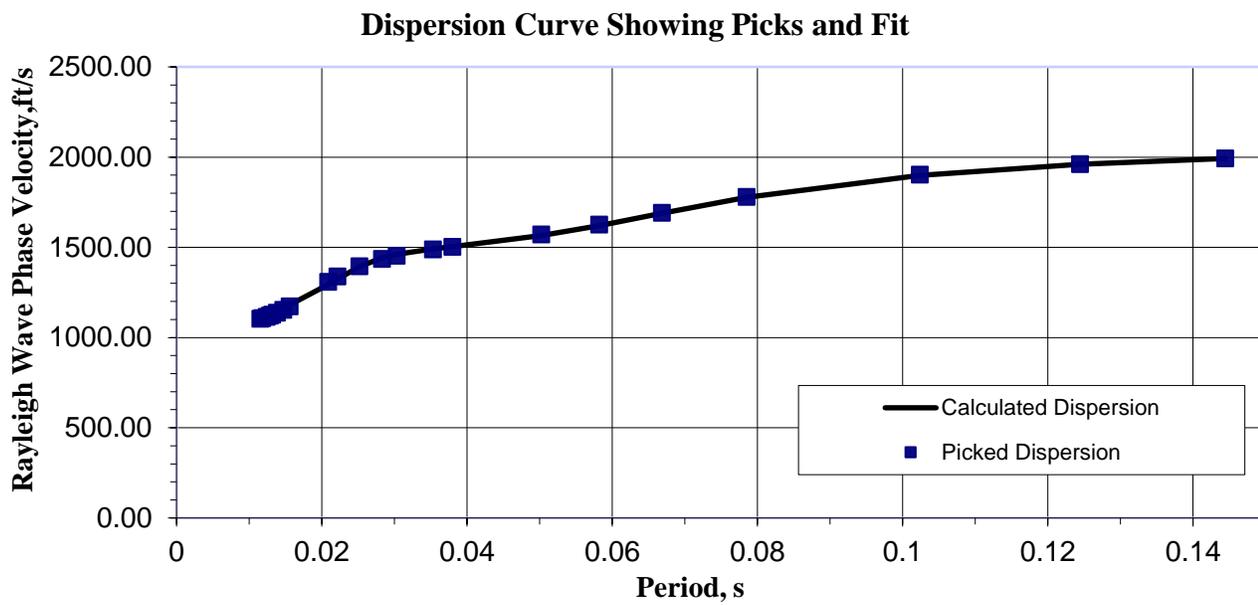


**Figure 3: 1D Vs profile with depth for 100 ft.**

*1D Vs Model for APN:163-02-601-007*



**Figure 4: Velocity spectra p-f image with picks & dispersion curve with picks**



**p-f Image showing dispersion and picks**

