PRELIMINARY GEOTECHNICAL EXPLORATION REPORT

EL MIRAGE ROAD, STATE ROUTE 303L TO JOMAX ROAD
DESIGN CONCEPT REPORT AND ENVIRONMENTAL ASSESSMENT
ADOT TRACS NO. T0428 03D
ADOT CONTRACT NO. 2024-001
MARICOPA COUNTY, ARIZONA

Prepared for:

BURGESS & NIPLE

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Ethos Project No. 2024029
August 26, 2025

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Attn: David C. Lenzer, PE
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SUBJECT: Preliminary Geotechnical Exploration Report
El Mirage Road, State Route 303L to Jomax Road
Design Concept Report and Environmental Assessment (DCR/EA)
ADOT TRACS No. T0428 03D
ADOT Contract No. 2024-001
Maricopa County, Arizona

Dear David:

Ethos Engineering, LLC (Ethos) is pleased to present the results of a preliminary geotechnical exploration performed for the planned El Mirage Road, State Route (SR) 303L to Jomax Road project. The study area begins at SR 303L and extends to Jomax Road. The existing El Mirage Road from the SR 303L Traffic Interchange (TI) to north of Desert Sun Lane is located within unincorporated Maricopa County. The section of El Mirage Road north of Desert Sun Lane to Jomax Road is located within the City of Peoria (City). The project is being administered by the Arizona Department of Transportation (ADOT). Our scope of services was performed in general accordance with our proposal dated February 9, 2024 (Revision No. 4).

The results of our field investigation, laboratory testing, and preliminary geotechnical engineering recommendations for support of the proposed improvements are presented herein. This preliminary report was prepared to support the Design Concept Report and Environmental (DCR/EA) phase of the project. Additional field exploration, laboratory testing, and engineering analysis will be required for final design of the project.

We appreciate the opportunity to be of service to Burgess & Niple, Inc. (B&N) on this project. If you have any questions regarding this report, please do not hesitate to contact us.

Sincerely,
Ethos Engineering, LLC

Jesse Huston, P.E.
Principal/Senior Geotechnical Engineer

Reviewed By:

Franciso J. Garza, P.E.
President/Senior Geotechnical Engineer

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1.0 PROJECT DESCRIPTION

El Mirage Road will be extended to provide a continuous connection between SR 303L and Jomax Road to meet 2050 regional traffic demand models. The El Mirage Road: SR 303L to Jomax Road Feasibility Study Report was completed in June 2022 by the Maricopa Association of Governments (MAG). The study evaluated alternatives for a continuous extension of El Mirage Road from SR 303L to Jomax Road. Three alignment alternatives were developed for El Mirage Road from SR 303L to Jomax Road based on constraints from existing power lines, floodplains, utilities, and section lines.

Alternative 1 from the Feasibility Study Report was identified to be carried forward as part of T0428 Design Concept Report. Because the corridor will ultimately be owned and maintained by the City, super elevation was removed from the MAG Feasibility Study alignment in lieu of larger horizontal curves. These modifications changed the location of the El Mirage Road crossing over McMicken Wash. The portion of the El Mirage Road corridor north of Happy Valley Road and the crossing over the Beardsley Canal remained unchanged. While both bridge and box culvert crossings were initially evaluated for each location, we understand the McMicken Wash crossing will likely use a multi-cell reinforced concrete box culvert (RCBC), and the Beardsley Canal crossing will use a single-span bridge supported on drilled shafts.

The new El Mirage Road corridor would be centered on permanent 130-foot-wide right of way to be purchased and ultimately maintained by the City. The proposed 4-Lane (initial configuration) roadway would include two vehicular travel lanes, a 6-foot bike lane, a 6-foot buffer, and an 8-foot sidewalk in each direction. The proposed 4-Lane (initial configuration) roadway would also include a 38-foot-wide center median to be utilized for future roadway. The 6-Lane (ultimate configuration) roadway will be widened toward the center to add one additional vehicular travel lane in each direction. The 6-Lane (ultimate configuration) roadway will utilize the 6-foot bike lanes, 6-foot buffers, and 8-foot sidewalks constructed in the initial phase.

2.0 FIELD EXPLORATION

2.1 Field Coordination and Permitting

Prior to our field exploration, Ethos prepared a Field Investigation Plan (FIP) to document the planned field exploration, and for use in environmental clearance and permitting. Ethos obtained Flood Control District of Maricopa County (FCDMC) right-of-way use permit #FRU2400455 dated January 08, 2025 and Maricopa Water District (MWD) Right-of-Entry agreement dated December 16, 2024 for borings at the McMicken Wash and Beardsley Canal, respectively. Ethos staked the planned boring locations in the field and coordinated utility clearance of each location with Arizona 811.

2.2 Subsurface Exploration

The subsurface exploration was performed between March 10 and 14, 2025 and included two borings at the McMicken Wash crossing (MW-1 and MW-2) and two borings at the Beardsley Canal crossing (BC-1 and BC-2). All four borings were advanced to an approximate depth of 75 feet. The boring locations are shown on Figures 1 and 2 attached to this report. Logs of the borings are presented in Appendix A.

Drilling was performed by Geomechanics Southwest, Inc. (GSI) with a truck-mounted CME-85 drill rig using percussion hammer (Tubex) drilling methods. Drive sampling was performed using standard penetration test (SPT) split spoon samplers or open-end drive samplers (2.42-inch-diameter brass rings) at maximum 5-foot intervals in each boring using a calibrated automatic hydraulic-actuated 140-pound hammer, free falling 30 inches. The hammer efficiency is noted in the heading of each boring log. The SPT and ring samplers were driven 18 and 12 inches, respectively, or to refusal (i.e. 50 blows for less than a 6-inch interval). Unless noted otherwise on the boring logs, the sample penetration resistance was recorded as the number of blows per six inches of penetration and are presented on the borings logs adjacent to each sample. Additionally, representative bulk samples of the roadway subgrade soils were obtained from the drill cuttings at each boring location.

The recovered soil samples were removed from the sampler, sealed to reduce moisture loss, and stored for subsequent review and laboratory testing. Upon completion, the borings were backfilled to the surface cement-bentonite slurry per the FCDMC permit requirements.

Encountered soils were visually inspected, labeled and classified in the field, and logged in general accordance with ASTM D2488, the Unified Soil Classification System (USCS), ADOT, and Ethos guidelines. Field direction and logging of borings were performed by Ethos personnel.

3.0 LABORATORY TESTING

Selected laboratory tests were assigned by Ethos on representative samples recovered from the borings to support our field classification and to provide information regarding engineering characteristics and properties of the subsurface materials. Lab testing was performed by ACS Services, LLC as a subcontractor to Ethos. Table 3.1 lists the laboratory tests performed for the project. A summary of the laboratory test results along with individual test worksheets are presented in Appendix B. The results of moisture content, in-place dry density, Atterberg Limits, and fines content (i.e., percent passing the #200 sieve) testing are also presented on the boring logs in Appendix A at the corresponding sample depth.

Table 3.1: Laboratory Testing Program

Item/Description	Number of Tests
Grain Size Analysis (Total - Coarse and Fine) - ASTM C136 & C117	12
Atterberg Limits (Plasticity Index) - ASTM D4318	12
Moisture Content - ASTM D2216	12
Direct Shear - ASTM D3080	2
pH and Resistivity - AZ Method 236e	4
Sulfates and Chlorides - AZ Method 733b	4

4.0 SITE CONDITIONS AND GEOTECHNICAL PROFILE

4.1 Site Conditions

The southern portion of this segment between SR 303L and Happy Valley Road currently exists as native desert without an existing roadway. Vegetation generally includes sparse desert bushes, with denser vegetation along McMicken Wash. North of Happy Valley Road and extending to approximately 850 feet south of Jomax Road, the east half of the roadway has been constructed providing access to the residential development along the east side of El Mirage Road. At the north end of the project segment, the Beardsley Canal is an open channel with banks elevated 5 to 10 feet above surrounding grades. The top of each canal bank is about 12 feet wide and serves as unpaved access roads.

4.2 Geologic Setting

Published statewide geologic mapping (Richard et al 2000) indicates the surficial geologic units across a majority of the site consist of late and middle Pleistocene-aged surficial deposits described as unconsolidated to weakly consolidated alluvial fan, terrace, and basin-floor deposits with moderate to strong soil development. Fan and terrace deposits are primarily well-graded, moderately bedded gravel and sand, and basin-floor deposits are primarily sand, silt, and clay.

4.3 Generalized Subsurface Profile

In general, the near-surface soils (within approximately 10 to 20 feet of the ground surface) consist of low to medium plasticity clayey sand and gravel (SC and SC-SP). The soils are generally very firm to hard. Below the surface layer and extending to the maximum depth explored in borings BC-1 and BC-2 at the Beardsley Canal crossing, the soils consist of gravel with variable amounts of sand, silt and clay (GP, GP-GM, GP-GC) with isolated sand zones (SP-SM). The soils are very dense and include weak to moderate cementation in parts. In borings MW-1 and MW-2 at the McMicken Wash crossing, a lower layer of clayey sand with gravel (SC) was encountered at an approximate depth of 50 feet and extended to the maximum depth explored. These soils are medium plasticity and hard. In all layers, the soils included fine to coarse and subrounded to subangular particles of sand and gravel.

4.4 Site Seismicity

The project seismic American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) criteria were determined in accordance with Section 3.10 of the AASHTO LRFD Bridge Design Specifications ((AASHTO, 2012). The horizontal design acceleration is defined as having a 7% chance of exceedance during a 75-year recurrence interval. Based on the conditions encountered in the field, a Site Class C is considered applicable for the project site.

The probabilistic horizontal spectral acceleration values for the designated return period and corresponding peak horizontal ground acceleration (PGA) were obtained from the U.S. Geological Survey seismic hazards program website (USGS, 2009). The resulting seismic design values are presented in Table 4.1.

Table 4.1: Summary of Seismic Parameters

Seismic Design Parameter	Value
Latitude	33.72633º N
Longitude	-112.32562º E
Site Class	C
Peak Ground Acceleration (PGA)	0.055g
Short Period Acceleration (S_S)	0.125g
Long Period Acceleration (S_1)	0.041g
Site Coefficient, F_{PGA}	1.2
Site Coefficient, F_a	1.2
Site Coefficient, F_v	1.7
Spectral Acceleration, A_s	0.066g
Spectral Acceleration, S_{DS}	0.150g
Spectral Acceleration, S_{D1}	0.069g
Seismic Zone	1

4.5 Groundwater Conditions

Groundwater was not encountered during the field investigation to the maximum depths explored of 75 feet. A review of groundwater data in the ADWR Groundwater Site Inventory (ADWR 2025) includes information from several ADWR index well sites located in the proximity of the site. With the exception of one well site located along the Jomax Road alignment at the Agua Fria River, the index wells indicate groundwater depths on the order of 200 to 300 feet in the project area.

The most recent groundwater reading from December 2024 at the Agua Fria River well site (Site ID 334328112175201) indicated a groundwater depth of 83 feet and corresponding groundwater elevation of 1,210 feet. In general, groundwater may impact design and construction of the project possibly for the deeper drilled shaft excavations and potential surface flows in McMicken Wash, but should not impact the majority of the roadway project.

5.0 ENGINEERING ANALYSES AND RECOMMENDATIONS

5.1 General

The following sections of this report provide preliminary geotechnical recommendations to support the DCR phase of the project. These recommendations are based on our understanding of the 15% project, the results of limited field exploration and laboratory testing performed for this phase of the project, engineering analyses, and discussions with the project team. Additional field exploration, laboratory testing, and engineering analysis will be required for final design of the project once design concepts are further developed. Foundations recommendations were developed following the 6th Edition of the AASHTO LRFD Bridge Design Specifications (AASHTO, 2012), which is the current ADOT design standard for geotechnical foundation design, and supplemental ADOT design memorandums outlined herein.

5.2 Shallow Foundations

Shallow foundations will be utilized for the RCBC at the McMicken Wash crossing. Preliminary plans include a 10-cell RCBC with 12-foot by 12-foot cells and an approximate overall footprint of approximately 130 feet by 145 feet on a slightly skewed layout with respect to the El Mirage Road alignment. The bottom of the RCBC is shown bearing at an approximate elevation of 1,294 feet, which is about 10 feet below the existing site grades. Based on the subsurface encountered in borings MW-1 and MW-2, the soils at and below the planned bearing elevation are very dense gravel with clay and sand. These soils will provide excellent support for the planned RCBC with anticipated settlements of ½-inch or less. A preliminary bearing resistance chart was developed per the methods presented in Sections 10.5 and 10.6, respectively, of AASHTO (2012), and ADOT Geotechnical Design Policy SF-1 (2010b). The bearing resistance design chart is presented in Appendix C.

5.3 Drilled Shaft Foundations

Drilled shafts are anticipated at the Beardsley Canal crossing. The axial compression resistances of the drilled-shaft foundations were determined using ADOT's Geotechnical Design Policy DS-1 memorandum (ADOT, 2010a). The ADOT memorandum outlines the development of drilled-shaft axial resistance charts based on methods specified in AASHTO LRFD Bridge Design Specifications, 5th Edition (AASHTO, 2010). The 6th Edition of the AASHTO LRFD Bridge Design Specifications (AASHTO, 2012) is the current ADOT design standard and was used for this foundation design.

The recommended design criteria presented herein are applicable to drilled, cast-in-place concrete shaft foundations. The drilled-shaft foundations for the project were designed using the Beta and intermediate geomaterial (IGM) methods based on the subsurface profiles at the bridge structure locations. A minimum drilled-shaft diameter of 4 feet is recommended to facilitate construction of the shafts. A minimum drilled-shaft embedment depth of 20 feet is recommended to provide embedment below the bottom of the adjacent canal. The drilled shaft design charts are presented in Appendix D by foundation structure.

5.3.1 Group Effects – Axial

Design criteria for reductions in axial resistance resulting from group effects are presented in Section 10.8.3.6 of the AASHTO (2012) manual. For cohesionless materials, the individual nominal resistance of each shaft in a group should be reduced by a factor, η, presented in Table 10.8.3.6.3-1 of AASHTO (2012) and reproduced in Table 5.1:

Table 5.1: Group Reduction Factors for Drilled Shafts

Shaft Group Configuration	Shaft Center-to-Center Spacing	Reduction Factor for Group Effects (η)
Single Row	2D	0.90
	3D or more	1.0
Multiple Row	2.5D	0.67
	3D	0.80
	4D or more	1.0

The design charts presented in Appendix C apply to single shafts, and therefore do not include a group reduction factor. For axial capacity reductions due to group effects, the factored loads should be increased by the inverse of the appropriate reduction factor when using the design charts.

For a single row of drilled shafts, the minimum center-to-center (CTC) spacing should be two diameters, and the appropriate reduction factors determined by linear interpolation for CTC spacing between two and three diameters. The reduction factors should be applied equally to all shafts within the group regardless of location within the group.

5.3.2 Lateral Resistance

Lateral soil-structure interaction analyses of single shafts are typically performed by modeling the lateral load-displacement behavior using a finite difference technique based on elastic beam column theory and soil reaction (p)-displacement (y) curves. The p-y curves define the behavior of the soil surrounding the laterally loaded shaft. These curves are nonlinear and are developed using soil strength, depth below ground and shaft diameter amongst other parameters. Many programs are available that use this approach with the most common locally being LPILE. The soil input parameters below are for use in LPILE.

Recommended soil input parameters for use in LPILE analyses are provided in Table 5.2 for the Beardsley Canal bridge. The soil input parameters were developed using the LPILE technical manual (Ensoft, 2019) and results of the geotechnical investigation.

Table 5.2: LPILE Input Parameters – Beardsley Canal Bridge

Stratum	Elevation [feet]	Soil Type in LPILE	Effective Unit Weight [pcf]	Friction Angle [degrees]	Cohesion [psf]	Soil Strain Ratio ε_{50}	Horizontal Subgrade Modulus, k [pci]
1	Above 1,335	Silt	120	30	100	0.020	330
2	Below 1,335	Sand	125	34	50	---	350

Notes: pcf – pounds per cubic foot; psf – pounds per square foot; pci – pounds per cubic inch.

Where embankments in front of drilled shafts slope downward away from the bridge abutment, the lateral soil resistance against drilled shafts should be reduced. It is conservatively recommended that lateral soil pressures (for loading normal to the column line) be neglected within the zone above the catch point (on the slope) of a horizontal line projected outward a distance of three shaft diameters (e.g., a horizontal distance of 12 feet to the catch point on the slope for a 4-foot-diameter shaft) from the front of the shafts.

5.3.2.1 Group Effects – Lateral

The design of laterally loaded drilled shafts must account for the influence from adjacent shafts in a group. Article 10.7.2.4 (AASHTO, 2012) defines a drilled-shaft group with respect to lateral loading as drilled shafts spaced less than five diameters CTC in the direction parallel and normal to the applied load. When the drilled shafts are in a group, the lateral resistance of the soil is reduced to account for the influence of adjacent drilled shafts by multiplying the p values of the p-y curves by P-multiplier values (P_m).

The values of P_m vary as a function of the CTC spacing and the drilled shaft position within the group. The loading direction and spacing are shown on Figure 10.7.2.4.1 from AASHTO (2012). Recommendations for P_m are shown in Table 5.3, based on AASHTO Table 10.7.2.4 1 (AASHTO, 2012) for CTC spacing of 3B and 5B. When determining P-multiplier values for two shafts of different diameters, the larger shaft diameter should be used to calculate the CTC spacing.

Table 5.3: P-Multipliers for Multiple Row Shading

CTC Spacing in the Direction of Loading	P-Multipliers, P_m		
	Row 1	Row 2	Row 3
3B	0.8	0.4	0.3
5B	1.0	0.85	0.7

Notes:

(1) B = drilled shaft diameter.

5.3.3 Drilled Shaft Construction

All construction techniques should be in accordance with Section 609 of the ADOT Standard Specifications and the project-specific special provisions. Straight, drilled shaft excavations will likely be advanced with single-flight-auger or bucket auger bits to the recommended depth. The shaft excavations should be cleaned so no more than 2 inches of slough or loose material is present in the bottom of the excavation.

Drilled shaft excavations may encounter caving conditions, difficult drilling conditions requiring increased excavation effort, and/or groundwater. The Contractor should be prepared to use temporary casing or other measures in the event such conditions exist.

5.4 Pavements

5.4.1 Existing Pavement

The east half of El Mirage Road is paved with an asphalt concrete (AC) surface from Happy Valley Road to approximately 850 feet south of Jomax. Based on a review of historic aerial photos, the pavement appears to have been placed around 2007. The thickness of the existing pavement section is currently unknown and no as-built plans were available to review.

The surface of the pavement was observed in January 2025 to preliminary evaluate the existing pavement condition. Based on these observations, the AC surface appeared to have moderate to severe weathering throughout. Moderate severity longitudinal and transverse cracking was typical throughout (spaced at 10- to 15-feet typically) with crack widths on the order of ½- to 2-inches. Isolated pavement areas appeared to have received maintenance at some point with crack sealant and surface treatments, although these treatments appear to be aged. Outside of these isolated locations, the pavement appeared to have limited maintenance. No obvious signs of subgrade related distresses (i.e., rutting, alligator cracking, etc.) were observed.

5.4.2 Preliminary Pavement Design

In general, the near-surface soils in the project area are anticipated to provide good support for pavements. The subgrade soils and thickness of the existing pavement will be confirmed during final design in accordance with the ADOT Geotechnical Project Development Manual (ADOT, 2024), along with the potential to rehabilitate the existing pavement.

Based on the existing pavement condition and age, we expect the AC surface is nearing its intended design life (i.e., 20 years typically). Additionally, the thickness of the existing section may not meet the current traffic and minimum thickness requirements for a City Arterial roadway. For preliminary planning, we recommend the existing pavement section be removed and fully reconstructed considering the pavement age and unknown overall thickness.

Evaluation of subgrade soils for El Mirage Road, including exploratory borings and laboratory testing required by ADOT, was not performed as part of the DCR phase. Design of pavements will be evaluated during final design following the methods outlined in the ADOT Pavement Manual (ADOT, 2017).

For preliminary pavement design, the near-surface soils encountered in borings at the McMicken Wash and Beardsley Canal crossings were utilized. Correlated R-values using the results of plasticity index and sieve analysis testing varied from 35 to 47 with an average 42. A preliminary design R-value of 35 was utilized which corresponds to a design resilient modulus of 21,050 pounds per square inch (psi). Preliminary traffic data for years 2030 (construction year) and 2050 was provided by B&N. Based on a review of the preliminary data, average annual daily traffic (AADT) values of 17,760 and 23,400 were utilized for years 2030 and 2050, respectively, with a corresponding growth rate of 1.4 percent over the 20 year design life. For preliminary design, 15 percent trucks (comprising 10 percent singles and 5 percent combos) were utilized and resulted in design equivalent single axle loads (ESALs) of approximately 8 million. Based on the preliminary values outlined herein, a preliminary pavement structural section including 6 inches of asphalt concrete over 12 inches aggregate base (AB) is recommended. It should be noted that this section exceeds the minimum pavement structural section required by the City for an arterial roadway.

5.5 Lateral Earth Pressures

Structures retaining soils should be designed for the lateral earth pressure imposed by the soils. The magnitude of the lateral earth pressure is a function of the backfill material, imposed surcharge loads, drainage accommodations and the rigidity of the retaining structure. The recommended lateral earth pressure values presented herein assume the backfill will be structure backfill comprised of granular soils which meet the requirements of Section 203 of the ADOT Standard Specifications. The limits of structure backfill should extend a minimum of 3 feet laterally from the back edge of all structure walls.

Walls which are free to deflect a minimum of 0.2 percent of the wall height should be designed for the full active earth pressure condition and an active equivalent fluid unit weight on the order of 35 psf per foot of wall height. Walls which are restrained from lateral movement should be designed for the at-rest condition using an equivalent fluid unit weight of 55 psf per foot of wall height.

The lateral earth pressures presented herein assume a horizontal backfill surface and do not include hydrostatic pressure or surcharge loadings which should be incorporated into the structural design in addition to the earth pressure loading. Vertical surcharge loads (e.g., traffic loading) should be added to the above earth pressures after multiplying them by an earth pressure coefficient of 0.30 for active conditions, and 0.45 for at-rest conditions. These values are based on an internal friction angle of 33 degrees for the structure backfill soils.

5.6 Slopes

5.6.1 Permanent Slopes

In general, permanent cut and fill slopes should have configurations no steeper than 3:1 (H:V). Temporary slopes should be excavated in accordance with OSHA (2020). In accordance with Subpart P, Appendix A, the existing embankment soils are generally considered to be Type C soils. For excavations less than 20 feet in such soils, Subpart P, Appendix B indicates a maximum allowable unshored slope of 1.5H:1V for Type B soils. Flatter slopes may be required where either sandy soils are encountered or where the soils become excessively wet and/or soft.

5.7 Surface Drainage

Long-term performance of pavements and structures will require that the subgrade soils and backfill be protected against excessive water infiltration and/or saturation. Surface drainage should be established away from foundations and pavements to minimize moisture infiltration into the subgrade. Structural fill and backfill should be well compacted to reduce possible moisture infiltration through loose soil intervals.

5.8 Preliminary Soil Corrosion or Degradation Potential

5.8.1 Metal in Contact with Soil

The corrosion potential of near surface soils on corrugated metal pipes was characterized using laboratory pH and electrical resistivity testing, performed on four (4) samples in accordance with Arizona Test Method 236. The laboratory pH values ranged from 8.1 to 9.6 (average 8.5). The resistivity values ranged from 790 to 2,310 ohm-centimeters (ohm-cm) (average 1,300 ohm-cm). It is recommended that the type and/or coating of metal in direct contact with soil be selected in accordance with ADOT Pipe Selection Guidelines (ADOT, 1996). The individual test results are included in Appendix B. Pipe locations where the pH is less than 6.0, greater than 9.0, and/or the resistivity is less than 2,000 ohm-cm require the use of special pipes and/or pipe coatings. Three of the tested samples had resistivity values less than 1,300 ohm-cm, based on this limited testing it does appear that specialized pipe or pipe coatings may be required. The actual soils that will be placed as bedding and backfill around pipes should be further evaluated during final design.

5.8.2 Concrete in Contact with Soil

Four (4) samples from the current investigation were tested for soluble sulfates and chlorides (Arizona Test Method 733 and Arizona Test Method 736) to support design of concrete structures. The individual test results are included in Appendix B.

Total soluble sulfate values ranged from 72 to 128 parts per million (ppm) with an average of 108 ppm. The sulfate test measures the water-leachable or "available" sulfate content. These results were compared to Table 19.3.1.1, "Exposure Categories and Classes," in Section 19.3.1, of the American Concrete Institute's (ACI's) *Building Code Requirements for Structural Concrete* (ACI 2019). All of the samples fall within Exposure Class S0 for water-soluble sulfate (SO_4^{2-}) in soil by percent mass (SO_4<0.1% or 1,000 ppm) and are categorized with a severity level of "not applicable" in terms of sulfate exposure. Based on ACI Table 19.3.2.1, "Requirements for Concrete by Exposure Class," in Section 19.3.2 (ACI 2019), there is no restriction on Portland cement type for concrete structures in contact with these materials.

Chloride values ranged from 31 to 183 ppm with an average of 143 ppm. Regarding chloride attack, Section 19.3.2 (ACI 2019) indicates that when concrete is exposed to external sources of chlorides, concrete should be proportioned to satisfy the requirements for the applicable exposure class in Table 19.3.1.1 (ACI 2019). The anticipated concrete exposure for this segment falls within Exposure Class C1. Table 19.3.2.1 (ACI 2019) should be referred to for requirements for concrete by exposure class. For Exposure Class C1, the minimum compressive strength of concrete specified is 2,500 psi and the maximum water-soluble chloride ion content in concrete, by percent weight of cement, is 0.30% for non-prestressed concrete and 0.06% for prestressed concrete.

5.8.3 Further Evaluation

The results presented in this section are general in nature and may not be representative of site conditions. We recommend that the results of our laboratory testing be reviewed by a person or firm experienced in corrosion protection designs for the actual construction at the site, and/or by the appropriate pipe or material manufacturer. A qualified corrosion engineer should be consulted if corrosion of underground utilities is a concern or if a detailed evaluation is necessary.

5.9 Earthwork

The following earthwork recommendations are intended to provide support for the proposed new RCBC, pavements, and associated embankments. The recommendations presented in this report are contingent upon performing the earthwork recommended herein. The grading activities at the site should be performed under observation and testing directed by a geotechnical engineer.

5.9.1 Site Preparation

Completely remove all vegetation (including roots) and other organics, debris, any unstable (soft, loose, disturbed, water softened, etc.) soils, any uncontrolled fill, structural elements not intended to remain, and other deleterious materials from proposed pavement, embankment and structure areas prior to construction. This site grading should extend laterally a minimum of 2 feet beyond pavement, embankment and structure areas unless noted otherwise. All areas of excavation should be observed and approved by a representative of the geotechnical engineer after clearing and before any filling operations begin at the site.

5.9.2 Subgrade Preparation

For all areas, prior to placement of fill or aggregate base, the exposed subgrade should be scarified to a minimum depth of 6 inches, adjusted to a moisture content within the range of plus or minus 2 percent of optimum, and compacted to at least 95% of maximum dry density as determined by the applicable ADOT test methods.

5.9.3 Fill Materials and Placement

In general, the existing site soils are considered suitable for reuse as embankment fill for support of foundations and pavements. Construction of embankments should be in accordance with Section 203 of the ADOT Standard Specifications (ADOT, 2021) and the project's Special Provisions. Fill material should be placed in loose lifts no thicker than 12 inches where heavy compaction equipment is used, provided compaction can be achieved throughout the lift thickness. Where hand operated compactors are used, loose lifts should not exceed 6 inches in thickness. Fill lifts should be of uniform thickness when compacted. All fill should be compacted to a minimum of 95% of the maximum dry density within plus or minus 2% of the optimum moisture content as determined per ASTM D698.

5.9.4 Structure Backfill

The limits of structure backfill placement are assumed to be the entire limits of excavations for the abutments, abutment wingwalls, and box culverts. In all cases the structure backfill should extend a minimum of 3 feet laterally from the back edge of all walls as shown on ADOT Drawing No. SD 5.02. The structure backfill material should meet the requirements of Section 203 of the ADOT Standard Specifications and those shown on ADOT Drawing No. SD 7.01. All structure backfill should be moisture conditioned to within 2 percent of the optimum moisture content and compacted to a minimum of 100 percent of the maximum ASTM D698 Standard Proctor density.

6.0 CLOSURE

The geotechnical services were performed in a manner consistent with that level of care and skill ordinarily exercised by other members of the geotechnical profession practicing in the same locality, under similar conditions and at the date the services were provided. Our conclusions, opinions and recommendations are based on the completed test borings, visual observations and the review of plans prepared by others. It is possible that conditions could vary beyond the data evaluated. Ethos makes no guarantee or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

This report may be used only by the Client and their representatives, and only for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on site and off site), or other factors may change over time, and additional work may be required with the passage of time. Any party other than the Client who wishes to use this report shall notify Ethos of such intended use. Based on the intended use of the report, Ethos may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the Client or anyone else will release Ethos from any liability resulting from the use of this report by any unauthorized party.

7.0 REFERENCES

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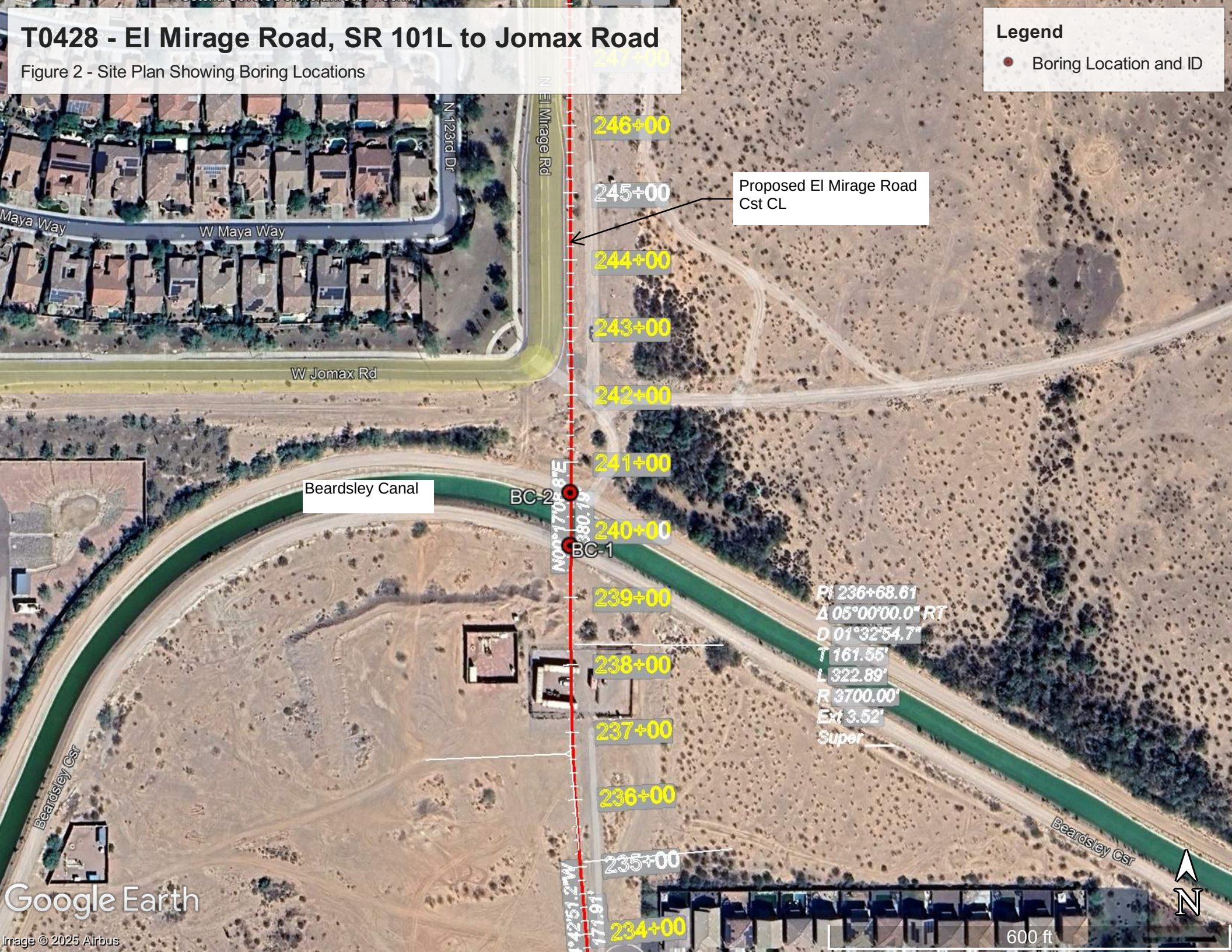
FIGURES

T0428 - El Mirage Road, SR 101L to Jomax Road

Figure 1 - Site Plan Showing Boring Locations

T0428 - El Mirage Road, SR 101L to Jomax Road

Figure 2 - Site Plan Showing Boring Locations



APPENDIX A

Boring Logs

SOILS SAMPLING & BORING LOG INFORMATION

The material and in-situ moisture descriptions of soils presented on the boring logs are based on visual observation and classification in accordance with the Unified Soil Classification System (USCS), presented on the next page. The field logs were modified, where appropriate, based on laboratory testing of selected samples.

The relative density and firmness described on the test boring logs are generally based on standard penetration test (SPT) blows per foot (N) for mostly cohesionless and cohesive soils. 2-inch outside diameter (O.D.) SPT samplers are advanced up to 18 inches into undisturbed soils beyond the base of either a hollow stem auger or drill casing. The samplers are driven with a 140-pound hammer and a 30-inch drop. SPT values are recorded on the boring logs for each 6-inch increment of penetration with sampler refusal based on a penetration of less than 6 inches and a blowcount of 50.

Relative Density

Relative density for mostly cohesionless, uncemented sands and sand and gravel mixtures is described based on the following SPT blowcounts:

N	Relative Density
0-4	Very Loose
5-10	Loose
11-30	Medium Dense
31-50	Dense
>50	Very Dense

Relative Firmness

Relative Firmness for cohesive and/or cemented soils including silts, clays and silty to clayey sandy and gravelly soils is described based on the following SPT blowcounts:

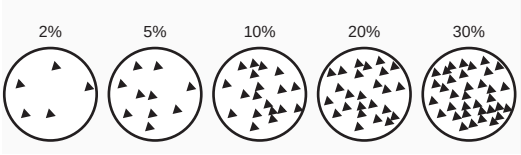
N	Relative Firmness
0-4	Very Soft
5-8	Soft
9-15	Moderately Firm
16-30	Firm
31-49	Very Firm
50+	Hard

Undisturbed samples of firmer soils, typically present in the southwest, are obtained with 3-inch O.D. samplers lined with 2.42-inch inside diameter (I.D.) brass rings. The samplers are advanced up to 12 inches into undisturbed soils beyond the base of either a hollow stem auger or drill casing. The samplers are driven with a 140-pound hammer and a 30-inch drop. The N value blowcounts are recorded on the boring logs for each 6-inch increment of penetration with sampler refusal based on a penetration of less than 12 inches and a blowcount of 100.

Boring Log Sample Type Legend:

Unified Soil Classification System
(ASTM D2487)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests				Group Symbol	Group Description
Coarse-Grained Soils (More than 50% Retained on No. 200 Sieve).	Gravels More than 50% of Coarse Fraction Retained on No. 4 Sieve	Clean Gravels Less than 5% Fines		GW	Well Graded Gravels, Gravel-Sand Mixtures or Sand-Gravel-Cobble Mixtures.
				GP	Poorly Graded Gravels, Gravel-Sand Mixtures or Sand-Gravel-Cobble Mixtures.
		Gravels with More than 12% Fines	Fines Classify as ML or MH	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			Fines Classify as CL or CH	GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sands 50% or More of Coarse Fraction Passes No. 4 Sieve	Clean Sands Less than 5% Fines		SW	Well Graded Sands, Gravelly Sands.
				SP	Poorly Graded Sands, Gravelly Sands.
		Sands with More than 12% Fines	Fines Classify as ML or MH	SM	Silty Sands, Sand-Silt Mixtures
			Fines Classify as CL or CH	SC	Clayey Sands, Sand-Clay Mixtures
Fine-Grained Soils (50% or More Passes No. 200 Sieve).	Silts and Clays (Liquid Limit less than 50)	PI > 7 and Plots on Above “A” Line		CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
		PI <4 or Plots Below “A” Line		ML	Inorganic Silts, Clayey Silts with Low Plasticity
	Silts and Clays (Liquid Limit 50 or More)	PI Plots on Above “A” Line		CH	Inorganic Clays of High Plasticity, Fat Clays, Silty and Sandy Clays of High Plasticity
		PI Plots Below “A” Line		MH	Inorganic Silts of High Plasticity, Silty Soils, Elastic Silts



Amount Modifiers

Rare	<2% (coarse only)
Occ	<5% (coarse only)
Trace	10%
Some	20%
Cons	30%

ethos ENGINEERING, LLC.	PROJECT NAME: El Mirage Road, SR 303L to Jomax Road	**BORING ID:**	**BC-1**
	PROJECT LOCATION: Sun City, AZ	AGENCY PROJECT NUMBER: T0428	
PROJECT NUMBER: 2024029	CLIENT NAME: Burgess & Niple, Inc.	DATE STARTED: 03/13/2025	DATE COMPLETED: 03/13/2025
DRILLING METHOD(S): Tubex	TOOLING: 4-1/2" OD Downhole Percussion Hammer	HAMMER TYPE: Auto	HAMMER EFFICIENCY: 85%
SURFACE ELEVATION: 1347'	STATION: 239+80 / OFFSET AND OFFSET DIRECTION: 0' (CL)		
DRILLING FIRM: Geomechanics Southwest, Inc	DRILLER: C. Feisler / FIELD ENGINEER: -	RIG TYPE: CME-85	RIG NUMBER: 118
REPORTED DEPTH: 75'	GROUNDWATER DEPTH: N/A / REVIEWED BY: J. Huston	LATITUDE: 33.72631	LONGITUDE: -112.32561
PROJECT ID: T0428	PAGE: 1 of 3 / REPORT BY: -	HIGHWAY: -	DRILLED BY: Geomechanics Southwest,…

Elevation (feet)	Depth (feet)	Graphic Log	Soil Description and Remarks	Samples: Bulk	Samples: Driven	Samples: Blow Counts/6"	Laboratory Results: Moisture Content (%)	Laboratory Results: Dry Density (pcf)	Laboratory Results: Atterberg Limits (LL-PL-PI)	Laboratory Results: Fines (%)
1345	0		**CLAYEY SAND WITH GRAVEL** (SC), trace to some fine subangular to subrounded gravel, fine to coarse subangular sand, moderate lime cementation, medium plasticity, light brown to white, slightly moist, hard			22-34-16 (50)				
						11-12 (23)	8.00		28-16-12	32
1340	5		Note: Occasional to trace fine subangular gravel and whiter color below 5 feet.			6-9-11 (20)				
1335	10					50/5"				
1330	15		Note: Some predominantly fine subangular gravel below 15 feet.			31-50/2"				
1325	20					50/2"				
1320	25		25.0 **SAND WITH SILT** (SP-SM), some fine subangular to subrounded gravel, predominantly fine to medium subangular sand, nonplastic, brown, moist, dense			4-9-26 (35)	3.30		NP	5.1
1315	30					50/5"				

ethos ENGINEERING, LLC	PROJECT NAME: El Mirage Road, SR 303L to Jomax Road		**BORING ID: BC-1**
	PROJECT LOCATION: Sun City, AZ		AGENCY PROJECT NUMBER: T0428
PROJECT NUMBER: 2024029	CLIENT NAME: Burgess & Niple, Inc.		DATE STARTED: 03/13/2025 / DATE COMPLETED: 03/13/2025
DRILLING METHOD(S): Tubex	TOOLING: 4-1/2" OD Downhole Percussion Hammer		HAMMER TYPE: Auto / HAMMER EFFICIENCY: 85%
SURFACE ELEVATION: 1347'	STATION: 239+80	OFFSET AND OFFSET DIRECTION: 0' (CL)	
DRILLING FIRM: Geomechanics Southwest, Inc	DRILLER: C. Feisler	FIELD ENGINEER: -	RIG TYPE: CME-85 / RIG NUMBER: 118
REPORTED DEPTH: 75'	GROUNDWATER DEPTH: N/A	REVIEWED BY: J. Huston	LATITUDE: 33.72631 / LONGITUDE: -112.32561
PROJECT ID: T0428	PAGE: 2 of 3	REPORT BY: -	HIGHWAY: - / DRILLED BY: Geomechanics Southwest,…

Elevation (feet)	Depth (feet)	Graphic Log	Soil Description and Remarks	Samples: Bulk	Samples: Driven	Samples: Blow Counts/6"	Laboratory Results: Moisture Content (%)	Laboratory Results: Dry Density (pcf)	Laboratory Results: Atterberg Limits (LL-PL-PI)	Laboratory Results: Fines (%)
			... continued from previous page **SAND WITH SILT** (SP-SM), some fine subangular to subrounded gravel, predominantly fine to medium subangular sand, nonplastic, brown, moist, dense							
	35		35.0 **GRAVEL WITH SILT AND SAND** (GP-GM), fine to coarse subangular to subrounded gravel, predominantly fine to medium subangular to subrounded sand, nonplastic, gray to light brown, slightly moist, very dense			40-50/3"				
1310										
	40					50/4"				
1305										
	45					50/5"				
1300										
	50					50/5"				
1295										
	55					12-50/4"	8.10		NP	5.8
1290										
	60					50/2"				
1285										

ethos ENGINEERING, LLC.	PROJECT NAME: El Mirage Road, SR 303L to Jomax Road		**BORING ID: BC-1**
	PROJECT LOCATION: Sun City, AZ		AGENCY PROJECT NUMBER: T0428
PROJECT NUMBER: 2024029	CLIENT NAME: Burgess & Niple, Inc.		DATE STARTED: 03/13/2025 / DATE COMPLETED: 03/13/2025
DRILLING METHOD(S): Tubex	TOOLING: 4-1/2" OD Downhole Percussion Hammer		HAMMER TYPE: Auto / HAMMER EFFICIENCY: 85%
SURFACE ELEVATION: 1347'	STATION: 239+80	OFFSET AND OFFSET DIRECTION: 0' (CL)	
DRILLING FIRM: Geomechanics Southwest, Inc	DRILLER: C. Feisler	FIELD ENGINEER: -	RIG TYPE: CME-85 / RIG NUMBER: 118
REPORTED DEPTH: 75'	GROUNDWATER DEPTH: N/A	REVIEWED BY: J. Huston	LATITUDE: 33.72631 / LONGITUDE: -112.32561
PROJECT ID: T0428	PAGE: 3 of 3	REPORT BY: -	HIGHWAY: - / DRILLED BY: Geomechanics Southwest,…

Elevation (feet)	Depth (feet)	Graphic Log	Soil Description and Remarks	Samples: Bulk	Samples: Driven	Samples: Blow Counts/6"	Laboratory Results: Moisture Content (%)	Laboratory Results: Dry Density (pcf)	Laboratory Results: Atterberg Limits (LL-PL-PI)	Laboratory Results: Fines (%)
1280			... continued from previous page **GRAVEL WITH SILT AND SAND** (GP-GM), fine to coarse subangular to subrounded gravel, predominantly fine to medium subangular to subrounded sand, nonplastic, gray to light brown, slightly moist, very dense Note: Red color and light HCL reaction below 65 feet.			50/5"				
	70									
1275						9-29-50/1"				
	75		75.0 Hammer stopped at 75 feet. Sampler stopped at 75.3 feet. Backfilled with 1-sack cement slurry full depth.							

ethos ENGINEERING, LLC.	PROJECT NAME: El Mirage Road, SR 303L to Jomax Road		**BORING ID: BC-2**
	PROJECT LOCATION: Sun City, AZ		AGENCY PROJECT NUMBER: T0428
PROJECT NUMBER: 2024029	CLIENT NAME: Burgess & Niple, Inc.		DATE STARTED: 03/10/2025 / DATE COMPLETED: 03/10/2025
DRILLING METHOD(S): Tubex	TOOLING: 4-1/4" ID Hollow Stem Auger		HAMMER TYPE: Auto / HAMMER EFFICIENCY: 85%
SURFACE ELEVATION: 1350'	STATION: 240+20	OFFSET AND OFFSET DIRECTION: 0' (CL)	-
DRILLING FIRM: Geomechanics Southwest, Inc	DRILLER: C. Feisler	FIELD ENGINEER: -	RIG TYPE: CME-85 / RIG NUMBER: 118
REPORTED DEPTH: 75'	GROUNDWATER DEPTH: N/A	REVIEWED BY: J. Huston	LATITUDE: 33.7266 / LONGITUDE: -112.32563
PROJECT ID: T0428	PAGE: 1 of 3	REPORT BY: -	HIGHWAY: - / DRILLED BY: Geomechanics Southwest,…

Elevation (feet)	Depth (feet)	Graphic Log	Soil Description and Remarks	Samples: Bulk	Samples: Driven	Samples: Blow Counts/6"	Laboratory Results: Moisture Content (%)	Laboratory Results: Dry Density (pcf)	Laboratory Results: Atterberg Limits (LL-PL-PI)	Laboratory Results: Fines (%)
1345	0		**CLAYEY SAND WITH GRAVEL** (SC), trace to some fine subangular to subrounded gravel, fine to coarse subangular sand, weak lime cementation, low plasticity, light brown, slightly moist, firm, weak reaction with HCl			5-11-19 (30)				
							6.60		30-17-13	39
						4-11-19 (22)				
	5					19-20				
1340			10.0							
	10		**GRAVEL WITH SAND** (GP), trace to some subangular sand, fine to coarse subangular gravel, moderate lime cementation, nonplastic, gray to brown, slightly moist, very dense			36-50/3"				
1335										
	15					50/5"	4.80		NP	4
1330										
	20					24-50/4"				
1325										
	25					30-40-50/2"				
1320										
	30					12-50/5"				

ethos ENGINEERING, LLC.	PROJECT NAME: El Mirage Road, SR 303L to Jomax Road		**BORING ID: BC-2**
	PROJECT LOCATION: Sun City, AZ		AGENCY PROJECT NUMBER: T0428
PROJECT NUMBER: 2024029	CLIENT NAME: Burgess & Niple, Inc.		DATE STARTED: 03/10/2025 / DATE COMPLETED: 03/10/2025
DRILLING METHOD(S): Tubex	TOOLING: 4-1/4" ID Hollow Stem Auger		HAMMER TYPE: Auto / HAMMER EFFICIENCY: 85%
SURFACE ELEVATION: 1350'	STATION: 240+20	OFFSET AND OFFSET DIRECTION: 0' (CL)	-
DRILLING FIRM: Geomechanics Southwest, Inc	DRILLER: C. Feisler	FIELD ENGINEER: -	RIG TYPE: CME-85 / RIG NUMBER: 118
REPORTED DEPTH: 75'	GROUNDWATER DEPTH: N/A	REVIEWED BY: J. Huston	LATITUDE: 33.7266 / LONGITUDE: -112.32563
PROJECT ID: T0428	PAGE: 2 of 3	REPORT BY: -	HIGHWAY: - / DRILLED BY: Geomechanics Southwest,…

Elevation (feet)	Depth (feet)	Graphic Log	Soil Description and Remarks	Samples: Bulk	Samples: Driven	Samples: Blow Counts/6"	Laboratory Results: Moisture Content (%)	Laboratory Results: Dry Density (pcf)	Laboratory Results: Atterberg Limits (LL-PL-PI)	Laboratory Results: Fines (%)
			... continued from previous page							
1315	35		**GRAVEL WITH SAND** (GP), trace to some subangular sand, fine to coarse subangular gravel, moderate lime cementation, nonplastic, gray to brown, slightly moist, very dense			21-50/1"				
1310	40					50/3"				
			Note: Medium plasticity clay lense from 42 to 44 feet.							
1305	45					35-50/3"				
			Note: Some to considerable fine to coarse subangular sand, light brown to gray below 45.5 feet.							
1300	50					50/5"				
1295	55					50/1"				
			Note: Fine to coarse subangular to subrounded gravel below 55 feet.							
1290	60					50/4"				
			Note: Fine subangular to subrounded gravel below 60 feet.							

ethos ENGINEERING, LLC	**PROJECT NAME:** El Mirage Road, SR 303L to Jomax Road		**BORING ID: BC-2**
	PROJECT LOCATION: Sun City, AZ		AGENCY PROJECT NUMBER: T0428
PROJECT NUMBER: 2024029	CLIENT NAME: Burgess & Niple, Inc.	DATE STARTED: 03/10/2025	DATE COMPLETED: 03/10/2025
DRILLING METHOD(S): Tubex	TOOLING: 4-1/4" ID Hollow Stem Auger	HAMMER TYPE: Auto	HAMMER EFFICIENCY: 85%
SURFACE ELEVATION: 1350'	STATION: 240+20 / OFFSET AND OFFSET DIRECTION: 0' (CL)		-
DRILLING FIRM: Geomechanics Southwest, Inc	DRILLER: C. Feisler / FIELD ENGINEER: -	RIG TYPE: CME-85	RIG NUMBER: 118
REPORTED DEPTH: 75'	GROUNDWATER DEPTH: N/A / REVIEWED BY: J. Huston	LATITUDE: 33.7266	LONGITUDE: -112.32563
PROJECT ID: T0428	PAGE: 3 of 3 / REPORT BY: -	HIGHWAY: -	DRILLED BY: Geomechanics Southwest,…

Elevation (feet)	Depth (feet)	Graphic Log	Soil Description and Remarks	Samples: Bulk	Samples: Driven	Samples: Blow Counts/6"	Laboratory Results: Moisture Content (%)	Laboratory Results: Dry Density (pcf)	Laboratory Results: Atterberg Limits (LL-PL-PI)	Laboratory Results: Fines (%)
			... continued from previous page **GRAVEL WITH SAND** (GP), trace to some subangular sand, fine to coarse subangular gravel, moderate lime cementation, nonplastic, gray to brown, slightly moist, very dense Note: Predominantly fine to medium subangular sand below 65 feet.			24-50/4"				
1280	70					36-50/4"	0.00		NP	0
1275	75		75.3			50/3"				
			Hammer stopped at 75 feet. Sampler stopped at 75.3 feet. Backfilled with 1-sack cement grout-bentonite slurry full depth.							

ethos ENGINEERING, LLC.	PROJECT NAME: El Mirage Road, SR 303L to Jomax Road		**BORING ID: MW-1**
	PROJECT LOCATION: Sun City, AZ		AGENCY PROJECT NUMBER: T0428
PROJECT NUMBER: 2024029	CLIENT NAME: Burgess & Niple, Inc.		DATE STARTED: 03/11/2025 / DATE COMPLETED: 03/12/2025
DRILLING METHOD(S): Tubex	TOOLING: 4-1/4" ID Hollow Stem Auger		HAMMER TYPE: Auto / HAMMER EFFICIENCY: 85%
SURFACE ELEVATION: 1305'	STATION: 162+80	OFFSET AND OFFSET DIRECTION: 0' (CL)	-
DRILLING FIRM: Geomechanics Southwest, Inc	DRILLER: C. Feisler	FIELD ENGINEER: -	RIG TYPE: CME-85 / RIG NUMBER: 118
REPORTED DEPTH: 75'	GROUNDWATER DEPTH: N/A	REVIEWED BY: J. Huston	LATITUDE: 33.70719 / LONGITUDE: -112.33041
PROJECT ID: T0428	PAGE: 1 of 3	REPORT BY: -	HIGHWAY: - / DRILLED BY: Geomechanics Southwest,…

Elevation (feet)	Depth (feet)	Graphic Log	Soil Description and Remarks	Samples: Bulk	Samples: Driven	Samples: Blow Counts/6"	Laboratory Results: Moisture Content (%)	Laboratory Results: Dry Density (pcf)	Laboratory Results: Atterberg Limits (LL-PL-PI)	Laboratory Results: Fines (%)
1300	0		**SILTY, CLAYEY SAND** (SC-SM), trace fine subangular to subrounded gravel, predominantly fine to medium sand, nonplastic to low plasticity, light brown, slightly moist, soft, weak reaction with HCl			2-2-2 (4)				
						4-5-4 (9)	3.60		23-19-4	43
	5					6-17				
1295			10.0							
	10		**GRAVEL WITH CLAY AND SAND** (GP-GC), considerable fine to coarse sand, fine to coarse subangular gravel, moderate cementation, low plasticity, light brown to white, slightly moist, dense			5-16-29	3.00		30-21-9	7.8
1290	15					50/3"				
1285	20					20-50/2"				
1280	25					17-24-15				
1275	30					50/5"				

ethos ENGINEERING, LLC.	PROJECT NAME: El Mirage Road, SR 303L to Jomax Road		**BORING ID: MW-1**
	PROJECT LOCATION: Sun City, AZ		AGENCY PROJECT NUMBER: T0428
PROJECT NUMBER: 2024029	CLIENT NAME: Burgess & Niple, Inc.		DATE STARTED: 03/11/2025 / DATE COMPLETED: 03/12/2025
DRILLING METHOD(S): Tubex	TOOLING: 4-1/4" ID Hollow Stem Auger		HAMMER TYPE: Auto / HAMMER EFFICIENCY: 85%
SURFACE ELEVATION: 1305'	STATION: 162+80	OFFSET AND OFFSET DIRECTION: 0' (CL)	-
DRILLING FIRM: Geomechanics Southwest, Inc	DRILLER: C. Feisler	FIELD ENGINEER: -	RIG TYPE: CME-85 / RIG NUMBER: 118
REPORTED DEPTH: 75'	GROUNDWATER DEPTH: N/A	REVIEWED BY: J. Huston	LATITUDE: 33.70719 / LONGITUDE: -112.33041
PROJECT ID: T0428	PAGE: 2 of 3	REPORT BY: -	HIGHWAY: - / DRILLED BY: Geomechanics Southwest,…

Elevation (feet)	Depth (feet)	Graphic Log	Soil Description and Remarks	Samples: Bulk	Samples: Driven	Samples: Blow Counts/6"	Laboratory Results: Moisture Content (%)	Laboratory Results: Dry Density (pcf)	Laboratory Results: Atterberg Limits (LL-PL-PI)	Laboratory Results: Fines (%)
1270	35		... continued from previous page **GRAVEL WITH CLAY AND SAND** (GP-GC), considerable fine to coarse sand, fine to coarse subangular gravel, moderate cementation, low plasticity, light brown to white, slightly moist, dense			10-22-23	5.30		31-17-14	9.5
1265	40					50/2"				
1260	45					50/5"				
1255	50					50/5"				
1250	55		55.0 **CLAYEY SAND WITH GRAVEL** (SC), trace fine subangular gravel, predominantly medium to coarse subangular sand, low to medium plasticity, light brown, slightly moist			16-50/4"				
1245	60					27-50/3"				

ethos ENGINEERING, LLC.	**PROJECT NAME:** El Mirage Road, SR 303L to Jomax Road		**BORING ID: MW-1**
	PROJECT LOCATION: Sun City, AZ		AGENCY PROJECT NUMBER: T0428
PROJECT NUMBER: 2024029	CLIENT NAME: Burgess & Niple, Inc.	DATE STARTED: 03/11/2025	DATE COMPLETED: 03/12/2025
DRILLING METHOD(S): Tubex	TOOLING: 4-1/4" ID Hollow Stem Auger	HAMMER TYPE: Auto	HAMMER EFFICIENCY: 85%
SURFACE ELEVATION: 1305'	STATION: 162+80 / OFFSET AND OFFSET DIRECTION: 0' (CL)		-
DRILLING FIRM: Geomechanics Southwest, Inc	DRILLER: C. Feisler / FIELD ENGINEER: -	RIG TYPE: CME-85	RIG NUMBER: 118
REPORTED DEPTH: 75'	GROUNDWATER DEPTH: N/A / REVIEWED BY: J. Huston	LATITUDE: 33.70719	LONGITUDE: -112.33041
PROJECT ID: T0428	PAGE: 3 of 3 / REPORT BY: -	HIGHWAY: -	DRILLED BY: Geomechanics Southwest,…

Elevation (feet)	Depth (feet)	Graphic Log	Soil Description and Remarks	Samples: Bulk	Samples: Driven	Samples: Blow Counts/6"	Laboratory Results: Moisture Content (%)	Laboratory Results: Dry Density (pcf)	Laboratory Results: Atterberg Limits (LL-PL-PI)	Laboratory Results: Fines (%)
			... continued from previous page			50/5"				
1235	70		**CLAYEY SAND WITH GRAVEL** (SC), trace fine subangular gravel, predominantly medium to coarse subangular sand, low to medium plasticity, light brown, slightly moist			50/5"				
1230	75		75.3			50/3"				

Hammer stopped at 75 feet. Sampler stopped at 75.3 feet.
Backfilled with 1-sack cement-bentonite slurry full depth.

ethos ENGINEERING, LLC.	PROJECT NAME: El Mirage Road, SR 303L to Jomax Road	**BORING ID:**	**MW-2**
	PROJECT LOCATION: Sun City, AZ	AGENCY PROJECT NUMBER: T0428	
PROJECT NUMBER: 2024029	CLIENT NAME: Burgess & Niple, Inc.	DATE STARTED: 03/12/2025	DATE COMPLETED: 03/13/2025
DRILLING METHOD(S): Tubex	TOOLING: 4-1/4" ID Hollow Stem Auger	HAMMER TYPE: Auto	HAMMER EFFICIENCY: 85%
SURFACE ELEVATION: 1307'	STATION: 165+60 / OFFSET AND OFFSET DIRECTION: 0' (CL)		-
DRILLING FIRM: Geomechanics Southwest, Inc	DRILLER: C. Feisler / FIELD ENGINEER: -	RIG TYPE: CME-85	RIG NUMBER: 118
REPORTED DEPTH: 75'	GROUNDWATER DEPTH: N/A / REVIEWED BY: J. Huston	LATITUDE: 33.70747	LONGITUDE: -112.32956
PROJECT ID: T0428	PAGE: 1 of 3 / REPORT BY: -	HIGHWAY: -	DRILLED BY: Geomechanics Southwest,…

Elevation (feet)	Depth (feet)	Graphic Log	Soil Description and Remarks	Samples: Bulk	Samples: Driven	Samples: Blow Counts/6"	Laboratory Results: Moisture Content (%)	Laboratory Results: Dry Density (pcf)	Laboratory Results: Atterberg Limits (LL-PL-PI)	Laboratory Results: Fines (%)
1305	0		**CLAYEY SAND WITH GRAVEL** (SC), considerable fine subangular gravel, fine to coarse sand, weak lime cementation, medium plasticity, light brown, slightly moist, firm			2-8-16 (24)				
						10-50/5"	3.00		33-20-13	18
	5		5.0							
1300			**GRAVEL WITH CLAY AND SAND** (GP-GC), considerable fine to coarse subangular sand, fine to coarse subangular gravel, moderate cementation, low plasticity, gray to light brown, slightly moist, very dense			44-50/2"				
	10					27-50/4"				
1295										
	15					50/4"				
1290										
	20					38-50/2"				
1285										
	25					50/3"				
1280										
	30					34-50/2"				
1275										

ethos ENGINEERING, LLC	PROJECT NAME: El Mirage Road, SR 303L to Jomax Road		**BORING ID: MW-2**
	PROJECT LOCATION: Sun City, AZ		AGENCY PROJECT NUMBER: T0428
PROJECT NUMBER: 2024029	CLIENT NAME: Burgess & Niple, Inc.		DATE STARTED: 03/12/2025 / DATE COMPLETED: 03/13/2025
DRILLING METHOD(S): Tubex	TOOLING: 4-1/4" ID Hollow Stem Auger		HAMMER TYPE: Auto / HAMMER EFFICIENCY: 85%
SURFACE ELEVATION: 1307'	STATION: 165+60	OFFSET AND OFFSET DIRECTION: 0' (CL)	-
DRILLING FIRM: Geomechanics Southwest, Inc	DRILLER: C. Feisler	FIELD ENGINEER: -	RIG TYPE: CME-85 / RIG NUMBER: 118
REPORTED DEPTH: 75'	GROUNDWATER DEPTH: N/A	REVIEWED BY: J. Huston	LATITUDE: 33.70747 / LONGITUDE: -112.32956
PROJECT ID: T0428	PAGE: 2 of 3	REPORT BY: -	HIGHWAY: - / DRILLED BY: Geomechanics Southwest,…

Elevation (feet)	Depth (feet)	Graphic Log	Soil Description and Remarks	Samples: Bulk	Samples: Driven	Samples: Blow Counts/6"	Laboratory Results: Moisture Content (%)	Laboratory Results: Dry Density (pcf)	Laboratory Results: Atterberg Limits (LL-PL-PI)	Laboratory Results: Fines (%)
			... continued from previous page							
	35		**GRAVEL WITH CLAY AND SAND** (GP-GC), considerable fine to coarse subangular sand, fine to coarse subangular gravel, moderate cementation, low plasticity, gray to light brown, slightly moist, very dense			50/5"				
1270										
	40		Note: Light reddish-brown, uncemented below 40 feet.			31-50/3"				
1265										
	45					24-50/2"				
1260										
	50		50.0 **CLAYEY SAND WITH GRAVEL** (SC), considerable predominantly fine subangular to subrounded gravel, fine to coarse subangular sand, medium plasticity, light reddish brown, slightly moist to moist, very dense			35-50/3"				
1255										
	55					31-29-40	8.90		39-17-22	16
1250										
	60					50/5"				
1245										

ethos ENGINEERING, LLC.	PROJECT NAME: El Mirage Road, SR 303L to Jomax Road		**BORING ID: MW-2**
	PROJECT LOCATION: Sun City, AZ		AGENCY PROJECT NUMBER: T0428
PROJECT NUMBER: 2024029	CLIENT NAME: Burgess & Niple, Inc.	DATE STARTED: 03/12/2025	DATE COMPLETED: 03/13/2025
DRILLING METHOD(S): Tubex	TOOLING: 4-1/4" ID Hollow Stem Auger	HAMMER TYPE: Auto	HAMMER EFFICIENCY: 85%
SURFACE ELEVATION: 1307'	STATION: 165+60 / OFFSET AND OFFSET DIRECTION: 0' (CL)		-
DRILLING FIRM: Geomechanics Southwest, Inc	DRILLER: C. Feisler / FIELD ENGINEER: -	RIG TYPE: CME-85	RIG NUMBER: 118
REPORTED DEPTH: 75'	GROUNDWATER DEPTH: N/A / REVIEWED BY: J. Huston	LATITUDE: 33.70747	LONGITUDE: -112.32956
PROJECT ID: T0428	PAGE: 3 of 3 / REPORT BY: -	HIGHWAY: -	DRILLED BY: Geomechanics Southwest,…

Elevation (feet)	Depth (feet)	Graphic Log	Soil Description and Remarks	Samples: Bulk	Samples: Driven	Samples: Blow Counts/6"	Laboratory Results: Moisture Content (%)	Laboratory Results: Dry Density (pcf)	Laboratory Results: Atterberg Limits (LL-PL-PI)	Laboratory Results: Fines (%)
			... continued from previous page							
1240			**CLAYEY SAND WITH GRAVEL** (SC), considerable predominantly fine subangular to subrounded gravel, fine to coarse subangular sand, medium plasticity, light reddish brown, slightly moist to moist, very dense			50/5"				
1235	70					32-50/2"				
	75		75.8			34-50/4"	10.10		34-19-15	15

Hammer stopped at 75 feet. Sampler stopped at 75.8 feet.
Backfilled with 1-sack cement-bentonite slurry full depth.

APPENDIX B

Laboratory Test Results

TABLE B-1: SUMMARY OF LABORATORY TEST RESULTS

Boring Number	Sample Depth [feet]		USCS/Group Symbol (ASTM D2487)	Percent Fines (minus #200) (ASTM C136)	Liquid Limit (ASTM D4318)	Plasticity Index (ASTM D4318)	Moisture Content [%] (ASTM D2216/T265)	Direct Shear (ASTM D3080)	pH (AZ 236)	Resistivity [ohm-cm] (AZ 236)	Sulfates [ppm] (AZ 733)	Chlorides [ppm] (AZ 736)
	Begin	End										
BC-1	0.0	5.0	SC	32	28	12	8.0		8.1	870	113	86
BC-1	2.5	3.5						X				
BC-1	25.0	26.5	SP-SM	5.1	NV	NP	3.3					
BC-1	55.0	55.8	GP-GM	5.8	NV	NP	8.1					
BC-2	0.0	5.0	SC	39	30	13	6.6		8.1	790	108	67
BC-2	5.0	6.0						X				
BC-2	15.0	15.4	GP	4	NV	NP	4.8					
BC-2	70.0	70.8	GP	0	NV	NP	0.0					
MW-1	0.0	5.0	SC-SM	43	23	4	3.6		8.2	2,310	72	31
MW-1	10.0	11.5	GP-GC	7.8	30	9	3.0					
MW-1	35.0	36.5	GP-GC	9.5	31	14	5.3					
MW-2	0.0	5.0	SC	18	33	13	3.0		9.6	1,230	128	183
MW-2	55.0	56.5	SC	16	39	22	8.9					
MW-2	75.0	75.8	SC	15	34	15	10.1					
			Average	**16.3**	**31.0**	**12.8**	**5.4**	**--**	**8.5**	**1,300**	**105**	**92**
			Standard Deviation	**14.3**	**4.7**	**5.1**	**3.0**	**--**	**0.7**	**700**	**24**	**65**
			Maximum	**43.0**	**39.0**	**22.0**	**10.1**	**--**	**9.6**	**2,310**	**128**	**183**
			Minimum	**0.0**	**23.0**	**4.0**	**0.0**	**--**	**8.1**	**790**	**72**	**31**
			Count	**12**	**12**	**12**	**12**	**2**	**4**	**4**	**4**	**4**

Notes: pcf = pounds per cubic foot; ohm-cm = ohm-centimeters; ppm = parts per million

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2501255	Material Type:	Soils
ACS Lab #	25-2080-7	Supplier:	Client
Client:	Ethos Engineering, LLC	Sample Date:	3/26/2025
Project Name:	El Mirage Road, SR 303L to Jomax Road	Sampled By:	Client
Project Address:	SEE WO	Test Date:	4/8/2025
Project City	Maricopa County	Tested By:	Mahalia Davis
Sample Location:	BC-1 @ 0 - 5	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	0	100	
1/2"	2	98	
3/8"	5	93	
1/4"	6	87	
#4	5	83	
#8	9	73	
#10	2	71	
#16	8	63	
#30	10	53	
#40	4	49	
#50	4	45	
#100	7	38	
#200	7	32	

Liquid Limit (ASTM D4318)	28
Plastic Limit (ASTM D4318)	16
Plasticity Index (ASTM D4318)	12
Moisture Content (ASTM D2216)	8.0
USCS Soil Classification	SC

Group Name (ASTM D2487)
Clayey SAND with gravel

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2501255	Material Type:	Soils
ACS Lab #	25-2080-9	Supplier:	Client
Client:	Ethos Engineering, LLC	Sample Date:	3/26/2025
Project Name:	El Mirage Road, SR 303L to Jomax Road	Sampled By:	Client
Project Address:	SEE WO	Test Date:	4/8/2025
Project City	Maricopa County	Tested By:	Mahalia Davis
Sample Location:	BC-1 @ 25-26.5	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	6	94	
1/2"	7	87	
3/8"	3	84	
1/4"	4	80	
#4	2	77	
#8	4	73	
#10	1	72	
#16	5	67	
#30	25	42	
#40	17	25	
#50	11	14	
#100	6	8	
#200	2	5.1	

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Plasticity Index (ASTM D4318)	NP
Moisture Content (ASTM D2216)	3.3
USCS Soil Classification	SP-SM

Group Name (ASTM D2487)
Poorly graded SAND with silt and gravel

Testing sizes reduced from standard minimums due to lack of material

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2501255	Material Type:	Soils
ACS Lab #	25-2080-10	Supplier:	Client
Client:	Ethos Engineering, LLC	Sample Date:	3/26/2025
Project Name:	El Mirage Road, SR 303L to Jomax Road	Sampled By:	Client
Project Address:	SEE WO	Test Date:	4/9/2025
Project City	Maricopa County	Tested By:	Mahalia Davis
Sample Location:	BC-1 @ 55-55.8	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	15	85	
3/4"	10	75	
1/2"	21	54	
3/8"	0	54	
1/4"	5	48	
#4	2	46	
#8	9	37	
#10	2	35	
#16	3	32	
#30	7	25	
#40	6	20	
#50	6	14	
#100	6	8	
#200	2	5.8	

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Plasticity Index (ASTM D4318)	NP
Moisture Content (ASTM D2216)	8.1
USCS Soil Classification	GP-GM

Group Name (ASTM D2487)
Poorly graded GRAVEL with silt and sand

Testing sizes reduced from standard minimums due to lack of material

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2501255	Material Type:	Soils
ACS Lab #	25-2080-11	Supplier:	Client
Client:	Ethos Engineering, LLC	Sample Date:	3/26/2025
Project Name:	El Mirage Road, SR 303L to Jomax Road	Sampled By:	Client
Project Address:	SEE WO	Test Date:	4/8/2025
Project City	Maricopa County	Tested By:	Mahalia Davis
Sample Location:	BC-2 @ 0 - 5	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	1	99	
3/4"	1	99	
1/2"	3	95	
3/8"	4	91	
1/4"	6	85	
#4	4	81	
#8	8	73	
#10	2	71	
#16	5	66	
#30	6	60	
#40	3	57	
#50	6	51	
#100	4	47	
#200	8	39	

Liquid Limit (ASTM D4318)	30
Plastic Limit (ASTM D4318)	17
Plasticity Index (ASTM D4318)	13
Moisture Content (ASTM D2216)	6.6
USCS Soil Classification	SC

Group Name (ASTM D2487)
Clayey SAND with gravel

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2501255	Material Type:	Soils
ACS Lab #	25-2080-13	Supplier:	Client
Client:	Ethos Engineering, LLC	Sample Date:	3/26/2025
Project Name:	El Mirage Road, SR 303L to Jomax Road	Sampled By:	Client
Project Address:	SEE WO	Test Date:	4/8/2025
Project City	Maricopa County	Tested By:	Mahalia Davis
Sample Location:	BC-2 @ 15 - 15.4	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	22	78	
3/4"	5	74	
1/2"	23	51	
3/8"	8	43	
1/4"	5	38	
#4	2	36	
#8	5	31	
#10	1	30	
#16	5	25	
#30	7	17	
#40	4	13	
#50	3	10	
#100	4	6	
#200	2	4.0	

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Plasticity Index (ASTM D4318)	NP
Moisture Content (ASTM D2216)	4.8
USCS Soil Classification	GP

Group Name (ASTM D2487)
Poorly graded GRAVEL with sand

Testing sizes reduced from standard minimums due to lack of material

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2501255	Material Type:	Soils
ACS Lab #	25-2080-14	Supplier:	Client
Client:	Ethos Engineering, LLC	Sample Date:	3/26/2025
Project Name:	El Mirage Road, SR 303L to Jomax Road	Sampled By:	Client
Project Address:	SEE WO	Test Date:	4/14/2025
Project City	Maricopa County	Tested By:	Keagen Mayfield
Sample Location:	BC-2 @ 70 - 70.8	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	33	67	
3/4"	48	19	
1/2"	3	15	
3/8"	11	5	
1/4"	4	0	
#4	0	0	
#8	0	0	
#10	0	0	
#16	0	0	
#30	0	0	
#40	0	0	
#50	0	0	
#100	0	0	
#200	0	0	

Liquid Limit (ASTM D4318)	
Plastic Limit (ASTM D4318)	
Plasticity Index (ASTM D4318)	NP
Moisture Content (ASTM D2216)	0.0
USCS Soil Classification	GP

Group Name (ASTM D2487)
Poorly graded GRAVEL

Testing sizes reduced from standard minimums due to lack of material

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2501255	Material Type:	Soils
ACS Lab #	25-2080-1	Supplier:	Client
Client:	Ethos Engineering, LLC	Sample Date:	3/26/2025
Project Name:	El Mirage Road, SR 303L to Jomax Road	Sampled By:	Client
Project Address:	SEE WO	Test Date:	4/7/2025
Project City	Maricopa County	Tested By:	Austin Archibald
Sample Location:	MW-1 @ 0 - 5	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)

Sieve Size	% Retained	% Passed	Specs
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	0	100	
1/2"	0	99	
3/8"	1	99	
1/4"	1	98	
#4	1	97	
#8	2	94	
#10	1	93	
#16	4	89	
#30	8	82	
#40	5	76	
#50	7	70	
#100	13	57	
#200	13	43	

Liquid Limit (ASTM D4318)	23
Plastic Limit (ASTM D4318)	19
Plasticity Index (ASTM D4318)	4
Moisture Content (ASTM D2216)	3.6
USCS Soil Classification	SC-SM

Group Name (ASTM D2487)
Silty, clayey SAND

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2501255	Material Type:	Soils
ACS Lab #	25-2080-2	Supplier:	Client
Client:	Ethos Engineering, LLC	Sample Date:	3/26/2025
Project Name:	El Mirage Road, SR 303L to Jomax Road	Sampled By:	Client
Project Address:	SEE WO	Test Date:	4/7/2025
Project City	Maricopa County	Tested By:	Austin Archibald
Sample Location:	MW-1 @ 10 - 11.5	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	7	93	
3/4"	19	74	
1/2"	18	57	
3/8"	10	47	
1/4"	9	38	
#4	4	34	
#8	8	26	
#10	1	25	
#16	3	22	
#30	5	17	
#40	3	14	
#50	2	12	
#100	3	10	
#200	2	7.8	

Liquid Limit (ASTM D4318)	30
Plastic Limit (ASTM D4318)	21
Plasticity Index (ASTM D4318)	9
Moisture Content (ASTM D2216)	3.0
USCS Soil Classification	GP-GC

Group Name (ASTM D2487)
Poorly graded GRAVEL with clay and sand

Testing sizes reduced from standard minimums due to lack of material

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2501255	Material Type:	Soils
ACS Lab #	25-2080-3	Supplier:	Client
Client:	Ethos Engineering, LLC	Sample Date:	3/26/2025
Project Name:	El Mirage Road, SR 303L to Jomax Road	Sampled By:	Client
Project Address:	SEE WO	Test Date:	4/7/2025
Project City	Maricopa County	Tested By:	Austin Archibald
Sample Location:	MW-1 @ 35 - 36.5	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	13	87	
3/4"	4	83	
1/2"	13	70	
3/8"	9	61	
1/4"	10	52	
#4	6	46	
#8	11	35	
#10	2	33	
#16	6	27	
#30	6	21	
#40	2	19	
#50	2	16	
#100	4	12	
#200	3	9.5	

Liquid Limit (ASTM D4318)	31
Plastic Limit (ASTM D4318)	17
Plasticity Index (ASTM D4318)	14
Moisture Content (ASTM D2216)	5.3
USCS Soil Classification	GP-GC

Group Name (ASTM D2487)
Poorly graded GRAVEL with clay and sand

Testing sizes reduced from standard minimums due to lack of material

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2501255	Material Type:	Soils
ACS Lab #	25-2080-4	Supplier:	Client
Client:	Ethos Engineering, LLC	Sample Date:	3/26/2025
Project Name:	El Mirage Road, SR 303L to Jomax Road	Sampled By:	Client
Project Address:	SEE WO	Test Date:	4/8/2025
Project City	Maricopa County	Tested By:	Austin Archibald
Sample Location:	MW-2 @ 0-5	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	1	99	
1/2"	3	96	
3/8"	6	90	
1/4"	13	77	
#4	8	69	
#8	16	53	
#10	3	50	
#16	10	40	
#30	9	31	
#40	3	28	
#50	2	26	
#100	4	22	
#200	4	18	

Liquid Limit (ASTM D4318)	33
Plastic Limit (ASTM D4318)	20
Plasticity Index (ASTM D4318)	13
Moisture Content (ASTM D2216)	3.0
USCS Soil Classification	SC

Group Name (ASTM D2487)
Clayey SAND with gravel

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2501255	Material Type:	Soils
ACS Lab #	25-2080-5	Supplier:	Client
Client:	Ethos Engineering, LLC	Sample Date:	3/26/2025
Project Name:	El Mirage Road, SR 303L to Jomax Road	Sampled By:	Client
Project Address:	SEE WO	Test Date:	4/7/2025
Project City	Maricopa County	Tested By:	Austin Archibald
Sample Location:	MW-2 @ 55-56.5	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	0	100	
3/4"	0	100	
1/2"	13	87	
3/8"	6	80	
1/4"	10	71	
#4	6	65	
#8	11	54	
#10	2	52	
#16	6	46	
#30	10	36	
#40	6	30	
#50	5	25	
#100	5	19	
#200	4	16	

Liquid Limit (ASTM D4318)	39
Plastic Limit (ASTM D4318)	17
Plasticity Index (ASTM D4318)	22
Moisture Content (ASTM D2216)	8.9
USCS Soil Classification	SC

Group Name (ASTM D2487)
Clayey SAND with gravel

Testing sizes reduced from standard minimums due to lack of material

Keagen Mayfield
Laboratory Manager

Keagen Mayfield
Signature

ACS Services LLC

Laboratory Soil Test Results

ACS PROJECT #	2501255	Material Type:	Soils
ACS Lab #	25-2080-6	Supplier:	Client
Client:	Ethos Engineering, LLC	Sample Date:	3/26/2025
Project Name:	El Mirage Road, SR 303L to Jomax Road	Sampled By:	Client
Project Address:	SEE WO	Test Date:	4/7/2025
Project City	Maricopa County	Tested By:	Austin Archibald
Sample Location:	MW-2 75-75.8	Reviewed By:	Keagen Mayfield

Sieve Analysis (ASTM C-136 / AASHTO T 27 / ARIZ 201)			
Sieve Size	**% Retained**	**% Passed**	**Specs**
6"	0	100	
3"	0	100	
2 1/2"	0	100	
2"	0	100	
1 1/2"	0	100	
1"	6	94	
3/4"	3	91	
1/2"	9	82	
3/8"	9	73	
1/4"	10	63	
#4	5	58	
#8	11	47	
#10	2	45	
#16	6	39	
#30	7	32	
#40	4	28	
#50	4	24	
#100	5	18	
#200	4	15	

Liquid Limit (ASTM D4318)	34
Plastic Limit (ASTM D4318)	19
Plasticity Index (ASTM D4318)	15
Moisture Content (ASTM D2216)	10.1
USCS Soil Classification	SC

Group Name (ASTM D2487)
Clayey SAND with gravel

Testing sizes reduced from standard minimums due to lack of material

Keagen Mayfield
Laboratory Manager

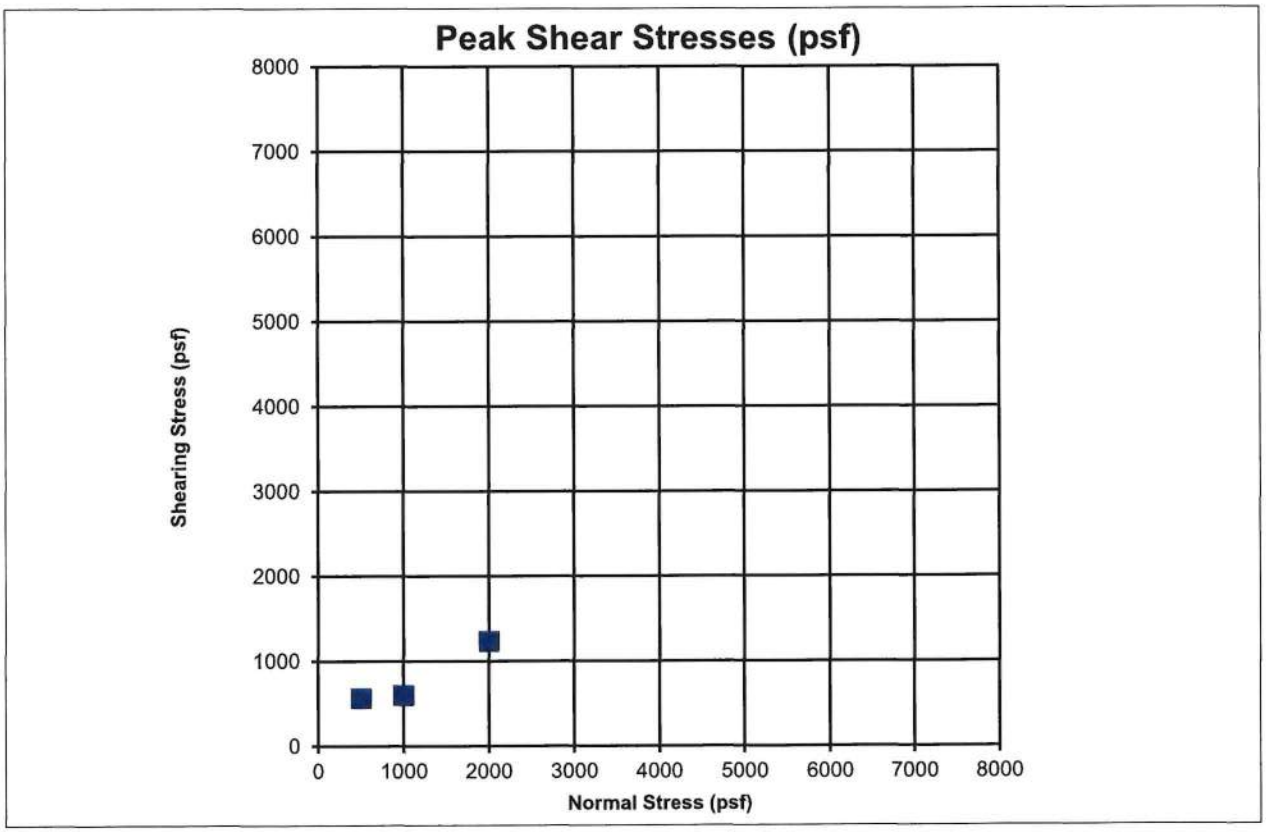
Keagen Mayfield
Signature

PROJECT: ACS - Lab Testing Services
LOCATION: Project #2501255
MATERIAL: See Boring Logs
SAMPLE SOURCE: BC-1 @ 2.5-3.5 25-2080.8
SAMPLE PREPARATION: SAT

JOB NO: 17-2023-4239
WORK ORDER NO: 114
LAB NO: 25-0526
DATE ASSIGNED: 4/8/2025

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)

Initial thickness of specimen (in.):	1.00	1.00	1.00
Initial diameter of specimen (in.):	2.42	2.42	2.42
Final thickness before shear (in.):	0.968	0.926	0.968
Shearing device used:	Humboldt Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (in/min):	0.008	0.008	0.008
Direct shear point:	1	2	3
Dry mass of specimen (g):	109.8	115.3	126.3
Initial Moisture Content:	6.6%	6.2%	5.9%
Initial Wet Density (pcf):	97.0	101.4	110.8
Initial Dry Density (pcf):	90.9	95.5	104.6
Final Moisture Content:	23.5%	21.2%	18.5%
Final Wet Density (pcf):	116.0	125.0	128.1
Final Dry Density (pcf):	93.9	103.1	108.1
Normal Stress (psf):	500	1000	2000
Maximum Shearing Stress (psf):	562	596	1230
Vertical Deformation @ Max Shear (in):	0.199	#N/A	0.202
Horizontal Deformation @ Max Shear (in):	0.500	#N/A	0.398



WSP USA
3630 E Wier Ave.
Phoenix, AZ 85040

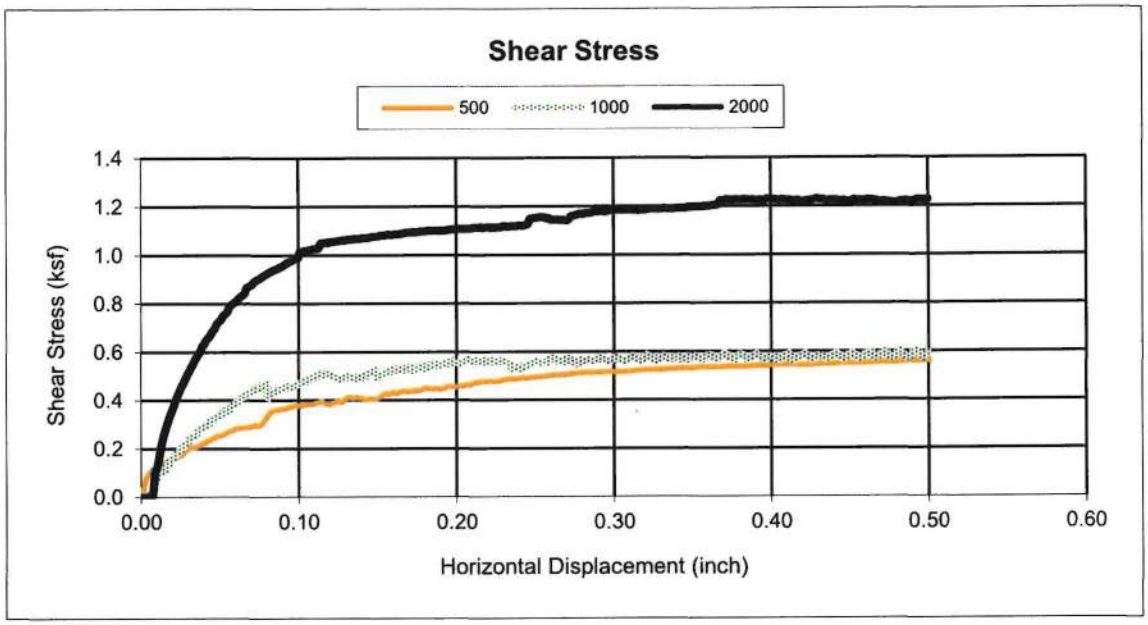
REVIEWED BY _____ 04/16/25

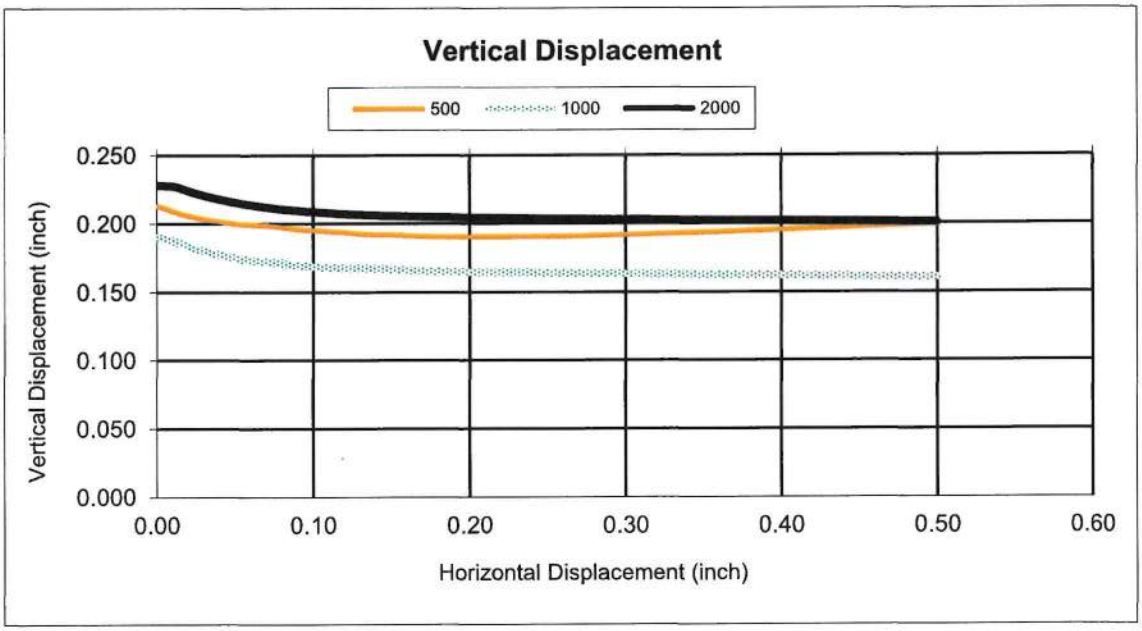
PROJECT: ACS - Lab Testing Services
LOCATION: Project #2501255
MATERIAL: See Boring Logs
SAMPLE SOURCE: BC-1 @ 2.5-3.5 25-2080.8
SAMPLE PREPARATION: SAT

JOB NO: 17-2023-4239
WORK ORDER NO: 114
LAB NO: 25-0526
DATE ASSIGNED: 4/8/2025

NORMAL LOADS (psf): 500 1000 2000

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)





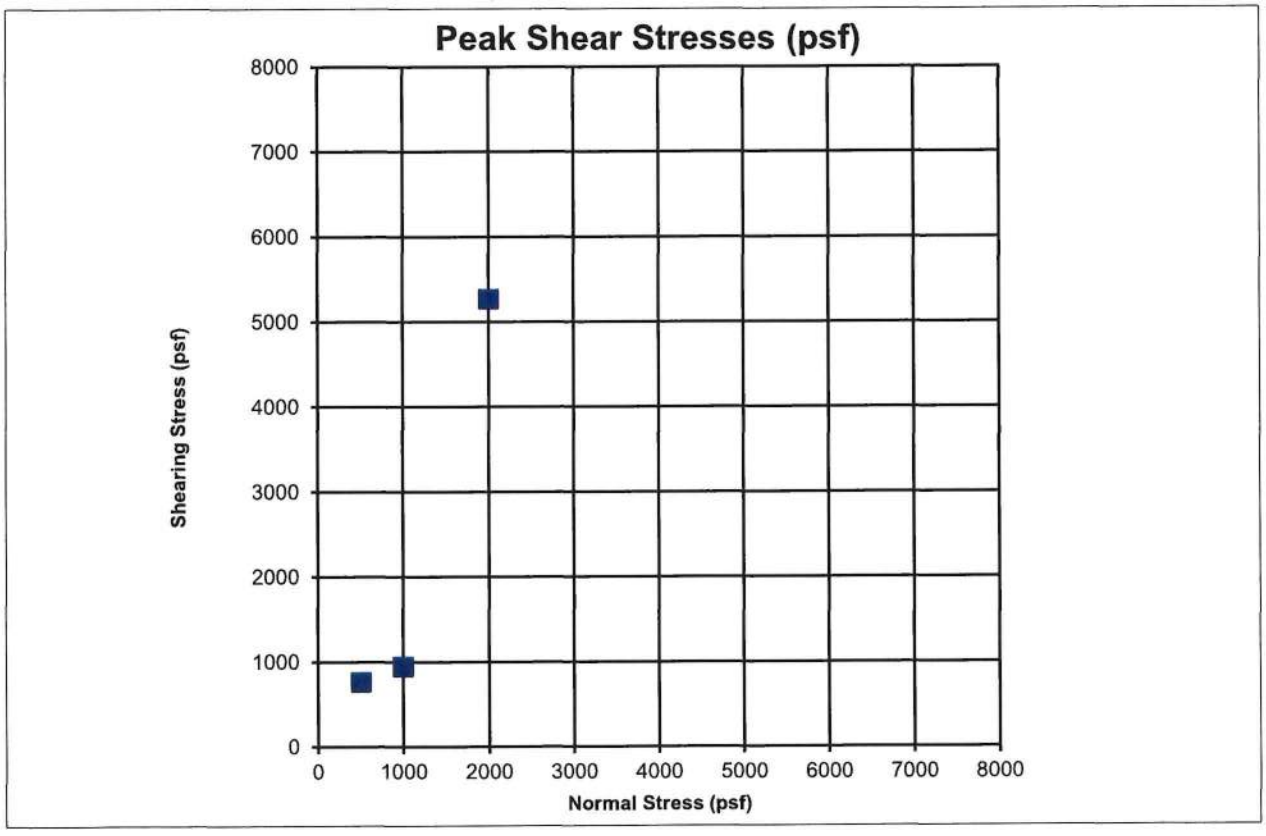
WSP USA
3630 E Wier Ave.
Phoenix, AZ 85040

PROJECT: ACS - Lab Testing Services
LOCATION: Project #2501255
MATERIAL: See Boring Logs
SAMPLE SOURCE: BC-2 @ 5-6 25-2080-12
SAMPLE PREPARATION: SAT

JOB NO: 17-2023-4239
WORK ORDER NO: 114
LAB NO: 25-0527
DATE ASSIGNED: 4/8/2025

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)

Initial thickness of specimen (in.):	1.00	1.00	1.00
Initial diameter of specimen (in.):	2.42	2.42	2.42
Final thickness before shear (in.):	0.960	0.948	0.979
Shearing device used:	Humboldt Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (in/min):	0.008	0.008	0.008
Direct shear point:	1	2	3
Dry mass of specimen (g):	118.3	120.8	139.8
Initial Moisture Content:	4.4%	4.3%	3.1%
Initial Wet Density (pcf):	102.3	104.4	119.4
Initial Dry Density (pcf):	98.0	100.1	115.8
Final Moisture Content:	23.8%	24.3%	19.5%
Final Wet Density (pcf):	126.3	131.3	141.3
Final Dry Density (pcf):	102.0	105.6	118.3
Normal Stress (psf):	500	1000	2000
Maximum Shearing Stress (psf):	763	942	5267
Vertical Deformation @ Max Shear (in):	0.296	0.209	0.331
Horizontal Deformation @ Max Shear (in):	0.327	0.457	0.469



WSP USA
3630 E Wier Ave.
Phoenix, AZ 85040

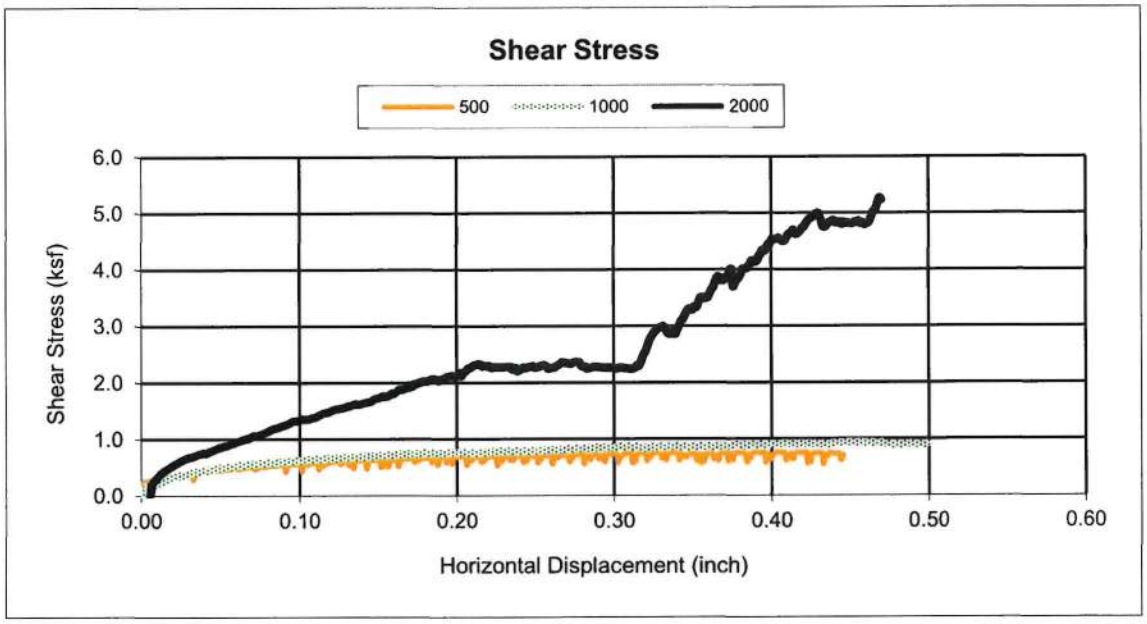
REVIEWED BY 04/16/25

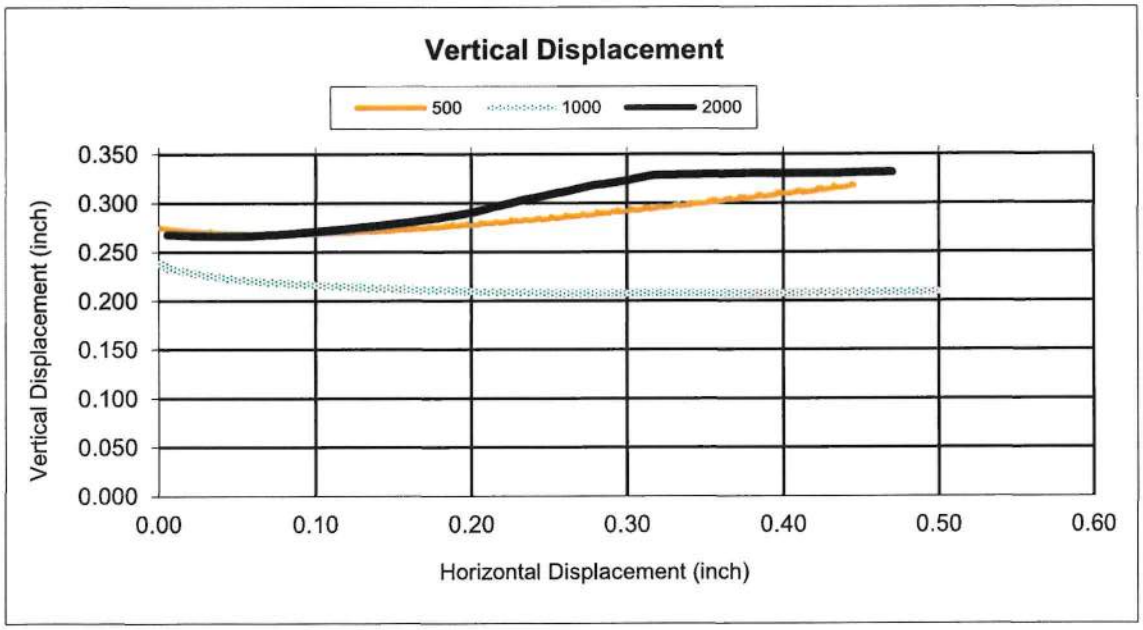
PROJECT: ACS - Lab Testing Services
LOCATION: Project #2501255
MATERIAL: See Boring Logs
SAMPLE SOURCE: BC-2 @ 5-6 25-2080-12
SAMPLE PREPARATION: SAT

JOB NO: 17-2023-4239
WORK ORDER NO: 114
LAB NO: 25-0527
DATE ASSIGNED: 4/8/2025

NORMAL LOADS (psf): 500 1000 2000

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS (ASTM D3080)





WSP USA
3630 E Wier Ave.
Phoenix, AZ 85040

ACS Services LLC

Soil pH and Resistivity Determination

AASHTO T-289 AASHTO T-288 / ARIZ 236

Project #	2501255	Material Type:	Soils
Lab #	25-2080-7	Supplier:	Client
Client:	Ethos Engineering, LLC	Sample Date:	3/26/2025
Project Name:	l Mirage Road, SR 303L to Jomax Roa	Sampled By:	Client
Project Address:	SEE WO	Test Date:	Wednesday, April 9, 2025
Project City:	Maricopa County	Tested By:	Mahalia Davis
Sample Source:	BC-1 @ 0 - 5	Resistivity Box:	
		Reviewed By:	Keagen Mayfield

pH Reading = 8.14

P = (SBF) x R x M

Where:

SBF = Soil Box Factor, cm
R = Dial Reading, OHMS
M = Multiplier

Water Added	SBF (cm)	Dial Reading (OHMS)	Multiplier	**P** (OHM-cm)
200	7.22	2.7	100	1950
50	7.22	1.8	100	1300
50	7.22	1.2	100	870
50	7.22	1.2	100	870
50	7.22	1.3	100	940

Colin Eggebrecht
Lab Supervisor

Keagen Mayfield
Laboratory Manager

ACS Services LLC

Soil pH and Resistivity Determination

AASHTO T-289 AASHTO T-288 / ARIZ 236

Project #	2501255	Material Type:	Soils
Lab #	25-2080-11	Supplier:	Client
Client:	Ethos Engineering, LLC	Sample Date:	3/26/2025
Project Name:	l Mirage Road, SR 303L to Jomax Roa	Sampled By:	Client
Project Address:	SEE WO	Test Date:	Wednesday, April 9, 2025
Project City:	Maricopa County	Tested By:	Mahalia Davis
Sample Source:	BC-2 @ 0 - 5	Resistivity Box:	
		Reviewed By:	Keagen Mayfield

pH Reading = 8.06

P = (SBF) x R x M

Where:

SBF = Soil Box Factor, cm
R = Dial Reading, OHMS
M = Multiplier

Water Added	SBF (cm)	Dial Reading (OHMS)	Multiplier	**P** (OHM-cm)
200	7.22	3.3	100	2380
50	7.22	2.2	100	1590
50	7.22	1.2	100	870
50	7.22	1.1	100	790
50	7.22	1.1	100	790
50	7.22	1.2	100	870

Colin Eggebrecht
Lab Supervisor

Keagen Mayfield
Laboratory Manager

ACS Services LLC

Soil pH and Resistivity Determination

AASHTO T-289 AASHTO T-288 / ARIZ 236

Project #	2501255	Material Type:	Soils
Lab #	25-2080-1	Supplier:	Client
Client:	Ethos Engineering, LLC	Sample Date:	3/26/2025
Project Name:	l Mirage Road, SR 303L to Jomax Roa	Sampled By:	Client
Project Address:	SEE WO	Test Date:	Wednesday, April 9, 2025
Project City:	Maricopa County	Tested By:	Mahalia Davis
Sample Source:	MW-1 @ 0 - 5	Resistivity Box:	
		Reviewed By:	Keagen Mayfield

pH Reading = 8.23

P = (SBF) x R x M

Where:

SBF = Soil Box Factor, cm
R = Dial Reading, OHMS
M = Multiplier

Water Added	SBF (cm)	Dial Reading (OHMS)	Multiplier	**P** (OHM-cm)
200	7.22	5.1	100	3680
50	7.22	3.5	100	2530
50	7.22	3.3	100	2380
50	7.22	3.3	100	2380
50	7.22	3.2	100	2310
50	7.22	3.3	100	2380

Colin Eggebrecht
Lab Supervisor

Keagen Mayfield
Laboratory Manager

ACS Services LLC

Soil pH and Resistivity Determination

AASHTO T-289 AASHTO T-288 / ARIZ 236

Project #	2501255	Material Type:	Soils
Lab #	25-2080-4	Supplier:	Client
Client:	Ethos Engineering, LLC	Sample Date:	3/26/2025
Project Name:	l Mirage Road, SR 303L to Jomax Roa	Sampled By:	Client
Project Address:	SEE WO	Test Date:	Wednesday, April 9, 2025
Project City:	Maricopa County	Tested By:	Mahalia Davis
Sample Source:	MW-2 @ 0-5	Resistivity Box:	
		Reviewed By:	Keagen Mayfield

pH Reading = 9.61

P = (SBF) x R x M

Where:

SBF = Soil Box Factor, cm
R = Dial Reading, OHMS
M = Multiplier

Water Added	SBF (cm)	Dial Reading (OHMS)	Multiplier	**P** (OHM-cm)
200	7.22	2.7	100	1950
50	7.22	2.2	100	1590
50	7.22	1.7	100	1230
50	7.22	1.7	100	1230
50	7.22	1.9	100	1370

Colin Eggebrecht
Lab Supervisor

Keagen Mayfield
Laboratory Manager

MOTZZ LABORATORY, INC.

Report: 954988
Reported: 4/10/2025
Received: 4/8/2025
PO: 2501255

Laboratory Analysis Report

ACS Services LLC
Keagen Mayfield
2235 W Broadway Road
Mesa, AZ 85202

Project: 2501255

Lab Number	Sample ID	
954988-1	25-2080-7	BC-1 (0-5')

Test Parameter

Test	*Method*	*Result*	*Units*
Sulfate	ARIZ 733b	113	ppm
Chloride	ARIZ 736b	86	ppm

MOTZZ LABORATORY, INC.

Report: 954989
Reported: 4/10/2025
Received: 4/8/2025
PO: 2501255

Laboratory Analysis Report

ACS Services LLC
Keagen Mayfield
2235 W Broadway Road
Mesa, AZ 85202

Project: 2501255

Lab Number	Sample ID	
954989-1	25-2080-11	BC-2 (0-5')

Test Parameter

Test	*Method*	*Result*	*Units*
Sulfate	ARIZ 733b	108	ppm
Chloride	ARIZ 736b	67	ppm

MOTZZ LABORATORY, INC.

Report: 954982
Reported: 4/10/2025
Received: 4/8/2025
PO: 2501255

Laboratory Analysis Report

ACS Services LLC
Keagen Mayfield
2235 W Broadway Road
Mesa, AZ 85202

Project: 2501255

Lab Number	Sample ID	
954982-1	25-2080-1	MW-1 (0-5')

Test Parameter

Test	*Method*	*Result*	*Units*
Sulfate	ARIZ 733b	72	ppm
Chloride	ARIZ 736b	31	ppm

MOTZZ LABORATORY, INC.

Report: 954987
Reported: 4/10/2025
Received: 4/8/2025
PO: 2501255

Laboratory Analysis Report

ACS Services LLC
Keagen Mayfield
2235 W Broadway Road
Mesa, AZ 85202

Project: 2501255

Lab Number	Sample ID	
954987-1	25-2080-4	MW-2 (0-5')

Test Parameter

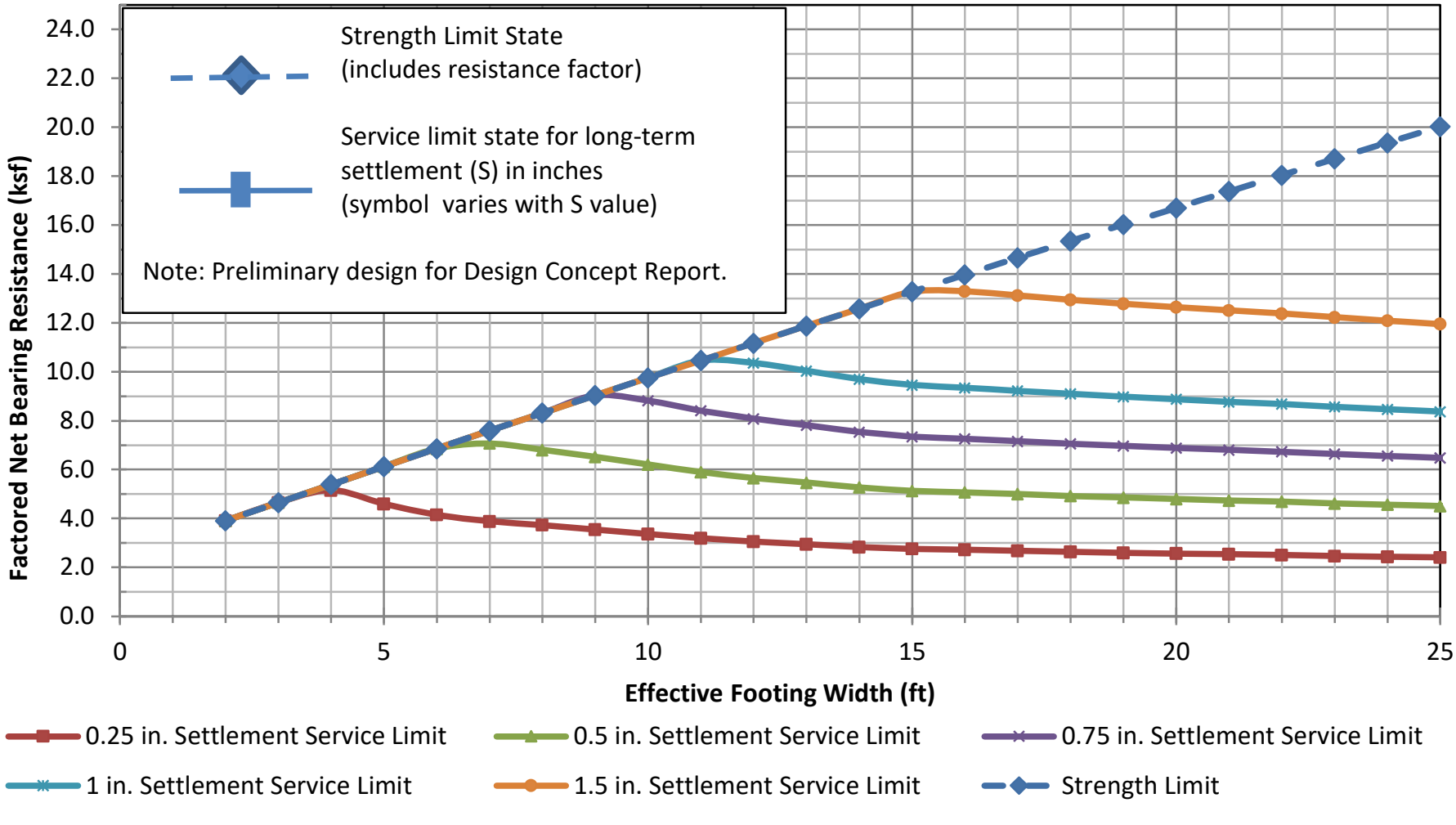
Test	*Method*	*Result*	*Units*
Sulfate	ARIZ 733b	128	ppm
Chloride	ARIZ 736b	183	ppm

APPENDIX C

Spread Footing Factored Bearing Resistance Chart

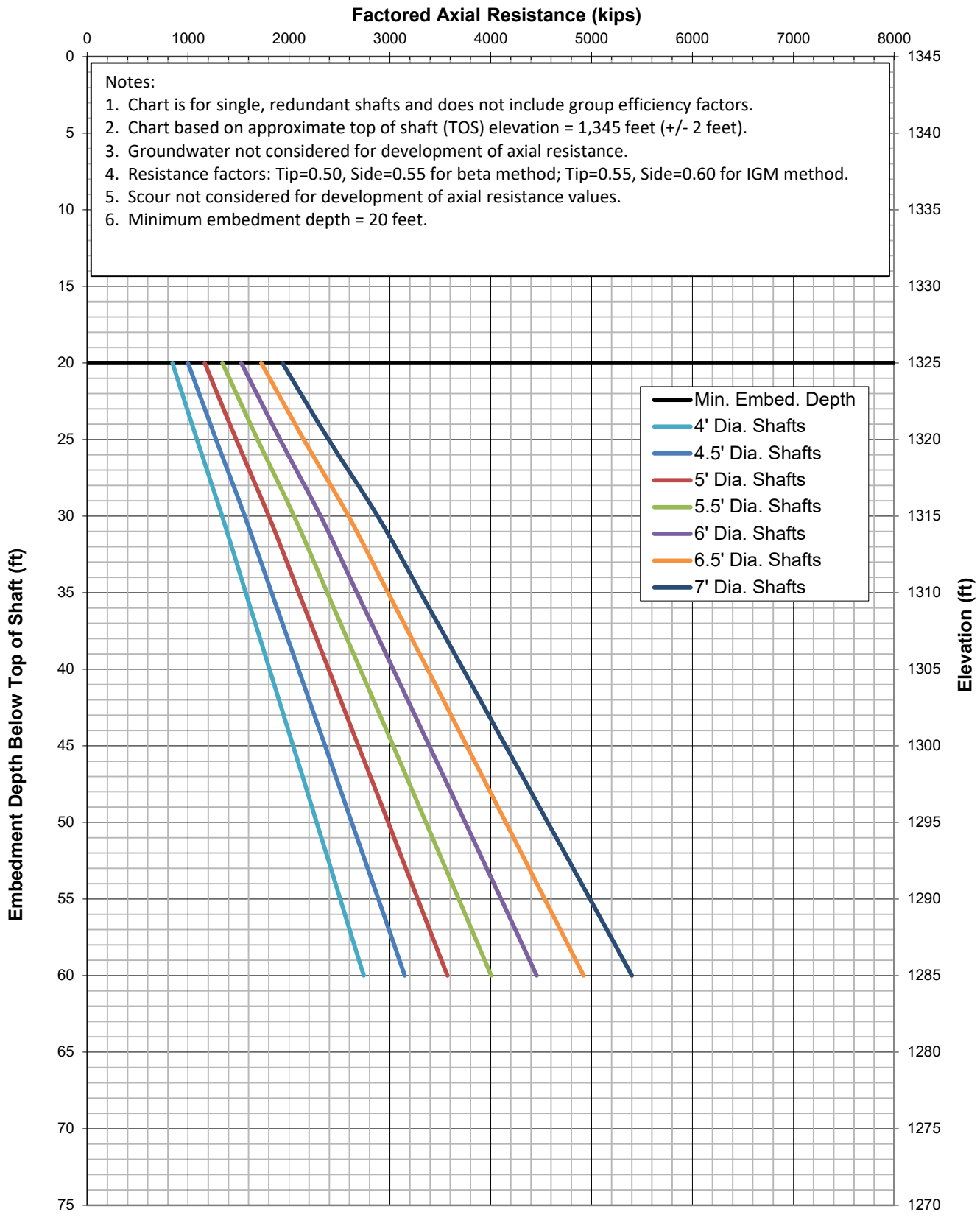
El Mirage Road, SR 303L to Jomax Road
McMicken Dam Wash RCBCs

Footing Length = 145 ft, Embedment Depth = 1 foot, Bearing Elevation = 1,294 feet

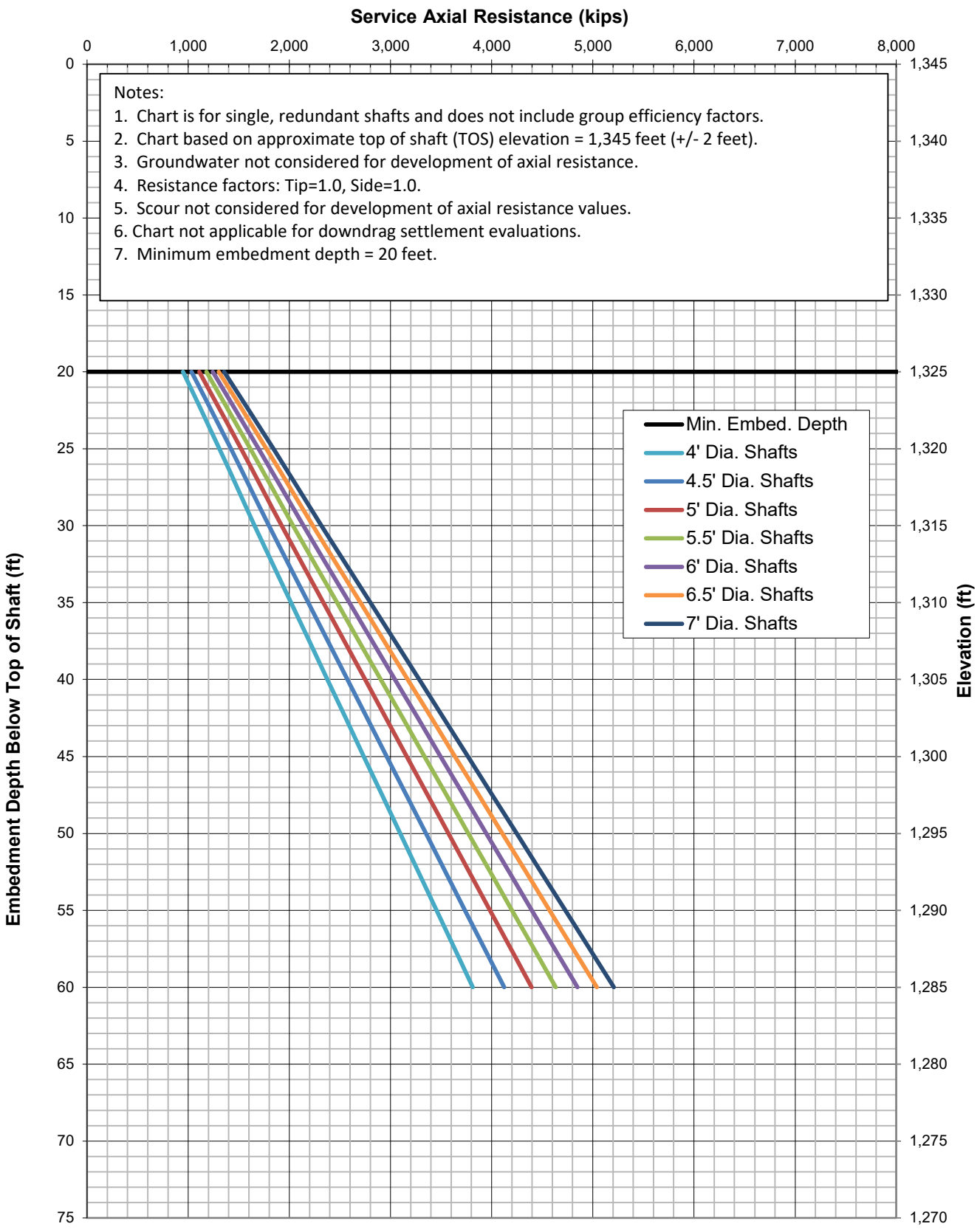


APPENDIX D

Drilled Shaft Axial Resistance Chart



ethos ENGINEERING, LLC.		**DRILLED SHAFT FOUNDATION DESIGN CHART** **Strength Limit Axial Resistance in Kips** **El Mirage Road, SR 303L to Jomax Road** **Beardsley Canal Crossing** **Preliminary Design for Design Concept Report**	Figure D1
Designer:	Date:		
M. Meza	4/29/2025		



ethos ENGINEERING, LLC.

Designer:	Date:
M. Meza	4/29/2025

DRILLED SHAFT FOUNDATION DESIGN CHART

Service Limit (0.25-Inch Settlement) - Axial Resistance in Kips

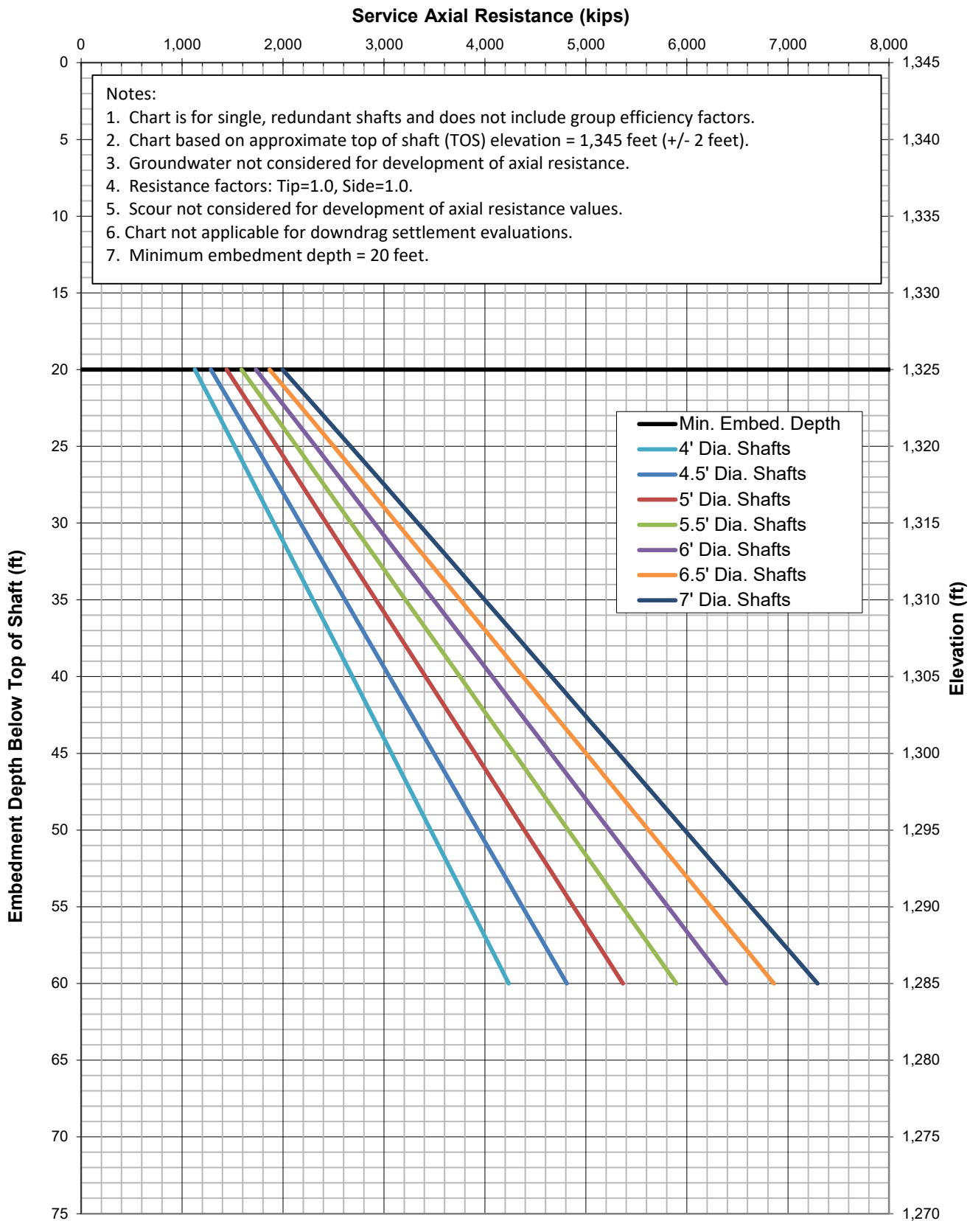
El Mirage Road, SR 303L to Jomax Road

Beardsley Canal Crossing

Preliminary Design for Design Concept Report

Figure

D2



ethos ENGINEERING, LLC.

Designer:	Date:
M. Meza	4/29/2025

DRILLED SHAFT FOUNDATION DESIGN CHART

Service Limit (0.5-Inch Settlement) - Axial Resistance in Kips

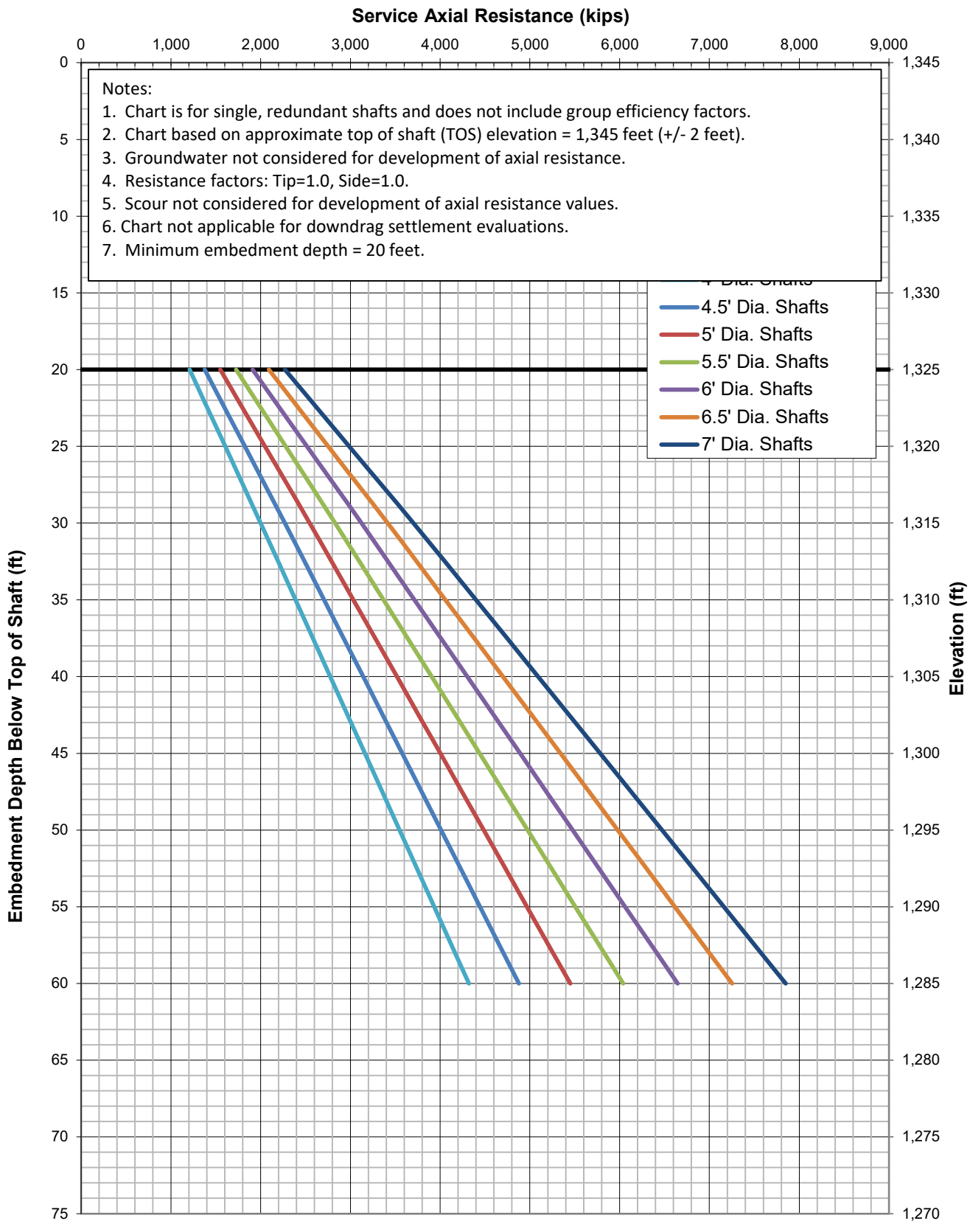
El Mirage Road, SR 303L to Jomax Road

Beardsley Canal Crossing

Preliminary Design for Design Concept Report

Figure

D3



ethos ENGINEERING, LLC.

Designer:	Date:
M. Meza	4/29/2025

DRILLED SHAFT FOUNDATION DESIGN CHART

Service Limit (0.75-Inch Settlement) - Axial Resistance in Kips

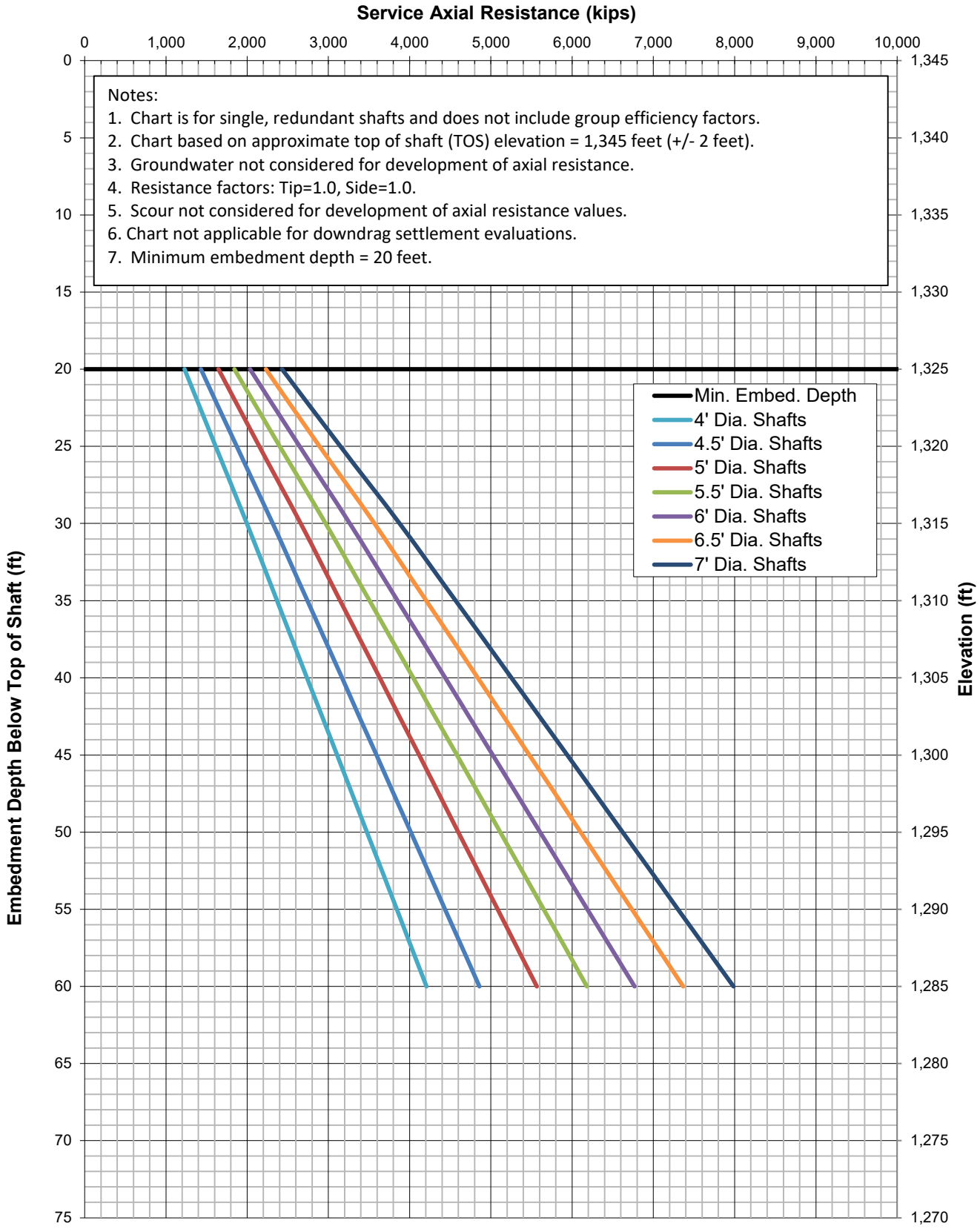
El Mirage Road, SR 303L to Jomax Road

Beardsley Canal Crossing

Preliminary Design for Design Concept Report

Figure

D4



ethos ENGINEERING, LLC.		**DRILLED SHAFT FOUNDATION DESIGN CHART** **Service Limit (1 Inch Settlement) - Axial Resistance in Kips** **El Mirage Road, SR 303L to Jomax Road** **Beardsley Canal Crossing** **Preliminary Design for Design Concept Report**	Figure D5
Designer:	Date:		
M. Meza	4/29/2025		