



August 22, 2023 Project No. 606630015

Mr. Jaime Rivera Pima County Regional Water Reclamation 3355 North Dodge Boulevard Tucson, Arizona 85716

Subject: Geotechnical Services Valley Vista Sewer and Pump Station Evaluation Oro Valley, Arizona

Dear Mr. Rivera:

In accordance with our proposal dated June 29, 2023, and your authorization, Ninyo & Moore has performed geotechnical services related at the above referenced site. This letter report presents the results of our evaluation and our findings, conclusions and recommendations regarding the project.

# SCOPE OF SERVICES

The scope of our services for this phase of the project generally included:

- Performing research of existing geotechnical reports, design and as-built documentation, and construction records related to the site grading and subsurface utilities within the affected areas.
- Conducting a visual reconnaissance of the affected areas surface and marking out of the field test locations.
- Contacting Arizona 811 to evaluate underground utility locations prior to drilling.
- Exploring the subsurface soils by drilling, logging, and sampling three exploratory soil borings to approximate depths of about 20 to 65 feet below ground surface (bgs). The boring logs are presented in Attachment A.
- Collecting bulk and relatively undisturbed ring samples of the soils in the borings for laboratory testing and analysis. The soil samples were transported to a Ninyo & Moore laboratory for testing.
- Conducting laboratory testing on subgrade soil samples generally included in-place moisture and dry density, gradation, Atterberg limits, consolidation, and maximum density characteristics. The laboratory test results are presented in Attachment B.
- Preparing this letter report.

Our scope of services did not include environmental consulting services such as hazardous waste sampling or analytical testing at the site. A detailed scope of services and estimated fee for such services can be provided upon request.

# **PROJECT AND SITE DESCRIPTION**

At the time of our study, the site occupied the easternmost portion of the Rancho Vistoso Valley Vista residential subdivision and encompassed the eastern segments of Kalalau Drive and Romsdalen Road, with single-family houses on both sides of the roadways. The roadways were two-lane asphaltic concrete paved facilities with a curb and gutter system and Portland cement concrete sidewalks. A Pima County pump station was located near the southeast corner of the site (near the intersection of Kalalau Drive and Romsdalen Road) and was surrounded by a perimeter masonry wall.

The subdivision site is situated near the western flank of Honey Bee Canyon within the Big Wash floodplain. Based on our field observations, the site improvements associated with the subdivision were built partly in shallow cuts (west side) and on fill embankments (eastern side) with the Federal Emergency Management Agency (FEMA) floodplain bank protection systems with relatively steep soil-cement paved embankments along the eastern and southeastern edges of the subdivision. These embankment heights varied roughly between 6 and 12 feet and native floodplain land extended to the east.

We understand that Pima County Regional Water Reclamation Department (RWRD) performed video inspections of a nearby sewer alignment in 2021 and 2023 within the Subdivision. The inspections demonstrated sagging of the sewer pipeline near the pump station, but leaking was not noticed. There has also been reported surficial distress of the roadway and in common area asphalt pavement in the pump station proximity near the pipe sagging area. Surface repairs have been made to the pavement since then. In addition, some residential properties located adjacent to the affected sewer line have reportedly developed various ground settlement caused distress. Lastly, the pump station site has exhibited movement and cracking of its perimeter wall and some gate deformations.

We have interviewed a Pima County (PC) facilities maintenance officer and a resident from an adjacent residential property. The PC officer reported that damage to the pump station facility has been occurring since 2021 and involved movement of the masonry walls resulting in cracking and deformation of the access gate system that affected its operation. The resident reported movement of his home floor slab. The house foundations were lifted by a system of jacked-up (helical) piers. Such remedial measured were observed by Ninyo & Moore on both homes adjacent to the pump station. Some evidence of the ground movement (settlement) around the aforementioned residences was observed as well.

The goal of this study was to explore the soils along the adjacent sewer line segments and within the pump station area, and evaluate possible cause of the aforementioned pavement distress. We have also been asked to develop possible mitigation measures.

# **BACKGROUND RESEARCH**

We have performed background research for the project that included a review of the following documents and records:

- Topographic Map and Aerial photograph review (Google Earth<sup>™</sup>);
- ProTeX, 2018, Geotechnical Investigation, Rancho Vistoso Neighborhood 5 Parcel X and W, Rancho Vistoso Boulevard and Moore Loop, Oro Valley, Arizona.
- The WLB Group, 2018. Public Sewer Improvement Plan for Moore Loop & Rancho Vistoso, Valley Vista, G-2018-091, AS-Built Sewer Plans dated 03/16/20;
- The WLB Group, 2019, Kalalau Drive Public Wastewater Pump Station, Moore Loop, Rancho Vistoso Valley Vista Lots 1 through 168 & Common Areas "A" & "B", dated March;
- The WLB Group, 2019, Final Site Plan & Public Street Improvement and Grading Plan, Rancho Vistoso Velley Vista, dated March;
- ProTeX, Field Density Summary Reports for the Sewer Line Backfill along Kalalau Drive, Ronsdalen Road, Danum Valley Drive, Gayser Valley Street, Harau Valley Road, and Sewer Easement, covering the period between June 11, 2019 and January 7, 2020;
- ProTeX, 2020, Letter of Final Compliance, 5X and 5W Lift Station @ Rancho Vistoso Valley Vista, dated June 18;
- ProTeX, 2020, Underground Improvements Package for: Rancho Vistoso Valley 5X and 5W:
  - Phase 1A dated 3/2/2020;
  - Phase 1B dated 1/23/2020; and
  - Phase 1C dated 3/25/2020.
- ProTeX, 2020, Street Improvements Package for: Rancho Vistoso Valley Vista 5X and 5W:
  - Phase 1A dated 4/7/2020;
  - Phase 1B dated 4/8/2020; and
  - Phase 1C dated 2/9/2020.
- ProTeX, 2019 and 2020, Building Pad-Post-Tension Foundation for 5X and 5W Mass Grading @ Rancho Vistoso Valley Vista:
  - Phase 1A dated 6/13/2019;
  - Phase 1B dated 1/8/2020; and
  - Phase 1C dated 3/18/2020.

The following sections summarize each of the documents and records reviewed.

#### **Topographic Map and Aerial Photograph Review**

According to the Oro Valley, Pima County, 7.5-Minute United States Geological Survey (USGS) Topographic Quadrangle Map (2021) the average site elevation is approximately 2,720 feet relative to mean sea level (MSL). The topography of the site is relatively flat and slopes gently from west to east.

Several historical aerial photographs from Google Earth<sup>™</sup> were reviewed for this project. Images dated 1992 through 2018 depicted the project area as undeveloped land with relatively dense vegetation. The Honey Bee Canyon with the Big Wash were located to the east of the site. Unpaved paths and trails were observed on the images from the late 1990's and later. Small drainages and washes traversed the site generally trending form northwest to southeast. An image dated December 2020 depicted the roadways and the pump station in place. By 2020, many of the building pads were prepared with few houses already built. Also, the FEMA floodplain bank protection system with soil-cement paved embankments was already constructed along the eastern and southeastern edges of the site. An image dated April 2023 depicted the project site as similar to its current condition.

### **ProTeX Geotechnical Investigation Report (2018)**

In 2018, ProTeX conducted a geotechnical exploration within the area generally west and north of the project site in support of the future Rancho Vistoso Valley Vista residential subdivision development. A total of 10 borings (B1 to B10) were drilled to a depth of 15 feet below ground surface (bgs) for the purpose of evaluating subsurface conditions. Standard Penetration Tests (SPT) were performed in selected borings and at selected depths, where bulk and relatively undisturbed ring samples were also collected. The laboratory testing program included gradation, Atterberg limits, expansion index, R-value and chlorides and sulfates content.

Based on the field exploration and laboratory testing the subsurface profile consisted primarily of native alluvial sediments including silty sands, sandy silts and clayey sands with plasticity index ranging from 0 (non-plastic) to 12. Based on the field blow count testing (SPT N-values), ProTeX concluded that the subsurface soils were loose to medium dense and susceptible to hydro-collapse. They further indicated that the potential for hydro-consolidation of the subsurface soils could be mitigated. It was recommended that "due to light to moderate vegetation and loose/soft surface conditions, the surface soils should be over-excavated a minimum depth of 1.0 foot below existing grade or 1.0 foot below finished pad grade elevation, whichever is deeper. After clearing and over-excavation, the exposed soils should be scarified a minimum of 8 inches, moisture conditioned and compacted.". This overexcavation recommendation was applicable to the building foundation pads.

The report provided compaction specifications for subgrade below post-tension and conventional foundations as evaluated based on the standard Proctor test (ASTM D698, as summarized below:

- Below conventional interior floors: 95 percent;
- Below conventional foundation level and post-tension slab-on-grade: 95 percent;
- Fills at depths 5 to 10 feet below finish grade: 98 percent; and
- Fills at depths 10 feet or greater below finish grade: 100 percent.

## WLB, 2018. Public Sewer Improvement Plans

These WLB plans present as-built information for the public 8-inch sewer and the 6-inch forcemain construction along the roadways within the subdivision (plan and profile sheets) including the pump station. For the sewer construction, the plans reference the Pima County Regional Wastewater Reclamation Department (PCRWRD) Engineering Design Standards 2016 Edition and the Standard Specifications and Details for Construction (2016). The ProTeX 2018 report was referenced for the roadway pavement sections. The public gravity sewer slopes towards the pump station. In the wet well sewage is pumped into the forcemain and disposed of offsite. Due to the original ground configuration and the final grades the profiles show mainly cut sections within the western portion of the subdivision and fill embankments towards the east. The Kalalau Drive and Romsdalen Road intersection area was constructed within a shallow (up to 4 feet deep) cut and on a low (up to 3 feet high) embankment. The pump station was constructed on an approximately 10 feet fill embankment.

## WLB, 2019, Kalalau Drive Public Wastewater Pump Station

These WLB plans present as-built information for the public wastewater pump station located near the Kalalau Drive and Romsdalen Road intersection including the 25-foot deep wetwell supported on a 12-inch thick concrete mat foundation and the containment structure with associated equipment and appurtenances. The perimeter masonry wall was supported on continuous spread footings. The gate track sections had 36-inch wide footings. Other improvements were supported on either slab on grade/pad foundations (containment structure, generator, motor control center) or extended footings (light poles, wetwell equipment rack). The General Notes sheet provides the following references:

- The General Sewer Notes in Note 3 reference the PCRWRD Engineering Design Standards 2016 Edition and the Standard Specifications and Details for Construction (2016).
- The General Notes in Note 1 reference the PCRWRD Standard Detail RWRD 001.

- The General Notes for the pump station in Note 5 state that all earthwork shall be in accordance with the requirements of the geotechnical report, "Geotechnical Investigation, Rancho Vistoso Neighborhood 5 Parcels W & X," ProTeX, ProTeX job number 7466, February 20, 2018.
- The General Notes for paving and grading state the following:
  - Note 4: Earthwork, except as modified by the soils report on record, shall conform to PAG SSPI, Section 203; and
  - Note 23: A report of soils investigations, including recommendations for grading procedures has been prepared by ProTeX, LLC, dated February 20, 2018, Project No.7466, all earthwork shall conform to the recommendations contained in said report and any amendments made thereto.

## WLB, 2019, Final Site Plan & Public Street Improvement and Grading Plan

These WLB plans present as-built information for the subdivision development. They generally reference relevant standards for the Pima county, Arizona Department of Transportation (ADOT) and the Town of Oro Valley. Specifically, the General Paving Notes state the following:

- Note 4: Earthwork, except as modified by the soils report on record, shall conform to PAG SSPI, Section 203; and
- Note 23: A report of soils investigations, including recommendations for grading procedures has been prepared by ProTeX, LLC, dated February 20, 2018, Project No.7466, all earthwork shall conform to the recommendations contained in said report and any amendments made thereto.

In addition, the typical street cross-sections reference the 2018 ProTeX report.

## **ProTeX 2019 - 2020, Field Density Summary Reports**

These ProTeX reports provide the results of field density testing performed during construction for the sewer line trench backfill along Kalalau Drive, Romsdalen Road, Danum Valley Drive, Gayser Valley Street, Harau Valley Road, and Sewer Easement, for the lower zone (depths between 2 and 7 feet below final grade) and the upper zone (depths between 0 and 2 feet below final grade). Sewer manhole backfill testing was reported separately. The tests generally passed the minimum specified compaction. However, the reports also contained incomplete information on the laboratory testing (index tests and standard Proctor) associated with the field tests.

# ProTeX, 2020, Letter of Final Compliance

This ProTeX letter of compliance provides construction inspection and testing results for the pump station, and specifically:

 Construction observation services and grout compressive strength test results for the perimeter wall;

- Field density test results for the access drive and the sewer line and the manhole trench backfill; and
- Laboratory test results including five standard Proctors and concrete compressive strength for the electrical slab and the containment slab.

The letter stated compliance of the construction with the project plans and specifications.

## **ProTeX**, 2020, Underground Improvements Packages

Each of these ProTeX packages were prepared for a different project phase (A through C) and included:

- Field density test results for trench backfill for dry utilities, the sewer line, storm drain and water line;
- Asphaltic core density test results; and
- Respective laboratory test results for soils including the standard Proctor, asphaltic concrete and concrete (compressive strength tests for curbs and different drainage improvements).

The results were stated to be in substantial conformance with Pima County and the City of Tucson specifications and requirements.

## **ProTeX, 2020, Street Improvements Packages**

Each of these ProTeX packages were prepared for a different project phase (A through C) and included:

- Field density test results for curb subgrade, street subgrade and aggregate base course; and
- Respective laboratory test results including the standard Proctor and concrete compressive strength for a sewer manhole base (Phase 1B).

The results were stated to be in substantial conformance with Pima County and the City of Tucson specifications and requirements.

## ProTeX, 2019 and 2020, Building Pad-Post-Tension Foundation

Each of these ProTeX packages were prepared for a different project phase (A through C) and included:

- Field density summary reports for each lot at various depths between 7 feet bgs and the finished grade; and
- Respective laboratory test results including standard Proctor.

The packages included the following statement:

Field observations were made to ensure that the site was cleared of all vegetation and structures, site was over excavated to a depth of 1 foot and exposed subgrade soils were scarified. Testing was performed to confirm moisture conditioning and compaction efforts are in compliance with the recommendations of the aforementioned geotechnical report. Field Density tests are enclosed. Based on the observations, laboratory testing, and field density testing, a bearing value of 1250psf at finished grade bearing on 1 foot of engineered fill is assigned for post-tensioned foundation systems. Building Pads are certified for one year from the date of this letter.

### ProTeX, 2022, Geotechnical Investigation – Forensics

ProTeX, conducted a forensic geotechnical investigation to evaluate the cause(s) of distress observed at residence Lot 19. The common area with the Pima County Pump Station located to the east of Lot 19 was also evaluated. A total of 23 borings were advanced to depth ranging between 25 and 71 feet bgs. The laboratory testing included index tests as well as consolidation (hydro-collapse potential). The field test results and observations indicated that the subsurface soils were very loose/soft with varying levels of moisture content with very damp to wet soils near the saturation level observed to substantial depths. Cracks in the roadway pavements an in the common area adjacent to the pump station were also observed.

In conclusions, ProTeX stated that the site soils are susceptible to progressive settlements and progressive displacement resulting in significant loss of soil support under certain foundation elements for the houses and site walls as well as underground utilities.

The recommendations included the following mitigation measures:

- Helical piers installed to competent material depths under foundations;
- Grouting compaction of subsurface soils around the houses and the pump station;
- Drainage evaluation to provide positive drainage away from foundation elements.

The depth of the above mitigation techniques was not defined and left to the remediation contractor/structural engineer judgement.

# **GEOTECHNICAL FIELD EXPLORATION AND LABORATORY TESTING**

On July 14 and August 9, 2023, Ninyo & Moore conducted a geotechnical exploration in order to evaluate the subgrade conditions. Our evaluation consisted of drilling, logging, and sampling three exploratory borings denoted as B-1 through B-3, using a CME 75 truck mounted drill rig equipped

with hollow-stem augers (Figure 2). Our borings extended to approximate 20 to 65 feet bgs. Bulk and relatively undisturbed soil samples were collected at selected depth intervals in our borings.

Ninyo & Moore personnel logged the boring in general accordance with the Unified Soil Classification System (USCS) and American Society for Testing and Materials (ASTM) test method D 2488 by observing cuttings and drive samples. Collected ring samples were trimmed in the field, wrapped in plastic bags, and placed in cylindrical plastic containers to retain in-place moisture conditions. Similarly, Standard Penetration Test (SPT) and bulk samples were sealed in plastic bags to retain their approximate in-place moisture. Detailed descriptions of the soils encountered are presented on the boring log in Attachment A.

The soil samples collected from our exploratory activities were transported to the Ninyo & Moore laboratory in Tucson, Arizona for geotechnical laboratory testing. The testing included in-place moisture and dry density, gradation, Atterberg limits, consolidation, and maximum dry density. The results of the in-situ moisture content and dry density testing are presented on the boring log in Attachment A and a description of each laboratory test method and the remainder of the test results is presented in Attachment B.

# **GEOLOGY AND SUBSURFACE CONDITIONS**

The following sections provide a discussion of the general site geology and description of the site subsurface conditions based on the results of our exploratory borings.

## Site Geology

The project site is located in the Sonoran Desert Section of the Basin and Range physiographic province, which is typified by broad alluvial valleys separated by steep, discontinuous, subparallel mountain ranges. The mountain ranges generally trend north-south and northwest-southeast. The basin floors consist of alluvium with thickness extending to several thousands of feet.

The basins and surrounding mountains were formed approximately 18 million years ago during the mid- to late-Tertiary age. Extensional tectonics resulted in the formation of horsts (mountains) and grabens (basins) with vertical displacement along high-angle normal faults. Intermittent volcanic activity also occurred during this time. The surrounding basins were filled with alluvium from the erosion of the surrounding mountains as well as from deposition from rivers. Coarser-grained alluvial material was deposited at the margins of the basins near the mountains.

The surficial geology of the site is described as being Holocene age (10,000 years or less) basin-fill deposits composed of active stream channels, low stream terraces, and relatively un-dissected alluvial fans (Pearthree, 1998). Our review of the United States Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS) online Web Soil Survey, indicates that the soils at this site are described as the Anthony fine sandy loam complex associated with the Big Wash floodplain. This unit consists of fine sandy loam, stratified loamy sand to very fine sandy loam, gravelly loamy sand, and gravelly loamy coarse sand. Loam is an agricultural soil classification that refers to a soil comprised of a mixture of clay, silt, and sand.

#### Subsurface Conditions

The boring logs contain our field and laboratory test results, as well as our interpretation of conditions believed to exist between actual samples retrieved. Therefore, these boring logs contain both factual and interpretive information. Lines delineating subsurface strata on the boring logs are intended to group soils having similar engineering properties and characteristics. They should be considered approximate, as the actual transition between soil types (strata) may be gradual. Detailed stratigraphic information and a key to the soil symbols and terms used on the boring logs are provided in Attachment A.

#### Asphalt Concrete Pavement

Asphalt concrete pavement was encountered at the surface of our borings B-1 and B-2. The AC thickness was evaluated to be 3 to 4 inches and it was underlain by 5 inches of aggregate base (AB) in B-1.

#### Fill

Fill soils were encountered under the pavement in boring B-1 and B-2 and at the surface of boring B-3 and extended to depths varying between 3 and 11 feet bgs. This fill was likely placed as part of the subdivisions site grading operations and/or recent site development including the roadways, sewer and the pump station construction. The fill soils consisted of dense to very dense silty sand with variable percentages of gravel.

#### Alluvium

Native alluvial soil deposits associated with the Big Wash floodplain were encountered below the fill soils and extended to the boring termination depths. The alluvium in our borings consisted of very loose to dense silty and clayey sands with variable percentages of gravel. The soil relative densities measured by the SPT blow counts were generally loose to very loose to depths of 20 to 25 feet and medium dense to dense below.

#### Groundwater

Groundwater was not encountered in our exploratory boring. Based on well data provided by the Arizona Department of Water Resources (ADWR), groundwater has been historically measured at a depth on the order of 100 feet bgs or greater. However, it should be noted that groundwater levels near the site can fluctuate due to seasonal variations, flows in the Big Wash, irrigation, groundwater withdrawal or injection, and other factors.

# **DISCUSSION OF LABORATORY TEST RESULTS**

As mentioned above, both fill and native alluvial soils were encountered in our borings and generally consisted of silty and clayey sands. The in-situ moisture contents estimated for the ring samples for the fill soils varied between 3.7 and 8.5 (with one result being 17.1 percent and close to saturation) and generally increased with depth. The alluvium soils showed moistures varying widely between 1.2 and 14.9 percent. However, in borings B-2 and B-3, the in situ moisture contents and the degrees of saturation were significantly higher than in our boring B-1. The alluvium soils showed significantly lower moisture contents and saturation levels below an approximate depth of 20 to 25 feet bgs. The fill soils relative compaction was estimated to be approximately 96 to 100 percent of the maximum dry density as evaluated in accordance with ASTM D698. The results of our consolidation tests indicate moderate collapse potential upon saturation (approximately 4 to 5 percent) of the fill soils and severe collapse potential (approximately 2 to 12 percent) of the alluvial deposits.

# **FINDINGS**

The findings below are based on the results of our field explorations and laboratory testing:

- The native alluvial soils exhibited SPT blow counts and dry densities that were lower than those for the fill material, especially at depths ranging between 20 and 25 feet bgs.
- The in-situ moisture contents and degrees of saturation were generally higher in the borings located closer to the pump station to approximate depths of 20 to 25 feet bgs.
- The collapse potential and compressibility measured from samples collected within the alluvial deposits were severe and higher than for the fill material.

# CONCLUSIONS

Based on the results of this study, which included the background review, field observations, personnel and resident interviews, field explorations, and laboratory testing we conclude that:

• The surface fill soils were placed in a relatively controlled manner during recent construction of the pump station site improvements.

- The fill and alluvial soils can be re-used as engineered fill and trench backfill. They will generally not be suitable for pipe bedding and haunching/shading.
- The collapse potential and compressibility of the underlying native alluvial deposits are severe and have been a contributing factor affecting the distress observed in the improvements within and in the vicinity of the pump station.
- A leaking utility may have contributed to the observed distress as evidenced by the increased moisture and saturation levels in fill and alluvial soils close to the pump station.
- The various improvements within and around the pump station are anticipated to experience increased risk of additional distress unless remedial measures are introduced as discussed below.

## RECOMMENDATIONS

The remedial work recommended below should be performed in general accordance with respective standards of the Pima County Regional Wastewater Reclamation Department. We recommend that Ninyo & Moore be retained for quality control/assurance of the remedial work.

- Sewer repair:
  - o excavate the affected sewer segments and remove the pipe;
  - o overexcavate the soils to a depth of 6 feet below the pipe invert;
  - re-place the overexcavated soils with moisture-conditioned (or dried out, as appropriate) and compacted lifts of 6-inch thickness after compaction;
  - o replace the pipe and backfill the trench per the original plans and specifications.
  - protect the pipe bedding and haunching/shading from fine particle migration by providing a suitable geotextile wrapping or controlled low strength material (CLSM) encasement around the pipe (if feasible).
- Wet well:
  - o monitor the structure for potential future movements;
  - contact Ninyo & Moore in the event of un-tolerable movements or distress for mitigation measures.
- For other surface improvements (perimeter wall, gates, etc.) evaluate the distress and select structures needing in-place remediation and those that will need to be fully removed and reconstructed.
  - For remediation consider in-situ ground improvement such as grout injections or installation of helical piers specified/designed by a specialty contractor.
  - If certain structures need to be fully removed and reconstructed, the following approach is recommended:

- remove the structure and expose the underlying subgrade soils;
- overexcavate the subgrade soils to 5 feet below the foundation bottom.
- scarify the excavation bottom to a depth of 6 inches, moisture condition and re-compact to 95 percent of maximum dry density as evaluated in accordance with ASTM D698;
- install a layer of triaxial geogrid (Tensar<sup>®</sup> TX7 or equivalent) per manufacturer instructions and place a 12-inch layer of aggregate base compacted to 95 percent of maximum dry density as evaluated in accordance with ASTM D698 on top of the geogrid ;
- replace the remaining zone with overexcavated soils that is moisture-conditioned (or dried out, as appropriate) and placed in 8-inch lifts compacted to 95 percent of maximum dry density as evaluated in accordance with ASTM D698.

# LIMITATIONS

The recommendations presented in this report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the findings and recommendations presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this letter report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

Our results are based on testing performed at the indicated test locations. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this letter may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings, opinions and recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

We appreciate the opportunity to be of service to you on this project.

ZONA

Respectfully submitted, ssiona **NINYO & MOORE** Morch Kant MAREK J. KASZTALSKI 8 Marek J. Kasztalski, PE **Principal Engineer** 

Fred Narcaroti Principal/Tucson Office Manager

MJK/FFN/SDN/jom

Attachments: Figure 1 - Site Location Figure 2 - Boring Locations Attachment A – Boring Logs Attachment B – Laboratory Test Results

# **FIGURES**

Ninyo & Moore Valley Vista Sewer and Pump Station Evaluation, Oro Valley, Arizona | 606630015 | August 22, 2023



VALLEY VISTA SEWER AND PUMP STATION EVALUATION ORO VALLEY, ARIZONA

606630015 | 8/23

**Geotechnical & Environmental Sciences Consultants** 

**Ningo** & **Moore** Geotechnical & Environmental Sciences Consultants

## **BORING LOCATIONS**

VALLEY VISTA SEWER AND PUMP STATION EVALUATION ORO VALLEY, ARIZONA



# **ATTACHMENT A**

Boring Logs

Ninyo & Moore Valley Vista Sewer and Pump Station Evaluation, Oro Valley, Arizona | 606630015 | August 22, 2023

# ATTACHMENT A

#### **BORING LOGS**

#### Field Procedure for the Collection of Disturbed Samples

Disturbed soil samples were obtained in the field using the following methods.

#### **Bulk Samples**

Bulk samples of representative earth materials were obtained from the exploratory borings. The samples were bagged and transported to the laboratory for testing.

#### The Standard Penetration Test (SPT) Sampler

Disturbed drive samples of earth materials were obtained by means of a Standard Penetration Test sampler. The sampler is composed of a split barrel with an external diameter of 2 inches and an unlined internal diameter of 1-3/8 inches. The sampler was driven into the ground 12 to 18 inches with a 140-pound hammer falling freely from a height of 30 inches in general accordance with ASTM D 1586. The blow counts were recorded for every 6 inches of penetration; the blow counts reported on the log are those for the last 12 inches of penetration. Soil samples were observed and removed from the sampler, bagged, sealed and transported to the laboratory for testing.

#### Field Procedure for the Collection of Relatively Undisturbed Samples

Relatively undisturbed soil samples were obtained in the field using the following methods.

#### The Modified Split-Barrel Drive Sampler

The sampler, with an external diameter of 3.0 inches, was lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sample barrel was driven into the ground with the weight of a hammer or the Kelly bar of the drill rig in general accordance with ASTM D 3550. The driving weight was permitted to fall freely. The approximate length of the fall, the weight of the hammer or bar, and the number of blows per foot of driving are presented on the boring log as an index to the relative resistance of the materials sampled. The samples were removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing

|                     | Soil Clas                   | sification Cl                      | hart  | Per AST                         | M D 2488                       |            |               |         | Gra             | in Size          |                              |  |
|---------------------|-----------------------------|------------------------------------|-------|---------------------------------|--------------------------------|------------|---------------|---------|-----------------|------------------|------------------------------|--|
|                     | rimon, Divis                | lana                               |       | Seco                            | ndary Divisions                |            | Dosc          | rintion | Sieve           | Grain Sizo       | Approximate                  |  |
|                     | Tilliary Divis              | 510115                             | Gro   | up Symbol                       | Group Name                     |            | Desci         | πρασπ   | Size            | Grain Size       | Size                         |  |
|                     |                             | CLEAN GRAVEL                       |       | GW                              | well-graded GRAVEL             |            | Bou           | Iders   | > 12"           | > 12"            | Larger than                  |  |
|                     |                             | less than 5% fines                 |       | GP                              | poorly graded GRAVEL           |            |               |         |                 |                  | basketball-sized             |  |
|                     | GRAVEL                      |                                    |       | GW-GM                           | well-graded GRAVEL with silt   |            | Cot           | bles    | 3 - 12"         | 3 - 12"          | Fist-sized to                |  |
|                     | more than                   | GRAVEL with<br>DUAL                |       | GP-GM                           | poorly graded GRAVEL with silt |            |               |         |                 |                  |                              |  |
|                     | coarse                      | CLASSIFICATIONS<br>5% to 12% fines |       | GW-GC                           | well-graded GRAVEL with clay   |            |               | Coarse  | 3/4 - 3"        | 3/4 - 3"         | Thumb-sized to<br>fist-sized |  |
|                     | retained on                 |                                    |       | GP-GC                           | poorly graded GRAVEL with      |            | Gravel        |         |                 |                  | Dog gized to                 |  |
|                     | INO. 4 SIEVE                | GRAVEL with                        |       | GM                              | silty GRAVEL                   |            |               | Fine    | #4 - 3/4"       | 0.19 - 0.75"     | thumb-sized                  |  |
| COARSE-<br>GRAINED  |                             | FINES<br>more than                 |       | GC                              | clayey GRAVEL                  |            |               |         |                 | 0.070 0.40"      | Rock-salt-sized to           |  |
| SOILS               |                             | 12% fines                          |       | GC-GM                           | silty, clayey GRAVEL           |            |               | Coarse  | #10 - #4        | 0.079 - 0.19″    | pea-sized                    |  |
| 50% retained        |                             | CLEAN SAND                         |       | SW                              | well-graded SAND               |            | Sand          | Medium  | #40 - #10       | 0.017 - 0.079"   | Sugar-sized to               |  |
| on No. 200<br>sieve |                             | less than 5% fines                 |       | SP                              | poorly graded SAND             |            |               |         |                 |                  | rock-salt-sized              |  |
|                     |                             |                                    |       | SW-SM                           | well-graded SAND with silt     |            |               | Fine    | #200 - #40      | 0.0029 -         | Flour-sized to               |  |
|                     | SAND<br>50% or more         | SAND with<br>DUAL                  |       | SP-SM                           | poorly graded SAND with silt   |            |               |         |                 | 0.017            | Sugai-Sizeu                  |  |
|                     | of coarse<br>fraction       | CLASSIFICATIONS<br>5% to 12% fines | []]]  | SW-SC                           | well-graded SAND with clay     |            | Fi            | nes     | Passing<br>#200 | < 0.0029"        | Flour-sized and<br>smaller   |  |
|                     | passes<br>No. 4 sieve       |                                    | SP-SC |                                 | poorly graded SAND with clay   | h clay     |               |         |                 |                  |                              |  |
|                     |                             | SAND with FINES                    |       | SM                              | silty SAND                     |            |               |         | Plastic         | Plasticity Chart |                              |  |
|                     |                             | more than                          |       | SC                              | clayey SAND                    |            |               |         |                 |                  |                              |  |
|                     |                             | 12 % IIIIes                        |       | SC-SM                           | silty, clayey SAND             |            | 70            |         |                 |                  |                              |  |
|                     |                             |                                    |       | CL                              | lean CLAY                      |            | <b>%</b> 60   |         |                 |                  |                              |  |
|                     | SILT and                    | INORGANIC                          |       | ML                              | SILT                           |            | (Id) 50       |         |                 |                  |                              |  |
|                     | CLAY<br>liquid limit        |                                    |       | CL-ML                           | silty CLAY                     |            | <b>ü</b> 40   |         |                 | CH or C          | рн                           |  |
| FINE-               | less than 50%               | OPCANIC                            |       | OL (PI > 4)                     | organic CLAY                   |            | <b>∠</b> 30   |         |                 |                  |                              |  |
| SOILS               | GRAINED<br>SOILS            | ONGANIC                            |       | OL (PI < 4)                     | organic SILT                   |            | <b>101</b> 20 |         | CL or           | r OL             | MH or OH                     |  |
| 50% or              |                             |                                    | СН    | fat CLAY                        |                                | . <b>S</b> |               |         |                 |                  |                              |  |
| No. 200 sieve       | SILT and<br>CLAY            |                                    |       | MH                              | elastic SILT                   |            | <b>۹</b>      | CL -    | ML ML o         | r OL             |                              |  |
|                     | liquid limit<br>50% or more | ORGANIC                            |       | OH (plots on or above "A"-line) | organic CLAY                   |            | 0             | 0 10    | 20 30 40        | 0 50 60 7        | 70 80 90 100                 |  |
|                     |                             | UNGANIC                            |       | OH (plots<br>below "A"-line)    | organic SILT                   |            |               |         | LIQUI           | D LIMIT (LL),    | %                            |  |
|                     | Highly (                    | Organic Soils                      |       | PT                              | Peat                           |            |               |         |                 |                  |                              |  |

### Apparent Density - Coarse-Grained Soil

| <b>_</b>            | parent De           | sinsity - Ouar                           | se-Graine           |  |                  | CONSISTER           | icy - Fille-C                            | nameu Su            | 40                                       |
|---------------------|---------------------|--|---------------------|--|------------------|---------------------|--|---------------------|--|
|                     | Spooling C          | able or Cathead                          | Automatic           | Trip Hammer                              |                  | Spooling Ca         | ble or Cathead                           | Automatic           | Trip Hammer                              |
| Apparent<br>Density | SPT<br>(blows/foot) | Modified<br>Split Barrel<br>(blows/foot) | SPT<br>(blows/foot) | Modified<br>Split Barrel<br>(blows/foot) | Consis-<br>tency | SPT<br>(blows/foot) | Modified<br>Split Barrel<br>(blows/foot) | SPT<br>(blows/foot) | Modified<br>Split Barrel<br>(blows/foot) |
| Very Loose          | ≤4                  | ≤ 8                                      | ≤ 3                 | ≤ 5                                      | Very Soft        | < 2                 | < 3                                      | < 1                 | < 2                                      |
| Loose               | 5 - 10              | 9 - 21                                   | 4 - 7               | 6 - 14                                   | Soft             | 2 - 4               | 3 - 5                                    | 1 - 3               | 2 - 3                                    |
| Medium              | 11 - 30             | 22 - 63                                  | 8 - 20              | 15 - 42                                  | Firm             | 5 - 8               | 6 - 10                                   | 4 - 5               | 4 - 6                                    |
| Dense               |                     |  | 0 20                |  | Stiff            | 9 - 15              | 11 - 20                                  | 6 - 10              | 7 - 13                                   |
| Dense               | 31 - 50             | 64 - 105                                 | 21 - 33             | 43 - 70                                  | Very Stiff       | 16 - 30             | 21 - 39                                  | 11 - 20             | 14 - 26                                  |
| Very Dense          | > 50                | > 105                                    | > 33                | > 70                                     | Hard             | > 30                | > 39                                     | > 20                | > 26                                     |
|                     |                     |  |                     |  |                  |                     |  |                     |  |



## USCS METHOD OF SOIL CLASSIFICATION

Consistency Fine Grained Sail

| DEPTH (feet)<br>Bulk SAMPLES<br>Driven BLOWS/FOOT | MOISTURE (%) | DRY DENSITY (PCF) | SYMBOL | CLASSIFICATION<br>U.S.C.S. | BORING LOG EXPLANATION SHEET  |
|---|--------------|-------------------|--------|----------------------------|---|
|   |              |                   |        |                            | Bulk sample.<br>Modified split-barrel drive sampler.<br>No recovery with modified split-barrel drive sampler.<br>Sample retained by others.   |
| 5<br>XX/XX<br>10<br>10                            |              |                   |        |                            | Standard Penetration Test (SPT).<br>No recovery with a SPT.<br>Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.<br>No recovery with Shelby tube sampler.<br>Continuous Push Sample.<br>Seepage.<br>Groundwater encountered during drilling.<br>Groundwater measured after drilling.  |
| 15  |              |                   |        | SM<br>CL                   | MAJOR MATERIAL TYPE (SOIL):         Solid line denotes unit change.         Dashed line denotes material change.         Attitudes: Strike/Dip         b: Bedding         c: Contact         j: Joint         f: Fracture         F: Fault         cs: Clay Seam         s: Shear         bss: Basal Slide Surface         sf: Shear Fracture         sz: Shear Zone         sbs: Shear Bedding Surface         The total depth line is a solid line that is drawn at the bottom of the boring. |
| 20  |              |                   | 1      |                            |   |



**BORING LOG** 

| et)     | SAMPLES       | DT              | (%)           | (PCF)         |       | NOI             | DATE DRILLED         7/14/23         BORING NO.         B-1           GROUND ELEVATION 2.716' + (MSL)         SHEET         1         OF         2 |
|---------|---------------|-----------------|---------------|---------------|-------|-----------------|--|
| ГН (fee |               | /S/FO0          | -URE (        | ISITY         | MBOL  | FICAT<br>S.C.S. | METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)   |
| DEP1    | 3ulk<br>riven | BLOM            | LSIOM         | Y DEN         | SΥ    | LASSI<br>U.S    | DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"   |
|         |               |                 |               | DR            |       | 0               | SAMPLED BY H LOGGED BY MH REVIEWED BY SDN  |
| 0       |               |                 |               |               | t." - |                 | ASPHALT CONCRETE: Approximately 3 inches thick.  |
|         |               |                 |               |               |       | SM              | AGGREGATE BASE: Approximately 5 inches thick.<br>FILL:   |
|         |               | 47              | 11            | 102.0         |       |                 | Brown, dry, dense, silty SAND; few gravel.   |
|         |               | 47              | 4.1           | 123.2         |       |                 |  |
|         |               |                 |               |               |       |                 |  |
|         | L             |                 |               |               |       | SM              | ALLUVIUM:<br>Brown, dry, medium dense, silty SAND; few gravel.   |
|         |               | 18              | 3.7           | 106.7         |       |                 |  |
| 5-      |               |                 |               |               |       |                 |  |
|         |               |                 |               |               |       |                 |  |
|         |               |                 |               |               |       |                 |  |
|         |               | 11              | 4.7           | 109.2         |       |                 | Dark brown; loose.   |
|         |               |                 |               |               |       |                 |  |
|         |               |                 |               |               |       |                 |  |
|         |               |                 |               |               |       |                 |  |
|         |               | 7               | 5.1           | 108.1         |       |                 |  |
| 10 -    |               |                 |               |               |       |                 |  |
|         |               | -               |               |               |       |                 |  |
|         |               |                 |               |               |       |                 |  |
|         |               | -               |               |               |       |                 |  |
|         |               | -               |               |               |       |                 |  |
|         |               |                 |               |               |       |                 |  |
|         |               | 4               |               |               |       |                 |  |
| 15 -    |               |                 |               |               |       |                 |  |
|         |               |                 |               |               |       |                 |  |
|         |               |                 |               |               |       |                 |  |
|         |               | -               |               |               |       |                 |  |
|         |               |                 |               |               |       |                 |  |
|         |               |                 |               |               |       |                 |  |
|         |               | 15              |               |               |       |                 | Medium dense.  |
| 20 -    |               |                 |               |               |       |                 |  |
|         |               |                 |               |               |       |                 | FIGURE A -1  |
|         | Ni            | nyo             |               | ore           |       |                 | VALLEY VISTA SEWER AND PUMP STATION EVALUATION<br>ORO VALLEY, ARIZONA  |
|         | V<br>Geotechn | ical & Environm | ental Science | s Consultants | _     |                 | 606630015   8/23   |

| 000000000000000000000000000000000000   |        | MPLES                           |       |        | CF)           |      | z               | DATE DRILLED 7/14/23 BORING NO. B-1   |
|--|--------|---------------------------------|-------|--------|---------------|------|-----------------|---|
| Image: Since of the second   | (feet) | SAI                             | -00T  | KE (%) | TY (PC        | OL   | S.              | GROUND ELEVATION         2,716' ± (MSL)         SHEET         2         OF         2  |
| 8       9  | PTH    |                                 | I/SMC | ISTUF  | ENSI          | SYMB | SSIFIC<br>U.S.C | METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)  |
| 20       SAMPLED BYMHLOGGED BYMHREVLEWED BYSDN         20       Total Deph = 20 feet.         21       Total Deph = 20 feet.         22       Groundwater not encountered during drilling.         Backfillet and asphall concrete patched on 7/14/23 shortly after completion of drilling.         Notes:       Groundwater not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the require due to seasonal variations in precipitation and several other factors as discussed in the requirements.         25  | DE     | Bulk<br>Drive                   | BL(   | MO     | JRY D         |      | CLAS            | DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"  |
| 20       Fold Depth - 20 fed:         Groundwater not encountered during driling.       Backfilled and asphall concrete patched on 7/14/23 shortly after completion of driling.         Notes:       Groundwater not encountered at the time of driling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.         Notes:       Groundwater, though not encountered at the time of driling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.         25       The ground elevation shown above is an estimation only. It is based on our interpretations of publicled mays and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.         26       Image: the time of the time of time of time of the time of time of time of time of the time of time of time of time of the time of time of time of time of time of the time of time of the time of time of the time of the time of t  |        |                                 |       |        |               |      |                 | SAMPLED BY H LOGGED BY H REVIEWED BY SDN<br>DESCRIPTION/INTERPRETATION  |
| to seasonal variations in precipitation and several other factors as discussed in the report.<br>The ground elevation shown above is an estimation only. It is based on our interpretations<br>of published maximum and the value of the purposed for the purposed for the purposed<br>of the solution. It is not sufficiently accurate for preparing construction bids and design documents.  | 20     |                                 |       |        |               |      |                 | Total Depth = 20 feet.<br>Groundwater not encountered during drilling.<br>Backfilled and asphalt concrete patched on 7/14/23 shortly after completion of drilling.<br>Notes:<br>Groundwater, though not encountered at the time of drilling, may rise to a higher level due |
| The ground elevation shown above is an estimation only. It is based on our interpretations is on published mass and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.  |        |                                 |       |        |               |      |                 | to seasonal variations in precipitation and several other factors as discussed in the report.   |
|  |        |                                 |       |        |               |      |                 | The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.        |
|  | 25 -   | $\left  \right $                |       |        |               |      |                 |   |
| 30<br>30<br>35<br>4<br>4<br>4<br>4<br>4<br>4<br>4<br>4<br>4<br>4<br>4<br>4<br>4  |        |                                 |       |        |               |      |                 |   |
|  |        |                                 |       |        |               |      |                 |   |
|  |        |                                 |       |        |               |      |                 |   |
|  |        |                                 |       |        |               |      |                 |   |
|  |        | $\square$                       |       |        |               |      |                 |   |
| AD FIGURE A-2 FIGURE A   | 30 -   |                                 |       |        |               |      |                 |   |
| 35<br>40<br>FIGURE A-2<br>FIGURE A-2<br>VALLEY VISTA SEWER AND PUMP STATION EVALUATION<br>ORO VALLEY, ARZONA<br>COMPANY<br>FIGURE A-2<br>VALLEY VISTA SEWER AND PUMP STATION EVALUATION<br>ORO VALLEY, ARZONA  |        |                                 |       |        |               |      |                 |   |
|  |        |                                 |       |        |               |      |                 |   |
|  |        |                                 |       |        |               |      |                 |   |
| 40<br>FIGURE A -2<br>VALLEY VISTA SEWER AND PUMP STATION EVALUATION<br>ORO VALLEY, ARIZONA<br>CONCECTOR<br>FIGURE A -2<br>VALLEY VISTA SEWER AND PUMP STATION EVALUATION<br>ORO VALLEY, ARIZONA  |        | $\left  \right $                |       |        |               |      |                 |   |
| 35<br>40<br>FIGURE A-2<br>VALLEY VISTA SEWER AND PUMP STATION EVALUATION<br>ORO VALLEY, ARIZONA<br>COGE20045 1 9/22  |        | $\left  \right $                |       |        |               |      |                 |   |
| 40<br>FIGURE A -2<br>VALLEY VISTA SEWER AND PUMP STATION EVALUATION<br>ORO VALLEY, ARIZONA<br>CORECTORING Sciences Consultation<br>ORO VALLEY, ARIZONA   | 35 -   |                                 |       |        |               |      |                 |   |
| 40         FIGURE A -2         VALLEY VISTA SEWER AND PUMP STATION EVALUATION ORO VALLEY, ARIZONA         September 1 Spingers Consultants   |        |                                 |       |        |               |      |                 |   |
| 40<br>FIGURE A -2<br>VALLEY VISTA SEWER AND PUMP STATION EVALUATION<br>ORO VALLEY, ARIZONA<br>GOEC20015 1 9/22   |        |                                 |       |        |               |      |                 |   |
| 40<br>FIGURE A -2<br>FIGURE A -2<br>VALLEY VISTA SEWER AND PUMP STATION EVALUATION<br>ORO VALLEY, ARIZONA<br>Generatia & Environmental Sciences Consultants<br>Environmental Sciences Cons |        |                                 |       |        |               |      |                 |   |
| 40<br>FIGURE A -2<br>VALLEY VISTA SEWER AND PUMP STATION EVALUATION<br>ORO VALLEY, ARIZONA<br>General & Environmental Sciences Consultants<br>General & Environmental Sciences Consultants   |        | $\left  \left  \right  \right $ |       |        |               |      |                 |   |
| 40<br>FIGURE A -2<br>VALLEY VISTA SEWER AND PUMP STATION EVALUATION<br>ORO VALLEY, ARIZONA<br>Geotechnical & Environmental Sciences Consultants<br>Geotechnical & Environmental Sciences Consultants<br>Geotechnical & Environmental Sciences Consultants<br>Geotechnical & Environmental Sciences Consultants   |        | $\left  \right $                |       |        |               |      |                 |   |
| FIGURE A -2 VALLEY VISTA SEWER AND PUMP STATION EVALUATION ORO VALLEY, ARIZONA Geotechnical & Environmental Sciences Consultants 606620045   | 40 -   |                                 |       |        |               |      |                 |   |
| Geotechnical & Environmental Sciences Consultants  |        |                                 |       |        |               |      |                 | FIGURE A -2   |
|  |        | Geotechnica                     |       |        | s Consultante |      |                 | ORO VALLET VISTA SEVVER AND FUMP STATION EVALUATION<br>ORO VALLEY, ARIZONA  |

|        | PLES     |                  |               | (1            |     |             | DATE DRILLED   |
|--------|----------|------------------|---------------|---------------|-----|-------------|--|
| set)   | SAM      | DOT              | (%)           | (PCF          | _   | NOIL        | GROUND ELEVATION 2,719' ± (MSL) SHEET 1 OF 4                         |
| TH (fe |          | NS/FC            | TURE          | NSITY         | MBO | S.C.S       | METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)       |
| DEP    | Bulk     | BLOV             | MOIS          | KY DE         | S   | CLASS<br>U. | DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"                           |
|        |          |                  |               | ЧО            |     | 0           | SAMPLED BY H LOGGED BY REVIEWED BY SDN<br>DESCRIPTION/INTERPRETATION |
| 0      |          |                  |               |               |     | SM          | ASPHALT CONCRETE: Approximately 4 inches thick.                      |
|        |          |                  |               |               |     |             | Brown, dry, dense, silty SAND; trace gravel.                         |
|        | -        | 71               | 6.3           | 128.4         |     |             |  |
|        |          |                  |               |               |     |             |  |
|        |          |                  |               |               |     |             |  |
|        | _        | 56               | 6.6           | 129.3         |     |             | Moist.   |
| 5 -    |          |                  |               |               |     |             |  |
|        |          |                  |               |               |     |             |  |
|        |          | 66               | 7.5           | 128 1         |     |             | Dark brown   |
|        |          | 00               | 1.0           | 120.1         |     |             | Built Brown.   |
|        |          | _                |               |               |     |             |  |
|        |          |                  |               |               |     |             |  |
|        |          | 50               | 17.1          | 113.0         |     |             | Moist to wet.  |
| 10 -   |          |                  |               |               |     | SM          | ALLUVIUM:<br>Dark brown, moist, dense, silty SAND; trace gravel.     |
|        |          |                  |               |               |     |             |  |
|        |          | -                |               |               |     |             |  |
|        |          | -                |               |               |     |             |  |
|        | L        | /                |               |               |     |             |  |
|        |          | 3                |               |               |     |             | Very loose.  |
| 15 -   |          |                  |               |               |     |             |  |
|        |          |                  |               |               |     |             |  |
|        |          | -                |               |               |     |             |  |
|        |          |                  |               |               |     |             |  |
|        |          |                  |               |               |     |             |  |
|        |          | 9                | 14.9          | 100.5         |     |             | Loose; moist to wet.   |
| 20 -   |          |                  |               |               |     |             |  |
|        |          | nın              |               | nro           |     |             | VALLEY VISTA SEWER AND PUMP STATION EVALUATION                       |
|        | Geotechr | nical & Environm | ental Science | s Consultants |     |             | ORO VALLEY, ARIZONA<br>606630015   8/23                              |

| DEPTH (feet) | Bulk SAMPLES<br>Driven SAMPLES<br>BI OWS/FOOT | MOISTURE (%) | DRY DENSITY (PCF)      | SYMBOL | CLASSIFICATION<br>U.S.C.S. | DATE DRILLED       7/14/23 & 8/9/23       BORING NO.       B-2         GROUND ELEVATION       2,719' ± (MSL)       SHEET       2       OF       4         METHOD OF DRILLING       CME-75, 8" Diameter Hollow-Stem Auger (GSI)       DRIVE WEIGHT       140 lbs. (Automatic)       DROP       30"         SAMPLED BY       MH       LOGGED BY       MH       REVIEWED BY       SDN |
|--------------|---|--------------|------------------------|--------|----------------------------|--|
| 20           |   |              |                        |        | SM                         | ALLUVIUM (Continued):<br>Dark brown, wet, very loose, silty SAND; trace gravel.  |
| -            | 34  | 6.8          | 104.7                  |        | sc –                       | Light brown, dry, medium dense, clayey SAND; with gravel.  |
| -<br>-<br>30 | 32  | 5.5          | 100.9                  |        |                            |  |
| -            | 59  | 4.3          | 108.3                  |        |                            | Dense.   |
| 35 —         | 2   | 4.3          | 94.9                   |        |                            | Medium dense.  |
|              | 33  | 7.7          | 94.3                   |        |                            |  |
| 40           | 46  |              |                        |        |                            | Dense.   |
| Geo          | Viny<br>otechnical & Env                      | D & Mo       | DOLC<br>es Consultants |        |                            | VALLEY VISTA SEWER AND PUMP STATION EVALUATION<br>ORO VALLEY, ARIZONA<br>606630015   8/23  |

| DEPTH (feet) | Bulk SAMPLES<br>Driven | BLOWS/FOOT     | MOISTURE (%) | DRY DENSITY (PCF) | SYMBOL | CLASSIFICATION<br>U.S.C.S. | DATE DRILLED       7/14/23 & 8/9/23       BORING NO.       B-2         GROUND ELEVATION       2,719' ± (MSL)       SHEET       3       OF       4         METHOD OF DRILLING       CME-75, 8" Diameter Hollow-Stem Auger (GSI)       DRIVE WEIGHT       140 lbs. (Automatic)       DROP       30"         SAMPLED BY       MH       LOGGED BY       MH       REVIEWED BY       SDN |
|--------------|------------------------|----------------|--------------|-------------------|--------|----------------------------|--|
| 40           |                        |                |              |                   |        | SC-SM                      | ALLUVIUM (Continued):<br>Light brown, dry, medium dense, silty clayey SAND; trace gravel.  |
| -            |                        | 35             | 8.3          | 101.4             |        |                            | Medium dense.  |
| 45 -         |                        | 53             |              |                   |        |                            | Dense.   |
| -            |                        | 57             | 3.3          | 112.4             |        |                            |  |
| - 50 -       |                        | 52             |              |                   |        | SM                         | Light brown, dry, dense, silty SAND; few gravel.   |
| -            |                        | 55             | 1.4          | 110.7             |        |                            |  |
| 55 -         |                        | 62             |              |                   |        |                            |  |
| -            |                        | 54             | 1.2          | 114.6             |        |                            |  |
| - 60 -       |                        | 58             |              |                   |        |                            |  |
|              |                        |                |              |                   |        |                            | FIGURE A -5  |
| G            |                        | al & Environme |              | s Consultants     |        |                            | VALLEY VISTA SEWER AND PUMP STATION EVALUATION<br>ORO VALLEY, ARIZONA<br>606630015   8/23  |

| DEPTH (feet) | Bulk SAMPLES | BLOWS/FOOT     | MOISTURE (%) | DRY DENSITY (PCF) | SYMBOL | CLASSIFICATION<br>U.S.C.S. | DATE DRILLED       7/14/23 & 8/9/23       BORING NO.       B-2         GROUND ELEVATION       2,719' ± (MSL)       SHEET       4       OF       4         METHOD OF DRILLING       CME-75, 8" Diameter Hollow-Stem Auger (GSI)       DRIVE WEIGHT       140 lbs. (Automatic)       DROP       30"         SAMPLED BY       MH       LOGGED BY       MH       REVIEWED BY       SDN  |
|--------------|--------------|----------------|--------------|-------------------|--------|----------------------------|---|
|              |              | 47<br>35       | 2.5          | 113.6             |        | 514                        | ALLOVIDIM (Continued):<br>Light brown, dry, dense, silty SAND.<br>Medium dense.   |
| 65 -         |              |                |              |                   |        |                            | Total Depth = 65 feet.<br>Groundwater not encountered during drilling.<br>Backfilled and asphalt concrete patched on 8/9/23 shortly after completion of drilling.<br>Notes:<br>Groundwater, though not encountered at the time of drilling, may rise to a higher level due<br>to seasonal variations in precipitation and several other factors as discussed in the report.<br>The ground elevation shown above is an estimation only. It is based on our interpretations<br>of published maps and other documents reviewed for the purposes of this evaluation. It is<br>not sufficiently accurate for preparing construction bids and design documents. |
| 70 -         |              |                |              |                   |        |                            |   |
| 80 -         |              |                |              |                   |        |                            | FIGURE A -6   |
|              | Geotechnica  | al & Environme |              | s Consultants     |        |                            | ORO VALLET VISTA SEVVER AND POWP STATION EVALUATION<br>ORO VALLEY, ARIZONA<br>606630015   8/23  |

| DEPTH (feet)<br>Bulk SAMPLES | BLOWS/FOOT | MOISTURE (%) | DRY DENSITY (PCF) | SYMBOL                                       | CLASSIFICATION<br>U.S.C.S. | DATE DRILLED       7/14/23       BORING NO.       B-3         GROUND ELEVATION       2,718' ± (MSL)       SHEET       1       OF       2         METHOD OF DRILLING       CME-75, 8" Diameter Hollow-Stem Auger (GSI)         DRIVE WEIGHT       140 lbs. (Automatic)       DROP       30"         SAMPLED BY       MH       LOGGED BY       MH       REVIEWED BY       SDN |
|------------------------------|------------|--------------|-------------------|--|----------------------------|---|
| 0                            |            |              |                   |  | SM                         | DESCRIPTION/INTERPRETATION           FILL:           Drawing days years days on the SAND: fairs group line  |
|                              | 71         | 6.2          | 128.0             |  |                            | Brown, dry, very dense, slity SAND; few gravel.   |
| 5 -                          | 76         | 5.9          | 130.3             |  |                            |   |
|                              | 73         | 7.0          | 123.7             |  |                            | Moist.  |
| 10                           | 52         | 8.5          | 125.1             |  |                            | Dark brown, dense.  |
|                              | 3          | 9.6          | 108.2             |  | SM                         | ALLUVIUM:<br>Dark brown, moist, very loose, silty SAND; trace gravel.   |
| 20                           |            |              |                   | <u>,,,,,,,,,,,</u> ,,,,,,,,,,,,,,,,,,,,,,,,, |                            | FIGURE A -5   |
| Geotechnic                   | nyo &      |              | s Consultants     |  |                            | VALLEY VISTA SEWER AND PUMP STATION EVALUATION<br>ORO VALLEY, ARIZONA<br>606630015   8/23   |

| Image: State of the second |                      | APLES          |             |       | CF)           |      | 7               | DATE DRILLED7/14/23BORING NOB-3   |
|--|----------------------|----------------|-------------|-------|---------------|------|-----------------|---|
| Hand   | feet)                | SAN            | 00T         | E (%) | Y (PC         | )L   | ATIONS.         | GROUND ELEVATION         2,718' ± (MSL)         SHEET         2         OF         2  |
| B        | PTH (                |                | WS/F        | STUR  | IISNE         | YMBC | SIFIC<br>J.S.C. | METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (GSI)  |
| 20       SAMPLED BYMHLOGGED BYMHREVIEWED BYSDNDESCRIPTIONINTERPRETATION         20       SM         20       ALLUVIUM (Continued):<br>Dark brown, moist, loose, silty SAND; trace gravel.         25       10         26       Medium dense.         7       Total Depth = 26.5 feet.<br>Groundwater not encountered during drilling.<br>Backfilled on 7/14/23 shortly after completion of drilling.         30       Notes:<br>Groundwater, though not encountered at the time of drilling.<br>Notes:<br>Groundwater in the report         30       The ground elevation shown above is an estimation only. It is based on our interpretation. It is<br>not sufficiently accurate for preparing construction bids and design documents.   | DE                   | Bulk<br>Driver | BLC         | MOI   | RY DI         | S    | CLAS            | DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"  |
| 20       SM       ALLUVIUM (Continued):<br>Dark brown, moist, loose, silty SAND; trace gravel.         25       10       Medium dense.         25       Total Depth = 26.5 feet.<br>Groundwater not encountered during drilling.<br>Backfilled on 7/14/23 shortly after completion of drilling.<br>Notes:<br>Groundwater, though not encountered at the time of drilling, may rise to a higher level dur<br>to seasonal variations in precipitation and several other factors as discussed in the report<br>The ground elevation shown above is an estimation only. It is based on our interpretation:<br>of published maps and other documents reviewed for the purposes of this evaluation. It is<br>not sufficiently accurate for preparing construction bids and design documents.   |                      |                |             |       |               |      |                 | SAMPLED BY MH LOGGED BY MH REVIEWED BY SDN<br>DESCRIPTION/INTERPRETATION  |
|  | 20<br>25<br>30<br>35 |                | 10          |       |               |      | SM              | ALLUVIUM (Continued):         Dark brown, moist, loose, silty SAND; trace gravel.         Medium dense.         Total Depth = 26.5 feet.         Groundwater not encountered during drilling.         Backfilled on 7/14/23 shortly after completion of drilling.         Notes:         Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.         The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents. |
| FIGURE A -   |                      |                |             |       |               |      |                 | FIGURE A -6   |
| VALLEY VISTA SEWER AND PUMP STATION EVALUATIO<br>ORO VALLEY, ARIZON<br>Geotechnical & Environmental Sciences Consultants   |                      | Geotechnica    | <b>YO</b> & |       | s Consultants |      |                 | VALLEY VISTA SEWER AND PUMP STATION EVALUATION<br>ORO VALLEY, ARIZONA<br>606630015 4 8/23   |

# ATTACHMENT B

Laboratory Test Results

# ATTACHMENT B

#### LABORATORY TEST RESULTS

#### **Classification**

Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with ASTM D 2488-00.

#### **In-Place Moisture and Density Tests**

The moisture content and dry density of relatively undisturbed samples obtained from the exploratory borings were evaluated in general accordance with AASHTO T265. These test results are presented on the logs of the exploratory borings in Attachment A

#### **Gradation Analysis**

Gradation analysis test was performed on selected representative soil samples in general accordance with ASTM D 422. The grain size distribution curves are shown on Figures B-1 through B-7. These test results were utilized in evaluating the soil classification in accordance with the USCS.

#### **Atterberg Limits**

Tests were performed on a selected representative soil samples to evaluate the liquid limit, plastic limit, and plasticity index in general accordance with ASTM D 4318. These test results were utilized to evaluate the soil classification in accordance with the USCS. The test results and classification are shown on Figure B-8.

#### **Consolidation Tests (Collapse Potential)**

Consolidation (collapse potential) tests were performed on selected relatively undisturbed soil sample in general accordance with ASTM D 2435. The samples were inundated during testing to represent adverse field conditions. The percent of consolidation for each load cycle was recorded as a ratio of the amount of vertical compression to the original height of the samples. The results of the tests are summarized on Figures B-9 through B-14.

#### Maximum Dry Density and Optimum Moisture Content Test

The maximum dry density and optimum moisture content of a selected representative soil sample was evaluated in general accordance with ASTM D 698. The results of these test are summarized on Figure B-15.









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| SYMBOL | LOCATION | DEPTH (ft) | liquid<br>Limit | PLASTIC<br>LIMIT | PLASTICITY<br>INDEX | USCS<br>CLASSIFICATION<br>(Fraction Finer Than<br>No. 40 Sieve) | USCS  |
|--------|----------|------------|-----------------|------------------|---------------------|---|-------|
| •      | B-1      | 0.7-5.0    |                 |                  | NP                  | ML  | SM    |
| -      | B-2      | 0.3-5.0    |                 | -                | NP                  | ML  | SM    |
| •      | B-2      | 31.0-32.5  | 22              | 14               | 8                   | CL  | SC    |
| 0      | B-2      | 46.0-47.5  | 20              | 16               | 4                   | CL-ML   | SC-SM |
|        | B-2      | 61.0-62.5  |                 |                  | NP                  | ML  | SM    |
| Δ      | B-3      | 0.0-5.0    |                 |                  | NP                  | ML  | SM    |
| x      | B-3      | 13.0-18.0  |                 |                  | NP                  | ML  | SM    |

NP - INDICATES NON-PLASTIC



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4318

#### FIGURE B-8

ATTERBERG LIMITS TEST RESULTS VALLEY VISTA SEWER AND PUMP STATION EVALUATION



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